Full STEAM Ahead

Science, Technology, Engineering, Art, and Math from nclab

More Than Coding

Issue 5, April 2017

The University of Nevada, Reno Innevation Center – A Catalyst for Enterprise

Rosanne Catron, Coordinator, Innevation Center, Reno

The University of Nevada, Reno supports a cooperative research and discovery environment. With an unusual, open approach to industry and entrepreneurs, the University has the goal of connecting the resources and knowledge of the campus with the greater community. It was with this goal in mind that the University of Nevada, Reno Innevation Center—Powered By Switch was opened a little over a year ago.

The Innevation Center is a synergistic, collaborative space stimulating the creation and incubation of start-ups and accelerating the growth of the region's knowledge-driven economy. It is designed to empower Nevada's next generation of economic leaders by igniting the creative and entrepreneurial spirits of the University's students and faculty, community creatives, makers, economic developers and emerging companies.

In the heart of downtown Reno, The Innevation Center is accessible to the general public during standard business hours and to members for extended hours. We offer co-working space, conference rooms ranging in size, with the largest holding up to 150 people, and a makerspace housing twelve 3D printers, hand tools, soldering stations, an industrial sewing machine, a laser cutter, CNC mill, CNC lathe, drill press and other shop equipment. The makerspace is used by startups, industry, hobbyists, student groups and more, and is the perfect place for prototyping, idea conceptualization, brainstorming and fun.

The Innevation Center hosts members who work in a variety of backgrounds, including software development, the biomedical field, and clean energy, just to name a few. In addition to members, a number of entrepreneurial groups, mentors and university students and staff work out of the building. We are also home to two, innovative university programs—NAASIC is advancing commercialization in autonomous systems, and NVIE is the statewide industrial extension partnership.

All of this adds up to an energetic, diverse space brimming with ideas. Anyone can become a member and benefit from co-working and networking opportunities, mentors and the University's business-oriented resources. Visit unr.edu/innevation call our front desk at (775) 682-8612 or contact Rose Catron at rcatron@unr.edu.

Chance At Computer Science With NCLab

Chance Harrison, Silver Springs, NV

My name is Chance Harrison, and I'm currently studying at both the Silver Stage High School and the Western Nevada College. Accomplishments that I am currently proud of are achieving A's in all my classes since my first year in high school, and completing my TestOut PC Pro Certification. I found a deep interest in computing, and will likely pursue a related career, thanks to NCLab.

The task of figuring out what might be worth pursuing after school is a task that students everywhere, myself included, must face. I happened to identify a career that I'm likely to be happy in, but for many others, it isn't always an easy task. NCLab played an essential role in this process, and I can't say that my interest in programming and computers would be the same without NCLab. I was first introduced to NCLab and the wealth of knowledge it had to offer in my final years of middle school. It was in my STEM (Science, Technology, Engineering, and Math) class, the one I looked forward to the most because of the many different things that we did as a class. However, NCLab succeeded at drawing my interest like very few things have before. The Karel the Robot course was my first experience with computer programming and I recall it being very rewarding. I found it was both challenging and motivating for me, each level serving as a stepping stone that increased both my understanding of the underlying concepts and drove me to continue progressing.

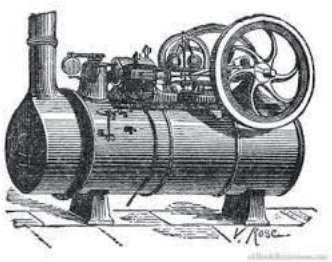
I had completed a considerable amount of the Karel course before I moved onto designing three-dimensional models with PLaSM in NCLab as well. PLaSM allowed for greater difficulty and complexity while allowing for more creative expression. From where I am today, I can say that the benefits from using NCLab, even back in middle school, have been long-lasting and continue to be important to me. This is because, as I mentioned above, I can attribute a considerable amount of my interest in technology (and to a greater extent, programming) that I possess today to my use of NCLab back then. It didn't only spark (and maintain my interest) but it also solidified many foundational skills that will be necessary as I move forward on a path towards programming, web development, and likely computer science.

