August 2014

The Art of Making Science

Fostering creativity through science and art

"The most beautiful experience we can have is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science."

- Albert Einstein, 1931

APS
AMERICAN PHYSICAL SOCIETY

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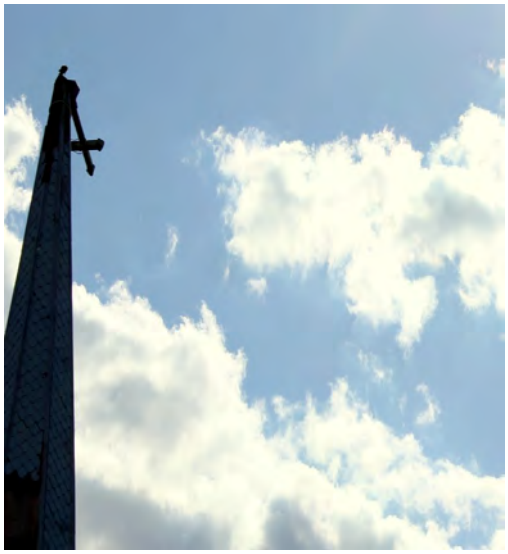
The College of Science and Mathematics

Busting Balloons — Danny Barry

For the making of this image I used a sound trigger I built on a bread-board. The sound trigger sent an electrical pulse to the flashes to capture the image. I set up the flashes in a dark room and placed the object in the center. So the time that it took the bullet to reach the object the sound would reach the trigger and fire the flashes.

Niagara Falls — Swetha Davuluri



Faith vs. Gravity — Haydee Salazar

Welcome to the Art of Making Science Magazine,

What defines art? What defines science? In fact, is there a clear definition of either? Are they mutually exclusive?

This magazine explores these questions and challenges you to open your eyes to the art of science around you. In this issue, you will read about physics students and performing artists collaborating on producing sustainability-themed short films through sustainable practices. You will view photographs taken by middle school and university students. Through these photographs, you will gain a sense of what the art of science means to others. You will read poetry written by molecular biology students. These poems use artistic means to describe cutting-edge scientific research. You will hear insights from physicist Dr. Jun Zhang and photographer Dr. Klaus Schnitzer about their thoughts on the intersection between art and science.

What lies inside is a part of an on-going project that promotes science-art connections and encourages students (and others) to see the art in science and the science in art. The project was motivated by our science students' perception of the disconnect between creative and scientific endeavors. All too often, people associate creativity solely with activities such as writing, painting, dancing—well, the arts. We seldom think of creativity or artistry as having a place in the sciences. This project started with a Physics and Art photo exhibit at Montclair State University and has grown to include middle school photo exhibits in local public libraries, a collaboration with a Creative Thinking course offered to the entire university community, the development of a physics course devoted to creativity through a project-based learning approach, a blog, a series of short films, the creation of greeting and post-cards, and several publications and presentations describing our efforts. What's next? We'll see…

We invite you to contribute to this discussion. Discuss this with others, contribute to our twitter conversation (#artofmakingscience), write on our blog (http://handspuntales.wordpress.com/) … Stay tuned!

Editors,

Ashwin Vaidya, vaidyaa@mail.montclair.edu

Mika Munakata, munakatam@mail.montclair.edu

Designer, Doug Platt

Coordinator, Jason McManus

This project was made possible by the students in Physics 210, middle school students and teachers in Clifton, Kearny, Paramus, Butler, Bloomfield, and Orange school districts, artist Anuj Vaidya, Montclair State University students and staff Raymond Burns, Justin Seventko, Karina Soriano, Colette Killian, and Montclair Public Library, Kearny Public Library, and Clifton Public Library/Allwood branch.

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Student Authors pages 4-5

Fall 2013 Physics 210 class
- Paul Bannon
- Randy Calabro
- Daniel DiCairano
- Nicholas Drywa
- Leo Hentschker
- Joshua Kilian-Meneghin
- Piotr Krepa
- Blake Moore
- Pranav Rele
- Christopher Schofield
- Siobhan Soltau
- Karina Ma. Soriano
- Samuel Zanone

Fall 2012 Physics 210 class
- Justin Allen
- David Betetta
- Raymond Burns
- Robert Gruytch
- Guillermo Hernandez
- William Lopez
- Sausan Odatalla
- Olivia-Ann Perez
- Jillian Varner
- Dana A. Zwolinski

Photographers

Clifton
- School 3
  - Miss Rich
    - Jayden Cruzado
    - Jayla St. Hilaire
    - Eva Zarucki
- School 8
  - Mr. Petryshyn
    - Sanjna Jariwala
    - Mya Castro
    - Angely Salazar
- Woodrow Wilson MS
  - Ms. Muratore
    - Tiffany Cristobal
    - David Hoffman
  - Ms. Russo
    - Jillian Bartkowski
  - Ms. Trobiano
    - Mackenzie Miller
    - Kiara Vega
    - Celine Bennion

Paramus
- West Brook School
  - Mrs. DiGirolamo
    - Jeremy Harris
    - Maryastel Tsiakaros
- East Brook School
  - Ms. Costanzo
    - Sarah Morella
    - Ben Park
    - Veronica Kim
  - Ms. Mahfouz
    - Zachary Clark
    - Sean O'Hare
- Yeshivat Noam
  - Ms. Sheinfeld
    - Naomi Kutin

Butler
- Richard Butler School
  - Ms. Lynch
    - Sandra B.

