Brooklyn Robot Foundry **Inception Date:** March 25, 2011
David VanEsselstyn and Jennifer Young, Co-Founders

**The story of why our project was formed:**
Jenny and Dave are friends who shared a vision for a space where kids could go and get structured support for working on robotics projects. Jenny is a mechanical engineer, and Dave has a Ph.D. in Educational Technology.

Each of them grew up tinkering in basement workshops with their fathers, and recognized the value that sort of activity had on their ability to problem-solve, troubleshoot, plan, invent and fearlessly break down mechanical and electrical systems into smaller chunks. They recognized the logistical difficulties that Brooklyn families had in offering these sorts of informal learning environments. Over lunch last year, they committed themselves to creating such an environment for the youth of Brooklyn, and created Brooklyn Robot Foundry.

**Project goals:**
Our fundamental goal surrounds offering hands-on experiences to kids that support their development and curiosities around engineering and robotics.

**Context:**
Thus far, we have been holding “pop-up foundries” based on the idea of pop-up shops that open in a storefront for a few days. While this works to our advantage in many ways, and we aim to retain some of this nomadic spirit so that we can reach a wider variety of audiences, we also are looking to settle down into a fixed storefront location in 2012.

**Design? Make? Play?**
Our classes have healthy doses of Creative Design, Making, Tinkering, and Play. Foremost, we aim to tap the intense curiosity and focus that kids have when you put achievable mechanical problems in front of them. We provide them with tools and materials and really try and get out of their way - intervening only to provide structured assistance when necessary, and to take advantage of teachable moments when they arise.

**Relevant Scientific and Engineering Practices**
These are the top five areas that our work is designed to address:
* Constructing explanations (for science) and designing solutions (for engineering)
* Cause and effect: Mechanism and explanation
* Structure and function
* Engineering design
* Links among engineering, technology, science, and society

**Project Evaluation**
Our evaluation regimen thus far has been informal, qualitative and mainly aimed at assessing satisfaction and excitement.

**Our Workshop: Building a Robot from Scratch**
We will be taking apart an electric fan, and building a "vibrobot" that is made of (mainly) found objects such as wire, a mint tin, batteries and parts of the fan (such as the motor). We'll decorate our robots and have them meet and greet each other in our "robot arena". We'll also intersperse the play with some science and engineering fundamentals.

The Eli Whitney Museum
Wm Brown, MSW, Director
Sally Hill, MFA, Designer

*Apprentices*: Rachel Green, Angus McMullan, Krzysztof Danielewicz,

**The Museum**
In 1798, Eli Whitney established an armory just north of New Haven that would train its workers and invent its methods, and construct its tools as its fulfilled it contracts. Whitney's vision: *trust experiment*. Whitney demonstrated the power of workshop learning.

On that site, the Eli Whitney Museum still trains, invents and constructs. The Museum designs, produces and teaches experimental learning projects to engage senses and skills that complement classroom and community learning.
The work takes two main forms:

**Classroom Projects**
The Museum produces about 42,000 projects to serve classroom and afterschool curricula – typically for K – 8th students. These are primarily science, engineering and math focused projects. There are however, social study, literacy and art projects as well. An optimal session is 1.5 hours.

**Workshop Projects**
The Museum produces about 35,000 component projects that make up Workshops that range from 1.5 hours to 30 hours (week-long summer programs). The range expands to include electronics, ceramics, sewing, computer skills, boat building, aeromodeling and architecure. The unifying ideal: invention that draws no lines between math, science, construction,history, art and story.

**An Essential Resource**
75 middle school, high school and college Apprentices participate in every aspect of the work. By high school graduation, most have worked 1,800 hours – the equivalent of 1.5 academic years. *They are the product by which we most carefully measure our impact.*

