Ytturralde: Impossible Figure Generator

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ABSTRACT

This research highlights José María Yturralde's most significant involvement and contributions to early computer art from 1968 to 1973. Yturralde collaborated with artists and scientists to expand and redefine his understanding of shapes, and explored ways that the mainframe computer could be used as a tool for complementing his art practices. He is known for developing a mathematical model with which he was able to create a highly sophisticated program where Penrose geometries could be recombined algorithmically. However, there is limited evidence and access to the code of the actual software. The authors' goal is to further understand Yturralde's contribution by developing a re-significance of his model, which they have accomplished through a modern interpretation of manuscripts.

Introduction

This paper revisits the art of José María Yturralde, an artist who was an early adopter of computational methods used to produce aesthetic forms. Yturralde's departure from constructivist and optical tendencies as a painter led him to explore the use of mathematical models to visualize multi-dimensional figures.

Yturralde's experience in painting, developed through a life-long career, is largely recognized internationally for its characteristic representations of enigmatic visual designs enhanced with color (Figure 1). Perhaps one of his most significant contributions was made during his participation in a seminal moment of computer art. In 1968, following the computer's arrival in Spain, a series of academic seminars began at the Centro de Cálculo de la Universidad de Madrid (CCUM) [1]. From 1968 to 1973, Yturralde and other key artists explored the use of mainframe computers as tools for creating art at CCUM. This interdisciplinary effort was accomplished through an academic seminar experience called *Generación Automática de Formas Plásticas* (GAFP): Automatic Generation of Plastic Forms.

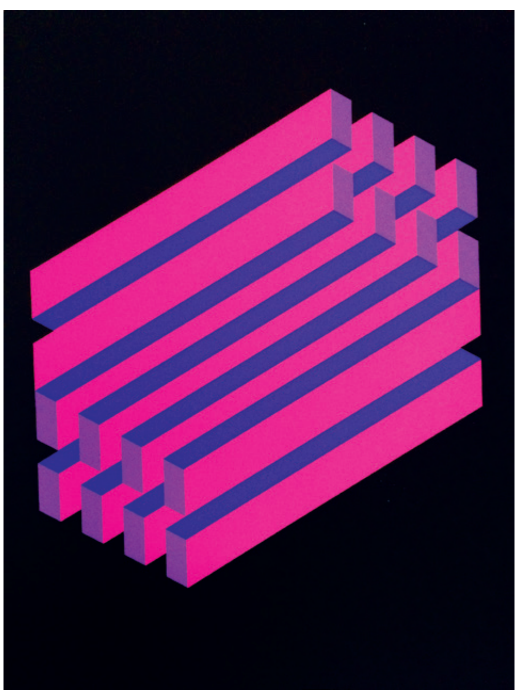

Figure 1. Figura Imposible, 25" x 33", 1972. Screenprint on cardboard. © 1972 José María Yturralde.

Our motivation for this study was to understand Yturralde's desire to incorporate computers and work with scientists to complement his artistic intent. We were particularly interested in a project developed through the GAFP seminar that Yturralde completed in collaboration with computer scientist Isidro Ramos Salavert and architect

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Guillermo Searle. The result of this collaboration was a computer program that recombined Penrose geometries algorithmically. While the software description is documented in a series of manuscripts and artifacts from various authors, there are few remains of the actual program (Figure 2). There is also no way in which to access the full code through modern computers and programming languages, leaving limited proof of its existence and little room for further investigation.

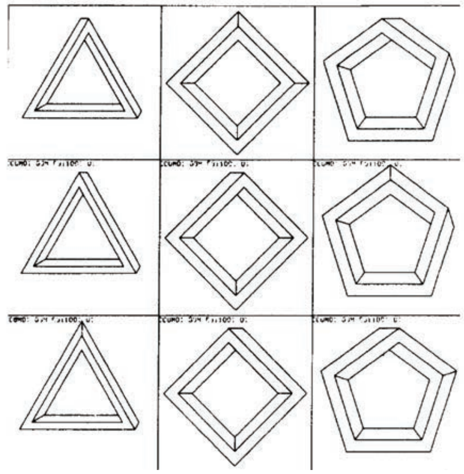

Figure 2. A possible output of the impossible figure generator found in Castaños Alés' dissertation [2]. © 1971 José María Yturralde.

Methodology

For this paper, we interviewed Yturralde about his arrival in the field of computer art as well as the process involved in the creation of the impossible figure generator. Additionally, we gathered a sample of secondary sources including dissertations, articles, newsletters, news-clippings and screen prints in which the project is directly referenced. The majority of these documents were translated from Spanish for this investigation. Our goal is to share our mutual inspiration from Yturralde's art with a larger community of scholars, media archaeologists, artists, designers, scientists and mathematicians.

Media Archaeology and the Re-Significance of Media Art

A possible starting point for the study of early computer-mediated works could be Erkki Huhtamo and Jussi Parikka's concept of "Media Archaeology." Media archaeology is a branch of "historically oriented media studies" [3] that "rummages textual, visual, and auditory archives as well as collections of artifacts, emphasizing both the discursive and the material manifestations of culture" [4]. Andres Burbano has furthered the study of media archaeology through his work "Re-significance of Media Technology." According to Burbano, the re-signification of media technology encompasses studying the media artifacts as well as inspecting the researcher's own attempt to recreate and update technologies of the past [5]. We explore Burbano's model as a methodology to gain a deeper understanding of Yturralde's contribution.

Through this research we aim to reconstruct an algorithm devised by the team Yturralde-Ramos-Searle at the GAFP. Additionally, this paper illustrates the historical context from which the algorithm emerged. In an interdisciplinary manner similar to the one at CCUM, the authors of this paper collaborated, bridging art and mathematics. We have created a modern-day impossible figure generator that will allow new generations to access and understand the computational methods used for the development of this early framework. With a historical mindset, we documented and preserved Yturralde's original materials through a contemporary interpretation of this model. A similar attempt at reinterpreting art through modern code is the Software Structures project by Casey Reas, in which the wall drawings by Sol LeWitt were visualized using the Processing language [6]. In contrast, we are reconstructing the algorithm that was used in the process, rather than recreating images that resemble the finished artworks.

Before Computer Art

José María Yturralde was an emerging artist in Valencia, Spain, around 1964. In the late 1950s, that area fostered an active interest in geometric abstraction. Many avant-gardes explored a constructivist aesthetic, one of them being the Arte Normativo movement from Valencia. The approach of the Arte Normativo artists was comparable to the concurrent Minimalist (or early conceptualist) tendencies that occurred in the United States, where paintings and sculptures were created based on strict sets of rules. The intention was to reduce the expressionist values in favor of a more rationalized composition [7]. Vicente Aguilera Cerni, who was a key member of the Arte Normativo group, later collaborated with Yturralde and others to found the new Antes del Arte group in 1967.

In addition to normative characteristics, Antes del Arte (Before the Art) embraced perceptualism in order to democratize the artistic experience. Antes de Arte believed also in the fusion of science and the arts [8]. In a recent interview, Yturralde recalled his participation in this group: "We wanted to find the geometrical, the mathematical and the intellectual basis of our work and we wanted to do it in a systematic way" [9]. Both Valencian avant-gardes were very influential for Yturralde, who started to use computers as part of a process to rationalize form.

CCUM

In 1966, IBM donated a 7090 computer to the Universidad de Madrid. This was Spain's first-ever mainframe computer. The 7090 had been recently decommissioned by CERN, a center for the study of elemental particles in Switzerland. Although this computer was donated, it was not significantly older or less powerful than those that were at MIT and other research institutions around the world at that time [10]. The university had to build a new building in which to host this computer and founded the Centro de Cálculo de la Universidad de Madrid (CCUM), a center for research in computing. To accelerate research, the director Florentino Briones and sub-director Ernesto García Camarero formed interdisciplinary groups through an initiative of public meetings called seminars [11]. Yturralde recalls:

> In respect to the computer, nobody knew what to do with it. I had an acquaintance with one of the scientists [at CCUM] who was also related to the world of art. We decided to create a group called Automatic Generation of Plastic Forms, and we initiated that seminar. We started to embrace musicians, architects, a painter, and, of course, scientists. [12]

The seminars took the form of regular meetings. The first Automatic Generation of Plastic Forms (GAFP) meeting occurred in December 1968 [13]. Yturralde and Vicente Aguilera Cerni came from Valencia to Madrid to participate and meet with the interdisciplinary group. In an interview, Yturralde states, "We talked about the importance that working with computers could have. We also talked about how artists and scientists should work closely together. This is an idea that has never left me" [14].

At the meetings, open discussions led to different types of efforts and collaborations. Some sessions included planning activities for events and writing articles for the Boletín CCUM, a newsletter-type publication with reflections and even computer code prototypes for artists. From 1969 to 1973 there were constant exhibitions organized by the CCUM, which grew exponentially greater in size and reach. The outreach plan was very successful in raising the awareness of computer art to the general public, making it also visible to an international community of computer artists. In 1972, the CCUM organized the largest exhibit of computer art ever done in Spain, which included some of the most important computer artists from Europe, America and Japan, in addition to the GAFP participants. The exhibit, entitled "Impulsos: arte y ordenador," brought together about 90 artworks by diverse pioneers of the field, such as Kenneth Knowlton, Charles Csuri, Frieder Nake, Michael Noll, and Manfred Mohr, to name a few. During the month-long exhibit, there was a conference cycle that invited keynote speakers to discuss the role of computers in art. One of the fathers of computing, Konrad Zuse, gave a lecture on 28 February 1972 [15].

This experience led to a crossover of Spanish artists in subsequent installments of international exhibits of computer art such as Tendencije 5 in Zagreb, Croatia [16]. After the 1972 exhibit, the GAFP group began a slow process of dissolution, with various generations of members and rotating participants. By the time Tendencije 5 opened in 1973, the GAFP seminar had dissipated.

According to some, the GAFP seminar experience was overwhelming and there was a gradual loss of interest amongst the participants. In the early days of mainframe computers, display terminals were uncommon and, therefore, the programmatic visualizations could only be seen when they were plotted. This was frustrating for many artists because they could not get immediate visual results (if any), while other times having extenuating deliberations about computers. Creating programs was a painstaking process that included many steps, from the formulation of a problem, to its translation into computer code, to the perforation of cards to finally be able to run the program. Manuel Barbadillo recalled that the whole process could take about three months [17]. Barbadillo left the group around 1971 because he felt that he could make greater progress in his art by working without computers [18]. In contrast, Yturralde's memory of this time was very positive and exciting. He remembers getting a lot of support from the CCUM and IBM [19]. He also participated continuously throughout the duration of the seminars, from 1968 to 1973.

Resistance to Computers in Art

The exhibitions received a lot of publicity, however not all the responses were positive. The art critics of the time did not embrace the practice of computer-aided art. According to Yturralde: "The art press messed around with us, they wrote very negative reviews," and critics "were sublevated against the idea of any attempt at rationalizing art" [20]. In the early stages of computer art, artists felt alienated by the idea of using computers.

Yturralde points out that this period was a time of social and cultural transformations [21]. He recalled the student and worker movements of Paris in May 1968, the hippie movement, and the final years of General Francisco Franco Bahamonde's dictatorship. It was a polarizing moment for a new generation that was fed up with Franco's more than repressive regime. For some reason, computers were in Spain a symbol of this brutal regime, and comparisons were drawn between machine and state. Early computer artists received harsh criticism for using computers as a tool for their creative practice and were called "Cyber-Fascists" during the 1972 conference [22]. The role of computers in art was often criticized in the arts scene as a form of escapism for not being engaged directly with the immediate social and political problems [23]. For those who opted to work with computers, these unfair claims had little to do with the reality of working with a computer. There was an intricate creative process needed to decompose the artistic process in a number of steps and constraints.

Impossible Figure Generator

Yturralde's interest in understanding the underlying structure of impossible figures led him to join efforts with Isidro Ramos Salavert and Guillermo Searle. Impossible figures have been a long-standing theme of research, dating back to the golden age of Islamic mathematics around the ninth century. These traditional patterns continue to inspire artists, designers and mathematicians.

In the West, the design of an "impossible triangle" became popularly known as the Penrose triangle after its publication in a scholarly journal in 1958 [24]. Although the original design of the impossible triangle, by Oscar Reutersvärd, dates back to 1934, Penrose and Penrose's article references M.C. Escher's steps series from the 1950s instead of Reutersvärd's as a point of departure for their study. José María Yturralde takes a similar starting point, inspired by Escher [25]. He collaborated with a team to produce a program that was designed to compute all the possible combinations of Penrose shapes of three, four and five sides. Yturralde recalls that the plotting process was slow, and that they spent full nights looking at how those "strange-type" [26] pens plotted the images. Hundreds of designs were generated algorithmically.

Yturralde studied the plotted shapes and chose the ones that seemed more appealing to him. After the computer designs were on paper, he was able to reproduce them at his studio in the form of paintings on wood, screen prints and lithographs [27]. There was also an additional system that determined the color mixtures of each plane, which he later made manually, as there were no color printers at the time.

Re-Significance of the Model

Yturralde's manuscripts about this project [28] serve as the foundation for the re-significance of the Impossible Figure Generator. However, our approach to Yturralde's figures uses ideas from analytic geometry and graph theory. A *graph* is a sketch where we represent the elements of some set V (known as the vertex) as circles, and represent a binary relationship by arrows between those circles [29].

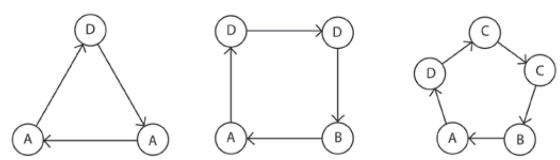

Figure 3. Labeled cycles of regular figures. © 2015 Esteban García Bravo and Jorge Garcia.

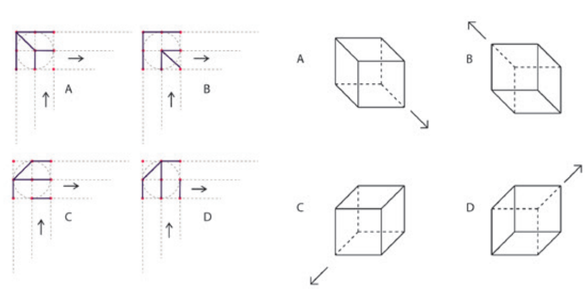

Figure 4. Example of the 4 variable vertices and the 4 types of shearing. © 2015 Esteban García Bravo and Jorge Garcia.

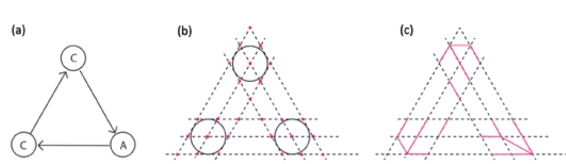

Figure 5. Example of the geometric process in 3 steps. © 2015 Esteban García Bravo and Jorge Garcia.

One particular kind of graph is called the *cycle*. A cycle follows the principle that if the arrows of the graph are followed beginning at one vertex, eventually the end vertex will be the same as the beginning vertex: all arrows will have been used, and all vertices will have been visited exactly once. In Figure 3, we see an example of cycles with three, four and five vertices. We can generate Yturralde's impossible figures if we start with cycles and at each vertex of the cycle we assign a label of one of four letters (A, B, C, D). Indeed, this labeled cycle has all of the information needed in order to generate an impossible figure, so we can think of this cycle as another representation of the same object. This representation is particularly useful for working with a computer. Figures 3 and 5 illustrate examples of the labeled cycles.

Implementation

Given a labeled cycle, we can assign coordinates in a plane to each of its points. For convenience we will adhere to the terminology used in Yturralde's manuscripts published by CCUM [30]. So, for a reason that will become apparent, we shall call the vertices *variables* and we shall call the edges *invariables*. Every variable in a cycle will always have two distinct neighbors [31]. For simplicity, we will add the restriction that the variable and its two neighbors cannot lie along the same line [32]. If we think of the variables as circles of radius *r*, then for every line we can create another two parallel lines at distance *r* from the given line—one above it and one below it. These three lines are the invariables. Now, at every variable we have two invariables converging. Because these two sets of intersecting lines are not parallel, the invariables have 3 x 3 = 9 intersection points, shown in red in Figures 4 and 5b. That is, every variable defines nine points due to its two invariables. We define a way to connect the points on the variables, depending on their labels, as the four cases shown in Figure 4. These cases are not arbitrary; they arise as the four possible ways to shear a cube to its four corners [33].

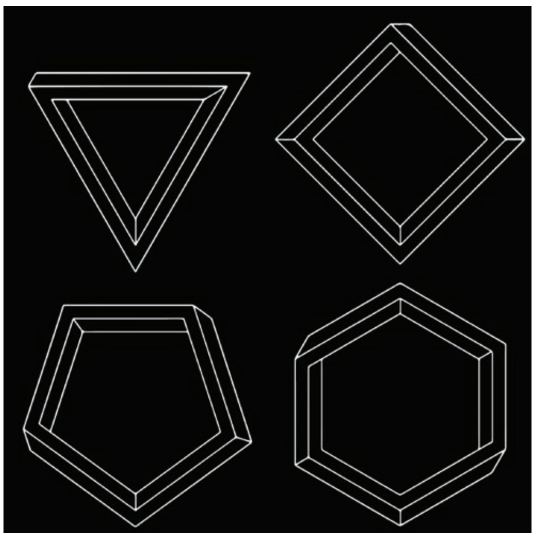

Figure 6. An iteration of our software implementation displaying 4 impossible shapes—available at <www.snebtor.org/yturralde>. © 2015 Esteban García Bravo and Jorge Garcia.

Finally, in order to generate the impossible figure we connect the variables and the invariables as we see in the complete process illustrated in Figure 5. Now that we have a procedure to go from the labeled cycle to the impossible figure, in order to reproduce the results of the program made by Yturralde, Ramos and Searle, we must generate all possible labeled cycles of size three, four and five. This enumeration generates not only the impossible figures but also the possible figures with the given size. As explained in Yturralde's manuscripts, with this model, there can be 4^V figure combinations, where V is the number of vertices of each shape. Yturralde observed that the algorithm could generate repeated, or even "possible," geometries, which he discarded by only focusing on the new and impossible designs [34].

Our implementation was made in Processing 2.0. Using this language makes the model more easily available to a wider audience of programmers with diverse levels of expertise. Processing's philosophy of bridging the gap between artists and programmers aligns with the original mission of the GAFP seminar. Additionally, we implemented a Processing code through a JavaScript interface to make it readily available for interaction and download at www.snebtor.org/yturralde (Figure 6).