Bloomfield
- Oak View Elementary
  - Mrs. Mautone
    - Joshua Soca
    - Mia Scollo
    - Matthew Santos
    - Alexander Cayanan
- Carteret School
  - Ms. Barbetta
    - Amy Gonglefski
- Demarest School
  - Ms. Barton
    - Juveria Amin
    - Christopher Paccione

Kearny
- Roosevelt School
  - Mrs. Pabst
    - Michael Uhler
    - Skyler Matusz
- Lincoln School
  - Mr. Fuchs
    - Matthew Martins
    - Gianna Hoch
    - Jose Fermin
    - Caitlin Mead

Montclair State University
- Natalia Aristizabal
- Danny Berry
- Swetha Davuluri
- Claudia Ko
- Margaret Mahon
- Laura M. Rolon
- Haydee Salazar
- Kathy Salowka

The Art of Making Science Project

The Art of Making Science project at Montclair State University strives to communicate the creativity inherent in the sciences to students and the general public alike. Supported by the American Physical Society outreach grant, the project uses connections between the arts and sciences to show the underlying unity and interdependence of the two disciplines in an innovative manner. This past year, the project was planned as one big 'performance' and brought together the two disciplines around the theme of sustainability. In the first phase, physics students learned about and built human-powered generators including hand cranks and bicycle units. In the second, using the generators to power video cameras, art students worked with a visiting artist to make short films on the subject of sustainability, science, and art. The generators and films were showcased and discussed at an annual university Physics and Art exhibition open to the university and local community. As an extension of the university-based project, middle school teachers were invited to hold a math/science photo contest in their schools. Over 50 entries from six school districts were considered. Many of these photographs were displayed at local public libraries. The winning photographs were made into greeting cards and jigsaw puzzles and distributed in the schools. The following pages describe the science-art collaborative project on sustainability, as written by the 23 students of Physics 210; the photos of the middle school students are seen throughout the magazine.

Human Energy as a Source of Power for Low-Energy Applications

Written by students in Physics 210 from Fall 2012 and Fall 2013, edited by Justin Seventko & Karina Soriano

In the modern age of industry, it seems as though almost everyday a new technological innovation is revealed. While these advancements in travel, resource acquisition, and entertainment are shaping societies across the planet, the energy needed to further this growth is leading to the excessive creation of "greenhouse gases" within the atmosphere. In turn, global climate change research has issued threatening projections of an environmental metamorphosis which could include an increase in storm activity, change in sea level, and variation in average local temperatures around the world (Frumhoff, McCarthy, Melillo, Moser, & Wuebbles, 2007). It is therefore imperative that we, as a society, develop alternative, "renewable" forms of energy to both meet our demands and perhaps prolong or even avoid these potentially extreme scenarios.

The bike project was originally brought to the attention of a set of Physics students as an extracurricular activity. The original plan was to make something that would use a human's physical ability – in this case riding a bicycle – to spin a generator and create energy that would be usable to charge a giant battery. These batteries would then be used to do everyday things such as turn on lights, create a video, or recharge your phone. Before discussing the actual process of the project, it is important to lay out some of the basic theory that underlies it.

Basics of electricity

Much of the electricity and energy that is used to power the world's electrical infrastructure, your car, or even your home generator is generated by rotating magnets inside a conductive loop of wire. Sources of raw power for rotating these magnets are provided by moving water, wind, steam, and burning fossil fuel. The main physical principles and properties, which describe this, process are induction, current, and voltage.

Current quantifies the flow of electric charge in a conducting wire. It is similar to current in a river, where current in a river is the amount of water flowing through a cross-section of the river per unit time. Current in a conducting wire is the amount of charge flowing through a cross-section of the wire per unit time. Most commonly the charge is "carried" by electrons. A basic way to think about this is that the conductive wire is full of randomly moving closely spaced electrons and when a current is introduced, more electrons are pushed into the wire and subsequent electrons are "pushed out" and this creates the flow that is measured. The unit that current is measured in is amperes (amps).

Voltage is a measure of electrical potential difference between two points. To really understand what this means, one must first understand the scientific concept of work. Work is measured in the most common measurement of energy, the joule. Forces do work to displace objects over a distance. In a conservative force field, the work difference from point A to point B is also called a potential energy difference. A force must be provided to move an object in a force field from one potential to another, either by the field itself or some external force. Electric fields are set up by charged particles and have polarity: opposite charges induce an attractive force, like charges induce a repulsive force. Voltage is a measure of the amount of work required to bring a charge from point A to point B in an electric field, or the difference in electrical potential from point A to point B. So for a 12V battery, there is a 12V potential difference from the negative to positive terminal of the battery with a lower potential at the negative terminal than at the positive terminal. When the terminal is connected electrons move from the lower potential to the higher potential due to the electron's negative sign inducing a current.

One of the most interesting things about electricity is its connection to magnetism. If you slide a compass near a current carrying wire, you will notice that as you slide the compass near the wire the needle will point in the direction of the current's magnetic field instead of North. This is because electricity and magnetism are not separate phenomena, but rather two faces of the same coin. As current moves through a wire, it sets up a magnetic field ring in the space around the wire. In the same sense, if a magnetic field is moved through a loop of wire, a current is induced in the wire and this process is called induction.

Current through a wire can be increased in a few ways, mainly by increasing the number of loops in the coil, increasing the strength of the magnetic field, increasing the speed at which you rotate either the coil or the field, or increasing the area enclosed by the coil. A car uses one of its drive belts to spin a magnet in a coil of conducting wire. A home generator uses a combustion engine to spin a magnet in a coil of wire, or to spin in a wire in a magnetic field. This is how these machines generate electricity.

Hand-Crank Generator

The first objective of this project was to build a hand-crank generator using only reusable material.

A hand-crank generator is extremely easy to build and use. In fact, while the materials are available in any hardware store, a resourceful person can build one using materials found in houses and cars. For example, you can find magnets in washing machines, generators, electric motors, speakers, and many others. A hand-crank can also easily fit in any backpack, glove compartment, or emergency kit and is therefore usable day or night, even in areas without electricity. Small weight is also great benefit in case of carrying it on a person. It will also provide a better surface area to grab and spin.