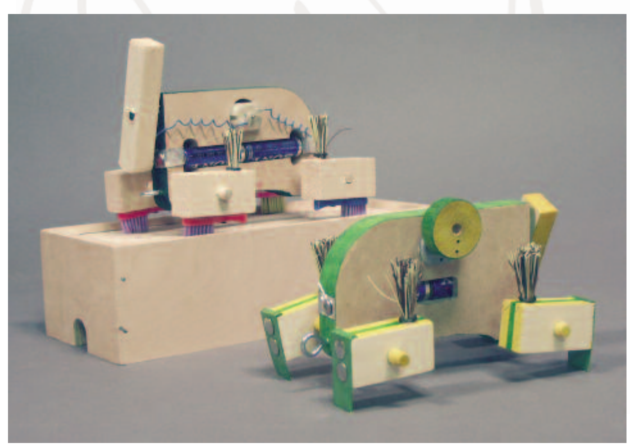
**Hacking Neil Downie: the Vibrocraft**
The English Scientist Neil Downie has collected and published a remarkable trilogy of science and engineering experiments.* With the author's permission, we have adapted experiments that he offered to college and secondary school students, for novice experimenters (9 years old and above).

The Vibrocraft is one of 20 Downie projects we have explored. It began in 2009 as a Workshop project and became a popular middle school project. *Vibrocrafts* are a staple of **Maker** literature. This project is open to flexible **Design** experiments and reinvention. And it has the compelling **Play** value that animates the best essential experiments.

In this project, as in all the Downie projects we've investigated, the scientific practices we've intended to address are: planning and carrying out investigations; constructing explanations and designing solutions; energy and matter: flows, cycles, and conservation; motion and stability: forces and interactions. These, and the fact that they are just great fun.

*Neil Downie, *Vacuum Bazookas, Electric Rainbow Jelly &27 Other Saturday Science Projects*
© 2001 Princeton University Press

In this Workshop, participants will build the Vibrocraft and then have the opportunity to solve the same problems that 9 year-olds try to solve (in a little less time however). And enjoy it.



*Eli Whitney Museum*
*915 Whitney Avenue*
*Hamden, CT 06517*
VOX: *203.777.1833*
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*www.eliwhitney.org*

**Making Sense**

The PDX Young Maker's Club is inspired by and loosely affiliated with the Young Maker's Organization organized by Tony DeRose in the bay area in 2010. The purpose of the club is to provide young people with the opportunity to take on, succeed at, and share truly ambitious projects. In particular, the PDX Young Maker's club is focused on high/low tech projects such as sewing circuits and wearable electronics, making circuits using paper and conductive tape, and other combinations of high tech / low tech materials to create artifacts that require both artistic and technical design. In addition to regular meetings and long-term project development by young makers ages 8-12 as part of the club, we have also begun to bring some of these projects informally into formal education settings. In particular, designing pop-up cards that include electronic elements such as LED lights or sound has been shared with 2nd graders and will be brought to a broader age range in the future.

The PDX Young Maker's club is a grass-roots, bottom-up, informal organization that, as a side effect of pursuing the passion of young people to make, provides experiential, open-ended learning opportunities that include STEM learning within a context that is very different from traditional formal educational settings. The approach shares much common ground with project-based learning in that students begin with a goal or outcome and learn the skills, tools, and craft required to achieve it "just in time" in contrast to typical formal learning where students would be expected to learn abstract concepts (such as concepts of current and capacitance) with little or no experiential grounding, with the goal of passing tests rather than, say, designing circuits.

We are exploring whether and how an experiential grounding in the purposeful use of STEM concepts in support of student interests and curiosity will provide both the mindset and grounded conceptual framework that will support future interest in STEM fields as well as a sense-making framework that will shift the advanced learning of the abstract models and systems behaviors in STEM curricula from rote memorization of facts and procedures to a joyful discovery of the principles that underlie modern science and technology. In particular, by combining the tools and materials of crafts and arts with the tools and materials of technology, we are finding that we are capturing the interest and genuine understanding of students (in this case mostly young girls) who may not have found traditional presentations of STEM work as compelling.

In many ways, our approach mimics the differences between abstract academic learning and on-the-job learning for STEM professionals. By focusing on open-ended exploration and student-driven interests, by emphasizing play and "futzing around" over artificial design goals, we are also including the elements of creativity and complex design environments typical of tech startups.

As we suspect this kind of learning is hindered by traditional assessment that shifts the focus from making to test-passing, we are deliberately avoiding any assessments other than the natural feedback which occurs among makers sharing projects and experiences. In fact, we recognize curriculum-aligned learning to be a *side effect* of making, not an explicit student goal. In the Making Sense workshop, participants will have the opportunity to experience making circuits with conductive tape, LED's, paper and a liberal dose of play.