In the future, we plan to be able to change the positions and the radii of the invariables to be able to generate forms beyond the ones generated by Yturralde. Additionally, a deeper analysis of the braids generated by the figures can lead to the automatic shading of those figures. The value of this is not only aesthetic, but can also lead us to further insight about the connection between the figures and their underlying labeled cycles. With these additions, we could allow users to experience Yturralde's studio practice, which included the fragmentation and coloring of the impossible shapes originally rendered by the software (Figure 7). However, the focus of this paper is to document the original software developed in the GAFP seminar.

Figure 7. Figura Imposible, 25” x 33”, 1972. Screenprint on cardboard. © 1972 José María Yturralde.

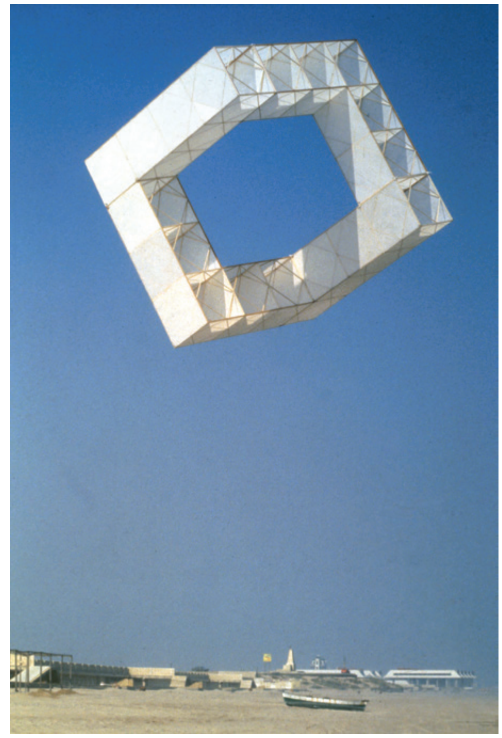

Figure 8. Estructura Volante, 80” x 80” x 80”. Balsa wood, nylon and Japanese paper. A flying structure from the cube series flying over the Saler beach in Valencia. © 1977 José María Yturralde.

After the Impossible

The impossible figures and Yturralde’s relationship with mathematicians opened ground for new ideas. Subsequent to his participation in the GAFP seminar, Yturralde took a deeper interest in n-dimensional figures and not just impossible figures. In a 2014 interview, Yturralde recalled his transition after the seminar experience:

> I was, and still am, very interested in the idea of multidimensionality. The fact that, for example, there could be a 12th dimension. I am fascinated to be able to advance within the world of art supported by science. The recognition and knowledge of other dimensions interested me. That was the reason why I went to MIT, to establish contact with geometers who helped me understand a little better those geometries that had more dimensions [35].

In 1975, Yturralde was a visiting scholar at the Center for Advanced Visual Studies (CAVS) at MIT. This experience allowed him to collaborate with scientists as well as with other artists such as György Képes and Otto Piene. During this time, he became familiar with hyper-polyhedra, lasers and natural power sources. The hyper-polyhedra research evolved in a series of flying structures (Figure 8) called Estructuras Volantes, featured in the 1978 Venice Biennale, the Sky Art exhibit of 1982, and Ars Electronica in 1983. Yturralde has been an emeritus professor of painting at the Universitat Politecnica de Valencia at the Facultad de Bellas Artes since 1979. His contributions have transcended both fine art and new media circles, and are illustrated in an outstanding exhibit record [36]. Yturralde’s relevance in Spain has led to comprehensive exhibits, such as his first retrospective at the Instituto Valenciano de Arte Moderno (IVAM) in 1999 [37].

Summary

Yturralde was able to utilize the computer as an opportunity to visualize impossible figures through the design of his Impossible Figure Generator. It was in this way that he joined a wave of artists who began to understand the potential of the computer as a tool to join art and science. Through his work, he demonstrates his inspiration in mathematics, but also represents the subtle language of art through a concrete aesthetic. This study is a comprehensive glimpse into a pivotal point in Yturralde's career. Through the re-creation and implementation of Yturralde's lost program, we have sought to not only enable an outlet for modern experimentation of impossible figures, but also to provide a historical analysis of Yturralde's time period to re-signify the original methods that allowed him to expand his visual knowledge of enigmatic shapes.

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28. Ibid.

29. This is not a complete description and we are actually using directed graphs. For the interested reader a formal description of graphs as mathematical entities can be seen in any book about graph theory. A good example is: *Introductory Graph Theory* by Gary Chartrand. Dover Publications, 1984.
30. Yturralde [27]. We reproduced the same geometric process described on Yturralde's texts and sketches.
31. One neighbor points to the Variable and the neighbor that the Variable points to.
32. This is a very common restriction in Computational Geometry, where they like to say that the variables are in "general position."
33. The cases C and D look suspiciously symmetric. However, they are not the same case, since we are dealing with *directed* graphs.
34. Yturralde [27].
35. Yturralde [9].
36. A chronology is posted on Yturralde's website: <www.yturralde.org/n-cronologia-es.html>. This website served as point of contact to access documentation originally published in the CCUM newsletters. The space in this article is too short to document Yturralde's accomplishments.
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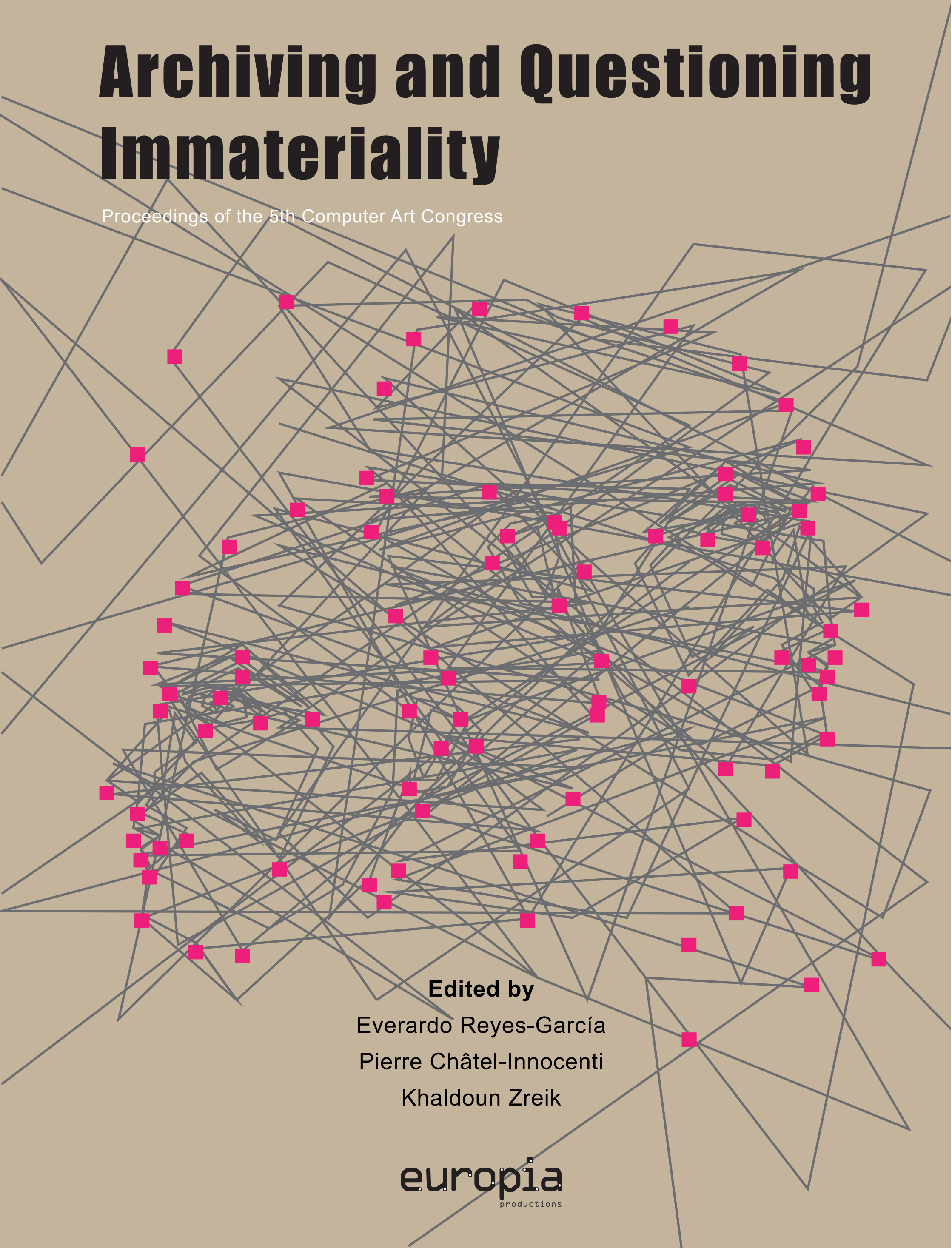
Archiving and Questioning Immateriality

Proceedings of the 5th Computer Art Congress



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Konrad Zuse: enabler of computational arts?

Andrés Burbano & Esteban García Bravo

Abstract

Konrad Zuse is known for building a programmable binary computer as early as 1941 and for designing and implementing the first high-level programming language called Plankalkül. However, his ideas and advanced projections about the potential of computer-aided art are still unknown among many new media researchers and media archaeologists. In this paper, we argue that the artistic use of Zuse's Graphomat Z64, one of the first flatbed drawing machines available, was not a coincidence, but rather a part of Zuse's original intent when he designed them. This study unveils rare manuscripts found at the Konrad Zuse Internet Archive, revealing the scientist's insightful thought about the future of computers in the arts. In writing, Zuse asked himself: Will technology spawn a new art movement?

Incidentally, around this time, pioneering artists such as Georg Nees, Frieder Nake and Jens Harke started to experiment with the Graphomat Z64. The fact that these artists and Zuse both saw the artistic potential of the machine independently of one another leads to an important question: Do notable developments in art occur because artists see opportunities within existing technologies? Or because creative scientists such as Zuse enable art through their machine designs? Zuse's participation in "Impulsos: arte y ordenador," a 1972 symposium and exhibit on computer art, at the Instituto Alemán in Madrid, also gives an account of Zuse's long-standing interest in the intersection of art and technology.

In this paper, we raise questions about innovation through technology and art and discuss how both are articulated in the origins of computer graphics. We trace the work of engineers, artists, technologists and mathematicians that converge at the dawn of computational arts.

Keywords

Graphomat Z64, Konrad Zuse, Georg Nees, Frieder Nake, Computer Graphics, Computer Art

1. Zuse's computers

Konrad Zuse's work, while well documented, had always played somewhat of a secondary role in the predominant narratives in the history of computing. However, in the last few decades, Zuse has received a renewed attention for the revolutionary contributions that he made to the development of informatics and computer culture in the 20th century (Rojas, 2002). Revealing documents have revitalized interest in Zuse's computer designs, thanks to the digitization of primary source materials at the Konrad Zuse Internet Archive. According to the Archive, his impact might have been downplayed "due to WWII, for a long time only few people knew about Zuse's work" (Konrad Zuse Internet Archive, Accessed August 31, 2016). For this paper, we used rare manuscripts and images from the Konrad Zuse Internet Archive collection and complemented them with secondary sources to aid in the understanding of these materials.

Most are not aware of Zuse's pioneering role in computing, or that he built the first functional, programmable computer. Zuse's Z1, created at the end of the 1930s, was fully mechanical, demonstrating that Charles Babbage's idea of a mechanical computer was in fact possible. Later on, based on the use of telephone relays, Zuse built an electromechanical working computer called the Z3. This machine utilized a punched film stock system, a system developed by Zuse to enable the user to to store information and input code. The Z3 also shared aspects of what later became known as Von Neumann computer architecture -for instance the separation between processor and memory (Burbano, 2014). As his work progressed designing computers after WWII, Zuse focused on ways to be more efficient in controlling the machines he created. He thus implemented what is recognized as the first programming language: the Plan Calculus or Plankalkül (Bauer, 2002). In 1949, Zuse founded the ZUSE KG in Berlin, a company that would develop new computers for industry applications (Zuse, 1993, p 119).

2. Graphomat Z64 impact in the early computer art in Europe

In his autobiography Zuse describes his teenage years as being undecided between studying engineering or fine arts. During this period he made several sketches on paper and attended painting classes and art openings. Also during this time period, after seeing the film "Metropolis" in 1927, Zuse was inspired to design his own city for a school project. In Figure 1, we see Zuse's almost premonitory design, bridging engineering with aesthetics through what could arguably be a prototype for an algorithmic visualization. Zuse ultimately chose a career in engineering - he explains, "In the end, the engineer in me won out" (Zuse, 1993, p. 10). Still, in spite of his ultimately decided career path, we are able to see his general tendencies toward artistic visualization.

Many years later, Zuse would intently design a machine for systematic drawing. In 1961, the ZUSE KG released the new Graphomat Z64 at the Hannover Fair (Horst 2016) & CompArt). This machine embodies Zuse's creativity applied in computer graphics specifically. At the beginning of the 1960s, the field was incipient, and the applications for industry were yet to be envisioned. Still, Zuse was particularly interested in the relationship between machines and the visual arts: "What we today call computer graphics would not be popular for a long time and was discussed and practiced only by an interested few." (Zuse, 1993, p 130).

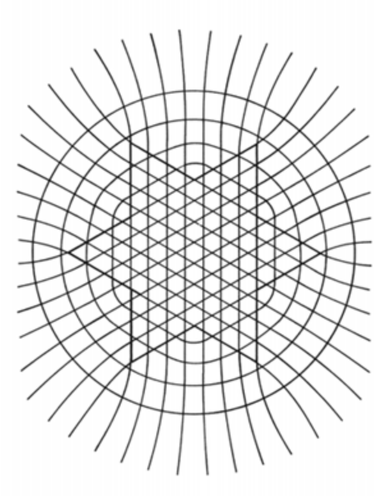

Figure 1. Zuse's City design. © Konrad Zuse

The Graphomat Z64 introduced Computer Aided Design (CAD) in Europe for diverse fields such as geodesy, meteorology, and road construction. Later on, it was used in the textile industry (according to Horst Zuse's site accessed in 2016). Mittelsten-Scheid, a carpet manufacturer, approached Zuse in 1961 to automate the control of carpet looms. In his own words, Zuse explains his philosophy towards computer tools for artists:

"He (Mittelsten-Scheid) wasn't particularly excited when I suggested including the artistic design of the pattern in the automation process. This was the only way I thought I could do the work. It never would have occurred to me to want to make the artist superfluous. On the contrary, I just wanted to place a new tool in his hand" (Zuse, 1993, p 130).

Although Zuse himself explains the machines were originally "developed primarily for technical ends," he explained that "the method can also be applied to artistic objects" (Zuse, 1969). For the sake of context, it is important to highlight that in 1961, graphic and text output was "literally peripheral" to computers as they did not necessarily provide the user with a screen or a printer (Patterson, 2015). Concurrently, in the United States, CalComp was manufacturing some of the first computer pen plotters. CalComp rendered graphics through a process that involved calculations within a mainframe computer. In contrast, the Graphomat Z64 constituted an ingenious apparatus that was able to both process and draw within the same machine. The

Graphomat Z64 was an "automatic drawing board" that was controlled by punched cards. Although the machine was extremely heavy (1,400 Kg), it was a stand-alone machine that materialized Zuse's intent to enable industry through computer graphics techniques. Graphomat Z64 had two stepper motors that moved along the X and Y axes with the option of 4 interchangeable pens. The Graphomat Z64 software allowed the plotting of dots, curves, and symbols (Zuse, 2016). Figure 2 shows one Zuse's diagrams to design the Graphomat Z64. One can see the plotter bed on the lower left and how it was connected to the X and Y stepper motors and relays.

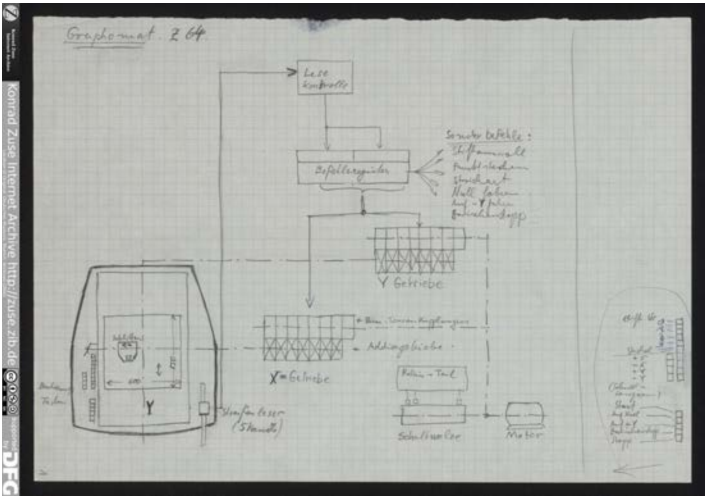

Figure 2. Zuse's graphomat Z64 design

The Graphomat Z64 was **implemented** by artists who wanted to explore programmatic thought and algorithmic visual compositions. At the University of Stuttgart, Georg Nees and Frieder Nake were inspired by Max Bense's informational aesthetics classes (Castaños Alés, 2001, p.34). By 1965, Nees and Nake were exhibiting some of the first computer-assisted drawings and paintings in the world. Nake recalls his first computer graphic in 1963 at Technische Hochschule of the Stuttgart Polytechnic (Castaños Alés, 2001, p.36) (Nake, 2012)(Kane 2014). He used an artistic process that included intuition and chance in programming and execution (Nake, 1968). This involved creating computer plots on paper that were later modified by painting. Other times, he also used the multi-color pen option provided by the Graphomat Z64. Figure 3 Shows "Hommage à Paul Klee", a plot from Frieder Nake from 1966 (Nake, 2009).

