Turbidity Paintings: Communicating Science Through the Lens of Art

Sara Gevurtz | Thomas Asmuth
Hastings College|University of West Florida
United States
skgevurtz@vcu.edu | tasmuth@uwf.edu

Abstract

The project "Turbidity Paintings," proposes a new visualization methodology to record images and collect data on water quality. The core of this is to develop a system of image collection using do-it-yourself technology. Collected information is being used to construct a library of time explicit images encoded with data metrics from a variety of domestic and international locations. "Turbidity Paintings" explores and challenges the divide between the arts and the sciences and directly questions the role of the artist when dealing with science and scientific data. Art and science are not so vastly different in their approaches. The role of the artist and the art in this project is to create an experimental model by which to develop new ways to create a dialogue around, in our example, water quality.

Keywords

Data Visualization, Transdisciplinary, Interdisciplinary, Environment, Water Quality, Science and Art, Steam, Design, Research, Science Communication, Turbidity

Introduction

The project "Turbidity Paintings" proposes a new visualization methodology to record images and collect data on water quality. Information gathered in the field is being used to construct a library of time-specific images encoded with data metrics from a variety of locations, both domestic and international. The project initially experimented with using submersible remote operated vehicles (ROVs) that would be equipped with specialty tools for data collection. It has evolved to the use of a rig setup. The artists capture images in order to map the turbidity or clarity of the water.

The project seeks to create data that simultaneously exist as both an aesthetic work and as useful data of its own accord. The images and the data collected are displayed as unaltered artworks. The data and images are being analyzed to determine trends and differences in water bodies in terms of water quality. In this manner, the project seeks to provide the unassailable truth of scientifically collected data without alteration, at the same time present the data in a way that engages and produces an emotive response in a lay audience.

The legibility of the images as pure data is not the only function of the project. The experimental project process seeks to create a dialogue between the sciences and the arts by bringing together a trans-disciplinary team of artists and scientists to collaborate and discuss. This notion is not a new one, but is increasingly relevant with the growing divide between the general public and the sciences. In fact, the concept of bringing the arts into the sciences provided the focus for an article in the New York Times titled "Are Artists the New Interpreter's of Scientific Innovation?" published in 2017. The problems of the future will require teams of critical and creative thinkers tackling these problems from different angles. More importantly, the opportunity to practice in the use of a hybrid language (or Creole) will help develop the idea of working on projects using experimental processes with teams of wide-ranging expertise. Indeed, a scientist collaborating on the team has been able to use the images generated in this project for to provide data for her research, thus illustrating the ability to create images that exist as both art and data.

The Need for Art Engaging Science

Communication of environmental science research presents a problem of abstraction by where 'one cannot see the forest for the data.' One can see the results of this complex issue in the considerable amount of controversy about human impact on the environment/climate filling news headlines. Commentary from international figures, from religious to presidential, publicly taking positions on crucial environmental data has become highly politicized. Due to this phenomenon, it is increasingly important to create work that engages and creates dialogues with and around these topics.

"Turbidity Paintings" is attempting to create a result that is both art and data. This is a direct challenge to the more traditional role of the artist when dealing with science, as someone who visualizes existing data for mass consumption to the public. While visualizing data gathered by scientists provides a very valuable service, this relegates artist to the role of the translator as opposed to co-equal collaborator and thereby diminishes the potential contribution of the artist. The objective of our inquiry is a real collaboration. In a sense, this project seeks a chimeric blending of art and science to create a more intertwined discipline by combining the DNA of each.

The call for a dialogue between the Arts and Sciences is not new. The most famous of these appeals for breaking down the perceived barriers between them is the 1959 lecture by C.P. Snow, "The Two Cultures." Snow observed that two languages, one of the sciences and one of the arts, were becoming increasingly dogmatic: untranslatable and unrelatable. He was deeply troubled that he saw little interest or ability in discussion across the aisle at the University of Cambridge. Sixty-five years later, his eerily prescient warnings closely reflect the siloed disciplines of academia and research today. Indeed, there has remained a deep polar divide across many aspects of human culture for the past six decades. Equally, Snow's essay is a watershed moment marking the start of a very early interest in interdisciplinary work.

Using Snow's appeal for a dialogue between the "Two Cultures" provides the first step of true collaboration. This project's inquiry seeks to go beyond an interdisciplinary methodology (the role of the translator mentioned earlier) to create a "transdisciplinary"

framework. The term "transdisciplinary" suggests a deeper engagement than the more commonly used term interdisciplinary.