Elena Baca, Explora
Pigments of Your Imagination, 2004

"Pigments of you Imagination" was inspired both by my personal experiences as an art educator in a science center, and by Explora's set of program criteria. At Explora we are concerned more with the learning process than with the product. I had observed that parents appeared to be just as apprehensive about art as they were about science. The kids I worked with thought art was fun, and some of the younger students didn't differentiate at all between art and science. I wondered, at what point do people (and schools) view art and science as separate entities?

Participants in "Pigments," question their preconceived notions about science and art, what paint is and how it is made. They use familiar materials in a new way: powdered tempera paints, a variety of dirt and soil samples, chalk, cooking oil, linseed oil, egg yolks, water and liquid soap. They are also provided with a simple data sheet to record recipes, and their evolving experiments. The addition of the data sheet makes what could be seen solely as art play a little more systematic, and encourages scientific thinking during art-making. They test and observe how their concoctions interact with each other, resist or blend. They compare transparency / opacity, viscosity/density. As participants are ready they can use their paints to create a painting to take home The goal of the program is a materials-rich, open-ended, inquiry-based experience in art and science with manipulative possibilities.

"Pigments of Your Imagination" is offered in Explora's Guide to Educational Programs, disseminated to teachers statewide every school year. It is offered as a program for school groups both on site and as outreach. Teachers book this program for students from third grade up. The program also has been offered as part of semester-long programs, like our Home School Science Exploration Series, Science to Grow On (a weekend program for students in grades K-3, where parent attendance is encouraged), Seasonal Camp Programs, and Programs for Elders (adults in an assisted-living facility). It also has been offered as part of professional development experiences for staff, volunteers and early childhood educators.

This program can emphasize design, make and/or play. Depending on the age group or the individual, the focus might be any or all. Younger participants tend to mix and play with the materials, while older students or those with more prior experience with art-making, might be more focused on the making and designing. I have observed many kids engaged in play, showing behaviors similar to those shown while mixing "mud pies." They might make five different black paints, very runny to so dense a stick can stand up in the paint. They were actively engaged, but did not have a specific goal in mind when they started. Children with prior experience in painting, older students or adults with preconceived ideas about what they want to paint tend to make specific colors to fulfill a certain idea. They are focused on design, and they want their paints to function in a certain way (opacity, flow or color), and they often are surprised once they start using their paints. The open-ended approach, the access to materials, and the ease of repeating the experience away from Explora have inspired many parents, students and teachers to continue the investigations and making once they've left.

The program has been designed to meet the scientific process and inquiry strand in the New Mexico State Content Standards for Science. Additionally, it addresses Scientific Process and Planning and Carving out Investigations. Crosscutting Concepts addressed include: Patterns, Cause and Effect, Scale/Proportion/Quantity, Structure and Function, and Stability/Change.

Participants question what paint is and how it is made. This applied chemistry / art experience explores the art / science connection by using familiar materials in a new way, testing and observing how they interact with each other, mix or don't mix, resist or blend and explore color. Record your experiments and use your paints to create an original work of art, with "Pigments of Your Imagination."

The NSF-Funded **IDEA Cooperative** was an out-of-school-time program at the **Science Museum of Minnesota** in the **Kitty Andersen Youth Science Center (KAYSC)**. The program ran from 2008-2011 in partnership with the **St. Paul Public Schools** and **St. Paul College**.

The program was conceived as a way of addressing the lack of participation in high school engineering programs on the part of young women and African-American and Latino young men. The intention was to create a program that would generate interest by highlighting the cooperative, community-building aspects of **designing** and **making**.

***The Invention Crew received the $10,000 Lemelson-MIT InvenTeam grant in 2010.***

The IDEA Cooperative was composed of a high school program, the **Invention Crew**, and a middle-school program, the **Design Team**. The motives for both programs were similar, however, their approaches were tailored to their different audiences.

The Design Team worked on short-term, structured design and making activities that would provide a broad range of experiences. The Invention Crew focused on long-term projects to address real-world problems, although they participated in a number of smaller activities to provide experience and context for their larger projects. The **design process** and **teamwork skills** were a primary focus for both crews.

Up to 24 high school youth and 36 middle school youth were in the year-round program at any given time. In total, 131 youth participated in the program (and nine of those youth were members for the entire three years.)