For me, a big challenge I faced was being diagnosed with Type 1 Diabetes (an autoimmune disease that causes the body to cease production of the essential hormone that is insulin) when I was in the 4 th grade. I used the past tense when describing my diagnosis because it isn't a negative or especially difficult thing for me anymore, if anything, I have learned to look at what positive things have come out of it. Challenges like Diabetes did not and will not stop me from pursuing my desires: programming and technology along with others. I hope that from my brief story you can take away the fact that the challenges you face do not and can not stop you from pursuing your goals.

What is the Fourth Industrial Revolution?

What is the Fourth Industrial Revolution, sometimes (inaccurately) called Industry 4.0 or just 4IR? Before we answer, let us take a step back.

1. Steam



The First Industrial Revolution, or "Industrialization", began in England in the late 18th century, following in the wake of James Watt and his steam engine (1774). Tasks previously done laboriously by hand in hundreds of weavers' cottages were brought together in a single steam cotton mill, and the factory was born. The initial focus of industrialization was on textiles. The First Industrial Revolution marked a major turning point in history – almost every aspect of daily life was influenced in some way. Economic historians are in agreement that the onset of the First Industrial Revolution is the most important event in the history of humanity since the domestication of animals and plants.

2. Electricity

The Second Industrial Revolution, also known as the "Technological Revolution," was a phase of rapid industrialization in the final third of the nineteenth century and the beginning of the twentieth century. It was powered by electricity. It is considered to have begun with Bessemer steel in the 1860s and culminated in mass production and the production line. The enormous expansion of rail and telegraph lines after 1870 allowed unprecedented movement of people and ideas, which culminated in a new wave of globalization.

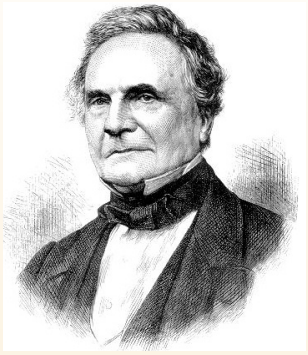
3. Computers

The Third Industrial Revolution, or the "Digital Revolution", refers to the advancement of technology from analog electronic and mechanical devices to the computers that are available today. The era started to during the 1980s and is ongoing. Advancements during the Third Industrial Revolution include the personal computer, the internet, and information and communications technology (ICT).

4. Cyber-Physical Systems

While the first three Industrial Revolutions were characterized mainly by advances in technology, the fourth one is characterized by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres. In other words, the Fourth Industrial Revolution not only changes what we are doing - it changes us, humans. This is possible thanks to emerging technology breakthroughs in fields such as artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing. Examples of this fusion include using 3D-printed parts such as artificial limbs or vertebrae to repair the human body, enhancing impaired human bodies with robotic parts, combining 3D printing with living stem cells to grow artificial tissues and bones. Engineers, designers, and architects are combining computational design, additive manufacturing, materials engineering, and synthetic biology to pioneer a symbiosis between microorganisms, our bodies, the products we consume, and even the buildings we inhabit.

Who Was Charles Babbage?



Charles Babbage was born in London Dec. 26, 1791 in London. He dedicated his entire life to the vision of a mechanical machine that would perform calculations. In Babbage's times, there was a very high error rate in the calculation of math tables. Babbage planned a new method that could be used to perform the calculations mechanically, removing the human error factor.

The Difference Engine

Babbage presented his proposal for a "difference engine" to the Royal Astronomical Society on June 14, 1822. This machine would calculate polynomials for astronomical and mathematical tables, using the difference method. The Society approved the idea, and the government granted him £1500 to construct it, in 1823. However, after many years of problems, the government officially abandoned the project in 1842.