To frame the term transdisciplinary as distinct, one can look to biology and the idea of mutualism. Mutualism is a "relationship existing between two organisms of different species which contribute mutually to each other's well-being." Commonly known as a symbiosis in the biological sciences, the idea has extended to the complementary dependencies in social systems. This operative function is expressed in the etymology of the prefix trans-.

While this points to experimentation and inquiry, explicitly, interdisciplinary is an attempt (whether successful or not) to form a bridge. Inter- also suggests the idea of being between domains, but notably outside. Trans- allows for passage into another discipline. The use of prefix trans- denotes a journey into the opposite domain. Latin preposition trans- [denotes] 'across, to or on the farther side of, beyond, over',[1] thus a constructive space, reframed by the overlay or admixture of new ideas. The subtleties suggest a direct interaction versus a negotiation. Metaphorically, interdisciplinary is the doorway, negotiation table, meeting, while transdisciplinary is the condition of interdependence, reliance. The two sides need each other to be entirely successful.

The lack of an interdisciplinary language may be a symptom that helps explains why many a lopsided collaboration takes place. In these interdisciplinary collaborations, the artist is often not an equal player in the collaborative efforts. Interdisciplinary resides implicitly as a connecting, but an exclusionary space, alien to the disciplinary frameworks which it sits "between, among, amid" fields of inquiry.

Our methodologies are based on science and the arts; we use all of this to capitalize on similar processes and to create a recombinant framework. To evoke yet one more biological metaphor: these mixtures are used to create a disciplinary offspring with characteristics of both progenitors.

Art As An Experiment

Art and science are both at their core experimental in nature. However, their end goals are often different. In science, the experiment is often intended to test a scientist's hypothesis. However, the experiment is sometimes also simply trying to determine something new. Occasionally they even come up with an aesthetic outcome simply by accident. Art, while not trying to answer a question or prove a hypothesis, is seeking to discover something new through media experiments and trials and errors. Both art and science are attempting to uncover the natural world through their different, though similar, methodologies.

The question thus becomes whether it was possible to develop a visual methodology that would result in a

piece that could reside in both the art world and the science world? Is it possible to create a piece that would not only result in an aesthetic work, but also provide valuable data on water quality? The process to obtain this data has been incredibly experimental, and essentially requires attempting the development o a new method of gathering and visualizing turbidity data with new do-it-yourself, or DIY, equipment. The development of the equipment has been an evolving experiment.

In 2015, the idea was proposed for Turbidity Paintings to be an image-oriented investigation of water quality. The aim was to focus primarily on turbidity, or the clarity of the water. Turbidity, as a specific metric, was an obvious candidate for various reasons including that it is regularly measured visually in the marine and environmental sciences using the Secchi disk. The Secchi disk is dropped into the water, and a measurement is taken at the point where the disk disappears under the water. Although this method is not purely an aesthetic practice, the procedure struck us as deeply intertwined with issues of perception and visual communication.

Aesthetics in the sciences is not a primary focus of research. It is often a byproduct. Many images have come out of research that one can view as "aesthetic or beautiful." While this might be the case, the goals for obtaining images or objects was to better understand, explore or explain a system. Therefore, this project explores the idea of creating scientific objects with this aesthetic awareness from the initial stages.

The second reason for choosing turbidity was that it is often an indicator of other problems in the water; turbidity is one of the many metrics monitored by water districts. Causes of turbidity can include suspended particles brought into the water by erosion or runoff and biological organisms (algal blooms), just to name a few. In the past year, there has been significant public awareness about issues that correlate to turbidity due to news coverage of environmental algal catastrophes in Florida and California. It is feared that these blooms will become more prevalent in the coming years thanks in part to the rapid changes in climate.

Figure 1. OpenROV at the University of West Florida Aquatics Center.

The original proposal was to use the OpenRov, an open source submersible that was designed as a modifiable kit project by a team in Oakland CA. This remotely operated vehicle (ROV) submersible is a spinoff of both the open source hardware movement and idealistic development in consumer drones. One key feature of the OpenRov as a platform is that the base model includes an HD camera. The base model also has undesignated ports to allow for the addition of sensors for customization.

The technology has been enthusiastically embraced as part of citizen science technologies because of the relatively low cost, and because it was developed through the open source community, it is easily modifiable. A large international community regularly helps test new developments and publishes directions on modifications to the platform and peripherals.

The intent was to be able to use the OpenROV to obtain images at various distances, with the result being a grid of images showing what we hoped would be relative turbidity within the water column. Along with the images that would be obtained, the goal was to be able to gather additional data using sensors added to the OpenROV. Examples of other types of data that would

be gathered include dissolved oxygen, temperature, Nitrite, among others. These would then be encoded into the label for each image. The idea for "encoding" the title with the data is a nod to On Kawara's methods of titling his work in the "Today" series. These images would create a database that existed as both usable data as well as an art object. The fact that it could be read as data is very important. This importance goes back to the fundamental idea that art could exist in both realms, and that a scientist could look at the images and make a deduction about the water quality based on the data presented in the work.