These two youth crews, and several others, are a part of the Kitty Andersen Youth Science Center. The KAYSC specifically focuses on serving young women and underrepresented populations with the mission of *"Empowering youth to change our world through science."* This mission is achieved by focusing on community, content, and careers. Last year, the 95 youth members of the KAYSC averaged 250 contact hours and reached over 50,000 museum visitors through their activities.

The workshop activity will lead conference attendees through the same design challenge KAYSC youth complete early in their program experience. The activity encourages participants to reflect on how they identify and solve problems as a group, however, the exact nature of the task needs to remain secret until the workshop.

**LEGO Engineering: Learning with your hands**

*Tufts University*
*Center for Engineering Education and Outreach*

**Inception Date:** 1997

**The Story:** In the mid-90's a few of us were working on getting engineering in the K-12 classroom when we came across the LEGO Control Lab Interface (CLI) - a serial device that allowed you to read sensors and turn on motors. We started working with LEGO on getting the CLI to work in LabVIEW for a few classes (at Tufts and in a local kindergarten). The resulting software worked well enough that we started a now 15 year alliance between LEGO Education, Tufts University, and National Instruments (makers of LabVIEW) that has led to the development of Robolab and, more recently, LabVIEW for LEGO Mindstorms. Along the way, we realized that we had no measurements to back up our success claims on the importance of engineering education, so we started a doctoral program in engineering education, looking at engineering learning from kindergarten to college, with even one thesis looking at teacher learning.

**Goals:** The main goal of the LEGO Engineering program is to increase the engineering literacy of high school graduates. We want them to learn how to define a problem, plot a path to a viable solution to that problem, and then how to realign that path as they go down it at see that the original path will not work.

**School Environment:** We have focused primarily on the school day - that is working with all students in all classrooms, rather than the after school environment. Although the latter is certainly a powerful teaching environment, it tends to attract students that are already interested in STEM. Our work includes working with language arts, science, and engineering teachers.

**Primary emphasis:** The primary emphasis of our work is really in getting students to think for themselves - that is design something that no one has done before, learn from failure and iteration, and work in teams, learning to listen to others. One of the key components of our work is that something is actually constructed, with the premise that "pure design" only really happens when it is combined with fabrication, and is only fun when play is involved.

**Project Research:** We have performed a number of research studies, from measuring the planning skills of 1st graders to measuring teacher interest and ability to teach open-ended problem solving. Most of the research is listed at [www.ceeo.tufts.edu](http://www.ceeo.tufts.edu).

**Workshop:** At the workshop, teams of two will work together to solve a LEGO robotics problem. Success at the workshop will be measured by the diversity in solutions (rather than how many people got the right answer).

**Craft Technology Lab**

*Michael and Ann Eisenberg, University of Colorado, Boulder*

The Craft Technology Lab (www.cs.colorado.edu/~ctg) was begun in 2000 as a research group at the University of Colorado. The central interest of the Lab is in mathematics and science education; in particular, we are interested in blending novel technologies with the best traditions of children's hands-on craft activities. Within the Lab, we and our students pursue a variety of projects; most of our work to date has been funded by the National Science Foundation (see our website for specific projects). Work in the Lab has resulted in numerous publications, several shareware applications, and two commercial products (the LilyPad Arduino, and the Aniomagic Schemer Button).

When we present talks about the Craft Technology Lab, we make a point of describing what we do as "imagining new activities for children". We prefer *not* to talk about our work in terms of "teaching skills", because we view skill training as secondary to the more important task of providing youngsters with expressive, challenging, content-rich things to do. (One of our mantras over the years has been: "Children don't need skills; they need purpose.") Historically, then, we have worked either in after-school settings or "elective courses", on the occasions when we have collaborated with schools; we have also taught workshops at the University of Colorado, at local libraries, and at children's museums.

The work of the Lab actually encompasses "design", "make", and "play" in varying amounts, depending on the particular project. The JavaGami project centers on creating mathematical models in paper (we've always seen this as mostly play!). A recent project in collaboration with the Lawrence Hall of Science focuses on giving children access to a programming interface for the giant "Science on a Sphere" display available at numerous planetariums; this could be viewed as "design" (of programs), or "play" (creating gorgeous designs on the giant sphere). Yet another recent project, "Plushbot", focuses on allowing children to create their own computationally-enhanced plush toys: a bit of "make", a bit of "design", and a lot of "play" (once the toy is complete).

