**CREATING PROBLEMS: A Math and Art Liberal Arts Research Collaborative**

***Introduction***

In this project, professors Cayla Skillin-Brauchle (Art) and Josh Laison (Mathematics) will be joined by students Peri Hildum (Art), Daphne Jacobsen (Math), Allison Kerkhoff (Math) and Arthur Stamey-Mills (Art) to explore the intersection of art and mathematics and produce a body of artistic works and mathematical theorems. The disciplines and scholarly pursuits of art and mathematics are surprisingly similar in their commitment to ideas of problem-solving and process. Both fields rely on asking a series of questions, testing them out, refining ideas, executing a finished a product and sharing results. In our early discussions we are finding that artists and mathematicians use similar language and creative processes to pursue distinctive works.

Conversations about formal mathematical definitions versus artistic interpretations (e.g. symmetry), aesthetics and how they communicate, systems to make patterns and how they are visualized, and the spectrum from abstraction (e.g. theoretical) to realism (e.g. analytical) have pervaded our initial meetings. We realize we handle similar pieces of language and processes differently and we have been interested in how they create vastly different outcomes.

***Goals***

We have a physical goal to create a studio space of interdisciplinary collaboration where we can see the similarity in drawings and math notes. We have a process goal to physically manipulate materials and space to express our ideas. We have a theoretical goal to create meaningful intersection between art and math, without essentializing either.

Overall, we intend to assemble a public display of works created throughout the summer revealing discoveries connecting mathematical and artistic thinking. We hope this exhibition can be presented in a variety of venues to reach a large audience. Possible venues include the student art gallery, Ford Hall, and public sites in Salem.

***Structure***

Our team will employ a mode of working in which we come together to conduct creative experiments, solve mathematical and artistic puzzles, and engage with diverse rule-systems. These guiding experimental activities will jumpstart our process while opening up potential lines for in-depth collaboration amongst team members.

As our LARC progresses, we envision these activities as one avenue for receiving meaningful feedback on our projects. Questions might arise: Does this visualization express this idea? What is your intellectual or physical experience of this artwork?

Cross-pollination of ideas will be encouraged by setting up an open studio work space. We envision this space as physical and intellectual ground for creative problem-solving. In frequent critiques we will discuss our work and provide feedback both from our own areas of expertise and as disciplinary outsiders.

**Faculty Team Members**

***Josh Laison, Associate Professor of Mathematics***

***(Word count 425)***

In our summer 2017 LARC project I plan to begin a new research project in graph symmetry breaking in collaboration with my research students Daphne Jacobsen and Allison Kerkhoff. In graph theory, a graph is a network of points, called vertices, and connections between those points, called edges. A symmetry of a graph is any permutation of the vertices that ends with vertices and edges in the same locations as they were before -- to someone who wasn't watching, the graph appears to not have moved. Research in symmetry breaking in graphs analyzes ways to remove the symmetry of a graph. For example, we can color vertices so that permuted vertices are now distinguishable, or fix vertices in place to prevent them from moving. A research question might be, for a particular family of graphs, what is the fewest number of colors needed to remove all of their symmetries?

***Project’s State of Evolution***

My interest in the field of symmetry breaking started with a research project with an undergraduate student in summer 2005, while I was a visiting professor at Colorado College. This project was published in the Electronic Journal of Combinatorics in 2009, and is a jumping off point for our current research. I have found discussion with student collaborators an invaluable source of new research questions, and we plan to begin this new project from a similar place of collective inquiry.