DIY Hand-Crank Generator

Material: Cardboard, Long metal screw, Two magnets, Pennies, Tape, Cutting Razor, Copper wire, Rubber cork

Procedure:

1) Cut a piece of cardboard using the magnet as a scale for size. The magnet should have the longer side as its vertical, with a half an inch cardboard above and below the magnet. Then lightly cut half way through the cardboard, half inch away on the left and right side of the magnet using a razor.

2) Bend the cardboard where it was cut to fold it. Put the two magnets together and place it on the side where the two folds prop up. Find how high the magnet reaches and add another half inch. Cut this half way through so that it will fold over the magnets and make a box. Use tape to secure the box and reinforce the edges.

3) Poke holes on the top and bottom of the box where the screw will go (between the two magnets). Place the screw in these holes and place the magnets on either side of the screw. Balance the magnets, either using tape or coins, so that they are not touching. Be careful as magnets might pinch fingers and cause injury. Put a rubber cork on the screw tip to avoid future injury as well.

4) Once your box is sturdy and your screw with the magnets are secure inside the box begin winding copper wire around the box (Before winding, be sure to have at least 6 inches of extra wire. This extra wire will connect the hand-crank in circuit with other devices). This is a delicate, time-consuming process that should not be rushed. If rushed, the wire will be wound too tight and will destroy the structure of the box. Winding the copper wire around each side of the screw alternatively for 500 loops. The wire should not be touching the magnet because of the extra space provided in setting up the box, if the wire does touch the magnet a new box with more space on all sides of the magnet will need to be crafted.

5) The end result will look something like the above picture.

Bicycle Generator

Secondly, we modified a bicycle to charge a battery that was used to create a video about green energy. The initial setup of our design was a stand that would prop the rear-wheel off of the ground and a chain that would connect the back wheel to a generator that produces electricity. This design is currently presented on a website titled "handspun tales" at handspuntales.wordpress.com

Bike used as generator

After the conclusion of that project, we challenged ourselves to come up with new ways to become more efficient with our energy output from the bicycle. One of the original considerations was to add a second power source attached to a chain. Our group then decided to think about placing the tire back on the bicycle and using it to generate power. However, we eventually decided that our original idea was the most ideal design.

Once the bicycle was complete, we had to measure how much energy was being produced by our bicycling and how much energy we were consuming to produce the energy. In order to do this, we used a microcontroller sold by WattsView in conjunction with the bicycle generator to actively track how much power in amperes is being produced.

Another consideration that needed to be taken into account was the carbon footprint of pedaling the bicycle. A carbon footprint is defined as the total sets of greenhouse gas emissions caused by an organization, event, product or person. Since carbon dioxide (CO_2) is the primary gas responsible for global warming, there is a major concern about the increasing CO_2 output caused by both industry and individuals, which has prompted efforts to both measure and reduce carbon output.

By using a device called an infrared gas analyzer, we were able to measure the amount of CO_2 produced by an individual before and after physical activity and thus their carbon footprint. The ultimate goal of this experiment it to decide if using man power increases the CO_2 concentration less than conventional methods of generating electricity.

Infrared gas analyzer

In our experiment, we did not notice a relationship to the individual's body mass to the amount of difference in CO_2 output. However, the intensity of physical activity plays an important role in CO_2 emission, pedaling at higher speeds seems to have caused an increase in CO_2 emission. The amount of energy exerted was proportional to the amount of CO_2 released. In other words, the more work a person or object does, the more carbon output there is.

Looking forward, we can see that manpower has a carbon output that does not take away from the grid, but rather, adds to it. In the same way, if a man is doing no work, there would still be carbon output, simply by breathing.

Sustainable Energy

In this project, we modeled how one can, using environmentally conscious techniques, develop a successful source of sustainable energy. However, the hand crank can only work on the small scale. There also exist other "larger" methods of producing energy in an environmentally conscious fashion. These include nuclear power points, plasma, and solar power. Every individual can do something to help the environment as well. The first step comes in recognizing flaws within our own society. We, as a culture, must cut down upon our energy consumption, even if that means giving up newer and more efficient technologies. In the United States' hyper-modernized society, we have come to demand the newest and most complex items science can produce. However, in this struggle for the cutting-edge, consumers often lose sight of how their actions impact the environment.

It is through simple acts of self-discipline that we can help the environment. Perhaps we, and landfills, can take in fewer technological devices. Even the smallest acts can have a huge impact upon our world. For more ways on how you can help the environment, visit http://www.50waystohelp.com/.

(Continued on Page 15)

HAND SPUN TALES
by Anuj Vaidya

I have been concerned lately with sustainability in my artistic production – both in terms of the personal and the ecological – and how much I consume in the production of my films and performances. As I inched towards a production of means, especially through this project (*Hand Spun Tales*) a question arose in my mind: ***Should artists be concerned with the carbon footprint of their practice?*** A friend questioned this line of thought**:** ***Why segregate responsibility to reduce carbon footprint occupationally? Should plumbers think about carbon footprint? Should philatelists? What about taxidermists?***

I think posing this question to a specific group brings attention to process in a way that a general question does not. The way we produce and consume art still continues to be rather egregious in its use of resources. We are talking about entrenched systems here – cultural biases that often eschew ecology in favor of perfection and the grand scale, that falsely pit culture against nature. Often our process is in direct contradiction to our intended goals, and it is a failure of our imagination to not think outside of these entrenched systems. This question, then, was meant to spark our collective imaginations around this issue, and that is exactly what happened at Montclair State University.

When I posed the question to my brother, Ashwin Vaidya, a professor of Physics at Montclair State University, he responded with an invitation - to come spend time on the MSU campus so we can collaboratively, as a community of scholars, artists and students, address this question.
And I accepted.