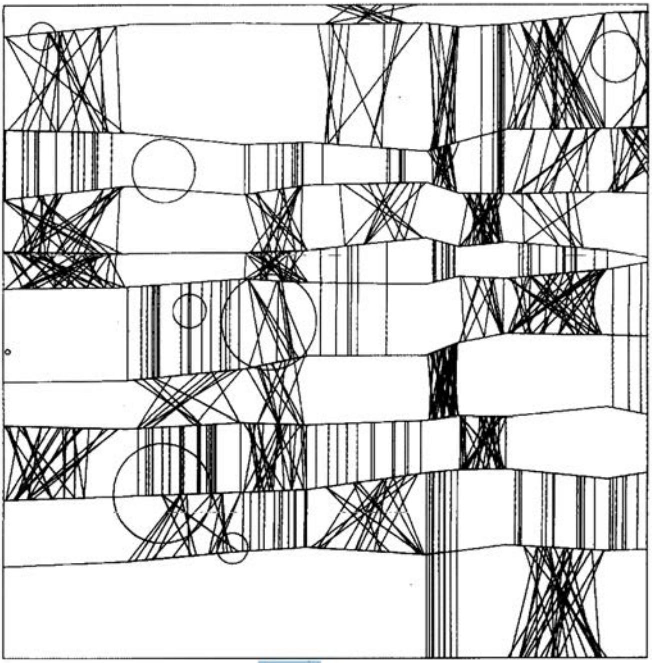

Figure 3. Hommage à Paul Klee , © Frieder Nake 1966

Evoking the lyricism of Klee's sensible geometric abstraction, "Klee" exemplifies how Nake used generative algorithms to achieve aesthetic forms. Other examples of Nake's work include painted over plots, using China ink.

3 Documents by Zuse about computers and the arts, design, and architecture

Rare manuscripts found at the Konrad Zuse Internet Archive raise deep questions about Zuse's original intent with the Graphomat Z64. The first document is a fourteen-page facsimile, typewritten in German, with a title that translates to "On the use of program-controlled calculating machines in the domain of graphics and the applied arts"(see Figure 4). Written in 1964, three years after Zuse launched the Graphomat Z64, this document clearly exposes Zuse's ideas and intentions regarding the possible interactions between visual arts, plotters, and computers. It should be noted that at this time there is no evidence that Zuse was aware of Nees and Nakes' artistic endeavors with his Graphomat Z64 (Zuse, 1964).

Konrad Zuse Internet Archive http://www.zib.de/zuse

013-007

Dr. Ing. E. h. Konrad Zuse

Über den Einsatz von programmgesteuerten Rechenmaschinen auf dem Gebiete der Grafik und des Kunstgewerbes

Die programmgesteuerten, heute im allgemeinen elektronischen Rechenmaschinen haben sich große Gebiete der Forschung, Technik, Wissenschaft und Wirtschaft erobert, und es werden täglich neue Anwendungsgebiete erschlossen.

Dabei taucht die Frage auf, ob es grundsätzliche Bereiche der Programmierung gibt, die von einer Rechenmaschine nicht überschritten werden können und die nach wie vor dem schöpferischen Menschen vorbehalten bleiben müssen.

Auf rein mathematisch- wissenschaftlichem Gebiet kommt man heute mehr und mehr zu der Erkenntnis, daß sich eine solche prinzipielle Grenze nicht angeben läßt. Zwar behandeln die heutigen Programme im allgemeinen Arbeitsroutinen, die vorher vom Menschen durchdacht sind, wobei die Maschine in der Schnelligkeit und auch dem Umfang des Zahlenmaterials nach im allgemeinen dem Menschen wesentlich überlegen ist. Grenzgebiete des menschlichen, rein wissenschaftlich-mathematischen Denkens bleiben dabei noch dem schöpferischen Mathematiker vorbehalten. Kenner wissen jedoch, daß hier keine prinzipielle Grenze vorliegt, sondern daß logisch schwierige Aufgaben, wie das Beweisen von Sätzen, das Auffinden der Lösung für eine schwierige Digitalgleichung oder dergleichen heute aus dem Grunde noch nicht mechanisiert werden können, weil wir keine Geräte besitzen, die in bezug auf logische Beweglichkeit und Umfang der Kapazität eines mitarbeitenden Speichers (Durchsuchung eines Erfahrungsvorrats) mit dem menschlichen Gehirn Schritt halten könnten.

- 2 -

Figure 4. "On the use of program-controlled calculating machine in the domain of graphics and the applied arts", 1964

The text is composed of five sections which discuss respectively: (1) the relationship/conflict between creativity and computation; (2) the areas within the applied arts and design where computers could have a place; (3) detailed capabilities of the Graphomat Z64; (4) proto-generative art ideas; and (5) other possibilities of interaction between computers and the arts, for instance, the use of TV screens and glass.

In the first section, Zuse explains that computer machines could perform operations thought before to be unique of human intellect, including those reserved for creative people. Zuse emphasizes that many of the tasks considered part of human thought, like calculations, are already performed by machines. He explains that placing this question in the creative arts scene is polemic, and therefore focuses on examples that could be relatively more familiar connecting computers with creation: in particular, music composition and electronic music. Zuse mentions that despite the fact that there was some work on computational creativity, examples such as music composition were not necessarily convincing because the creative element seems to be missing. According to Zuse, those compositions described are essentially based on statistical processes that are nurtured with random numbers, and have an additionally programmed “irregular” element..

In the second section, Zuse quotes texts that anticipated questions about computers and the arts such as: "Computers and Automation" and "Computer Art Concert." He goes back to the ontological question of “What is art?”, arguing that in principle, it is a controversial discussion, and is therefore a fertile ground for new ideas. Zuse identifies more specific fields in the visual arts where there is a clear interaction between arts and mathematics, such as pattern design. Zuse analyzes tasks that could be performed with software, which would play a supplemental role in the execution of creative ideas. Additionally, he explains why software design could be essential in this role, more so than the hardware.

In the third section, Zuse introduces his Graphomat Z64, the device he conceived, designed and produced, which works in combination with a computer that is controlled by punched tape. Zuse describes the technical implementation and the properties of the machine such as accuracy and speed. According to Zuse, the Graphomat Z64 could plot with different colors and draw patterns or mosaics. Zuse focuses on describing the characteristics of the graphics when plotted with the device, such as hue, brightness, shape, fill, border, line width, curves, and mosaic-like composition. He emphasizes the potential use of perspective systems and projections of 3D shapes to represent graphics in a 2D plane. He imagines practical applications of the Graphomat Z64, such as drawing patterns for carpet and wallpaper design, and even programmed abstract art. One of the most interesting points is when Zuse describes basic generative possibilities that could be applied to the visual arts with these machines. He explains that the designer would still develop the shapes to a certain extent and control the combinations based on variable parameters. Additionally, he talks about concrete uses like drawing arbitrary curves and use the computer to perform the necessary interpolation calculations.

The last section describes other possibilities in the interaction between computers and images. Zuse compares the Graphomat Z64 with other products recently available in the market such as printers explaining that though the printers were conceived to work with characters, they can be used to draw patterns too and envisions the possibility of displaying images in Braun tubes or TV screens. This possibility was more unusual than plotting the images on paper, given that those devices would display images in an invisible grid. Probably the most premonitory example is the idea of using the patterns to create colored windows with the glass and other transparent materials producing unusual visual effects. By today's standards LCD and LED displays are an ubiquitous form of presenting "digital" images. It is important to consider that raster, or pixel-based images were not accessible until the early 1980s, when the first color displays came out to the market (Garcia Bravo, 2015). In other words, Zuse's ideas in relation to computer graphics were about twenty years ahead.

A second manuscript found at the Zuse archives was "The Computer as a Tool for the Artist." This short text was published in 1969 in the journal Umschau In Wissenschaft und Technik. Unlike the aforementioned text written in 1964, this paper is not directly related to one of his machines or products and instead presents information about new technical advancements and equipment in general. Zuse introduces his arguments explaining the extended use of computers in several aspects of research, especially engineering. Alternatively, Zuse introduces again the idea of computers in the arts, and he exposes two clear options to explore this relationship. The first is the possibility of generative processes in human computer interaction and the second one refers to the use of the computer as tool by the artist, focusing on computer-assisted practices that we now call CAD. In regard to these points, Zuse explained that; "the first case is related to define aesthetic laws, or parameters, formulated mathematically to design the artistic product" and that "the computer, with some peripherals, is used by the artists as a series of technical extensions and is used as a new tool by the artist" (Zuse, 1969).

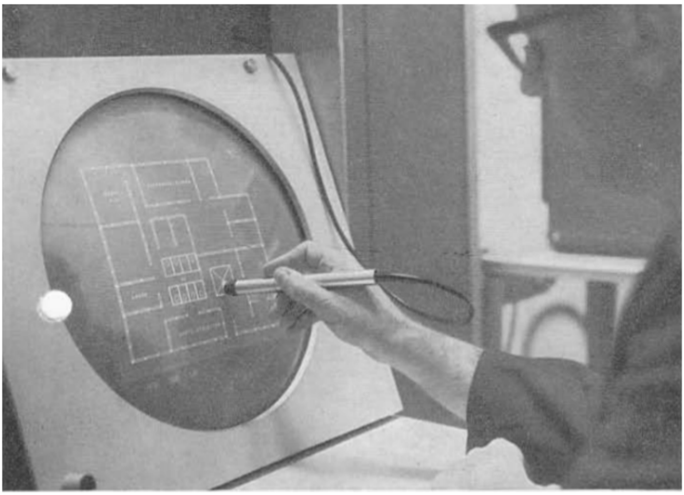

Figure 5. "The Computer as a Tool for the Artist", 1969

Zuse stated the purpose of this text was to describe in depth the second possibility and not the first. It is unfortunate that the first possibility was not further explored, but he likely took this approach so it would sound more familiar and less esoteric to the reader. Still, it is apparent that he was interested in the generative/parametric aspect. The text exemplifies his reflections with the novel interaction with visual, touch interfaces. The article is illustrated with a photo of Zuse interacting with an architectural plan displayed on a screen with an optical pen in his hand. According to his words, he was "collaborating" with the computer, and he reminds the reader that this kind of interaction could happen not only architectural plans, but also with artistic objects. At the technical level, Zuse considers this process as a dialog between the human and the computer in which the user can configure, complement and change the drawings, hence "working together" with the computer.

Zuse envisioned the many things an artist could do such as visualizing different perspectives of an architectural plan, or defining with a program the basic parameters of a visual composition. The artist could determine the rules and the amount of randomness to combine strokes in the best way possible. Zuse argues that the computer representations are not artworks in their own right, pointing to the limitations of the available plotters and other instruments of that time. Independently of software and hardware limitations of only drawing lines, dots and curves, he envisioned that a new artistic movement could emerge from these experiments. For this to happen, it would be necessary for people who understand visual representation to learn programming, and to have the time to adapt to it. Another limitation that he discussed was the costly equipment and the fact that it was still in development. Zuse also pointed out the absence of a market interested in those kind of experiments.

The tone of Zuse's words and his descriptions of the possibilities, always in future tense, shows that he was not aware that an artistic movement was already emerging, and that some of the artists, capable of visual representation were learning programming at the same time. He was also unaware that artists like Nees, Nake and Harke were actually using his Graphomat Z64. By 1969, the use of computers in the arts had already proliferated, although modestly, in diverse nodes such as in research centers and Universities in the United States, Tokyo, Madrid, Stuttgart, Zagreb and Brazil.

Whether Zuse did or did not know that there were in fact visual artists who programmed software when he wrote that article in 1969, he eventually became a participant of the computer art scene himself. In 1972, he made part in a pivotal computer art event in Madrid called "Impulsos: Arte y Ordenador." The event was organized by the Centro de Cálculo de la Universidad de Madrid

(CCUM) and it took place at the Instituto Aléman (German Institute) of Madrid (Castaños Alés, 2001). The event consisted of a symposium and an art exhibit. Zuse was invited to give a presentation at this event. His talk was titled "Del computador a los grafismos de computador" (From the computer to computer graphics) and it took place on February 28 of 1972 (Castaños Alés, 2001, p. 120). The art exhibit gathered some of the most recognized pioneers of computer graphics in the world, including works by Charles Csuri, Herbert Franke, Kenneth Knowlton, Georg Nees, Manfred Mohr, Frieder Nake, Michael Noll and Lillian Schwartz among many others. In the exhibit catalog, Zuse contributed a text that summarized the history of computing from Charles Babbage to modern day. He also establishes a distant connection with the first calculating machines from the 17th Century, towards the development of binary code. Zuse explains the idea of a "universal algorithmic language" capable of algebraic operations, introduced in by him 1945. It consists of a language that did not literally speak the machine code, but was mediated by a compiler that translated the information typed by the user. Since 1955, these concepts are familiar for anyone who uses computer languages to design software. In his manuscript, Zuse emphasizes on the importance of software design towards human-computer interaction. At the very end of this text, Zuse revisits his three ideal methods of "collaboration" between man and machine: 1. Formal languages, 2. Visual light displays (like TVs) and 3. Automatic drawing devices (such as the Graphomat Z64) (Zuse, 1972).

4. Discussion: reflecting on the origins of computer arts

The story of Zuse's Graphomat Z64 and his visionary approach towards graphics demonstrates a paradox in the way that artists approach new technologies. Two standpoints may be theorized about this relationship: on one hand, there is the view that artists discover a new aesthetic vocabulary, having been presented "misusing" or "bending" technological systems to produce unintended effects (glitches). (Blais & Ippolito, 2006). This approach takes into account artists who work only after the technological artifact is ready for public distribution. On the other hand, there is a perspective that technologies can emerge as the result of an art-science collaboration and fulfill an innovation cycle. One example of this dialogue could be appreciated at the Bell Labs in the beginning of the 1960s. Bell Labs, emphasized on interdisciplinary research between artists and scientists to design and create satellite communication, digital photography and incidentally, another branch of Computer Art.

Neither of these claims about the relationship between the artists and the technology is absolute, and should not eclipse each other.In fact, in our view, neither of them describes accurately what happened with the Graphomat Z64.

Historical accounts on how computer art emerged often narrate a story of creative use of uncreative technical equipment. This was the case of Zuse's Graphomat Z64 as described on the CompArt site, a comprehensive and respectable database of digital art published by the University of Bremen:

"The ZUSE Graphomat Z64 was a flatbed drawing machine of high precision. Its engineer, famous computer pioneer Konrad Zuse, had originally intended it to be used for the production of maps and land registration purposes. Both Georg Nees and Frieder Nake did their first computer art pieces on the Graphomat. This historical fact may be seen as a case of an unintended use of technical innovation." (CompArt Center for Excellence Digital Art, Accessed March 3, 2016).

Other texts have also addressed the "unintended use" theme with the Graphomat Z64. As one example, Rhonda Bowlin explains: "A digital artifact like the Z64 is rather meaningless without the context of human intent for its use, especially when notable use diverges the original intended use."

After analyzing the found texts by Zuse in the topic of Computer Art, it is evident that the narrative of the "unintended use" of the Graphomat Z64 must be challenged. Our position contradicts the view that the use of the Graphomat by artists like Nees and Nake was simply an unintended use of technological innovation - but how do we tell the story again? Nake himself discusses the complex relationship between artists and engineers as social actors. He is clearly aware of the importance of redefining this relationship, focusing on an emerging production of art by people who were not necessarily trained as artists (Nake, 2009). Zabet Paterson explains that "the rhetoric of the day emphasises this: there were artists on one side and engineers on the other, and their collaboration was the result of fortuitous encounters. Yet this binary is a drastic simplification if not an outright historical falsification" (Paterson, 2015 p. xv).

There are some possibilities to re-think this inclusion in the origins of computer arts. One way is the idea that it was a fortuitous event that allowed computer art to happen. This school of thought would argue that despite the fact that Zuse did have artists in mind and built machines to facilitate graphics, the use by artists like Nees and Nake could have still been a mere coincidence. Two different practices and views interacted indirectly and somehow by chance, allowed a new artistic movement to be born. This is supported by the fact there is no evidence that Nake was aware of Zuse's writings about artists when he created his first plots in 1963 (Nake, 1968). There had not been an interaction between them except the one mediated by the Graphomat Z64. Zuse's manuscript one year later, reveals that apparently he was not aware of the computer art movement that was gestating at the University of Stuttgart (Zuse, 1969). This view is reminiscent of Jasia Reichhardt's concept of "Cybernetic Serendipity," the title of a seminal exhibit of computer art from 1968. We often focus on the phenomena that directly show connections but in this story, paying attention to the broken links is equally important. In this case there are, in fact, two broken links: an engineer who built the machine who wrote about the potential artistic uses, but did not know about the artists using his equipment for such a purpose at that time; and a group of artists who cleverly used the machine and did not know about the engineer's texts or intentions. In our opinion, we are dealing with an inexplicable communication process facilitated and led by the Graphomat Z64, the artifact itself.

It is possible that the design qualities of the Graphomat Z64 itself helped to open a tangible door for the artists to approach computing. Although this view can point to technological determinism, (where art history would be explained only by the evolution of the technological devices), we believe that there is enough supporting information to claim that there were specific qualities of the Graphomat Z64 (like the accessibility, the versatility, the compactness and the transparency of the core functionalities) that aided the apparition of an avant-garde artistic movement. Was there somehow a discourse engraved in the machine that eventually artists such as Nees and Nake could read? Is it there an inherent discourse in the technological tools?

Given the conscious effort of Zuse in facilitating graphics through a combination of hardware and software, it is possible to argue that Graphomat Z64 provoked the artists. Our final thought is that the Graphomat Z64, constituted by its material configuration and its software implementation, served as a medium in an unusual, yet not accidental manner, enabling engineers' and artists' common intention of connecting machines to human thought, intentions and expression.