***Methods for Engaging in Collaborative Work***

In theoretical mathematics research, a group of researchers work in collaboration to discover new mathematical patterns. Often the central theme or underlying narrative of a research project changes as the project progresses, based on which new questions the team is asking and what the answers turn out to be. In this project, we will additionally adapt and transform this traditional way we think about these problems through the influence of our artist collaborators. We will produce, not only new mathematics, but artistic works which grow naturally from our interest in communicating the depth and beauty of the mathematical forms under study. We envision an iterative process by which our mathematical results might inspire artistic creations which would in turn inspire new mathematical questions, and so on, leading to uniquely original outcomes. Graph theory, with its emphasis on aesthetic pictorial visualization of mathematical ideas, is particularly suited to this process. With our new familiarity with artistic technique, we hope to be able to create art that communicates mathematical questions and inspires the audience to formulate and solve their own mathematical problems.

***Outside Funding***

We require no outside funding.

***Cayla Skillin-Brauchle, Assistant Professor of Art***

***(Word Count 457)***

“Draw a straight line and follow it.”

 --Fluxus score by LaMonte Young

Fluxus, an experimental art movement born in the 1960’s, relies on scores. Scores are directives or rules passed from one artist to another resulting in impromptu performance art, sculpture, and drawing. This summer I plan to dive deeply into the study and practice of rule-based systems as a mechanism to push my studio practice in unexpected directions. Particular goals include: investigating new approaches to conceive performance art events, exploration of public intervention tactics, and developing an alternative methodology for a new drawing project.

My artwork, particularly my drawings and installations, continually reference patterns and often utilize systems to create the basis for artwork. Creatively analyzing and visualizing personal data is a long-time practice. It was not until Josh Laison suggested that my work was mathematical that I began to wonder how thinking more acutely mathematically could enrich my studio practice. The subsequent conversations with Josh and our student collaborators have deepened my interest and brought up many questions/debates about the overlap of mathematical and artistic thinking.

***Project’s State of Evolution***

In April 2017 I will present a new body of work, SUPERSPEED!, at the Hallie Ford Museum of Art. This project is the culmination of a research project started in 2012 as part of a Fulbright-Nehru Fellowship to Mumbai, India. During our 2017 LARC my investigation into rule-systems is a way to reinvigorate my studio practice in the wake of this massive exhibition and begin to develop my next body of art-work.

***Methods for Engaging in Collaborative Work***

Fluxus scores are inherently social. Traditionally one writes a score and passes it to another artist, musician, etc., who, in turn, performs the score the best way they see fit. The aforementioned experiments proposed as a building block of this LARC will allow me to do just that—deeply consider the social possibilities and limitations of my practice. I see these times together as opportunities to pilot projects, refine pedagogy surrounding performance art and drawing, and as collaborative engagements.

As an artist I require both time to dive deeply into my personal studio practice and the stimulation and feedback of other artists. These two modes, making and thinking, are crucial for crafting meaningful artwork. Arthur Stamey-Mills, Peri Hildum, and I will negotiate that balance together as a group of artists with our mathematician collaborators. I hope to model what it means to be an artist deeply committed to making communicative and socially-engaged artwork and intend to do this by: 1) Problem-solving artistically and mathematically with my LARC team 2) Presenting my in-progress projects (including thought-processes and my artistic choices) to the team for feedback 3) Investing in their projects.

***Outside Funding***

Currently we have no outside funding.

**Student Team Members**

***Peri Hildum***

***(Word Count 499)***

I intend to develop the relationship between math and art to show how creative and analytical thinking interact with one another. As an artist, I have learned concepts of math throughout my life and accepted them as a method of creation but never quite understood how important they relate to one another. Architecture and design are two forms of art that I am interested in for my senior thesis as well as possible career outlets and studies for graduate school. Having a deeper understanding of math and its connection in art is a vital subject to my understanding and thought process. Mathematical subjects will add an additional level of practicality and reasonability to making and carrying out project proposals. The research I will do will not be a single art project but multiple pieces exploring concepts shared in art and math.

I visualize my studies in math and art in the form of a Venn diagram. One circle is a strictly artistic theory focusing on a pursuit of aesthetic and challenging creations. The other circle is a mathematical and analytical way of thinking with the goal to write theories, make discoveries, and solve problems. Both circles are only my initial definitions of math and art which I am looking to develop and overlap in the middle. I want to make the two circles overlap completely. This will be in my art theory, the prompt of a piece I work on, or a statement I intend to make with a single work or concentration. Specific subjects I plan to study include patterns, processes, and perspectives.