Providing Context

This residency at Montclair State University was part of an ongoing exploration towards a work-in-progress, **Sitayana** – a queer eco-feminist reading of the Indian epic, *The Ramayana*. The work hopes to meander towards a film/performance hybrid, making various stops along the way to examine process and pedagogy through technology, ecology and collaboration. The project wishes to extend the notion of sustainability into artistic practice. To this end, the goal of the project is to consume as little electricity or fuel in its production as possible.

The collaboration between art and science at MSU was intended to explore the possibilities of hand-crank mechanism for cameras and cell phones and bicycle-powered viewing device as creative explorations of human-powered energy solutions. Other detours along my way will include forays into photography - exposing photographs on grass using natural sunlight, weaving - using recycle fibre-optics, green editing stations - using modified sewing machines for pedal-generated power or through solar power, kinetic sculptures and many as-yet-unidentified points of examination.

In this way, the work intends to be artisanal – in the sense that it is hand-made. It also aspires to be larval – in the process of becoming, in a constant state of potential, a perpetual work-in-progress if you will. Perhaps by embracing queer aesthetics and queer process – always willing to engage in methods and ideas unconsidered, unimagined and on the margins - this project will spark the imagination and illuminate the many possible ways of existing in this world that has inherited us.

At the cross roads of creativity and sustainability in art and science

So with this ethos of possibilities in play, I began the conversation with Ashwin and his students about how to address the above question, other important goals of the project were:

· *to consider collaboration as a strategy towards sustainability*

· *to examine pedagogy through this conversational/ collaborative process*

When we talk about sustainability, it is often in the context of production and technology. But I wanted to extend the notion of sustainability to the personal. It is important to recognize that any process depends on the participation of healthy individuals, and the healthy individual in turn is only possible through collaboration and community - the whole is the sum of its individual parts, and sometimes even bigger than its individual parts!

I also sought out collaborators so I would not have to reinvent the wheel, and also from the knowledge that I could not reinvent certain wheels! I needed the expertise of the students/professors in the physics department to help engineer the hand-crank and bicycle powered mechanisms that were the cornerstone of this project. I also sought out collaborators in the writing, drama and music departments, who could help me bring my vision to life within the three month period of the residency. Ultimately, both for Ashwin and for me, collaboration became a teaching tool. It allowed us to take on a complex project within the classroom, to engage students both in theoretical as well as practical undertakings, and to extend learning beyond the classroom. It also helped elucidate, for students, the similarities in the processes of both art and science: both are rooted in creativity and in the process of inquiry, and both achieve success through a process of constant re-assessment and revision.

Outcomes

I had originally imagined the outcome from this residency as a multimedia performance piece to be performed/exhibited on campus around the theme of 'ecology in mythology' - a small detour from my larger project, but exploring similar themes. More specifically, the piece would be a conversation between Sita, Loowit and Gaia – three embodiments of the earth from different mythological traditions (South Asian, Native American and Greek respectively). In keeping with the ecological theme, the project would be created and exhibited without the use of any electricity – instead, all parts of the project were to be human powered: hand-crank mechanisms to power the video and audio recording devices, and bicycles to power monitors that the films were to be screened on (both to be developed by Ashwin and his students in the Physics Department); the background score and text were to be performed live by musicians and performers (from various other departments at MSU).

The first revision of our goal had to do with technology. While the hand-crank mechanism worked in theory, it failed to be a practical human-powered energy solution. On a weekend shoot, I managed to get 3 minutes of camera power from 12-14 hours of hand-cranking! So instead, we decided to rely on bicycle-power for the whole project, which would only need 4 hours of biking for a days worth of camera charging or computer usage. This would not afford the production flexibility that a hand-crank offered - as the bicycle-power mechanism was stationary, whereas the hand-crank could be carried off-site to shooting locations; it just meant that the shoot would need to be more economical in its shooting ratio and would require more pre-production planning and rehearsal, so that we could get what we needed with one cycle of the camera's battery power. In effect, it just meant using an analog production methodology with a digital recording/editing system.

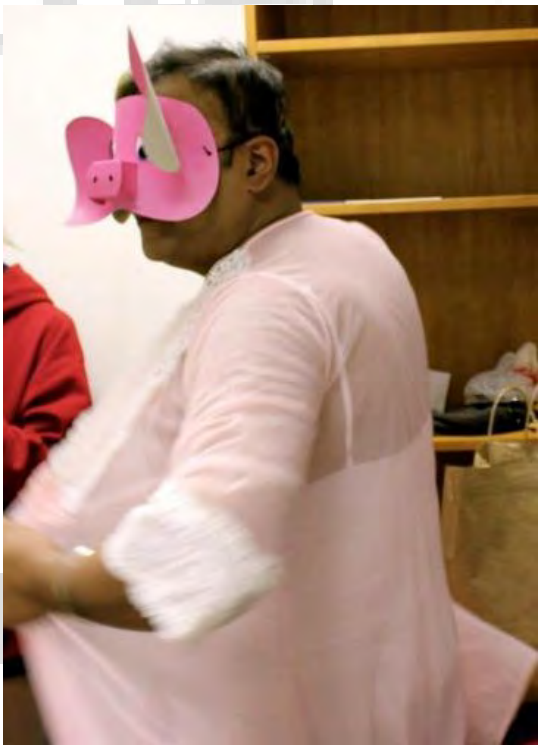
The second revision had to do with the nature of collaboration. Having to negotiate students schedules and departmental imperatives meant that we had to constantly revise expectations of what was possible within the scope of the project. For instance, it became very clear very early on that the possibility of a live performance was next to nil because of scheduling issues. Time, in a sense, became the common limiting factor to both the artistic and the scientific arms of the project - the difficulty in finding common time for the former, and the quantity of time to be surmounted in the hand-crank method for the latter. It made the process of creative inquiry in art and science visibly analogous for all the participants.