Acknowledgements

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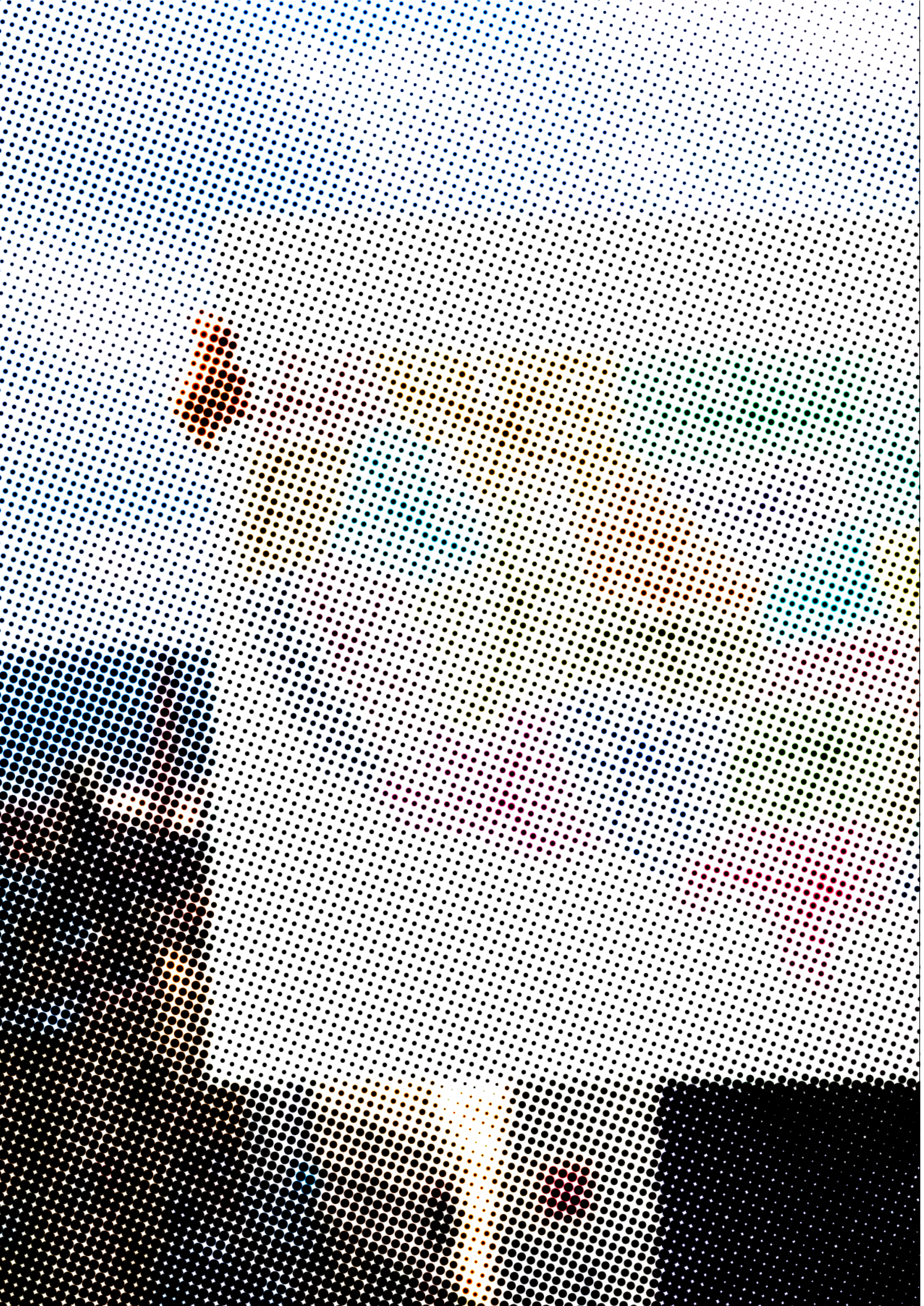
Esteban García Bravo explores computational arts as a researcher, a practitioner and as an educator. He earned his MFA from Purdue University in 2008, and a Ph.D. in Technology, also from Purdue, in 2013. His research on computer art history and digital media art practices has been featured in the annual meetings of international organizations such as SIGGRAPH (2011,2015), ISEA (2012, 2013, 2014) and Media Art Histories-MAH (2013). His artwork has been displayed internationally in media art festivals, gallery exhibits, museums and artist-in-residence programs. Esteban is currently an Assistant Professor in the department of Computer Graphics Technology at Purdue University, where he teaches digital imaging, visualization and computational aesthetics.



Metamorphoses

VISAP'16, the IEEE VIS Arts Program
Oct 23 – Oct 28, 2016
Baltimore, Maryland

Geode

Esteban Garcia Bravo
Maxwell Carlson
Aaron Zernack
Jorge Garcia

Purdue University
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5

A glowing formation stands in the landscape, inviting viewers to reach out from the distance. Geode is a video mapped sculpture that results from our analysis of improvisational geometry in three-dimensional space. The project departs from a neo-concrete inspiration, asking us about the aesthetic potential of emotive geometry, utilizing non-orthogonal shapes and mathematical models based on points and infinite planes. However, Geode takes neo-concrete art to a new dimension by integrating digital geometry in response to audio synthesis. In this way, we accomplish a crystal-like organic shape that glows like a geode. The surface variations are the result of real-time sound synthesis. We visualize soundscapes by transforming analog signals into digital data in real-time. The sculpture's metamorphosis is experienced visually by sound-driven generative geometries. Geode is a collaborative effort to fuse public sculpture, soundscape, and visual projection into one immersive experience.

Educational Communications and Technology: Issues and Innovations

Lucy Santos Green
Jennifer R. Banas
Ross A. Perkins *Editors*

The Flipped College Classroom

Conceptualized and Re-Conceptualized

AECT ASSOCIATION FOR EDUCATIONAL COMMUNICATIONS & TECHNOLOGY

Springer

First, pre-class online learning matters. Students who fully completed online lectures and obtained higher grades in online homework were more likely to succeed in the course. However, not every student was good at regulating him or herself in watching the lectures and completing the assignments. Therefore, to help students focus and go through the online lectures, the instructor could make use of incentives. In this case study, the graded quizzes had been proven as an effective strategy to help students complete the lectures.

Second, students need the will to succeed in the flipped class. The more confident students felt in their abilities of learning math, the higher the grades they obtained in the exams. Therefore, students with high confidence in learning math are good candidate for taking flipped courses. For students with low confidence in learning math, instructors could verbally increase students' confidence by complimenting their growth, attributing the poor performance to the lack of effort, and encouraging them try harder.

Last, students need the skill to succeed in the flipped class. Students who were more willing to seek help from others achieved higher final scores in the course. For students who are not quite skilled to interact with help-seeking strategies on their own, instructors should provide additional support and create time and space to facilitate students' use of the help-seeking strategy. For example, in the pre-class learning, instructors could create a course online discussion forum to enable and encourage students to ask and answer each other's questions regarding online lectures by giving extra grades. For the in-class learning, instructors could pay more attention to those who are not engaged in the group activity, provide individualized instructions on the content, and encourage them to work together with group members.

In summary, the evaluation of the case revealed that successful students in the course were those who completed online lectures and mastered the content, were confident in their math learning abilities, and were skillful of seeking help from others while encountering obstacles. Thus the case study suggests that instructors should integrate design strategies to support students' pre-class learning, their will and their learning skills in flipped classes.

A Case Study on Computer Graphics Technology

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Instructional Context

Course Name and Description

Fundamentals of Imaging Technology (FIT) is a three-credit-hour in the Computer Graphics Technology (CGT) program within the Purdue Polytechnic at Purdue University. During approximately 16 weeks, students internalize the creative process and its phases through five projects aimed to create communicative digital images for industry and to apply, analyze and compare attributes of imaging technologies.

Place of Course in Larger Program of Study

The CGT program includes a number of specializations, including Web, Human Centered Design and Development, Animation and Gaming. FIT is a freshman introductory course, designed to provide basic skills applicable to all specialization areas.

Learning Goals of the Course

FIT develop basic graphic design skills, including the ability to visualize and communicate through images, and an understanding of basic design elements such as typography, shape, colors, and organizational principles. Additionally, FIT aims to develop students' understanding of the applications of Digital Art in today's world and guide them to explore careers in this field.

Description of the Learners

FIT is designed for students who are majoring in computer graphics and adjacent fields, as well as others who may have an interest in this topic. The majority of students arrive with a strong desire to learn digital imaging and image processing software as a stepping-stone to their dream career in animation, film or video games, although many have limited or no background in working with digital images and art.

Rationale for Flipping

FIT instructors noticed that many students struggle with their coursework, and, more concerning in an artistic field, were reluctant to "bend the rules" or explore creative applications beyond what was required. Personal experience and anecdotal evidence led instructors to suspect this may in part be due to the traditional lecture-and-lab approach that lacked opportunities for individual mentorship, in-class individual and group projects to unleash students' talents, or opportunities for peer critique.

In Fall 2014, the instructor (first author) attempted to implement a studio model within the existing constraints of a course taught by large lecture plus a two-hours weekly lab. Weekly live demonstrations of targeted skills and video recordings posted afterwards on an online repository were used to introduce new skills. TAs provided one-on-one mentoring during labs. Group critiques occurred at the end of the semester.

Although overall satisfaction increased, students indicated in course evaluations that class time could be used better, with more in-class work and feedback time. Students found in-person lectures unnecessary, although they appreciated on-demand video demos. While they appreciated the end-of-semester project critique, they wished critique had occurred throughout the semester.

Models and Theory Used to Guide the Flipping

For many centuries, art was taught through apprenticeship at a Master's studio. Today, most art programs utilize mentorship-based studio classes. Teaching largely occurs through formal and informal critiques (reviews of in-progress or completed student projects) by instructors, and informal peer and group critiques. Through project work, students become aware of the iterative nature of design, and the (sometimes frustrating) nature of the creative process (Cennamo & Brandt, 2012).

In an attempt to maximize in-class time, we combined the studio model with a "flipped" classroom. While research on flipping college arts and humanities courses is at its inception, we decided to focus on the foundational principles behind the "flipped" methodology, by offering outside-of-the-classroom instruction via topical videos (Bergmann & Sams, 2012; Goodwin & Miller, 2013; Vaughan, 2014). This would allow students and instructors to use "lecture" time to cover strategies and techniques appropriate for students' individual projects, discuss issues, and to collaborate, create, and iterate.

Structure and Implementation

Structure of the Flipped Course

Each session included interactive studio activities. Students watched videos before or after class. Lectures were replaced with collaborative time, allowing students to work in teams for peer-learning and critiques. The instructor and teaching assistants (TAs) provided one-on-one mentorship. Project iterations could be resubmitted after changes based on peer review.

Preparation of Learners for Participating in Flipped Instruction

Scaffolding student learning and helping them stay on-task at home proved to be important. The syllabus included a weekly calendar, list of videos to be viewed prior to each class meeting, and additional learning resources to support student learning outside the classroom. We introduced students to the flipped format through a detailed description and a video during the first week of the class.

Description of In-Class and Out-of-Class Activities

Each session, the instructor offered a brief summary of the online lecture and an in-class exercise to practice new concepts. At this time, students could also ask the instructor to clarify challenging techniques taught in the video, or explore the topic further with instructor support and immediate feedback. The rest of the class time was devoted to independent or group work and peer critique, following the studio model.

Tools Used to Support the Flipped Process and Learners

One concern in "flipping" the classroom through video presentations was providing sufficient video resolution to illustrate the subtleties of image treatment or computer drawing. Videos were made in high definition (HD) and available for streaming on a separate course site designed for HTML5-enabled browsers (http://snebtor.org/digital-imaging). Course projects, assignments and grades were hosted through BlackBoard.

Differentiation of Instruction

Understanding that students learn at different paces and that online videos may not provide sufficient support for some students to master graphic design skills, teaching assistants were available for one-one-one tutoring and mentorship. Time freed from lecturing during the class allowed the instructor to provide individual feedback to students throughout the class—an advantage taken by the majority of students in the classroom.

Assessment of Student Learning

Assessment was conducted using a three-step approach that supported development of creativity and risk taking. First, students were asked to provide peer critique during the class using a rubric. Providing written feedback ensured that students had a chance to formulate their feedback thoughtfully, and provided peers with a written record that could be used for redesign. Next, the instructor provided feedback. Finally, students had a chance to incorporate all feedback received and submit the artifact along with a reflection on the creative process and redesign for their final grade. To ensure smooth progression through these steps, sufficient time was provided between the critique session and final due date.

Lessons Learned

The Instructional Experience

Instructors initially feared that students would not attend the in-class sessions because content was available online. However, this did not prove to be the case. Students were eager to improve the quality of their projects. Through group work and peer critiques, students went from passive listeners to active participants who learned from one another, forming a community of engaged learners. The instructor's time was used for group or individual questions rather than lecturing on course content. One-on-one mentorship by the instructor and TAs enabled students to push themselves and the quality and complexity of student projects improved. Students learned to communicate with images to a higher competency level than in previous course iterations. The instructor felt well connected with the creative process of students. Teaching was no longer a tedious repetitive task, because the experience allowed the instructor to meet specific needs of each group and enjoy watching and guiding students in their development throughout the semester.

Based on the positive feedback received from students and the overall success of the class, the next course redesign will utilize a fully combined studio and "flipped" classroom approach. The same space will be used for all class sessions, with no artificial lecture and lab divide. Short instructional modules will be added as needed. Mentorship will be expanded by involving more instructors and TAs, and increasing the number of sections to allow for smaller cohorts. These modifications require major institutional changes, and we are excited to have been given the opportunity to transform the foundations class to a more active approach.

The Student Experience

The benefits of the merged studio and flipped classroom approach did not go unnoticed by students. Many shared that they found the videos helpful in mastering skills, which were further enriched by in-class activities, immediate feedback from the instructor and TAs, and peer critique. Students indicated that the ability to repeatedly review videos on demand helped them feel in control of their learning. Students felt that both the instructor and TAs were much more involved than in other courses, creating a rapport that was somewhat unprecedented for this class. However, students and instructors alike felt that the divide between lecture and lab time was artificial, and that the course experience could be further improved by providing project work time and mentorship during all class meetings.

A Case Study on Computer Science

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Instructional Context

Course Name and Description

Introduction to Computer Science and Web Programming provides a broad overview of computer science while utilizing HTML and JavaScript to introduce beginning programming skills and concepts.

Place of Course in Larger Program of Study

This introductory service course is designed for non-computer science majors, and those considering computer science as a major.

Learning Goals of the Course

The learning goals of this course include:

- Explain the historical background and technology that led to the development and growth of computers and the Internet.
- Identify, compare, evaluate, and use language constructs in HTML in designing Web pages that include text, sound, images, and data structures.
- Identify, compare, evaluate, and use elements of HTML forms and JavaScript to make Web pages interactive, and to give data-processing capabilities to Web pages.

Description of the Learners

Students range from freshman to seniors. The majority of students are required to take this course for their (non-computer science) major or minor. Some students who are considering computer science as a major take the course to see if they will like it.

Rationale for Flipping

As I started teaching college-level computer science courses, I quickly realized that if students do not complete the assigned homework and projects, they generally struggle grasping and remembering the concepts I present in class. I started including activities in class that forced them to spend more time on the task of programming, and perceived a general improvement in student learning. This was the beginning of the path that ultimately led me to utilizing flipped classroom pedagogy. Flipping tends to force this practice since the students spend most of the classroom time working through reinforcement activities.

Model (s) and Theory (ies) Used to Guide the Flipping

Based on constructivist learning theories, I draw heavily on learner-centered traditions such as inquiry- and problem-based learning, providing students opportunities to expand their knowledge, supported by scaffolding. Students work in small groups, providing support to others, and building community. Application and problem solving occur during class, based on foundational knowledge acquired outside the classroom.

Structure and Implementation

Structure of the Flipped Course

In addition to almost daily programming activities, I deliver a few short "traditional" lectures in the classroom. These lectures however, usually include some sort of memorable demonstration, such as tearing apart a phone book to illustrate a binary search. I assign six individual projects that the students work on outside of class time, and one group project at the end of the semester that utilizes all of the semester's content. There are also two exams and a final exam during the semester.

Preparation of Learners for Participating in Flipped Instruction

On the first day of a semester I briefly describe that we will have small group, in-class activities instead of traditional homework, and that I have provided access to videos in Blackboard, our learning management system. I also explain research has shown that flipping a course can have positive effects on the students' learning outcomes. Further, I explain that it is more important than usual that they read the textbook and watch the videos before coming to class because that is the only way they will be prepared to participate in the in-class activities. Throughout the semester I periodically remind the students that they must come to class prepared if they expect to succeed. I explain that I am not going to hand them their "learning on a platter," but rather that they are going to have to work at it a bit more than in most other classes. But I also explain that I will provide a learning environment where they can better succeed, provided they come to class prepared.

Description of In-Class and Out-of-Class Activities

Before class, I expect students to read the textbook, and watch related videos I make available through Blackboard. To encourage this pre-class activity, and to assess their level of understanding of the material in that day's in-class activity, I administer a short clicker-based (i.e., electronic student response system) quiz whenever we start a new chapter. These quizzes are scored based on correctness, but only 70–80 % of the questions must be answered correctly to earn full credit for the quiz. If a significant percentage of the class struggles with a question, I spend a few minutes explaining that topic or skill before starting the day's in-class activities. These clicker quizzes—which comprise five to ten percent of the final course grade—are meant to encourage students to attend class, and be prepared by having read the textbook and viewed the videos.

To provide active learning opportunities instead of classroom lectures, I develop in-class programming activities that reinforce the material provided outside of class. On activity days, the students self-form groups and collaboratively work on the day's activity. When I first flipped this class, I had students form groups of three to five participants. Recently, I have found that pairs of students work well, utilizing pair programming. See McDowell, Werner, Bullock, and Fernald (2006), Shore and Warden (2007), Simon and Hanks (2008), and Porter, Guzdial, McDowell, and Simon (2013) for a description of pair programming, and research supporting its use.

While the groups are engaged in the activity, a graduate assistant and I walk around the room to monitor progress, and to answer questions as they arise. My intent is to make the activities challenging for all, but possible for the best groups to complete in the provided class time. At the end of class, the students are encouraged to electronically share the solution so that everyone has access to the day's work. All students are expected to complete and submit them in Blackboard.

Tools Used to Support the Flipped Process and Learners

I self-record and edit videos for a majority of the course's content, and provide student access to them through Blackboard. By using a webcam, and TechSmith Corporation's Camtasia® on my notebook computer, I can record videos at any time and place at my convenience. I record most videos in my office, capturing what is being displayed on my computer screen, my voice, and a "head shot" of me. When the video is produced, the head shot is usually displayed in the corner of the video. I choose to self-record videos, rather than utilize prerecorded resources on the Web, as I feel it important to provide a personal link with the students, and it provides me complete control over the content presented.

I utilize an electronic student response system (i.e., clicker). Clickers are the size of a television remote and have buttons a student uses to respond to questions I pose. I collect student responses wirelessly via a receiver connected to my computer, and then can easily display results immediately. I use clickers to quiz students, gather opinions, and gauge student understanding.

Differentiation of Instruction

By having students work in pairs many of their questions can be answered by their partner. The act of explaining a concept seems to reinforce their understanding of the material. When a pair is stumped, the graduate assistant and I are in the classroom to address their question. I always encourage students to come to my office when they have questions, or feel they are not understanding the material.

Assessment of Student Learning

I did not substantially alter my formal assessment of students when I flipped the course. However, I conduct much more informal student assessment in the classroom while they work on the activities than I could ever hope to have, if I had not flipped the class.