Patterns play a big role in math and art. Analysis of patterns can be the audience's way of understanding a mathematical study as well as in art. I would like to play with how the audience views and processes different forms of data. Applying this in a visual element will involve texture and size. For this I will experiment with textures of varying materials such as acrylic based house paint (which I have previously worked with in past art classes), paper (in various forms), and marks on different surfaces.

The process of ideas in math and art are surprisingly similar. The creator of the idea writes it on a piece of paper and perfects it by erasing and adding lines of information. I plan on taking notes on the similarities and differences in these processes and adjust my own idea making.

A year ago, I took a sculpture class and multivariable calculus. This combination inspired me to bring my drawings and two-dimensional art to a three-dimensional level. I am interested in studying shape and space and the interaction of the mind with these visual concepts. Materials I am interested in using for this concept include, but are not limited to: string, wire, paper, cardboard, and wood installations. These would allow me to create structures on varying scales that will perplex not only the mind of the viewer but the mind of the creator as well.

***Daphne Jacobsen***

***(Word Count 475)***

I have studied Linear Algebra, Abstract Algebra, and Real Analysis. The most lasting remnant of these abstract courses was a paper hexaflexagon, whose rotations and flips are an example of the dihedral group of order eight. The hexaflexagon tangibly let me understand the properties of a group. This understanding is part of my ability to connect mathematical ideas and to problem solve. With it, I climb into the abstract structure of math. In a field comprised of grandiose abstract theorems that fit perfectly together and appear all over our world, problem solving lets me connect and understand the abstract principles. When I transition classes, to walk over to the Art Building, my conception of problem solving also shifts. There, I am familiar with the ideas and problems, unlike in Ford, because they are of my own creation. The problems I must solve are how to best communicate my idea to others with my art. My notion of problem solving in math and art overlap in my work to understand other’s work and communicating my own.

With my personal project I will connect my ideas of problem solving in math and art with tactile outcome. With this artistic object I hope to inspire others to ask mathematical questions and find the answers within the work. This idea first came to me when I was interacting with a polygon that says “O**I**U**N**T” on Professor Laison’s door. To understand that the squiggle was one shape with an inside and an outside I had to trace the edge of the shape with my finger. I would like to share this experience in understanding through the LARC project. I am very interested in the collaborative and experimentative aspects of this project. My idea for my personal venture is loose and I anticipate that this idea with transform and clarify with the LARC group. I could see it turning into a project with yarn or other fiber arts; an interactive outside space, such as a maze; or small pieces reminiscent of children’s toy with which people can create patterns based on their rule systems.

This project will strengthen my skills in experimental thinking and challenge me to work in an environment without a controlled outcome. These concepts are important life skills, will serve me in any area and expand ability to design a fulfilling future for myself. I gravitate towards creative thought and it serves me everyday in math, art, and the formation of new ideas. However, I admit undetermined future does scare me. While I am interested in data analysis and strategic, analytical thinking, I recognize that those skills are a very powerful tool that can help in every industry. Participating in this LARC will help me better understand my academic focuses, expand my experience with public engagement, and most importantly, give me the confidence to define my own success.

***Allison Kerkhoff***

***(Word Count 497)***

Math and art are too often seen as complete opposite ends of the spectrum. While I have always had some interest in art, and I love watching artistic projects unfold, I have typically either been a facilitator or observer of them rather than a participator. Recently, I have taken up painting, and it has completely changed the role of art in my life. When I was young and became overwhelmed, I would do math problems; now, I paint. Both math and art have become a sort of escape for me, which is why I am thrilled for the opportunity to work on this LARC.