The final piece was then presented as a pared down live performance, just involving myself and one other student. It was imagined as a *A Diane Sawyer Exclusive*, an interview with Miss Piggy where she speaks about her new celebrity cause – Ecology, her chance encounters with earth goddesses (Sita, Loowit and Gaia) from three different mythological traditions, and her upcoming directorial debut – *Escape from Taxidermy*. The performance was peppered with video clips from production interviews and dreams, and the trailer for the aforementioned film - all shot and edited using a bicycle-powered battery to power up the camera and computer!

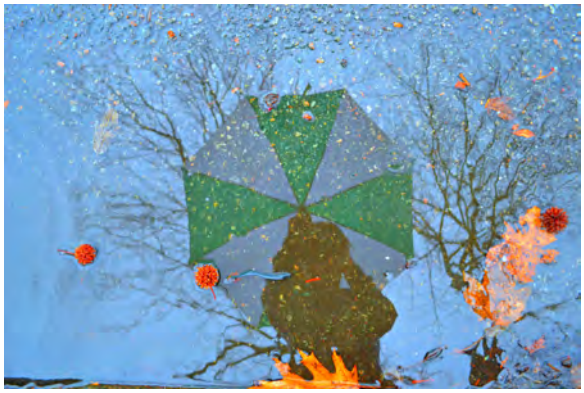
I'll leave you with the words of Miss Piggy in a song from the performance - which encapsulates the spirit of this collaboration:

Miss Piggy says crank!
Miss Piggy says bike!
Now move your hands
and move your feet,
You know you can
generate some heat!
Miss Piggy says crank!
Miss Piggy says bike!
I know you've heard
of entropy,
Let's slow it down
for you and me!
Miss Piggy says crank!
Miss Piggy says bike!
Let's take control
of energy,
Create our own
'lectricity!
Miss Piggy says crank!
Miss Piggy says bike!
Let's all unplug
let's all unwind,
and to this earth
let's all be kind.
Miss Piggy says crank!
Miss Piggy says bike!

Miss Piggy wishes to thank Neil Baldwin, Julie Dalley, Joanna Madloch, Shruti Ramachandran, Andrea Claudio, Nina DeGori, Aryana Sedarati, Jessica Marrazzo, Mike Deering, Chelsea Miele, Jason Weinstein and Monika Szumist for making this fabulous project possible.



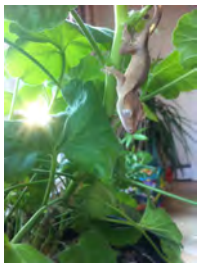
Middle school students' pictures

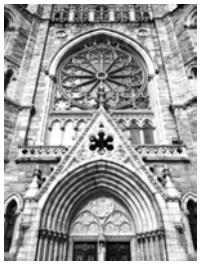


Veronica Kim
8th Grade, Ms. Costanzo
East Brook Middle School, Paramus, NJ

Celine Bennion
8th Grade, Ms. Trobiano
Woodrow Wilson Middle School, Clifton, NJ





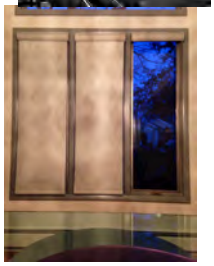








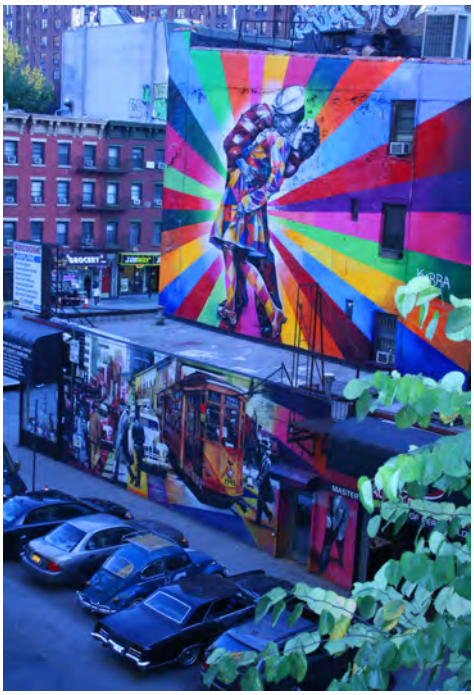




Top row (from left to right): Amy Gonglefski, 5th Grade, Ms. Barbetta, Carteret School, Bloomfield, NJ**; Juveria Amin,** 5th Grade, Ms. Barton, Demarest School, Bloomfield, NJ**; Zachary Clark,** 5th Grade, Ms. Mahfouz, East Brook Middle School, Paramus, NJ; **Jose Fermin,** 8th Grade, Mr. Fuchs, Lincoln School, Kearny, NJ; **Caitlin Mead,** 8th Grade, Mr. Fuchs, Lincoln School, Kearny, NJ

Second row (from left to right) : Christopher Paccione, 5th Grade, Ms. Barton, Demarest School, Bloomfield, NJ**; Naomi Kutin,** 7th Grade, Ms. Sheinfeld, Yeshivat Noam, Paramus, NJ**; Sean O'Hare,** 5th Grade, Ms. Mahfouz, East Brook Middle School, Paramus, NJ**; Sandra B.,** 7th Grade, Ms. Lynch, Richard Butler School, Butler, NJ; **Matthew Martins,** 8th Grade, Mr. Fuchs, Lincoln School, Kearny, NJ

Third row (from left to right): Sarah Morella, 8th Grade, Ms. Costanzo, East Brook Middle School, Paramus, NJ**; Ben Park,** 8th Grade, Ms. Costanzo, East Brook Middle School, Paramus, NJ**; Maryastel Tsiakaros,** 5th Grade, Mrs. DiGirolamo, West Brook School, Paramus, NJ; **Joshua Soca,** 7th Grade, Mrs. Mautone, Oak View Elementary School, Bloomfield, NJ; **Jeremy Harris,** 5th Grade, Mrs. DiGirolamo, West Brook School, Paramus, NJ