While the images need to exist as data, they must also be viewable as art. "Turbidity Paintings," makes references to the 20th Century artists who worked within the procedural art movements such as Conceptual Art and Art & Language. The intent of the project leans heavily on rule-based systems as found in Ono's Grapefruit or Brecht's event scores:

1. submerge backdrop
2. take a photo of water against background at 4, 3, 2, and 1 foot
3. other data used as title (see example of chart and concatenation of metrics below)

Parameter	Results
Dissolved oxygen	51.5%
Dissolved Oxygen	3.66 mg/L
Salinity	25.8 ppt
Specific Conductivity (Corrected for Temperature)	40.32 mS
Specific Conductivity	39.55 mS
Temperature	24.0 C
NH3 [endif]	0.47 mg/L
PO4	0.15 mg/L
NO3	0.00 mg/L

30.353476, -87.038614, 51.5%, 3.66mg/L, 25.8ppt, 39.55mS, 24.0C, 0.47mg/L, 0.15mg/L, 0.0mg/L

Figure 2. Example of data obtained from field.

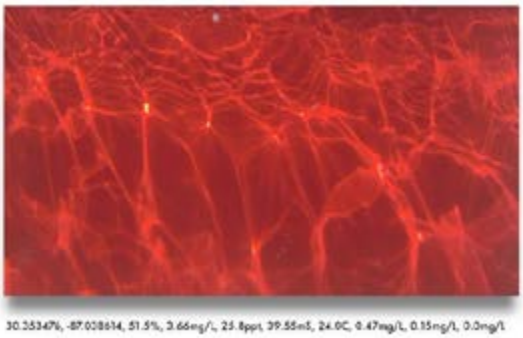

Figure 3. Example of image taken from rig using red backdrop, including data title.

Distinguishing the aesthetic goals of the work is necessary. The images collected are of the water column, not nature photography of the ocean floor or the sea life below. Despite the locations of the production, the methodology will adhere to assessable and repeatable procedure in deference to the references as mentioned earlier and the tenets of sound experimental design.

Transdisciplinary in Action

The project is not only conceptually hybrid but intentionally requires a "transdisciplinary" team. The project would not be possible without all the disciplines coming together to work on it. During the early preproduction of the work science experts were consulted that led to the assembly of a multifaceted team of student assistants and colleagues from digital art, engineering, biology, environmental science and marine studies.

The opportunity to explore the transdisciplinary practice with the student production and research assistants was pivotal. The project has also become multi-regional, though, for logistical reasons, it is currently focused in Pensacola. The usefulness of being in multiple locations hinges on the idea that the project will prove that it can draw useful data from multiple different water sources. The issues that are problems for an ocean are going to be different than the issues facing a river or lake.

Once the ROVS were ready for deployment, they were taken out to the water. The ROVs were first taken to a controlled environment. The location chosen for the maiden voyage was the Aquatics center at the University of West Florida. Here, the ROVs were launched, and the team was (both figuratively and literally) able to get their feet wet in learning how to operate the OpenROV. There has been quite the learning curve with this project. As the project is forging new terrain, there was no pre-existing manual to be followed, except for the all-important instructions from OpenROV that stated what to do in case water floods the main compartment of the submersible. Some of the first things that became apparent were the critical necessity of that having a team on hand. The difficulty of driving the sub (though the extent of this problem did not become apparent until taking the ROV to a body of water that had more of a current), and the very necessity of developing a checklist or manual for "preflight," during and "postflight."

While much of the checklist has been developed, the technology has proven to be challenging. The focus has therefore shifted from whether we can use the OpenROV to get useful photographs, to whether the whole premise of obtaining photos that result in both an art piece and usable data is possible. In order to test this further, a more rudimentary rig was developed using primarily PVC pipe and a GoPro for the camera. (Figure 4)

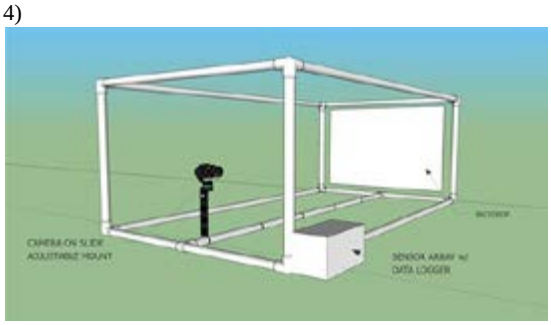

Figure 4. Mock up of rig.