Our projects generally include elements drawn from a wide variety of STEM disciplines. Often they focus on spatial visualization and cognition (3D geometry, non-Euclidean geometry, and so forth), engineering design, and programming; but we prefer not to be pigeonholed into any one choice of subject matter. Our workshop for this event will focus on a venerable Craft Technology project, JavaGami, in the area of 3D geometry. We will also briefly talk about some of our other representative projects, and our overall approach to educational technology.

**Click! Spy School** a program of Girls, Math & Science Partnership, an initiative of Carnegie Science Center, Pittsburgh, Pennsylvania.
Presenters: Nina Barbuto, Heather Mallak, Sandlin Seguin Ph.D.

*Click!* Spy School is a program of Girls, Math & Science Partnership (GMSP), an initiative of Carnegie Science Center, which engages girls ages 10–14 in solving mysteries and completing covert missions using key science concepts through informal science learning experiences. This program combines relatable and fun narratives with cutting-edge technology to foster tactile-based inquiry, real-world problem solving skills, and career exploration in science, technology, engineering, and math (STEM). Local and national female STEM professionals from esteemed companies and universities regularly contribute to the curriculum, guest counsel, serve as professional mentors, and act as cameo roles in the camps' narrative. *Click!* Spy School engages girls predominantly through onsite programs based at Carnegie Science Center, as well as through interactive online experiences and condensed activity sessions. Each program of the *Click!* Spy School promotes learning through "play," while incorporating elements of "design" and "make" into specific activities. Playing is an integral part of solving the mystery; by enacting the role of an agent-in-training, each participant is learning through doing.

Conceived in 2005 by the University of Pittsburgh's Learning Research and Development Center (LRDC) in collaboration with Carnegie Mellon School of Design, *Click!*'s mission is to provide out-of-school-time informal science learning experiences for middle-school girls. During *Click!* programs, girls are introduced to important concepts such as: understanding real-world applications of STEM, investigating and interpreting information, collecting and analyzing data, constructing explanations and designing solutions, and obtaining and communicating information. Since the program's inception, *Click!* has reached more than 600 girls through onsite visits to the Science Center, partnerships with public and private schools, Girl Scout activities, community outreach, and other established afterschool programs.

The *Click!* Spy School summer camp, the program's longest running initiative, takes place in the urban setting of the Science Center, located on Pittsburgh's North Shore. Focusing on three distinct areas of exploration—biomedical science, environmental protection, and expressive technology—the summer camp provides girls an immersive, hands-on learning adventure where they act as agents-in-training to help solve real-world crises as they learn about science and explore STEM careers. Using the surrounding city landscape, participants are able to explore global issues by discovering the science behind their own neighborhood assets including a real Cold War-era submarine, river kayaking, Heinz Field, local art museums like the Mattress Factory, and corporations like Delmonte Foods. Agents-in-training complete missions using fingerprint analysis, GPS location, water testing, collecting clues, DNA testing, basic computer programming, calculating carbon footprints, science trivia, and much more. Condensed *Click!* activity sessions have taken place at offsite locations, such as the Greater Pittsburgh YWCA, with follow-up activities at Carnegie Science Center.

In 2010, a MacArthur grant in Digital Media and Learning allowed GMSP to translate the *Click!* Spy Camp into a web-based interactive program to address the gender gap in online gaming. A virtual *Click!* Spy School was created to capture the onsite experience, complete with female senior agents who mentor and communicate mission-relevant messages to agents-in-training. The online Spy School begins with solving an environmental crisis in Africa. Using "mini-games" that are mission-customizable, junior agents can simulate the activities of the onsite camp while interacting with other junior agents and gaining understanding of possible STEM careers. The online Spy Camp will remove the geographical barriers and allow girls all over the world to benefit from *Click!* programs.