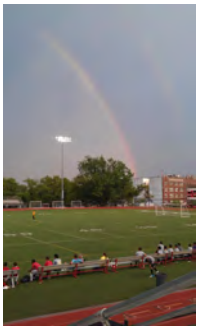
Gianna Hoch
8th Grade, Mr. Fuchs
Lincoln School, Kearny, NJ

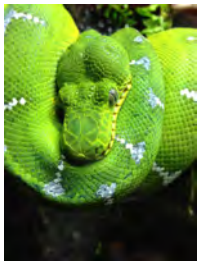
New York can be bright, New York can be pretty
Who ever knew there could be math in the city
Rectangular windows all in a straight row
Two squares in each window one high and one low
Across is a billboard with colors so bright
A sailor is holding his lady so tight
Her stockings are lines with diamonds galore
Colorful shapes, angles and more
On the building below what you will see
Is a trolley and cars that are painted 3D
There's circular leaves attached to that tree
Which stand near the sailor who ship sails the sea



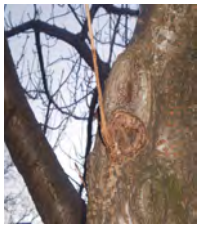









Top row (from left to right): Matthew Santos, 5th Grade, Mrs. Mautone, Oak View Elementary School, Bloomfield, NJ; **Alexander Cayanan,** 5th Grade, Mrs. Mautone, Oak View Elementary School, Bloomfield, NJ; **Mia Scollo,** 5th Grade, Mrs. Mautone, Oak View Elementary School, Bloomfield, NJ; **Michael Uhler,** 6th Grade, Mrs. Pabst, Roosevelt School, Kearny, NJ; **David Hoffman,** 7th Grade, Ms. Muratore, Woodrow Wilson Middle School, Clifton, NJ; **Sanjna Jariwala,** 5th Grade, Mr. Petryshyn, School #8, Clifton, NJ

Second row (from left to right): Skyler Matusz, 6th Grade, Mrs. Pabst, Roosevelt School, Kearny, NJ ; **Eva Zarucki,** 5th Grade, Miss Rich, School 3, Clifton, NJ; **Jayla St. Hilaire**, 5th Grade, Miss Rich, School 3, Clifton, NJ; **Mackenzie Miller,** 8th Grade, Mrs. Trobiano, Woodrow Wilson Middle School, Clifton, NJ; **Mya Castro,** 5th Grade, Mr. Petryshyn, School #8, Clifton, NJ

Third row (from left to right): Jayden Cruzado, 5th Grade, Miss Rich, School 3, Clifton, NJ; **Angely Salazar,** 5th Grade, Mr. Petryshyn, School #8, Clifton, NJ; **Jillian Bartkowski,** 8th Grade, Ms. Russo, Woodrow Wilson Middle School, Clifton, NJ; **Tiffany Cristobal**, 7th Grade, Ms. Muratore, Woodrow Wilson Middle School, Clifton, NJ; **Kiara Vega,** 8th Grade, Ms. Trobiano, Woodrow Wilson Middle School, Clifton, NJ

Interview with Dr. Klaus Schnitzer

Dr. Schnitzer is a professor of Art and Design at Montclair State University. He received his B.A. in Social/Political Science at SUNY in 1967 and his M.F.A from Ohio University. A genuine interest in cars fostered Klaus Schnitzer's 'other' career as an internationally renowned automotive photographer and writer. Assignments take him all over the world and have resulted in books, feature articles, and more than 110 cover photographs for national and international publications.

What is the common ground that science and art share with each other? What are some differences?

Many times when you take a photograph from high above it looks very scientific. Much of modern art looks like things that you can see with a microscope.

The main differences are the outcome that science and art are trying to achieve. Art is a lot more subjective while science is objective. Science is looking for repetitive answers and facts. While art focuses on beauty and many different outcomes.

In the world that we live in Art & Science need each other. For example, to make a car you need knowledge of aerodynamics along with knowing what kind of design would be best.

Is this connection widely recognized in your field? If so, do you have interesting examples of them?

Art is always trying to borrow from other subjects. It takes from other subjects and tries to look at it from its own lens. Science is very important to art, because it is able recognize many things that are invisible to the naked eye. With the knowledge of things that are invisible, artists can be more creative with what they produce.

Have you done anything to make this connection stand out for your students?

Science has been something that many of the art students become scared of. Whenever I start to talk about it, it seems they just blank out. More recently in the years students have thought it to be "cool" to be ignorant about science. However since we work with cameras all the time, I always tell them about the scientific functions of how the camera works. I tell them it is through science that broadens the possibility of what art can be.

What kind of perspective do artists receive from the understanding of physics, and scientists from the arts?

When artists are able to appreciate science more, they can see more of what is occurring in front of their eyes. When artists are able to understand and see more they have more to work with so that they can be creative.

By having students study physics through art, what is some of the potential that can be realized?

Many artists are scared of science and do not want to go near it. However by teaching science through art, this can make science something that is less intimidating and more attractive to different students. There are countless projects that can be done and created with the combination of art and science.

Interview with Dr. Jun Zhang

Dr. Zhang is a professor of Physics at the New York University. He received his Ph.D. in 1994 in Physics from the Niels Bohr Institute at the University of Copenhagen. He specializes in the physics of fluids, which includes biomechanics or bio-locomotion (organism swimming and flying), geological fluids (thermal convection, continental drift), solid-on-solid friction, and self -organization phenomena at microscopic scales.

What is the common ground that science and art share with each other? What are differences?