Because of the volume of students and activities, it is not practical to evaluate every activity submission from every student. Most submissions are not graded for accuracy, only that they submit something. Sporadically, I do evaluate a few of the activities for accuracy, and award three to four times as many points for those activities. This keeps the students on their toes because they do not know when I will grade for accuracy, and thus they have to always submit completed solutions, just in case.

Lessons Learned

The Instructional Experience

During six semesters of flipping this course, I learned the following.

- Recording and editing videos take much longer than I expect. Videos do not need to be perfect, since I am not perfect in a lecture either.
- I need one instructor or assistant per 10–15 students in the classroom, so students do not have to wait too long to get questions answered during activities.
- Students want credit for the work they are doing (e.g., group activities), even if it is just a couple of points.
- The flipped classroom will be a new experience for most students. Many will need help understanding how to be successful in it. Students who do not want

to make an effort will likely do worse than in a traditional lecture-based course.

The Student Experience

A sampling of responses from student surveys include the following.

About videos:

> It left time in class to explore the concepts in a practical manner.
> They were more personal than others because using his face in the video made it feel one-on-one. It also helped me understand material better.

About in-class group activities:

> They encouraged participation in class and with classmates.
> Group activities make the class more engaging.
> Could learn off of other students in class. Reinforced understanding of concepts. Developed team-work skills.
> Feels like I am learning, not memorizing.
> My preferred way to learn CS by far.

A Case Study on Computing Science

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Instructional Context

Course Name and Description

Computing Science 174, *Introduction to the Foundations of Computation*, *Part One* (CMPUT 174) is an introduction to programming and computational problem solving using Python. It uses computer games (Pygame) for problems, assessments, and laboratories.

Place of Course in Larger Program of Study

After CMPUT 174, students can take a typical sequence of courses on data structures, algorithms, and higher-level Computing Science topics.

Reflection & Self-assesment

Project 4

In this project, I was able to:

- Generate and communicate new ideas formulating them into effective visual concepts ☐
- Combine typography, images, colors and other elements to create organized visual relationships ☐
- Manipulate images and digital tools to create well crafted shapes (symbols and/or icons) ☐

Project strengths

Project weaknesses

What do you think was your biggest struggle in creating this project?

What strategies will I use to improve my design? (Be very specific)

Date of projected re-submission ____________

ISEA2014
LOCATION

المؤتمر العالمي العشرون لدعم الابتكار
في مجال الفنون والتكنولوجيا

The 20th International Symposium on Electronic Art

ISEA2014
Conference Proceedings

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ZAYED UNIVERSITY

2467/3970: A SHORTCUT TO CONNECTING PURDUE UNIVERSITY (USA) AND UNIVERSIDAD DE ANTIOQUIA (COLOMBIA) IN AN INTERDISCIPLINARY EXPERIENCE BETWEEN ART AND TECHNOLOGY

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ABSTRACT

2467 miles / 3970 kilometers separates West Lafayette (USA) from Medellín (Colombia). Although this distance represents geographic, cultural and social differences, it also outlines a bridge for creative possibilities that connect two cities by an intercultural dialogue around new media. In particular, this paper describes the process and strategies that we developed between 2013 and 2014 to teach a study abroad course entitled "Interactive Art and 3D Animation" in the city of Medellín.

The purpose of this interdisciplinary course was to approach the topic of location, society and technology through each student's experience of the city. We combined each other's research expertise both in digital media and interactive visualization to create an integrated learning experience. Namely, merging Restrepo's experience leading the research group Hipertrópico – using digital media and open source software to develop socially interactive projects – with García's background on computer graphics visualization. This paper explains the collaborative efforts that brought both of these universities together, elaborating on the planning, methodology, realization and outcomes of the course in May 2014.

INTRODUCTION

This paper gives an account of the different steps that were required for the realization and socialization of the academic experience Open Studio / Estudio abierto: Interactive art & 3D animation in Medellín. The experience was designed to facilitate an intercultural and interdisciplinary exchange among students, professors and researchers from Purdue University and Universidad de Antioquia in Medellín (UdeA).

BRIDGING TRUST

This project idea was born in Sydney, Australia, at the 2013 International Symposium of Electronic Arts. We were both participating in the Latin American Forum panels. After the panel, we had a first conversation about the curricular similarities that our departments at our corresponding institutions (Purdue and UdeA) had on digital media. We both identified a great opportunity for educational research and development for the future. Upon our return, we expressed to the department heads and deans of each college our desire to solidify a Colombia – USA exchange. We would like to mention that the institutional support that we received was a strong step towards the realization of this project. To create a bridge between the two universities, we required the involvement and effort of several stakeholders. At Purdue, we were encouraged by Dr. Patrick Connolly, Department Head of the Computer Graphics Technology and Dr. Robert Cox- Dean of Globalization. At UdeA, we had the unconditional support of Francisco Londoño, Dean of the School of Fine Arts, the Hipertrópico research group -a group of faculty devoted to the teaching and exploration on the digital arts. We were guided locally throughout this process by staff and administrators of the international relationships programs and globalization offices. All these people played an active role in the planning and creation of this intercultural bridge.

At the early stages of planning starting on September 2013, we held bi-weekly meetings via Skype. The meetings included the entire faculty from the Hipertrópico group in Medellín (Pablo Pulgarín, Carlos Mario Sánchez and Alexandra Tabares) and Esteban García in West Lafayette. This process was important to dialog and to get to know each other, as well as to outline the recruiting strategies and the content of the academic experience. These meetings continued regularly until the beginning of the course.

In November, Restrepo visited the Purdue campus to meet with the dean of globalization and other faculty at the College of Technology. We held our first student call-out and visited classrooms to promote our program, we also advertised using flyers across campus. During this four-day visit, we worked extensively to sketch the methodology of the course. During the following months (December through February) more call-outs followed and we recruited twelve Purdue students. Six UdeA students were selected by faculty to participate of this experience. We were especially intent on creating an intercultural classroom. Our entire course was bilingual, an aspect that facilitated conveying information, as well as the integration and cooperation of the participants.

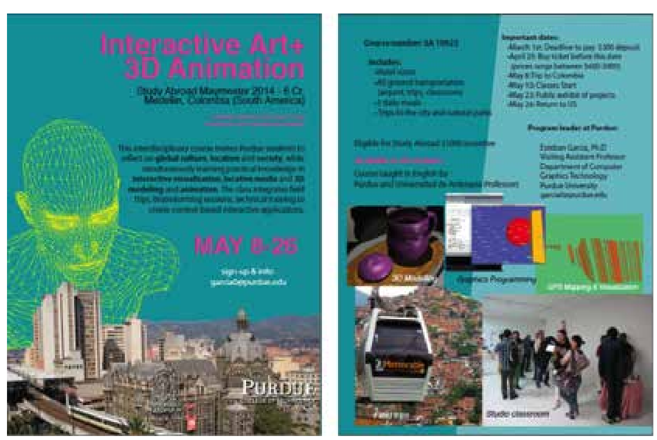

Fig. 1. Flyer for the open call, 2013, Esteban García, paper, © Esteban García.

METHODOLOGY

Inspired on the pedagogies proposed by the artist Luis Camnitzer and the idea of an open studio we designed a collaborative learning experience. At a conference, Camnitzer proposed a non-hierarchical (horizontal) teaching model in which students played an active role as co-investigators. Additionally, he outlined the challenges of teaching technology in the field of art, especially those that include programming:

"*We teach the techniques of coding and de-coding without discussing the functions and relationships that they have with the perceptual actions that allow the existence and definition of these techniques.*" [1]

Consequently, we considered the importance of coupling technology with reflection in our curriculum design. The concept of "journey" enriched the methodology because it provided a groundwork that allowed the participants to think about on new intercultural realities and to activate them through the creation of new media projects. It is important to also highlight the interdisciplinary connections of the academic exchange as a whole. This course brought students and faculty from the fields of Fine Arts and Technology together. The course introduced students to computer code literacy and digital media while prompting them to research and create something on the topic of location, specifically in the city of Medellín. The course was themed around the topic "*Digital Cartography: Mapping the City.*" Students were asked to document their visit to Medellín using diverse media, such as sketching, journaling, photography, video and audio recordings through a series of field trips. These audiovisual documents became the source material for new interactive artworks. The distribution of the activities was designed to encourage participants to integrate the technological and academic work with the contextual experience gathered during the field trips. Our plan of activities followed Camnitzer´s idea in which the student drives the learning experience through their own reflections:

"*Only a good plan of study is capable of guiding a student to focus on the surrounding reality and equipping him/her for the construction and refinement of the culture and community within he/she acts. In this sense a functional plan of study is like a plan of action – a strategy – and it has to obligatorily express an ideology. It is also, as an strategy, a parallel action intertwined with the individual creation of an art piece. Therefore, this is why many times there is no difference between art making and teaching.*" [2] All the components of this course were woven together by field trips inside and outside the city, brainstorming sessions, technical training, conceptual dialogues and experimental input from all co-investigator participants. During the first week, students gained technical competence in the areas of programming and 3D animation through lectures and exercises. In the second week, both individual students and student teams developed their own projects reflecting on the course topics and content in the studio. By the end of the second week there was a public exhibit of the resulting projects at the Cultural Center of Universidad de Antioquia. The image below shows an outline of the schedule:

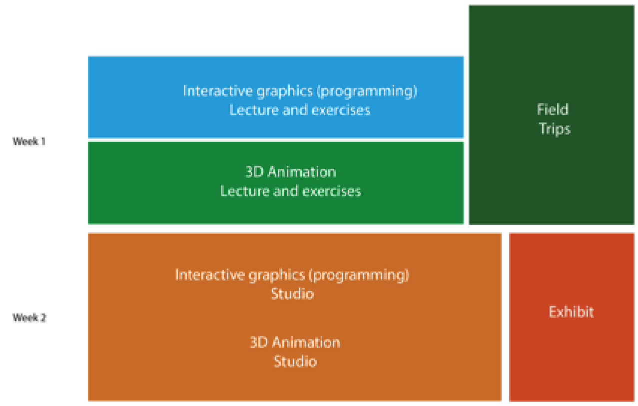

Fig. 2. Structure of the course, 2013, Esteban García and Isabel Restrepo, digital image, © Esteban García and Isabel Restrepo.

To provide the students with the opportunity to get familiar with the place of exhibition, most classes were taught at the Centro Cultural Facultad de Artes. For two weeks, students used this place as both a classroom and their studio. However, participants were introduced to other working spaces, such as Ruta N Medellín, an institution that hosts one of the Purdue's global offices and that also has great facilities for projects that focus on technology and innovation.

As explained before, the personal documentation made by the students was the source material (data) for the creation of the artworks. The course involved three full-day field trips to facilitate the gathering of the data. Trips included: Parque Explora Medellín, Parque Arví and Universidad de Antioquia campus in Santa Fé de Antioquia. These field trips were also an opportunity for participants to have direct contact with geographical, social, political and economic realities and thus broadening the perspectives of all involved.

THE REALIZATION OF THE COURSE

The course started with a general introduction to the philosophy and concepts that tied the entire course experience. We started the session allowing every participant to introduce themselves to the rest of the group. This was the first point of contact between the Purdue and UdeA students. After this, we led a brainstorming session prompting the group to think about the following terms: the journey, the shortcut, journaling, blogging, location, mapping, translation, critical cartography, icon design and ethnography. For this activity, we used *An Atlas of Radical Cartography*, a book that compiles designs and essays on mapping social issues. [3] We invited the students to become aware of their surroundings and to document their experiences through journaling, sketching and digital documentation.

Fig. 3. Introductory section: Fundamental concepts at School of Art, Universidad de Antioquia, May 10, 2014, digital image, © Esteban García and Isabel.

RESTREPO

During the first week, the classroom time was distributed in two four-hour blocks that introduced students to the development of technical competencies to create 2D and 3D imagery. The first block focused on interactive graphics (Processing) and the second block focused on 3D animation (Blender). We alternated the classroom experience with field trips to Cable Metro and Parque Arví. In this way, students acquired basic skills by using the mentioned programs and, at the same time, got direct experiences of the city.

Fig. 4. Field trip to Parque Arví, May 13, 2014, digital image, © Esteban García and Isabel Restrepo.

The work done in Processing emphasized the idea of connecting two disciplines: Art and Technology. A search that is presented in the philosophical conception of the Processing language:

"Hybrids that can fluidly cross the chasm between technology and the arts are mutations in the academic system. Traditionally, universities create technology students or art students–but never mix the two sides of the equation in the same person. During the 1990s the mutants that managed to defy this norm would either seek me out or else I would reach out to find them myself. Bringing these unique people together was my primary passion and that's how I came into contact with Casey Reas and Ben Fry." [4]

The interactive graphics module was called "Programming for Visualization" and was structured to provide the following an introduction to programming using the Processing development environment. The module covered five thematic units in six days: (1) Fundamentals, (2) Interactivity, (3) Media, (4) 3D and (5) Processing. There were three small assignments in which the students applied the concepts from the modules. We helped each of the students or groups to assist with them with their specific programming questions and debugging. Our approach to teaching programming was allowing students to learn by doing and by letting them explore and play with the code structures and problems that we provided. The assignments required the use of their own collections of data, for example, in the first assignment, we asked them to create a landscape of the city using programmed vector graphics. Figure 5 shows an example of one of the assignments done in processing. The student integrated his vision of the city with the possibilities of creating 2D imagery through the use of processing. At a later stage these cable car images were turned into interactive programs.

Fig. 5. Cable Car (Cable Metro), 2014, Photo and digital image © Isabel Restrepo and Aaron Doenges.

The Blender workshop was called "Basic Principles for 3D Animation Utilizing Blender," and was designed under the following themes:

- Introduction to the construction and display of storyline
- Interface and basic commands of Blender
- Modeling techniques in Blender: Predefined structure, box modeling, modeling, lathe, spline, loft, path, metaballs and text
- Properties of objects and their relation to the 3D environment
- Texture and lights
- Basic principles of animation

During the sessions students were introduced to the technical possibilities of the software through examples and were encouraged to develop their own perspectives by themselves. In this way, students had the opportunity to work with the program according to their own projects and ideas. Some of the participants from Purdue had experience on working with other software for 3D modeling, like Maya, so it was easy for them to raise comparison between those programs and Blender, as an open source version. In both learning modules, students developed a series of works that primarily represented their impressions about the city and started to observe social and cultural phenomena. This point can be seen in the amount of projects that depicted the mountainous geography of the city, the piled distribution of buildings and the aerial perspective of the Cable Metro and other characteristic icons of the city.

Fig. 6. A compilation of works done by participants of Open Studio in Blender and Processing, 2014, Digital images © Isabel Restrepo and Esteban García.

In the second week, students were asked to develop their own projects integrating what they learned in the interactive graphics (programming) and 3D animation modules with their experience of the city. The module was called "studio" and the faculty played the role of mentors in helping develop their ideas technically and conceptually. For the creation of the projects students were invited to work in teams and to depart from their own observations or questions during their journey. The studio component included the following activities: collective work sessions, brainstorming, planning, development and installation of the projects.

RESULTS

Each project revealed a unique perspective and process. The resulting projects were very diverse including interactive installations, videogames, animations and paintings. In several cases we observed that this experience was life changing in the sense that many students discovered a new passion through developing their work. We would like to mention the project *Diario cartográfico – Cartographic Diary* (2014) as an example of the studio work done by Sara Echeverri and Diana Marcela Zuluaga. The main goal of the students in this project was to capture the visitor's movement in real time, as a way to facilitate the interaction with the space using digital and interactive content. The interface of the project included a camera that was installed on the ceiling, a map that was displayed on the floor and a video projection on the wall. In terms of the coding for the interactivity, the students, in cooperation with the professors, determined the brightest point in the space as a pattern for the recognition of movement. The movements of the users were designed to active different imagery in five sensitive zones. Although the project had some technical difficulties, it was a successful experience of bridging art and technology, allowing fine arts students to begin to work with code. After the course ended, one of the students decided to further her work in *Processing* by enrolling in a programming class taught at Universidad de Antioquia.

Fig. 7. Diario cartográfico, 2014, Interactive Installation, Sara Echeverri y Diana Marcela Zuluaga © Photos by Isabel Restrepo.

Guillermo Blanco and Alex Stamm were interested in Medellín's nightlife. They designed a survey and conducted interviews on the street asking people about their bar or club preferences. They were interested in applying this ethnographic research applied to the design of an interactive app. The project was called *Medellín: Vida Nocturna* and it provided the users information about the types of music, the cost and a rating system of the city's preferred dance clubs and bars. The app used GPS data to locate the clubs on an interactive map with diverse genres of music. Guillermo and Alex's friendship evolved into a strong designer-developer team. Both of them were so thrilled about the results that they would like to pursue app development professionally. They are currently working on a new version of the software and are planning to continue travelling around the world collecting data for their *Vida Nocturna* project.

Through this experience, another student became aware of her true passion. At the time she was enrolled as a freshman in computer graphics at Purdue, but this studio experience helped her to come to the realization that she didn't quite want to be in front of a computer and that she did want to become an artist. She realized that she was not as much interested in coding as she was in painting and upon her return, she changed her major to Fine Arts. Her experience during the studio allowed her to further explore in the area of painting. Other projects allowed students to deepen their existing interests. One example of this is the animation *Equalizing the City* by Aaron Doenges and Jonathan Simonson. The animation tells the story of a white van that strolls through the city dancing to rhythm of Salsa and Electronica music. Both John and Aaron are animation majors. For the development of the projects students worked directly in the exhibition space, allowing them to experience and learn about the display of interactive and non-interactive artworks, as well as creating an exhibition. To create a coherent unit in the space, the faculty planned the space distribution of the projects, considering the equipment that was available for the exhibition.

PUBLIC EXHIBIT

The resulting projects were presented to the general public at the Centro Cultural of Universidad de Antioquia (Colombia) and displayed online on the site www.2467-3979.org. All participants were present at the reception, allowing students to interact with the audience, answer questions relating with their projects or provide additional information about their process. To complement the information about the exhibition and the course, a brochure was designed and distributed at the opening.

Fig. 8. Images of the opening of the exhibition Open Studio / Estudio Abierto. May 25th, 2014, © Photos by Isabel Restrepo and Alexandra Tabares.