GMSP and Carnegie Science Center are working diligently to bring *Click!* programs to girls worldwide. Although *Click!* Programs are best supported by institutions like museums, science centers, and schools, in development are additional online offerings, as well as scalable, satellite camps that can be customized for the venue, audience, budget, and curriculum. Partnerships are instrumental to *Click!*'s success. In 2012, *Click!* will partner with the Carnegie Library of Pittsburgh's vision for a system-wide digital learning program for the teenagers of Pittsburgh. *Click!* has a strong commitment to encourage girls to see themselves as architects of change and to think of themselves as key contributors to all fields of STEM, in the Pittsburgh region and beyond.


Click! Agent Training, a collaboration with the New York Hall of Science, asks teams to crack the case on an intelligence breach at a temporary Click! base located in the museum. Each team will have to work together in order to gather data and collect clues in the exhibition spaces, while receiving mission messages from three female STEM professionals on handheld communication devices. The goal is to save the New York Hall of Science so that future generations of secret agents have a laboratory to hone their science skills.

CONSTRUCTION KIDS

**Build a Small Wooden Car**
**Presenter**: Deb Winsor
ConstructionKids, Inc, Brooklyn NY

The Small Car that ConstructionKids will share with participants is emblematic of the wide range of project design challenges that educators face when incorporating hands-on learning into a science and math curriculum. Participants will make the project, while doing so we will point out broader teaching points, design challenges and educational potential of hands-on building projects as we have observed in our workshop and with schools.

The Small Car is a project that appeals to children of all the ages that we currently serve in our program, (ages 2-12). The Car is also enjoyed by parents and teachers who 'make' the project alongside the children. The Small Car has been used by schools as a primer project for curriculum such as Simple Machines, Transportation and Urban Studies, non-fiction writing programs, Math, and elementary science. ConstructionKids will bring several other projects for participants to review, the Small Car is one of several thematic series that we offer.

While seeming simple, the Small Car, like all Maker projects, embeds sophisticated educational material in a fun project. First, there is the mastery of a new physical skill set (hammering), followed by design, planning and sequential assembly. Children are challenged to recall observations, invent a design program and implement their plan. We will draw from our experiences in traditional classrooms, mixed age groups, and homeschool groups, as well as our experience with inclusion classes and special needs students, an area we feel has enormous potential to benefit from the hands-on 'maker' teaching methodology.

One of the fundamental values of ConstructionKids is to offer children the skills and tools to build solid 3D objects, using real tools and familiar 'grown-up' materials. A broad tactile vocabulary is essential to a child's education in this era of virtual engagement. We look forward to sharing this project and our experience as teachers/makers.

Presenter: HTINK

Project Collaborators: Cognizant, NYSCI, Dreamyard, Newark Museum, Big Picture Learning, MakerBot Industries

Project Title:
'Making the Future' - Inception date: Oct. 2011

Description/Background

Before getting involved with Cognizant's "Making the Future" initiative, HTINK had been setting up 'Young Maker' programs in the NYC area in collaboration with schools, community groups, and family groups. All partners involved in the project want to inspire as many young people as possible to become Makers. While the goal is to get students working with their hands and making things, there is a strong emphasis on students learning about "physical computing," i.e, how the physical world interacts through the virtual world. This can include anything from building a robot, electronic instrument, video game controller/video game, making a light-up LED jacket, or using a 3-D Printer to create physical objects.

Starting in February, HTINK will be co-facilitating two programs that will serve as a model for other programs on a national scale. One program will be an after school program located at Dreamyard, the largest arts education provider in The Bronx, NY. The other program will be located in Newark, NJ at the Newark Museum, and will be an in-school program with students from the Big Picture charter school network. "Makerspaces" will be created in both locations, and will include soldering irons, laptops, traditional handtools, MakerBot 3-D printers, and other low-cost digital fabrication tools.

During the workshops participants will be introduced to 3-D printing with the MakerBot Thing-o-Matic. We'll walk you step-by-step through the process of creating a 3-D computer model and preparing it for printing with the MakerBot. Participants will be given an overview of various 3-D modeling software tools that are available for free online. Specifically, we will be working with TinkerCad and 3-D Tin, which are free modeling tools that can be run from a web-brower. In addition, participants will be shown a set of lesson plans that can be used with their students over the course of a semester. No prior knowledge of 3-D modeling or 3-D printing is required.