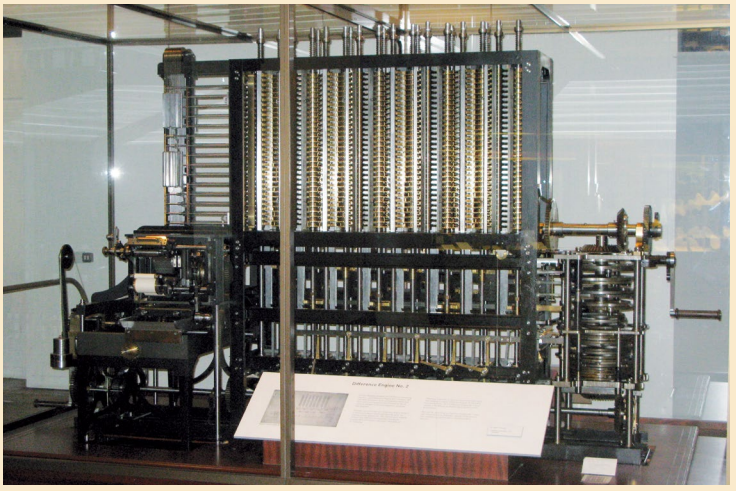
The Analytical Engine

Between 1833 and 1842, Babbage tried to build a machine that would be programmable to do any kind of calculation, not just ones relating to polynomial equations. The first breakthrough came when he redirected the machine's output to the input for further equations. The analytical engine used punched cards adapted from the Jacquard loom to specify input and the calculations to perform. The engine consisted of two parts: the mill and the store. The mill, analogous to a modern computer's CPU, executed the operations on values retrieved from the store, which we would consider memory.

Second Difference Engine

Between October 1846 and March 1849, Babbage started designing a second difference engine using knowledge gained from the analytical engine. It used only about 8000 parts, three times fewer than the first. It was a marvel of mechanical engineering. Unlike the analytical engine that he continually tweaked and modified, he did not try to improve the second difference engine after completing the initial design. Babbage made no attempt to actually construct the machine. His 24 schematics remained in the Science Museum archives until a full-size replica was built 1985-1991 to celebrate the 200th anniversary of Babbage's birth. It was 11 feet long, 7 feet high and 18 inches deep, and weighted 2.6 tons. It worked flawlessly.

There are many articles on Babbage's life and achievements. This article is only an appetizer.. Watch this video to see his incredible machine in action: http://youtu.be/jiRgdaknJCg.



Carson City Library: Closing the Books to Open New Kinds of Learning

Sena Loyd, Director, Carson City Library

Libraries have to change. We understand knowledge doesn't necessarily just come from books. We're in the generation where information is at our fingertips, but the way we access it is constantly changing. And how do we know what information is correct? The Carson City Library is bridging that gap between information and technology to prepare young library users for the world they will live in.

Habits of Mind (Craft) and NCLab are some of the programs we use to close the books in order to open the digital world for students to access knowledge through 21st century skills. In Habits of Mind (Craft), youth in grades 6-10 are invited to play the adventuring video game Minecraft that allows them to collaborate in building structures as well as entire communities. The library hosted two Saturday workshops each month last year, along with a build-a-thon, where students focused on creating and learning. "It's a canvas where they can take an abstract concept and make something real," said Robert White, a Carson High School junior who serves as coordinator for the Habits of Mind (Craft) program. "We use it as a kind of sandbox they can actually play in and make it happen

Through our other program, NCLab, students learned coding and 3D modeling during camps, which allowed the students to engage in self-paced coursework combined with creative activities. Each camp included physical activities, games and tournaments. As part of the coding instruction, students learned programming language to write and execute code that controls digital technology.

Aubrey White, assistant youth librarian, teaches Reese MacKenzie, left, and Tarah Wright, both 11, during a coding and 3D modeling camp at the Carson City Library. Photo by Cathleen Allison / Nevada Photo Source.

The skills learned in the one-day camps serve as a base for students to understand the principles they will need as they progress in their education and enter the workforce. Computers are not going away. More and more, the level of skill a student has is going to impact them not only in the future but right now in school. Even students who had no interest in technology benefited from the camp. Computer coding teaches problem-solving and it develops the ability to fail. They learn how to use trial and error. If something doesn't work, they just keep trying, and they figure it out. When students participate in these programs at the library, they come away better equipped to face the challenges of today's world and prepared to continue their education. The best part is, they're having so much fun, they barely even realize how much they're learning.

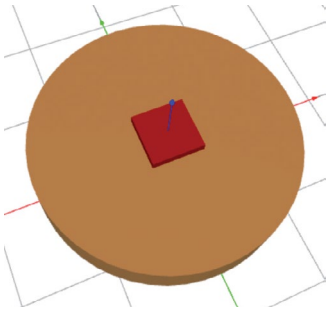
Habits of Mind(Craft) is run on the Minecraft EDU platform. NCLab is an open public cloud computing platform that provides fully supported self-paced online STEM courses for K-12 schools, homeschoolers and libraries.