EVALUATION

The evaluation of the entire experience was done in a rural campus of Universidad de Antioquia in the East region (El Carmén de Viboral). The students were asked to answer some questions in a written paper followed by a group debrief. In general, students highlighted as positive aspects of the course the intercultural exchange among students and professors, the possibility of developing practical projects that relates with contextual concerns, the opportunity to find new venues for their careers and the involvement that they developed for the projects, independently of a grade. Some of the comments of the students were:

Savanah Mick (Purdue): "On this trip I learned a lot about how Colombian culture differs from American and learned to appreciate and admire different ways of life."

Ryan Walker (Purdue): "I learned a lot about Colombian culture, became much more confident with Spanish and made several new friends. I learned how to wash clothes by hand too. In general, there are too many things to list on a single piece of paper."
Alex Stamm (Purdue): "In general the immersiveness of the experience is what taught me. The fact that we were forced into new exciting experiences forced us to learn. Intensive experience brings intensive learning."

David González (UdeA): "This has been an incredible experience for me. Although in the moments previous to the beginning and during the first and second day it was somewhat stressful because of the language issue and uncertainty about the working methodology, I feel that I was able to couple with this process and to become more comfortable through the days. I found that our classmates from the USA were really nice and humble, they were engaged with the process, hard workers with lots of interesting ideas and knowledge that I hope to achieve with time."

Diana Zuluaga (UdeA): "When I heard about this project, I was very interested on the idea of being able to meet with students from another country and culture. Although the communication was difficult, smiles and gestures became the unifying bridge. It was a very positive and enriching experience in which the intensity and the complexity of the teaching did not impede interaction. I learned a few words and sentences in English, so learning to speak it like them is going to be my objective from now on."

As instructors, we wanted to finalize the course in a meaningful way by providing a space for collective reflection and feedback. This experience was very informative to us as it helped us to realize that this experience had a much greater impact on the students than we originally imagined. Overall, we were impressed with the quality of the projects, but mostly with the personal growth that each student had. After becoming aware of cultural differences, students grew into empathetic, respectful and compassionate global citizens.

SPREADING AWARENESS

The socialization of the experience has been an ongoing process that includes material in different media. The first step was writing a report that was socialized with the directors of Universidad de Antioquia and Purdue University. During the realization of the course, press articles were written in the webpages of Universidad de Antioquia. Some of the professors and students were interviewed. Additionally, some information can be found in the Facebook account of the research group Hipertrópico (comunicaciones Hipertrópico). Along with this, the professors have shared the experience in different academic events, to share, discuss and analyze the meaning of this type of experience. Our goal is to continue providing this experience on a yearly basis.

CONCLUSIONS

From the analysis of our planning, methodology, realization and outcomes of the open studio experience, we found great results on allowing students drive their own learning experience. In this way, students were motivated to have an active role in the creative process: they picked themes of interest, means for developing projects and the appropriate teams to work with. The theme of the course was a good excuse to invite the participants to explore the city as well as learning technical aspects through the exploration of open source software.

Based on the results of the projects, the reflections and the affect of participants' decisions for future development, we feel that our experience was successful. Through this project we were able to bridge cultural and academic perspectives. Being part of a multicultural classroom facilitated a unique environment for learning that enhanced meaningful discoveries that broaden the perspectives of all involved. This exchange activated the emergence of creative thinking and artistic explorations through the convergence of art and technology.

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Transforming a Computer Graphics Department from Traditional Education Methods to a Polytechnic Approach

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Prof. Raymond Patrick Hassan, Purdue University

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Transforming a Computer Graphics Department from Traditional Education Methods to a Polytechnic Approach

Abstract

The computer graphics department at a major research institution in the United States of America is undergoing a radical transformation involving the transition of teaching methods, classroom structure, instructor roles, and student autonomy. There are many challenges impacting this transformation, including resource allocations of time, space, and faculty/student ratio demands, how to manage both 'legacy' programs for existing students concurrently with the polytechnic program for incoming students, and how to scale up the successful polytechnic model implemented in small cohorts to a much larger group.

Additionally, the polytechnic approach focuses on skill competencies rather than the traditional course credit tracking for student achievement. A competency-based methodology utilizes demonstrated learning by the student and can be challenging due to a more open and student-driven process that allows for multiple paths for achievement. The polytechnic approach to learning emphasizes learning by researching and doing, risk taking, and the blending of liberal arts into technical subject matter and education. The faculty members involved in polytechnic instruction are active as mentors to the students, providing guidance as the students strategically plan out their own educational paths. This approach intrinsically motivates students and provides graduates that better meet the needs of industry.

This paper documents the process followed to transition from a traditional instructional unit to a polytechnic focused department, reports on the challenges encountered and overcome, provides initial results and feedback, and discusses potential plans for the future. A discussion on the concept of a polytechnic institution, its definition, and transformative nature is included to clarify the reasons behind this radical and somewhat unsettling approach to education reformation.

Introduction

Academic institutions of higher learning are facing many difficult challenges, including declining enrollment trends, complaints about costs vs. value, curricular stagnation, and inability to adapt quickly to changing environments facing graduating students. Many researchers and authors claim that the traditional educational methods and structure espoused by universities is outdated and potentially restrictive to learners. [1, 2] The College of Technology at Purdue University is dealing with these challenges also, and has chosen to address them through the use of a holistic transformation of our educational methodologies, underlying principles, and focus. The College created the Purdue Polytechnic Institute to redefine undergraduate education and provide a novel learning experience to our students. [3] Within the College of Technology, the Department of Computer Graphics Technology has elected to dedicate our efforts at reinventing our department to align with these polytechnic values. The radical changes associated with these values include a transition of teaching approaches, and more fundamentally, teaching philosophies, classroom structure, instructor roles, and student autonomy.

The Polytechnic Foundation

Although there is no single definition for what constitutes a polytechnic approach or institution, it is generally accepted that key components of a polytechnic entity may include crucial characteristics of student mentoring, problem-based instruction, integration and collaboration of subject matter, entrepreneurship, and intrinsic student motivation. Sorensen [4] claims that

> Polytechnics are comprehensive universities offering professional, career-focused programs in the arts, social and related behavioral sciences, engineering, education, and natural sciences and technology that engage students in active learning, theory and research essential to the future of society, business and industry.

Olin College has created an engineering program based on the polytechnic approach. Specific criteria that Olin incorporated into their structure included a curriculum that was designed to be flexible and responsive to changing world needs, a focus on innovation, problem solving, inquiry, research, and entrepreneurship, and contact with students not limited to in-the-classroom experiences. [5] These combined foci of solid foundational knowledge, entrepreneurial thinking, and creativity and innovation help clarify the key elements that were chosen to build the Purdue polytechnic model in the College of Technology.

The Polytechnic Effort in the College of Technology

The 50-year old College of Technology was created with the mission of educating practitioners in emerging technologies and technology managers, to complement other colleges at Purdue University in fulfilling the Land Grant mission. The PPI will be a renewal and extension of the essence of what the College of Technology was created to be while at the same time improving Purdue's standing as a national university. According to Robinson, [6] the role of education is three-fold: develop individual talents and sensibilities (**individual**), deepen understanding of the world (**cultural**), and provide skills to earn a living (**economic**). It is essential to keep an eye on all three and promote them equally. Understanding how the three interconnect is key to transforming the education system of the 21st century. Any new educational system must address all three facets at the same time. This requires that we debunk old myths and artificial boundaries that underlie the current system. We will focus on integrated learning and learning in context. In particular, students will practice the full cycle of innovation desirability-feasibility-viability[7] throughout their studies.

Higher education has traditionally excelled at graduating STEM professionals with depth of content knowledge. While this is an important workforce attribute, business leaders find new graduates are not well equipped with the 21st century workplace competencies needed in today's business environments. It is the combination of the depth of knowledge and the breadth of general, transferrable skills, defined as "deeper learning" that is needed to drive US innovation.[8] Wealth-driving business sectors are demanding workplace competencies such as analytical reasoning, effective communication, self-direction, and the ability to work in virtual and multi-cultural teams from new hires.

By design, PPI directly contributes to building an innovative workforce by incorporating teaching and learning methods that support "deeper learning" and the development of 21st century workforce competencies (Figure 1). Through purposeful university-industry partnerships our graduates will be technology fluent, self-driven learners. Supported by curriculum that allows for research, exploration, work-based learning, and teamwork we are creating innovators that have already been challenged to solve the ill-structured, real-world problems that industry faces.

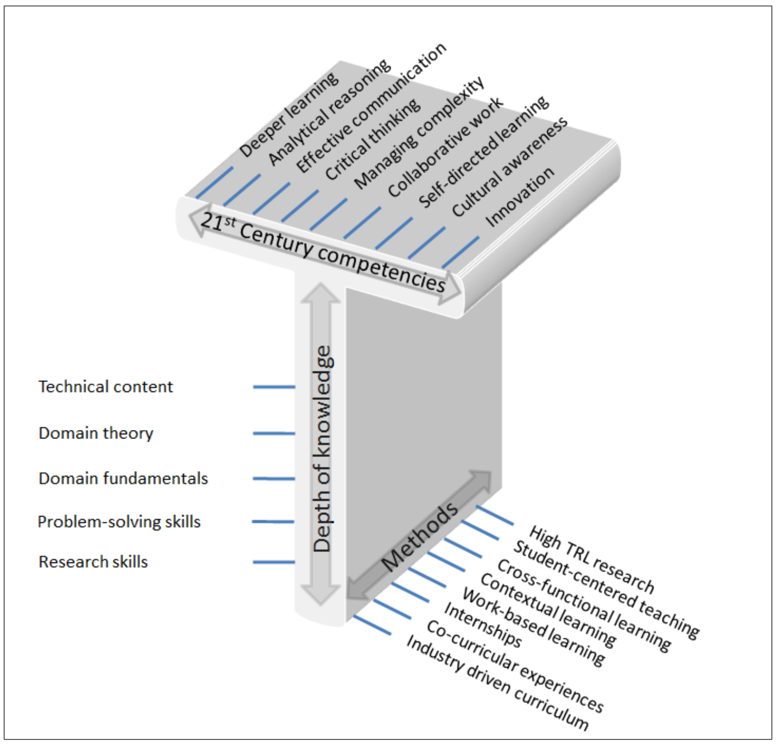

Figure 1 "T"- Shaped Professional (Image created by N. Hartman, C. Bozic, & G. Bertoline)

Creating the "T" shaped professional requires that all programs espouse both philosophical and practical characteristics of the Polytechnic Initiative at multiple programmatic levels.

In 2013, the College of Technology at Purdue University committed itself to developing a polytechnic approach to radically transform the undergraduate learning experience. The basic tenets of this effort include many of the components described in general above, such as entrepreneurial thinking, collaborative teaching environments that combine faculty from different disciplines into a holistic learning experience, and emphasizing student and faculty creativity in problem-solving experiences. However, the polytechnic effort in the College of

Technology also focuses on creating a culture of success and community, student/faculty mentoring, incorporating of industry and alumni partners, student involvement and input into the learning process, and student leadership development.[9]

A dedicated entity called the Purdue Polytechnic Institute (PPI), later renamed the Purdue Polytechnic Incubator, was created to provide an experimental 'sandbox' to test and refine polytechnic approaches and to help drive the reformation of the technology learning experience. During the fall semester of 2014, the PPI began with its first cohort of freshmen students, self-selected from departments across the College of Technology. The PPI experience incorporated combined studio and seminar experiences that provided collaborative learning opportunities in technology, programming, English, and communications, with an emphasis on project-based problems. One of the novel approaches taken by the PPI was the elimination of course-based objectives, and the adoption of competency-based goals in their place. The faculty members who participated in the PPI were released from other teaching loads and were designated as 'PPI Fellows' to highlight the considerable commitment of time and effort involved in this undertaking.

In parallel with the PPI incubator effort, the College of Technology also initiated an 'Accelerator' effort to encourage existing departments and programs in the College to begin transitioning to more polytechnic-like approaches. The adoption of both Incubator and Accelerator approaches provided a synergistic effort that required the involvement of nearly all faculty, staff, and administration of the College of Technology, and effectively hastened the transition of the College on multiple 'fronts' simultaneously. The effort to transform the Department of Computer Graphics Technology was initiated from the Accelerator efforts, but the Department was also targeted for this transition based on the creativity and forward-thinking nature of the department members.

The Polytechnic Transformation of the Department of Computer Graphics Technology

During the fall semester of 2014, the Department of Computer Graphics Technology was invited by the Dean of the College of Technology to apply to become polytechnic certified, with a goal of implementing some aspect of a polytechnic program by the fall of 2015. This action would require the department to measure itself against a list of criteria and to propose how those requirements were going to be met. These criteria included the following:

- All faculty and staff in the department will complete requisite training in polytechnic teaching and administrative development (administered by college and university programs)
- A plan will be established for faculty development and sustainability
- A polytechnic-based learning experience will be developed that will transform the existing undergraduate curricula, and will include the following components:
    - Freshman Technology Experience

    - Discipline Specific Technology Skills Program
    - Faculty-Student Connections Program
    - Technology Global Experience
    - Extracurricular Certifications
    - Internship, Co-op, or required field experience
    - Capstone Experience
    - Technology Backbone
    - Competency-based Option
    - Student-created Plans of Study
    - Integration of Math, Sciences, and Humanities
    - Business, Leadership, and Entrepreneurship
- Submittal of a plan for periodic review of all undergraduate programs every three years, to include the following:
    - Enrollment trends
    - Student Success
    - Placement and Starting Salaries
    - Diversity of the Students
    - Advisory Board Review
    - Student Surveys

It became obvious that in order for this transformation to succeed, the faculty and staff members of the department would need to be fully committed to the polytechnic principles and methods. Additionally, it became apparent very quickly that the department could not transition to meet all these criteria en masse, but that a staged approach would be required. After the faculty and staff agreed that the department collectively wanted to pursue this polytechnic status, a proposal was written to identify plans to meet the criteria. This proposal established the initial steps to be taken by the department, but was recognized as a 'living document' that would be continuously revisited and revised as progress was made in the various areas of focus.

After submitting the proposal, the next step in the process of transforming the department was to strategically break down the requirements into specific tasks and topics. The faculty and staff training, development, and sustainability criteria, as well as the periodic review requirement were allocated to the department head for planning and oversight. It was decided that the polytechnic-based learning components would be best addressed with a small team approach. These topic areas were identified as primary, secondary, or tertiary level targets based on several factors, including current department status, logical progression of initiatives already in effect, documented priorities of department and college administration, and (very importantly) faculty and staff interest:

Primary Priority Components

- Freshman Experience

- Faculty-Student Connections Program
- Capstone Experience
- Competency-based Option
- Integration of Humanities
- Entrepreneurship

Secondary Priority Concerns

- Extracurricular Certifications
- Technology Global Experience
- Internship, Co-op, or Required Field Experience
- Integration of Math and Sciences
- Business and Leadership

Tertiary Priority Concerns

- Discipline Specific Technology Skills Program
- Technology Backbone
- Student-created Plans of Study

Additionally, two other primary priority-level focus areas were identified: IMPACT/Problem Based Learning Space Planning and Undergraduate Student Recruiting. The faculty and staff members in the department were then invited to self-select onto teams for each of the identified components. Each team was tasked with identifying the following four items in the context of that challenge area:

- What needs to be Done (recommended transition)
- When It Needs to Happen (timeline and milestones)
- How to Do It (steps involved in the transition process)
- Resource Needs (people, capital equipment, training, etc.)

Progress to Date

The department has focused on the eight primary priority items to be implemented for fall 2015. Other items from the secondary and tertiary activities may also be initiated on a piecemeal basis at that time, but our initial focus is on the primary items. The teams for each of these areas are meeting on a regular basis and progress has been made in each area as explained below:

\- Freshman Experience

The goals of the freshman experience in the department include retention of new beginning freshmen students as well as the development of intrinsic motivation. The overarching vision of the experience involves providing the students aspects of industry involvement, career understanding, application of mini-projects to provide exposure, and an intellectually stimulating journey through the first year curriculum. In order to accomplish these goals, mentorship and faculty contact is crucial, which ties strongly to the Faculty-Student Connections aspect below.

The experience will build on two parallel efforts – the College of Technology initiative for a college-level commonality involving the first year foundational technology course, English composition, and communications; and the department level effort to meld the computer graphics introduction classes into studio/seminar experiences with the goal of eventually incorporating psychology and philosophy content.

A pilot study with students during the fall of 2014 of the Purdue Polytechnic Incubator introduced a program dissolving the boundaries of traditional disciplines, namely, humanities and technology. During one semester, a cohort of students was introduced to foundational concepts of English and Communications in the context of digital technologies. The integrated courses were delivered under a studio model and the students were able to explore topics of interest while earning technical knowledge. Students were very satisfied with the ability to work closely with faculty and receive personalized responses to their own self-paced learning.[10] Students felt engaged and interested on the hands-on projects, but there was not a significant evidence of whether this was caused by the merger of disciplines or not.

- Faculty-Student Connections Program

The department strives for relevant mentoring environments for all of its students. As part of this goal, the department will formalize a faculty-student mentorship program. Additionally, the department will leverage the proposed programs' focus on faculty-student and student-student mentoring. This will include peer mentoring and upper class student-younger student mentoring throughout the learning experience. Cohorts of freshman students will be formed (similar to existing learning communities) to provide collaborative and mutual support resources for every student in the department. Finally, the department will expand on the concept of faculty-student mentoring to include student-professional mentoring via interaction with members of the department industrial advisory board.

- Capstone Experience

The department currently has a semester-long senior capstone experience, but plans are in place to change that to a year-long experience. The capstone is crucially important as both the culmination of technical learning and the implementation of acquired skills in a manner that mimics the professional environment. This assists in the preparation of students to be immediate contributors in industry. One important goal is to have these capstone experiences be industry sponsored. Additionally, we would like to ensure that each capstone experience is individually relevant to each CGT student, so emphasis will be placed on project definition and development closely related to each student's area of focus. Finally, several CGT programs are forming plans for curricula that provide multiple capstone experiences on an annual basis. These opportunities would be industry sponsored ongoing projects that will heavily leverage student-student mentoring and the principle of proximal learning.

- Competency-based Option

The department has already made significant progress in defining competencies for freshman level courses, and in establishing related badges and badging procedures. Competencies have been defined for all of the computer graphics courses, and it is expected that freshmen students master these by the end of the first year in the department. Additionally, competencies and badges have been defined for all courses in the animation major, providing the students with the structure necessary for a full competency based degree option.