In my opinion, science often exhibits profound beauty as we try to understand the world around us and to explain things in rational ways that we have invented. Art is mostly visual (even with music), and is also profoundly pleasing as we express our feelings about this world. Science and art meet quite often since we interpret constantly the world outside us and we need to use all different means to be connected with the world. At the level of an individual person, the art or science a person creates has to be new in order to be recognized. Replications don't go too far.

Science emphasizes logic and reasoning; it has to be based on very solid grounds. This often makes science appear to be somewhat conservative. But in order to drive science forward one needs unbounded imagination. I personally find it very exciting that we deal with these two seemingly contradictory aspects. Art, on the other hand, is boundless in many ways.

Is this connection widely recognized in your field? If so, do you have interesting examples of them?

People certainly enjoy and sometime are excited about nice (flow) visualizations in my field. In fact competitions for flow visualizations are held annually at the APS' Division of Fluid Dynamics (DFD) meetings. The best works are selected into the "Gallery of Fluid Motion." This has been really popular amongst scientists in the related fields. I thought it is a very nice thing to do; it makes scientists think like artists, at least for a couple of hours.

Have you done anything to make this connection stand out for your students?

Last semester, a student walked into my lab and wanted to do a project with me that involved flow visualization, I told him that "this is not only a science project, it's an art project as well. Imagine that this is something to be shown in MOMA (Museum Of Modern Art). So please be demanding." I really see it this way and the student got the point.

What are the limitations artists and physicists encounter without the understanding of the other?

I remember once I met a cartoon animation artist who worked on a sequence of a falling leaf. It was a real struggle for him to make the sequence look real. Being real here is being physical. As we know, many scenes in action movies are created today by computers. If the trajectory of the swinging Spiderman does not "obey" the physical laws of motion, the audience will be able to tell immediately and they will walk out of the movie.

As for physicists or mathematicians, we often hear that an experiment is beautiful and a proof is elegant. Who says these intellectual activities are not art?

Is there anything you have done that shows the beauty of the combination of Art and Science?

I have put some of my works from the laboratory on some covers of journals and books. Some of my artworks from the experiments are used in posters and murals. I hope that they have beautified a few places. See here for some examples: http://physics.nyu.edu/jz11/gallery7.html

Just so happened that I have worked as a freelance illustrator for about two years for two Chinese magazines. But that was more than 20 years ago. I guess at the personal level, I can hardly separate art and science.

Mo Bio Poets

Recently, a new technique for editing DNA has been in the news. (See NYTimes March 3, 2014). What used to take a long sophisticated process has now been simplified through this new technique. The technique is based on a naturally-occurring phenomena involving bacteria's ability to protect themselves from viruses. Upon store some of the genetic information of the viruses and later use them to target and destroy genes of the viruses. This new discovery has implications for fields ranging from pharmaceuticals to agriculture.

Students in Dr. Molina's Biology 435/548 Experimental Biology class were given the challenge of using poetry to describe this recent discovery. The undergraduate and graduate students rose to the occasion. Below are selected submissions that showcase not only their creative spirit but also their deep understanding of the subject.

The Genome Editor (Acrostic style)

Tautology your cover
Hidden within the orderly chaos
Eager to protect your home
Great your chosen purpose
End all unknown intruders

Nascent your new role
Obfuscated were your discoverers
Manacled by esoteric codes
Eclipsed were the answers
Elucidated by your careful work

Ebullient your discoverers
Deify they made you at every turn
Illimitable your potential
Obliterate every obstacle
Ravenous for new perplexities

By Cantius Peterkin

"A look into the future" Victoria Lussier

"New Face of the Era"

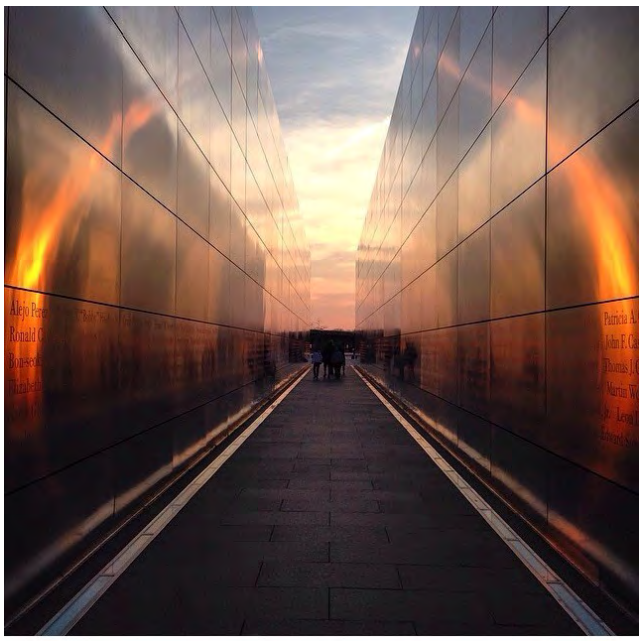
You are not the apple of my eye, but rather the optimism for my future,
So promising and critical, more than a surgeon's suture.
Giving hope to the world of stem cell engineering and gene therapy,
As well as providing tissue and animal models for diseases like HIV.
Bacteria never cease to amaze me, for its complexities even form holes in my cheese,
But alas, we found you, in our fellow friend *Streptococcus pyogenes*.
An adaptive immune system in bacteria were you,
But now co-opted to engineer vertebrate genomes – who knew?
Psi packing signal, rev response element, central polypurine tract,
These are some of the components to keep your lentivector in tact.
Along with your nuclease, this lentiviral vector includes a crucial part,
The ability to navigate precisely, sgRNA, you work of art.
Snip snip, snip snip - your enzyme obediently cuts with ambition,
A student, an observer, and an admirer – I am humbled at your orchestrated precision.
Oh my friend, you cannot be seen with a naked eye,
However your impact is colossal, and so we bid TALENs and ZFNs a good-bye.
Easily adaptable to modify a genome that is RNA friendly,
Simple, convenient, and imperative – you are all those and plenty.
I must concede, you truly are a new face in the era of genomic editing,
You are the CRISPR/Cas9 system, a system beautifully developing.