Acknowledgment: This article is based on an article of the same title published by IMLS (https://www.imls.gov) on Wednesday, March 8, 2017.

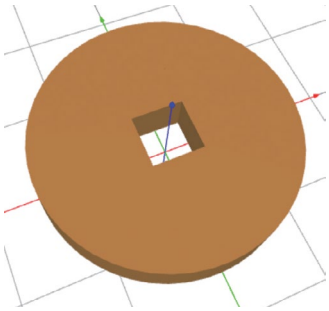
The Art of 3D Modeling – Efficient Boolean Operations

In 3D Modeling, Boolean operations build and modify models by creating intersections and unions of objects, as well as subtracting objects from each other. All these are set operations that students know from Venn diagrams. Let's stay with the last one for the moment. In order to demonstrate subtraction, let's consider a pair of overlapping objects, such as a cylinder and a cube:

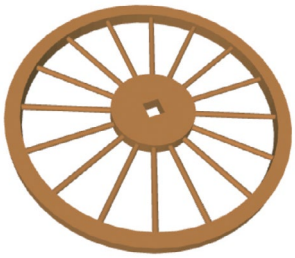
Subtracting the cube from the cylinder is not technically difficult – usually this is done using a single command or mouse click in the 3D modeling software. As a result, one obtains a set of 3D points that belong to the cylinder but not to the cube.



However, Boolean operations become tricky when complex objects are involved. Let's have a look at this spoked wheel which is an extension of the hollow cylinder that we just made.



The wheel can be built in many different ways. Let's consider two, which we will call Method A and Method B. In Method A, (1) create the interior cylinder, (2) subtract the cube from it and (3) create a union with the spokes and the rim. Method B will create exactly the same result by (1) creating a union of the interior cylinder, the spokes, and the outer rim and (2) subtracting the cube from it. However, one of these two approaches will be significantly computationally simpler and faster than the other. Can you guess which one it is?



Before we answer, let's understand how the subtraction works. It is an operation that compares 3D objects. The surface of each object is defined via certain number of faces. The algorithm analyses the interaction of all faces of one object with all faces of the other object. Therefore, the computational complexity increases rapidly when objects have a large number of faces.

In Method A, the subtraction occurs between two relatively simple objects – a cylinder and a cube. In Method B, the cube is subtracted from a much more complex object that is formed by the inner cylinder, 16 cylindrical spokes, and the outer rim. Therefore, Method A is computationally much more efficient. In concrete numbers, the CPU time for the former approach was 1.9 s while the latter approach took 5.4 s which is almost three times more.

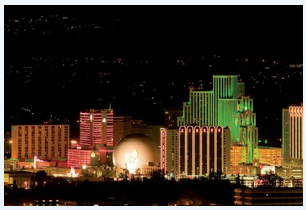
The conclusion of this simple experiment is that the order of Boolean operations matters. If subtraction is needed, then it is a good idea to do it as soon as possible, between as simple shapes as possible. Subtracting complex objects can be extremely costly in terms of CPU time.

Our Story – Bringing Equity To STEM Education

OUR STORY

Our story is about sharing a passion for computing, and bringing equity to STEM education.

Reno (2008)



Pavel comes to Reno in 2008 and joins UNR as an Associate Professor of Applied and Computational Mathematics. He is your typical scientist who barely cares about anything but crunching numbers on supercomputers and writing scientific articles and books about it.

Road Trip (2010)

In 2010, Pavel joins a colleague and visits a number of K-12 schools in rural Nevada. He realizes that most of the schools sadly lack the technology and knowledge to teach their students essential 21st century STEM job skills. Therefore he starts visiting rural schools more often, and trains teachers in computer programming, 3D modeling, computer algebra, computational chemistry, fractals, LaTeX, and other cool STEM subjects. The number of schools that are interested in these workshops is quickly growing.