The computer graphics students that were enrolled on the fall 2014 cohort from the Purdue Polytechnic Incubator, were early adopters of a pilot competency-based option. The students were successful and actively more engaged with their learning process. Instead of grades, students earned the first semester computer graphics competencies through the successful completion of challenges and projects. Each project went through different iterations, until the student demonstrated mastery of the competency. Given that the sequence of the course could be taken in any order, the instructor provided a map of challenges to complete during the semester. A map of challenges and their relation to a competency is shown in Figure 2. The freshmen students found the designated paths very useful,[11] because as new learners they had difficulties on deciding where to start.

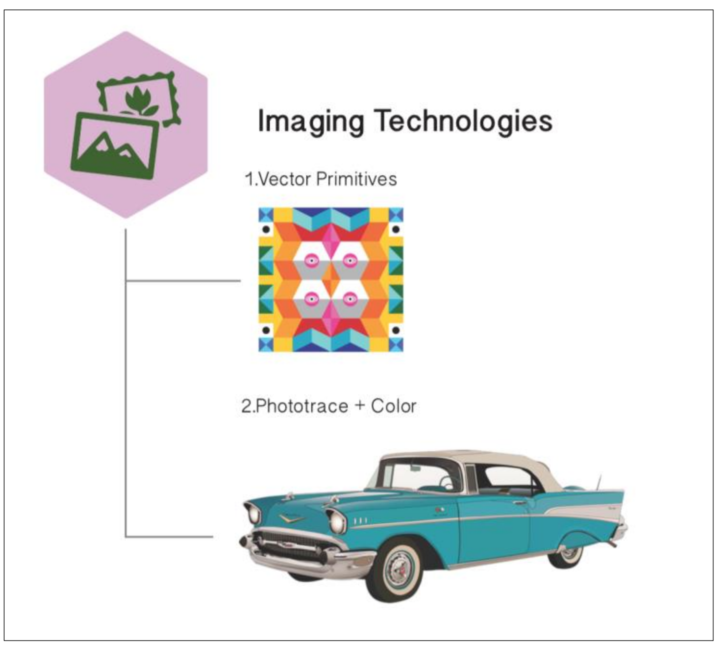

Figure 2. Map of challenges and competencies

Currently badges have been created for the animation major, each with its own unique challenges and related learning outcomes, that lead the students from beginner to expert levels in the various disciplines of computer animation. Purdue's Openpassport platform will be used to assign and manage the badges, and students from the Introduction to Computer Animation course will beta test the application in its first run. Students from this class will initially have access to the lower-level badges, which mostly correspond to the discrete disciplines of specialization within computer animation, namely 3D Polygon Modeling, 3D Surfacing, 3D Lighting, 3D Rigging, 3D Animation, and 3D Effects. Each lower-level badge links to a higher-level badge, creating a badge tree that sometimes branches and converges with other badge trees at the highest level. Most of the badge trees have four levels of mastery, beginning with preliminary, then emerging, advanced, and finally master. Their challenges have been designed with a parabolic gradation of difficulty, with the master level badges indicating a rare and unusual level of student skill, experience, and understanding of a discipline. Also one non-discipline specific badge, the 3D Pre-Pro Team Workhorse badge, has been created to award students who provide outstanding leadership or far exceed expectations in the final team-based project (See Figure 3).

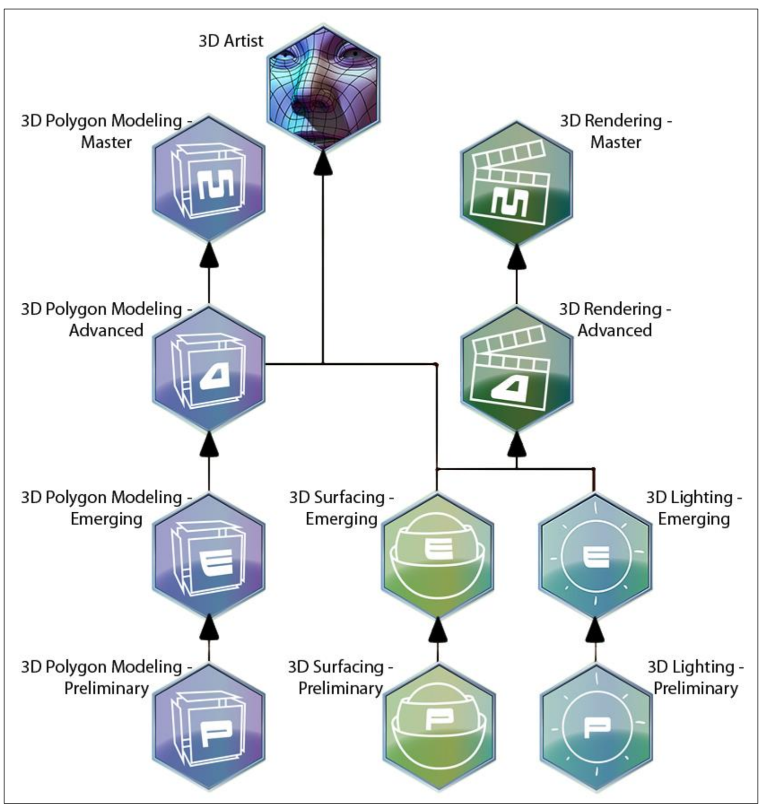

Figure 3. Animation Badge Examples

In the Introduction to Computer Animation course, assignments are given that correspond to badge challenges. Exercises 2 and 3 for example directly correspond to the Prop Model challenge and the Character Model challenge, respectively, within the 3D Polygon Modeling - Preliminary badge. For a student to earn the badge, both assignments need to be perfect. It would be possible for a student to submit their work, earn a very high grade with only a single imperfection, and still not obtain the badge. For completion of the badge, students must be willing and able to accept critique and fix any problems, even on their best work. The idea is that this process will make their best work better, reinforce their learning, instill ownership of mistakes, and it will simulate one aspect of a working environment.

Continuing with the example of the 3D Polygon Modeling - Preliminary badge, the next badge in line for that skill tree would be the 3D Polygon Modeling - Emerging badge. The preliminary badge is a prerequisite for the emerging badge, and the emerging badge challenges are Rig-Ready Character and 3D Scene. Each challenge for this badge expands on challenges from the preliminary badge, exacting an acutely different level of time, effort, and ultimately skill from the badge seeker. These challenges however do not directly correspond to course assignments, but can still be pursued in the course via the open-ended final team project. The emerging badges would not necessarily be required of any student in the Introduction to Computer Animation course. Instead this badge and the badges above it must leverage student intrinsic motivation to be obtained.

As students progress through the courses in the animation major, they become increasingly engaged in team projects. Animation teams typically require members to have complementary skills. For example a team full of 3D Rigging expertise and no 3D Polygon Modeling expertise will never finish their character models, and their rigging skills will be wasted. It is expected that students will use their badges to identify equally skilled teammates with differently focused specializations. Thus the demand for higher level badges can be driven through both scholastic and social compulsion.

At the highest level, the master badges need not correspond with course work. Master level badges in this progression correspond with jobs, and the advanced and master level challenges either critique the entire body of a student's work or test the student's ability to produce the highest possible quality of work with the shortest possible limit of time. Such challenges strongly resemble portfolio requirements and interview tests that students will face as they begin their career. The process of earning these highest level badges should instill confidence and strong determination. It is expected that students who earn the highest level badges in a discipline should have far less trouble finding jobs.

The future of badging in the Department of Computer Graphics Technology will see interconnecting badge trees from all Computer Graphics Technology majors and course levels. Top level students may be selected to pursue a competency-only path to graduation in their major within Computer Graphics Technology, eschewing grades for refinement and perfection of project, portfolio, and concept.

- Integration of Humanities

At the department level, requirements for mathematics, sciences, and humanities will remain a critical part of the expected curricula. Initially, instruction in mathematics and science will be accomplished through traditional stand-alone courses offered outside the department. However, as this effort matures, it is anticipated that the integration of these subjects will be accomplished through means of team teaching with collaborative faculty from outside departments, as well as by computer graphics faculty with specific skillsets in the topic areas. We anticipate a much quicker integration of humanities into the experience, partially due to the success in this area by the College during the fall of 2014 in the Incubator experience. Although the pilot study did not find an advantage of teaching integrated courses, it was an important step towards the re-envisioning of the existing curriculum. The Purdue Polytechnic Incubator operated as a faculty network that explored best practices on education by deconstructing the models of traditional disciplines. This allowed for re-visioning of the traditional educational model by including co-teaching and group reflections as a core component of the experience. The integration of humanities and technology provided with a rich ground for student development. Rather than focusing only in a mechanistic approach to technology, students were able to draw parallels with their cultural contexts and provide solutions to unstructured problems.

The integration of the disciplines poses a big challenge that requires joint efforts across different colleges on campus. Thanks to the pilot study, many bridges and faculty connections were made, allowing for future development.

- Entrepreneurship

Entrepreneurship is a relevant principle in the professional world of computer graphics, and is therefore a significant component across all majors. This will be extended and increased in new majors that are being proposed in the department. Multiple courses in entrepreneurship are required in most majors in the department, often coupled with extensive project-based learning situated in simulated business environments. Several majors also utilize production studio models that enable students to bring commercial-grade graphics products to real world markets. This approach will allow the studios to become industry outsourcing partners contracted to produce digital assets for commercial enterprises. These efforts are coordinated very closely with industry partners and provide many opportunities for students to work on real world problems while interacting closely with industry sponsors.

- IMPACT/Problem Based Learning Space Planning

One exciting aspect of a transformative polytechnic approach to instruction is the emphasis on student interaction, studio-based and problem/project-based learning methods, and the strategic use of adaptive, configurable learning space. Faculty from the department are leveraging this time of transformation to provide input into the redesign of traditional computer lab space into multi-use, compute-intensive environments. Serendipitously, the opportunity to collaborate in this space design exercise is also providing opportunities to resolve other problematic issues with computer resource allocation and capability. The faculty members are eagerly anticipating using the new instructional space as a key component of the polytechnic environment.

- Undergraduate Student Recruiting

As the transformation gathers momentum, we have been placing emphasis on recruiting and information dissemination. One of the key goals of the initiative is to provide this new educational experience to as many students as possible, and to leverage these efforts to grow our program offerings and department. As the recruiting team has met, they have committed to improving and increasing the department's Web presence; developing and advertising new majors, minors, and specializations; improving outreach efforts to high school students, parents, and advisors; and leveraging technology tools to showcase the professional fields related to computer graphics. A fortuitous byproduct of these efforts is the enhanced focus this has provided for strategic examination of our current academic programs and future plans.

Conclusion

At this point in time, much has been accomplished in the transformation of the department, yet much more lies before us. Great benefits have already been achieved as a result of reaching consensus on department strategic direction and future goals, as well as agreement on educational approaches and methods that are radically changing how we look at and provide instruction. Even in the planning and early implementation/experimentation stages, we are seeing beneficial impacts on our students. There is also a palpable level of excitement and refocusing among the faculty that has had an energizing effect on the department. Realistically, we realize there will be challenges ahead in implementation, especially in areas impacted by the 'scaling up' of polytechnic efforts and approaches to a large number of students, and in faculty members needing to 're-invent' themselves as effective educators in this new paradigm. However, we believe the potential benefits far outweigh the costs that may be accrued, and see this as a necessary and novel initiative that will establish the future of the department and college.

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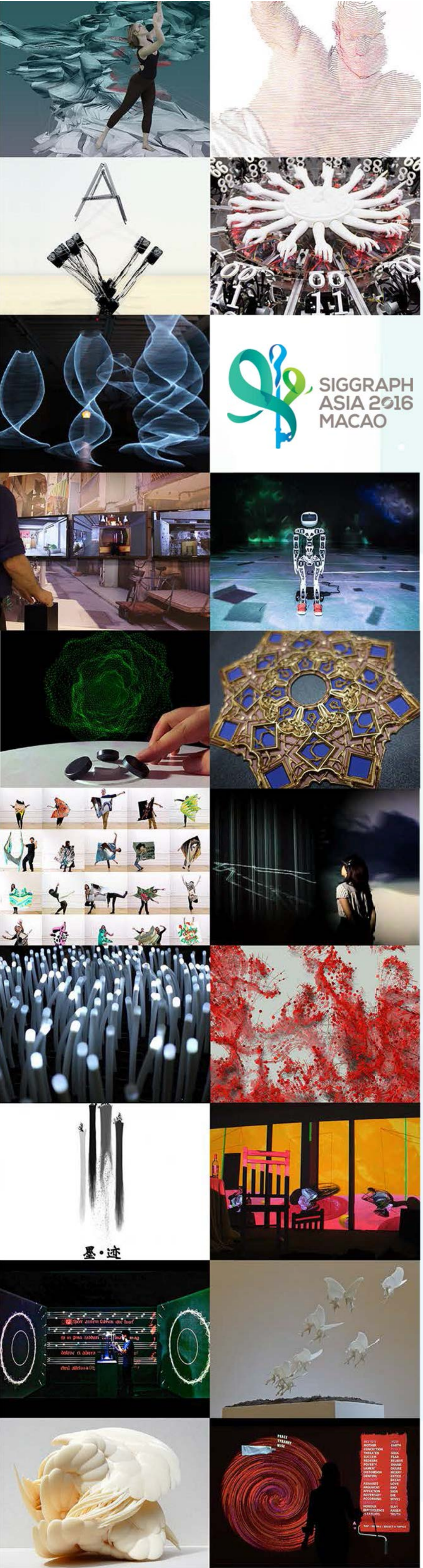


MEDIATED AESTHETICS

Art Gallery SIGGRAPH Asia 2016

December 5, Monday - December 8, Thursday
Macau University of Science of Technology

Monday 10am - 7pm, Opening Reception 5pm - 7pm
Tuesday 10am - 6pm, Wednesday 10am - 6pm, Thursday 10am - 4pm

Art Talks - Presentation by the Artists
December 5, Monday 10am - 4pm
The Venetian Macao, Meeting Room Naples 2653

Bodygraphe 身體圖像
Esteban Garcia Bravo
埃斯特班•加西亞•布拉沃
Tim McGraw 蒂姆•麥格羅
Aaron Zernack 艾倫•澤乃克

Journey through the centre_01
穿越核心的旅程_01
Keith Brown 凱斯•布朗

Forces in Equilibrium 平衡下的外力
Wei-Chun Chen 陳威郡
Su-Chu Hsu 許素朱
Yu-Hsiung Huang 黃裕雄

MovISee 我動故我見
Yen-Ting Cho 卓彥廷
Yen-Ling Kuo 郭彥伶
Yen-Ting Yeh 葉彥廷

Homes 家
Tamas Waliczky 湯瑪斯 瓦利奇
Anna Szepesi 安娜•塞派希
Jane Prophet 珍•潘洛菲特

Convolution by Wild System
野生系統的摺積定理
John McCormick約翰•麥考密克
Adam Nash亞當•納什

The Unbearable Lightness and Heaviness of Being
生命中不能承受之輕與重
Yuko Oda 小田 祐子

Medallions 浮雕圖像
Joe Takayama 高山稜

Agitato 忐忑
Rebecca Ruige Xu 徐瑞鴿
Sean Hongsheng Zhai 翟红生

Time Machine 時間機關
YouSuk Kim金裕錫
HuiBeom Yu 俞熙範
JungHwan Sung 成政桓

Criss~Crossing The Divine / Interactive Spiral Vortex Paint Game
縱橫交錯的預卜 / 互動式螺旋作畫
Nina Yankowitz妮娜•楊可維奇
Peter Koger彼得•考格爾
Barry Holden巴里•赫爾登
Mauri Kaipainen毛里•凱裴南

One-Stroke 一筆
Yuichiro Katsumoto 勝本 雄一朗

Sympathist 共感者
Wei-Peng Kuo 郭為凡
Jian-Wun Jhemg 鄭建文
Chia-Hsiang Lee 李家祥
Pey-Chwen Lin 林珮淳
Ink Fall 墨·迹
Haozhe Li 李昊哲

Notations 共譜
Johnson Liew 劉祖昇
Jie-Jun Zhu 周佳穎
Sheng-Chieh Wang 王聖傑
Jia-Ying Chou 朱潔君

Light Storm PLUS 光風暴 PLUS
He-Lin Luo 羅禾淋
I-Chun Chen 陳依純
Yi-Ping Hung 洪一平

Luminescent Tentacles 冷光觸手
Akira Nakayasu 中安 翌

NARCISSUS 水仙
Santiago Echeverry
聖地亞哥•艾奇維里

C. Bacon C. 培根
Wu Jiaru 吳佳儒

Art Gallery Chair
Scottie Chih-Chieh Huang, Chung Hua University, Taiwan

Art Gallery Co-Chair
Cynthia Beth Rubin ACM SIGGRAPH Digital Arts Community, Independent artist, USA

design by Rianti Hidayat

Bodygraphe

Esteban Garcia Bravo

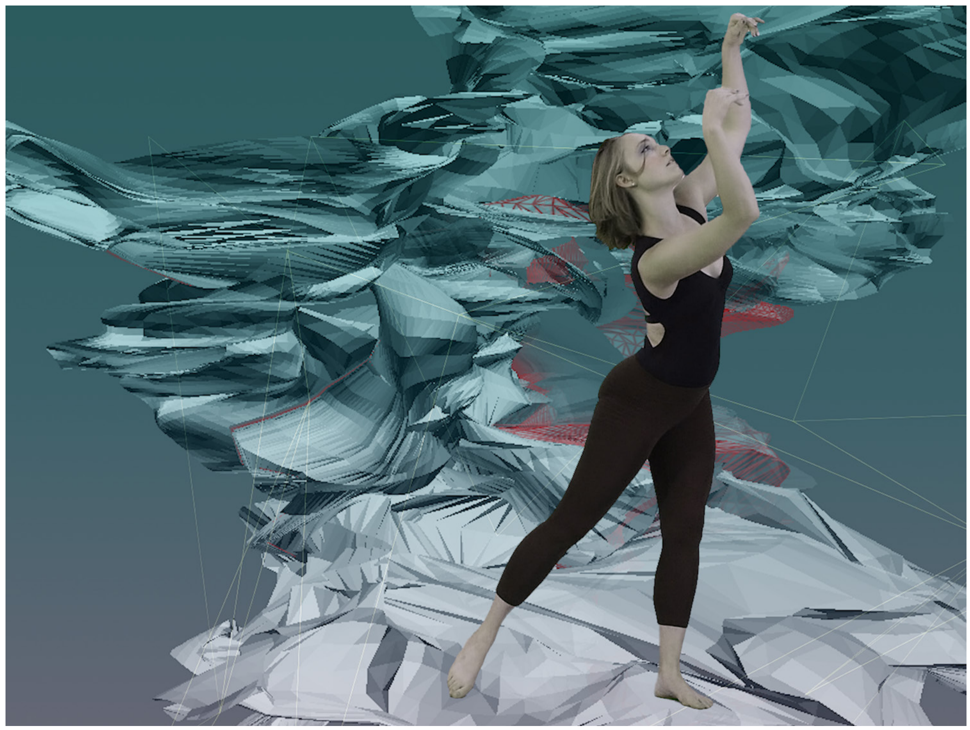
Purdue University
USA
garcia0@purdue.edu

Tim McGraw

Purdue University
USA
tmcgraw@purdue.edu

Aaron Zernack

Castle Bravo Tapes
USA
mineusprint@gmail.com



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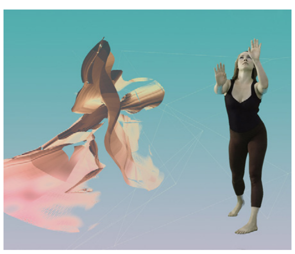
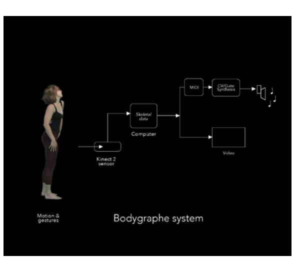
Amberly M. Simpson
Choreography
simpson.amberly@gmail.com





Bodygraphe is an interactive, visual music application that unifies gestural computing with live performance art. Dancers become instruments and conductors that wholly generate graphics and sounds that correspond with their movements in real time. This video is the result of a process in computational aesthetics that explores the relationship between the body and form. Most specifically, we were inspired by visual art avant-gardes that prioritized expressive geometry, such as the Neo-concrete movement of the 1950s. Through this project, we seek to make an aesthetic statement while also offering new implications for research regarding the interconnectivity between body and technology.