Scientific and engineering practices, crosscutting concepts, or disciplinary core ideas

- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Using mathematics and computational thinking
- Structure and function
- Links among engineering, technology, science, and society

## Ingenuity Lab – Lawrence Hall of Science, UC Berkeley

The *Ingenuity Lab* is a museum based drop-in lab space launched in fall 2009 where visitors of all ages engage in monthly rotating engineering design challenges. The program builds on the best elements of infusing “tinkering” or “maker” content in science centers, but amplifies an emphasis on the engineering design process and engineering careers. The Ingenuity Lab is operated in partnership with *Berkeley Engineers and Mentors* (BEAM), a student-run group focused on engaging engineering students in education and outreach. BEAM students work with Lawrence Hall of Science educators to develop and facilitate engineering design challenges. The facilitation of the challenges serves to draw attention to the engineering design methodology, using Engineering is Elementary® representing that process, and makes explicit connections between the action of participants and the work of professional engineers. As visitors brainstorm ideas, build a prototype and then test their design to find a creative solution, they apply problem solving skills and work cooperatively to solve real-world challenges using science and engineering. The joy to experiment, test and play is as important as to troubleshoot and learn from failure. The challenges are open-ended and allow for varying degrees of complexity. The use of simple materials teaches that science is everywhere not only in special labs and kits. Examples of challenges are: Wind Turbines, Vehicles, Solar Energy, and Hydraulics. The Ingenuity Lab is open to the public on weekends as well during winter break and on Holidays. The Lab reaches 15.000 visitors (including adult visitors) per year. The success of the Ingenuity Lab has lead to the addition of two other programs by the Hall.

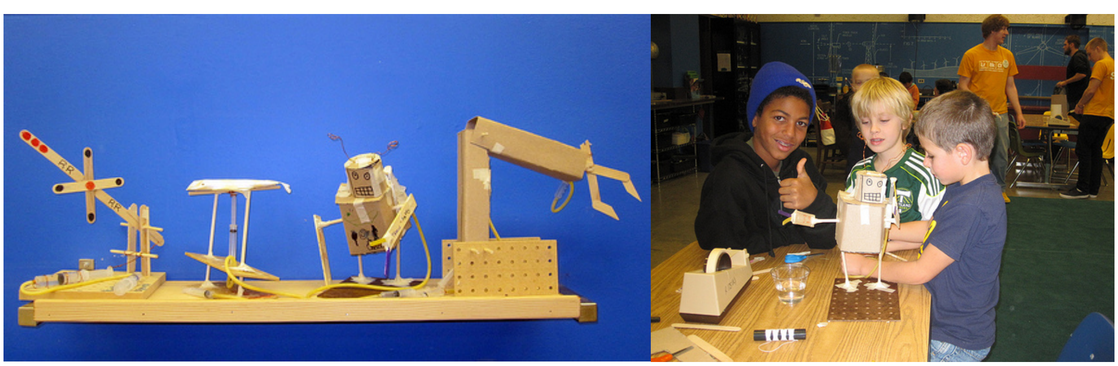
- *”Ingenuity in Action”*, (opened 2010) a floor exhibit based on three of the Ingenuity Lab’s most successful challenges, hardened and scaffolded to require less facilitation.
- *Inventor's Lab*, (opened 2011) a satellite site in Vallejo replicating some of our most popular programs including the Ingenuity Lab.

Program evaluation to date has found that visitors exhibit the behavior of engineers while participating in the design challenges, and that direct interaction with engineer facilitators increases their awareness of the connection between their participation and the work of professional engineers.

The program is designed to address the following outcomes from the new K-12 framework:
1. Scientific and Engineering Practices: 1, 2, 6
2. Crosscutting Concepts: 2
3. Engineering, Technology, and Applications of Science: ETS 1, ETS 2

**Workshop Session:** “Ingenuity Lab – Engineering Design Challenge: Hydraulics”
Presenter: Monika Mayer; Science Education Specialist; Lawrence Hall of Science

This hands-on workshop provides an overview of the Ingenuity Lab, a museum based engineering design program for visitors of all ages. The session gives a synopsis of how the program evolved, highlighting our collaboration with the UC Engineering Department and providing feedback from visitors, educators, and engineering students. Participants will engage in a representative engineering challenge to design, build and test their own working hydraulic system that will lift a weight, operate a crane, or move a dentist chair.



*Sample designs that utilize a model of a hydraulic pump created during weekend drop-in sessions*
*To see more pictures from this challenge go to the Ingenuity Lab* Flickr Website.