NCLab

NCLab (Network Computing Laboratory) is soon created as a free public cloud platform to provide instant online access to a wide range of computational STEM activities. The platform is used for teacher training, camps, and after school programs. The International Society for Technology in Education (ISTE) invites Pavel to train hundreds of teacher annually through their webinars and hands-on ISTE conference workshops.

Working with Students

In 2013, the NCLab Team organizes the first 2-day computer programming and 3D modeling summer camp. It is a huge success. Due to an increasing demand, camps are offered in all school breaks throughout the year, with several sections in the summer. After school programs in the Reno-Sparks area are added in 2014.

The Pull

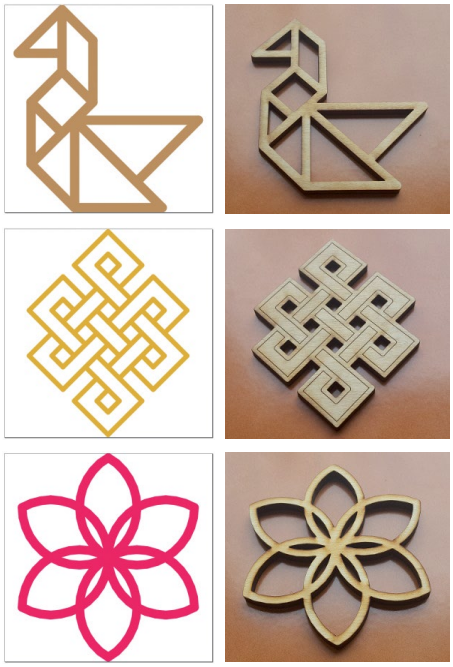
In five years, without any marketing or sales efforts, through a purely organic growth, NCLab expands to all Nevada school districts. In 2016, it is selected by the Nevada Department of Education to become the integral part of the Nevada Ready 21 program, and is endorsed by Governor Brian Sandoval. In the same year, NCLab is adopted by the system of Nevada public libraries and by the Signature Academies (CTE high schools) in Nevada. At the same time, NCLab starts expanding organically into numerous other states and to other countries.

Our Story Continues…

Currently, the NCLab team and network are growing to meet the rapidly increasing demand for our self-paced and self-graded computer programming and 3D modeling courses. For our customers, that means new and expanded educational products, streamlined procedures, faster computations and more. We are more passionate than ever before about bringing equitable access to STEM education to all learners than ever before. Stay in touch – we'd like to hear from you. Read our newsletter, check our blog, and contact us!

Laser Cutting With NCLab

Recently, the NCLab Team added SVG output to both the Turtle Coding course and the Turtle Coding app. What does this mean? SVG files are vector images that are superior to many other image file formats. But more importantly – they are universally accepted by laser cutters. Laser cutting allows students to have their Turtle designs cut out of wood or plastic, and use them as decorations or for other purposes. A big advantage of laser cutting is that it is much cheaper and faster than 3D printing! (The Turtle also has STL file output for 3D printing.) Craft and hobby stores sell thin boards of hard wood (such as basswood), and soft wood (such as balsa) for about $ 3 each. These are excellent for laser cutting. Here are a few designs which have been turned into laser prints. The viewer images are on the left, and the laser cut prints, made of 6 mm basswood, are on the right. You can print these yourself using these links in the electronic newsletter: swan.svg, diamond.svg, mystery.svg. Their Turtle source codes can be found in the NCLab Turtle Gallery.

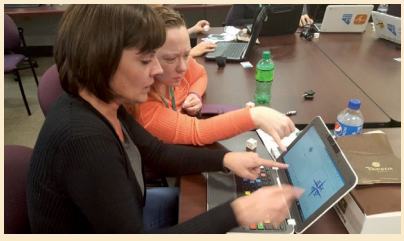


Training NV Ready 21 Educators and Coaches in Las Vegas

On Saturday, March 3, Nevada Ready NCLab trained 21 teachers and coaches in Las Vegas, Nevada. Although webinars are useful and convenient, we once again saw that nothing beats a live training. It was awesome meeting and talking with so many dedicated educators, and we look forward to working with several new schools.

Sheila explains principles of game-based learning.

Cool teacher certificates prepared by our friends at CTL.



When fearless math and science teachers set their mind to building a compass, nothing can stop them!