By Nozrin Laskar

MSU Photo Contest Winners

Liberty Center

Laura M. Rolon



This picture was taken over this past summer on a trip to Liberty State Park in Jersey City, New Jersey. I enjoy visiting this historical landmark because of Hispanic roots. Although I was born in United States, my mother is from Honduras a small Central American country. My grandmother was the human ladder for the proceeding generations, as she was the first to arrive to this country in the mid 1950's in search for a better life and opportunities. Liberty State Park was the gateway to the millions of Italians, Irish, and Jewish immigrants that came in the late 1800's. In this park, there is a new monument called Empty Sky, which is a memorial for those that lost their lives in the tragic event of September 11th. This image gives a slight illusion of flames coming out through the sides of the walls of the memorial, which I believe is very intriguing to the eyes and artistic. This image also gives the impression of a full circle of natural light. Sunlight can be defined as a portion of the electromagnetic radiation given off by the sun, in particular, infrared, visible and ultraviolet light. I believe that a part of the artistic and scientific significance that this photograph, it also shows how history can be shown and expressed in such amazing ways that will never be forgotten..

Walking Shadows

Haydee Salazar

By definition, a shadow is a dark area or shape produced by a body coming between rays of light and a surface. In normal life, we don't really think about the physics of light behind our own shadows.

This picture was taken from the top floor of Carparc Diem. In this picture we can see people crossing the street, and their perfect shadows reflecting against the pavement. You can see details such as the girl holding her cup of coffee, which you cannot notice on her actual image but you can see it on her shadow.

Waterfall

This photo was taken at the Delaware Water Gap, one of the peaceful places I like to visit when I get a chance. There was numerous little waterfalls and I took the opportunity to shoot some from a closer distance. The moss in the foreground serves as a stationary piece, showing the real beauty in the movement of the water in the background.

All three pictures on this page are by Kathy Salowka

Sunset

During sunrise and sunset, when the sun lies low on the horizon, the rays of sunlight must pass through almost 30% more area of atmosphere than they do during the day, and a higher number of larger atmospheric particles before they reach us. The shorter violet and blue wavelengths scatter away from our field of vision. However, the longer wavelengths of light do not scatter as much and the sky becomes filled with yellow, orange and red. Red has the longest wavelength in the visible spectrum, so when the sun lies on the horizon, it appears red. During a rainstorm, the water vapor in the air acts like a prism, separating light by the various wavelengths, resulting in rainbows.

Gravity

When taking this photo, I thought that I would not find any drops of water on a rail, particularly so many of them. Gravity would have taken all of them to the ground, but it was not the case with these drops. I shook a pair of bleachers to move these drops, but to my surprise, they stayed intact on the metal rail.

Water has amazing qualities that we keep learning about. The droplets stay on the pole, intact, without falling down. The surface tension of the object keeps the drops on the pole. Adhesion is the property which makes raindrops stick to things just like that pole.

(Continued from page 5)

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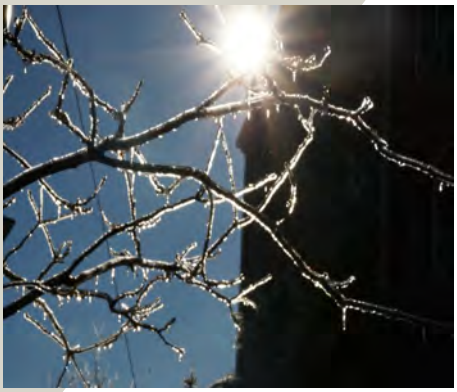
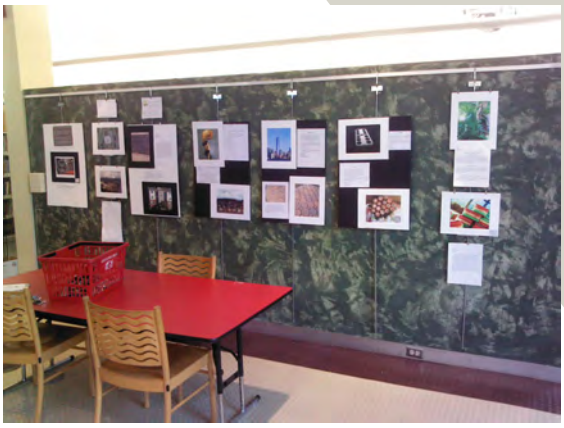


Melting Ice —
Varsha Nimbagal



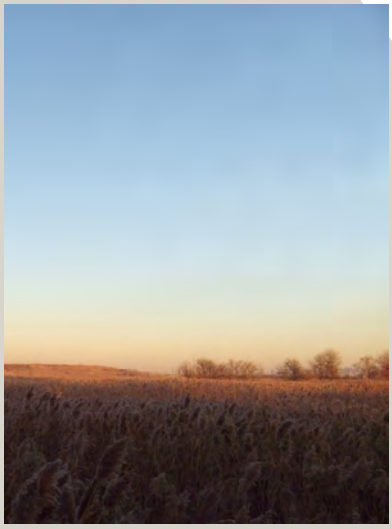
Illuminations —
Claudia Ko

Nature as the Ultimate Artist —
Natalia Aristizabal

The displays at Kearny Public Library, Montclair Public Library, and the Allwood branch of the Clifton Public Library (from top to bottom)

Sponsored by: The College of Science and Mathematics, and The Research Academy for University Learning at Montclair State University.

This project is funded by the Art of Making Science Grant from the American Physical Society.



Endless Sky —
Margaret Mahon