About the Artists

Esteban García Bravo holds a PhD in Computer Graphics from Purdue University, a MFA in Studio Arts from Purdue University and a BFA in Time Based and Electronic Media Art from Universidad de los Andes, Bogotá. His research on computer art history and digital media art practices has been featured in the annual meetings of international organizations such as SIGGRAPH, ISEA and Media Art Histories-MAH. Tim McGraw's areas of interest are procedural content generation, image processing and scientific visualization. He has been awarded 4 patents for visualization systems developed with Siemens Corporate Research. He has industry experience as a mechanical design engineer and as a game developer (Electronic Arts, Schell Games, Rainbow Studios). He received his Ph.D. in Computer and Information Science and Engineering from the University of Florida. Esteban Garcia Bravo and Tim McGraw are both faculty members in the department of Computer Graphics Technology at Purdue University.

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SHIMMER: THE ART OF LIGHT

HOME ARTISTS VENUES PRESS ABOUT CONTACT

CURRENT SHIMMER ARTISTS

The 2017 Shimmer Call to Artists is available here. Proposals are due November 21, 2016.

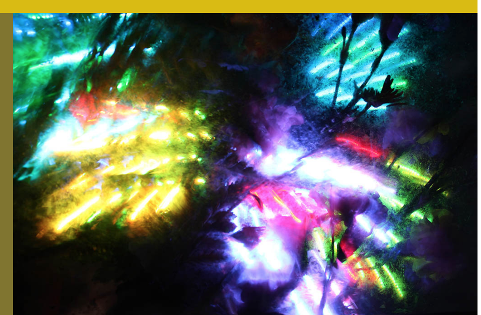
We are updating this page, so check back soon for artist bios and sponsor information. See our artists from SHIMMER 2016 here.

ALEX INGERSOLL

Stevens Point, WI • alexingersoll.com

ANDREA WOODS VALDES

Durham, NC • souloworks.com



ANDREW GOODMAN

Warren, RI • andrewlloydgoodman.com

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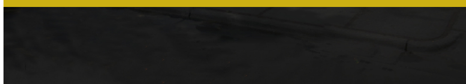

ANDY BERNER

Carrboro, NC

• cargocollective.com/andyberner

BOB KAPUTOF

Richmond, VA

• arts.vcu.edu/kineticimaging/faculty/bob-kaputof

CARLA ROKES

Wilmington, NC

• http://carlarokes.com/home.html

CARTER HUBBARD

Lake Oswego, OR

• www.carterhubbard.com

ERIN OLIVER

Durham, NC • erin-oliver.com

ESTEBAN GARCÍA BRAVO / MAXWELL CARLSON

Lafayette, IN

• carlsongarcia.com

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GREG CARTER

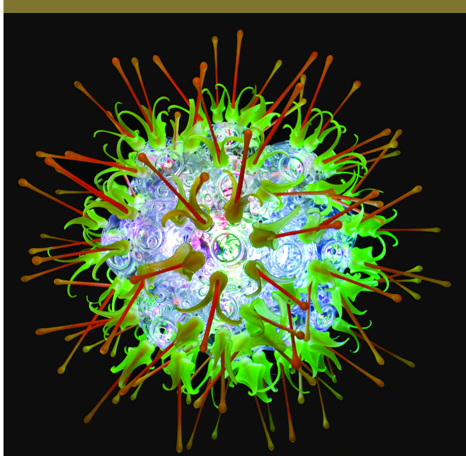
Raleigh, NC • facebook.com/cyberpig

HYE YOUNG KIM

Greensboro, NC • hyekimstudio.com

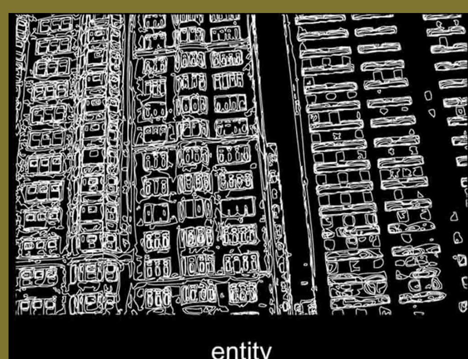
JAN-RU WAN

Chapel Hill, NC • janruwan.com



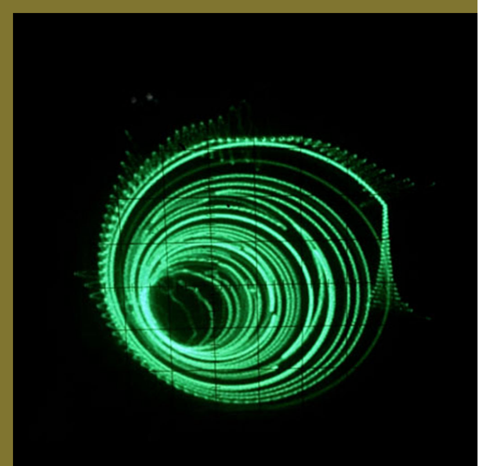
JONATHAN DAVIS

Pittsboro, NC • www.jonathanmichaeldavis.com



JOSEPH FARBROOK

Tucson, AZ • farbrook.net



LEE WEISERT / JONATHAN KIRK

Chapel Hill, NC / Chicago, IL • portableacoustic.com, leeweisert.com, jjksound.com

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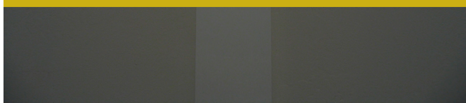


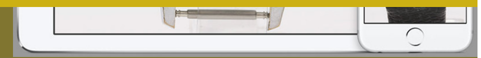
LIEN TRUONG

Chapel Hill, NC • lientruong.com

MATTHEW FORD / LIAM O'NEILL / TOMMY NOONAN

Carrboro, NC / Saxapahaw, NC

• culturemill.org



RHONDA WEPPLER / TREVOR MAHOVSKY

New York, NY / Toronto, ON

• wepplermahovsky.com

STACEY HOLLOWAY / JACOB PHILLIPS

Birmingham, AL •

staceyholloway.com,

jacobphillipsart.com

TIAN JIANG

Chicago, IL • tian-jiang.org

TIMOTHY DAVID ORME

Madison, SD

• timothydavidorme.com

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• zachduer.com

TODD BERRETH / PATRICK FITZGERALD / EMIL POLYAK

Raleigh, NC • studioberreth.io

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Logic Sunrise by Carlson / Garcia – Mad Tease by Dana Kalachnik

February 3 @ 6:00 pm - 10:00 pm

« iMOCA's Museum of Real and Odd The Midwest Sasquatch-Marc A. DeWerth »

Join us for another thought provoking First Friday down in Garfield Park. Listen Hear will be premiering two exhibitions. "Logic Sunrise" by the collective Carlson / Garcia and photography from Dana Kalachnik

"Logic Sunrise" by Carlson / Garcia – http://carlsongarcia.com/

This exhibit is inspired on the simple beauty of observing color and shape interaction. Logic Sunrise appeals to the visual perceptual system of the viewers for a pleasant sense of surprise through changing surfaces of orchestrated lights. Using primary red, green and blue LED pulses, our work engages providing a visual experience to all ages. The sculptures installed on a gallery wall, invite viewers to experience their own retinal interpretations of thousands of colors modulated algorithmically in the form of light. The designs are the result of a collaborative process engaged in a poetic exploration of shape.

The idea of "art as research" is a sentiment that we share by pushing experimentation in all aspects of our production: from the design of counter-intuitive shapes to the use of digital logic.
Carlson Garcia is a collective effort by artists Maxwell Carlson and Esteban García Bravo to create a unique display of sculptures and assemblages.
We explore designs that evoke multiple retinal interpretations of space questioning constructs of shape and color perception. Our aesthetic is influenced on lyrical geometric abstraction and optic tendencies that occurred during the twentieth century, while also incorporating new technologies for the design and manufacture of sculpture.

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RT @katiehc: Great to hear from @MaxYoder of @lessonly at the @IndyChamber Forward Lunch with @IndyHub at @bigcar! https://t.co/v57loPfcSv
14 hours ago

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"Mad Tease" by Dana Kalachnik – http://danakalachnik.com/
My aim is to look at the hidden ugliness beneath the surface of self and broadcast these perceived dirty things in a beautiful, euphoric and vibrant way. My artwork revolves around a singular driving concept, which I call "All the Women in Me."This succinct phrase encompasses my photographs because I am constantly meditating on the vast complexities of womanhood. I am overwhelmed with the beauty of the female form to provoke and celebrate a new explanation of self while also propagating
feminine solidarity.

I am starting to learn my stories that help me make sense of who I am, and often writing new ones. Lately, my stories are bits and pieces, recollections, details, an emotion or a gesture that resonates with me. Malleable and bending my stories take interest in what we portray to others and what we cover up with our actions and language.

Womanhood by nature is a metamorphic and an alluring creature. It is subtle yet provocative. It is lush with dark secrets, relationships, and self discovery. My art reflects this through its diaristic aesthetic as there is a continuous movement between one series to the next.

+ GOOGLE CALENDAR + ICAL EXPORT

Details

Date: February 3

Time: 6:00 pm - 10:00 pm

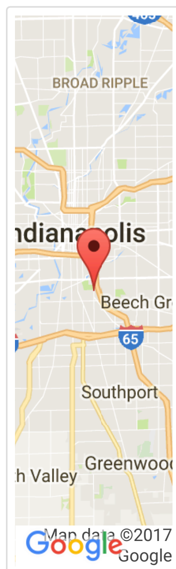
Venue

Listen Hear

2620 Shelby St,
Indianapolis, IN 46203 United States + Google Map

Phone: 317-721-0238

Website:
https://www.facebook.com/pages/Listen-Hear/1019844324696664



« iMOCA's Museum of Real and Odd The Midwest Sasquatch-Marc A. DeWerth »

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Arte y tecnología, juntos y revueltos

En el espacio Casa Hoffman, de Bogotá, una muestra colectiva con obras de arte de **corte experimental.**

María Alejandra Toro Vesga
Cultura y Entretenimiento

Video, sintetizadores de sonido, impresoras, reproductores de discos que hoy en día son objetos de culto y para algunos obsoletos, forman parte de *Aparato*, muestra colectiva con artistas colombianos y extranjeros que se presenta en Casa Hoffman. Cada uno de ellos explora temáticas que van desde la política hasta la historia o la biología y tienen como elemento común que operan con la intervención del ser humano.

Uno de estos objetos es una greca que pesa 10 kilos. Sí, una greca para hacer tinto, corriente en cafeterías y oficinas. Esta se transformó en un vaporizador de tetrahidrocannabinol (THC), componente químico de la cannabis. La idea es del Colectivo Paramédicos (Colombia), y es "una ambivalencia entre la legalización de la sustancia y su consumo generalizado", explican los artistas en el texto de la propuesta.

La muestra "propone explorar la porosidad física y conceptual del aparato, en tanto máquina que captura o produce imágenes o sonidos (...), pero también en tanto sistema, cuerpo y red de neuronas", señala el texto de la muestra, que fue curada por Andrés Burbano. Una obra que refleja lo anterior fue concebida y desarrollada por Juan Cortés, con tres piezas, las cuales, a partir de un mecanismo sencillo y con materiales cotidianos como imanes, limadura de hierro y óxido, crean un microam-

Obra de William Aparicio, quien participa en 'Aparato'. Archivo particular

Obra de Ana María Londoño.

¿DÓNDE Y CUÁNDO?

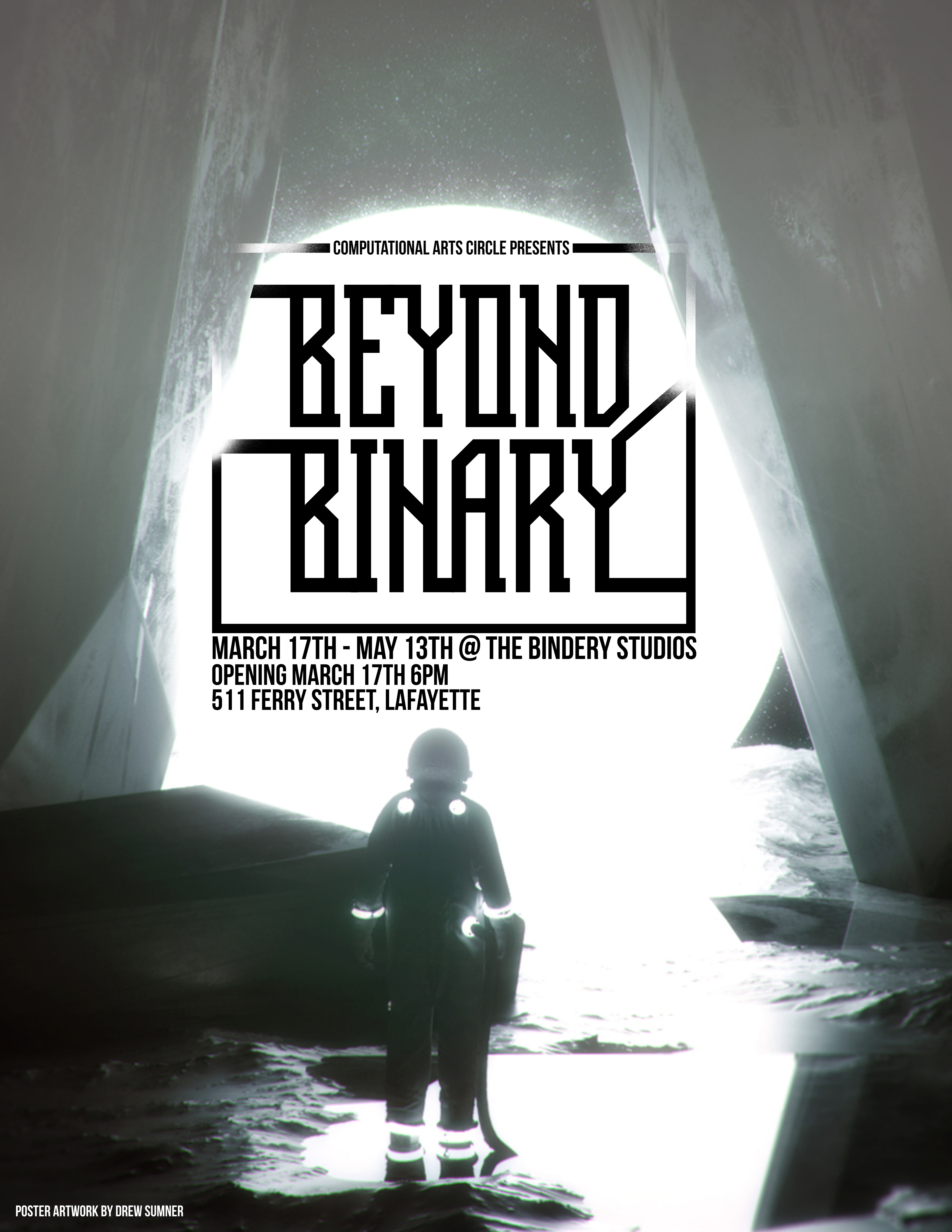
'Aparato' se verá hasta el 30 de abril, en Casa Hoffman. Cra. 3ª Nº 63-68, Bogotá. Horario: martes a sábado, de 3 a 7 p.m. Informes: 312-4390627.

bras (Xavier Hurtado), *Drum Machine* (David Vélez), *Skriabin* (Jorge Barco) o *Traza una línea recta y síguela* (Mauricio Bejarano).

Pero esto no significa que haya ausencia de sonido en el resto de las obras. Al contrario, en el caso de Jorge Vaca, el sonido de una impresora de punto se convierte en un tempo que inevitablemente devuelve al siglo XX, cuando estuvieron en auge.

O *Durmientes*, de Gabriel Zea, quien expuso en la Biblioteca Nacional como homenaje a Gabo y que solo opera si detecta movimiento. Y el silencio – que puede convertirse en un sonido– se presenta en las piezas de Bejarano y en *U.P.S.H.C. A.R. (Un pueblo sin historia condenado a repetir)*, de Carlos Rojas Verona. Esta creación es definida por su autor como un "ensamble cinético" en el cual el caballo de juguete, el baúl antiguo y un gramófono recuerdan otras épocas. Una crítica social y política no explícita, pero presente.

Otras obras, las de Karen Aune, el Colectivo Espacial Mexicano, William Aparicio y Carlson-García (EE. UU.-Colombia), son creadas gracias a la fascinante y cada vez mayor relación entre arte y tecnología, que permite modificar láminas de microfilmes (como las usadas en bibliotecas) y usar programas de computador para propiciar reflexiones y experiencias.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