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)882)-/'&.'RS$G'C2)3'.-0/')*0'5)B$-$2/O'9#2',#)./'.5'/,#..-'N3.A8/'5.3,20'A/'&.'5$*0'D)C/'&.'$BB20$)&2-C')*0'
$*&A$&$72-C',.BBA*$,)&2'&#2',.*/&3)$*&/'.5'&#2'2"#$%$&')*0'B$*$B$T2'0)*N23.A/'%2#)7$.3'7)-A)%-2'0)
)0)8&'$&'&.'272*'C.A*N23',#$-032*'J)/'C.A*N')/'&#322'C2)3/'.-0K'D#.')-/.'D)*&'&.'&3C'&#2'&..-/O'

9#3.AN#')'52D'/B)--'%A&'8.D235A-'&D2)</'&.'&#2'2"#$%$&'D2'D232')%-2'&.',#)*N2'7$/$&.3/M'2"82,&)&$.*/')*0'%2#)7$.3
)&'&#2'2"#$%$&O'U.3'2")B8-2K'D2'%2-20'/&.3)N2'%$*/'&.'B)&,#'2-2B2*&/'$*'2-2,&3.*$,/'J)B$%$&$,'%$&/6'B2&)-'%$&/6'
2&',2&23)K')*0'823$.0$,)--C'/.3&'&#2'B)&23$)-/'.*'&#2'&)%-2O'9#$/',#)*N2',.BBA*$,)&20'&#)&'D2',)32')%.A&'&#2'
8$2,2/')5&23'&#2CM32'32B.7206')*0',A&'0.D*'/$N*$5$,)*&-C'0$/,3$B$*)&2'%)*N$*NO'

!"#$%&'%()"*B22&/'/2723)-'.5'&#2'B)?.3'N.)-/'5.3'9!:;+'+8)3<O'P&'N$72/'7$/$&.3/'&#2'.88.3&A*$&C'&.'-2)3*'&.'A/2'32)-'
&..-/'J)*0'32)-$T2'&#)&'&#2C'A/2'32)-'&..-/K6'$*&3.0A,2/'&#2B'&.'&#2'32)-'2-2,&3.*$,/6'%32)</'&#2'&)%
2-2,&3.*$,/'%2$*N'83$/&$*2')*0'/#.D/'7$/$&.3/'&#)&'D2'&3A/&'&#2B'&.'&3C'/.B2&#$*N'0$55232*&6'32)-6')*0'J$5'D2'#)0*
-2)3*20'#.D'&.'5),$-$&)&2'$&'2552,&$72-CK'8.&2*&$)--C'0)*N23.A/O'

V/'8)3&'.5'&#2'/,)$-%.'/012'2"#$%$&$.*6'!"#$%&'%()"*$-)%-2'&.'/,#..-'N3.A8/')*0'B2B%23/'.5'&#2'N2*23)-'8A%-$,'
7$/$&$*N'&#2'/,$2*,2',2*&23O'92*/'.5'&#.A/)*0/'.5'82.8-2'#)72'A/20'$&'$*'&#2'5$3/&'&#322'B.*&#/'.5'.823)&$.*/O'

P&'5.,A/2/'.*'&#2'5.--.D$*N',.32'$02)/@'

- V/<$*N'WA2/&$.*/'J5.3'/,$2*,2K')*0'025$*$*N'83./'/2B/'2*N$*223$*NK
- >-)**$*N')*0',)33C$*N'.A&'$*72/&$N)&$.*/
- !*N$*223$*N'02/$N*
- :$*</')B.*N'2*N$*223$*N6'&2,#*.-.NC6'/,$2*,2')*0'/.,$2&C

='Q.3</#.8'(2/,3$8&$.*@'9)<2')8)3&'2-2,&3.*$,/'&.'N2&')'#)*0/'2"823$2*,2'.5'#.D'&#$/'8.&2*&$)--C'0)*N23.A/'
),&$7$&C'%2'5),$-$&)&20'$*')'D)C'&#)&X'/)52')*0'/A/&)$*)%-26'2*,.A3)N$*N'7$/$&.3/'&.'&)<2')',.*/&3A,&$72')883.),#'
&.'02/&3A,&$.*O