Figure 5. Rig being taken out.

Since June 2016 the team has been making trips to lakes and beaches around the Pensacola area to develop the methodology and gather images. These trips have

allowed for the start of the collection process of the data and images. Early results are culminating in a range of images that are both aesthetically interesting as art objects and do seem to display a certain amount about the relative clarity of the water.

The preliminary data obtained with the GoPro has been encouraging enough to procure funding for a new higher resolution DSLR camera and underwater housing setup to replace the GoPro for the rig. Higher quality images have therefore resulted, bringing to light the formations of gradations in color fields not previously observed. (Figure 7)

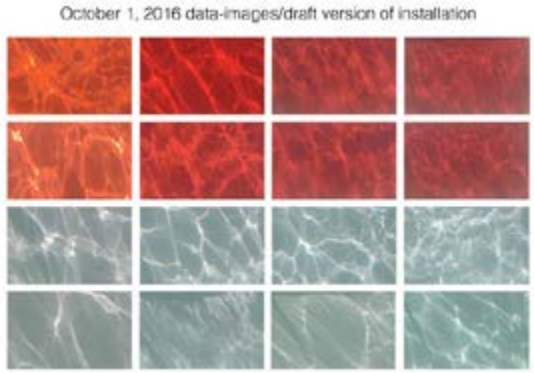

Figure 6. Mock up of grid layout of images gathered. Images gathered from GoPro

Figure 7. Samples of images obtained with DSLR camera setup on October 13, 2017

Initial Results

The collaboration between artist and scientist has so far led to multiple trips out, collections of thousands of images, and data sets to go with the images. Furthermore, the connection with the scientist has opened up for the possible investigation into analyzing the images directly. The scientist the team is working with, Lisa Waidner studies a particular type of bacteria that uses both photosynthesis and anaerobic metabolism. She was able to analyze the images to determine whether there was bacteria in the water. Due in part to this collaboration, the images can exist beyond art objects.

The images that resulted from the project were able to validate the research that Lisa Waidner was already doing, and therefore the collaboration was beneficial to her research. This sort of validation in the sciences is called “ground truth,” where information is being gathered by observation. This ability for the artist and the scientist to collaborate and work together to create an outcome where the research is strengthened demonstrates that a true partnership between the disciplines can create a constructive dialogue.

Furthermore, the data being obtained alongside the images, when viewed with the images, is resulting in trends to become visible. (Figure 8)

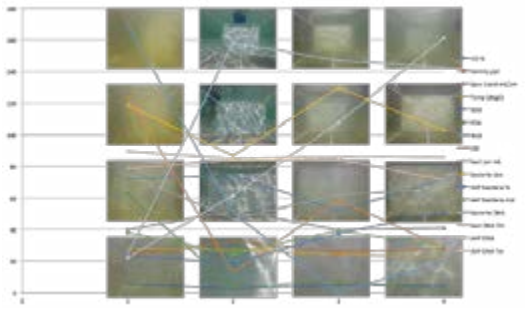

Figure 8. Grid of images and corresponding data aligned. Y-axis is distance from backdrop; X-axis is date of image collection.

Conclusion

A true collaboration between artists and scientists can create a valuable dialogue and outcomes for both parties. As this project is demonstrating, the dialogue between a marine scientist and an artist has resulted in usable data and art images, and data that helped field validate the data the scientist was already collecting. Furthermore, the need for these collaborations between artists and scientists is only going to increase in importance. As recognized by the recent article in the New York Times mentioned earlier, it is becoming increasingly important to have artists working with scientists, beyond the role of simply visualization of the science. They must also be asking the questions along with the scientists of the implications of the research being presented.

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Authors Biographies

Thomas Asmuth is an Associate Professor at the University of West Florida where he teaches courses in digital media. He received a bachelor's of arts degree from San Francisco Art Institute and an MFA in digital media at San Jose State University.

An advocate of transdisciplinary collaboration, he often involves other artists, engineers, and scientists in his work. He is collaborating with artists and environmental scientists on "Turbidity Paintings," a project funded by the Florida Research Fellowship. Asmuth and his team presented their work at the International Symposium on Electronic Art 2016 in Hong Kong.

Sara Gevurtz is an Assistant Professor at Hastings College. Gevurtz received an MFA in Digital Media Art from San Jose State University. She received her bachelor's degree in biology from the University of California, San Diego. Her artistic research focuses on ecological and environmental issues.

Gevurtz has shown work and published nationally and internationally, including an article in the journal *Plastik Art & Science* by the Pantheon-Sorbonne University, "Paris 1" in 2013. Currently, she is working with both artists and scientists on a project using submersibles to collect images and data on water quality.