An overarching question that I hope to be closer to answering by the end of the summer is: what is a true blend of math and art? With this question in mind, I will be working under Professor Josh Laison to explore the more visual side of math. While we want to steer clear of deeming math as art simply because it is visual, this seemed like a natural place to start. We want to keep our subject area broad, as per the nature of math research. I find the idea of graph symmetry breaking incredibly interesting, and I personally would like to explore the tactile nature of math and art. While I am a mathematician, being a visual thinker is difficult for me. This is why physical mathematical objects that I can touch and move are incredibly important in my understanding of math. Because of this, I would also like to create art that in turn communicates our math research in a tactile way. The senses are incredibly important in my understanding of math, and I hope to use them as a bridge between math and art this summer.

I would like to be a high school math teacher, and this LARC is already giving me new insight into how I will structure my classroom. High school math can be very mundane to people who are simply not interested in learning it. I hope to engage students of all learning styles and types of thinking, whether they are left brained or right brained, to learn through using the arts as a tool of creative understanding of math. With math as a doorway to creativity, my students will be excited to learn math in a new and different way.

It is unfortunate that math and art seem, to many people, like two fields that people tend to stay away from if they believe they are “not good at them,” as if you need some special innate skill to be able to enjoy either subject. I truly believe you do not need some special genetic skill to be successful in either, but just a passion to learn about both. Throughout the summer we as a community will develop a unique understanding of how the two disciplines can come together rather than oppose each other, and this makes me incredibly excited to pursue this LARC.

***Arthur Stamey-Mills***

***(Word Count 492)***

My fascination with the combinations of math, particularly geometry, and art has grown slowly throughout my entire life. I took my first dance class when I was four years old, creating shapes with my body for many years through modern and ballet dance classes. I took my first geometry class in 8th grade and was instantly hooked on the transformation of lines into angles and then into shapes. I took my first visual art class in my junior year of high school and finally found a place to display my combinations of movement and shapes on a two-dimensional medium. This LARC excites me because I feel that all of my fascinations are being combined into one opportunity.

Looking at a line or segment is in many ways my base for experimentation and creation. These simple lines can create infinitely complex pieces within one space. Over this upcoming summer I plan to play with how lines can create patterns and connect in a variety of media, such as video and installation art. I also want to create a three-dimensional grid and examine how grid theory and the algebraic structure of groups can create interesting visuals; and also see how those visuals can change as the point of view shifts within the space. To further my examination of lines in space, it would be interesting to use different mediums such as elastic or string, but also looking at human movement and dance. This LARC will allow me to explore my ideas and collaborate with the ideas of others to create a piece of art that will communicate mathematics to an audience in a multi-sensory way.

Personally, I find that it is very limiting to plan exactly what I want to do and then stick to that same plan until fruition. One of the most important ways to grow my artistic style is to generate new ideas and possibilities whilst I create and plan. Art is fluid and every new idea can inspire new projects and directions. Having the chance to work with my peers on this project will allow not only my to grow as an artist and mathematician, but for us all to learn from each other and grow as a collective. Along with getting input and observing other people’s creations, I feel my grant work will be ever developing, all while having the goal of making meaningful artwork.

As I continue to explore higher education one thing continues to be an important idea in formulating my future; being unconstrained in the subjects I attend and pursue. This LARC will directly contribute to that mentality, in which my interests won’t be just art or just math but a thoughtful connection between different disciplines. These new connections with subjects and people will continually open up ways of thinking critically and produce growth in how I communicate and think. This opportunity and challenge will help build inspiration for all things I pursue in the future.

**Budget items:**

Field Trip Expenses (gas, additional travel costs, sites and tours cost) $375

Art and Math Supplies for Various Mixed Media Work $1050

(Materials, Facilities, 3D Mediums, Software, Books, Videos, etc)

 $175/6 people

Exhibition (Presentation, Transport Costs, Publicity) $75

+ **\_\_\_\_\_\_\_\_**

 Total:  **$1500**