

Sci-Tech at Glenview North



Glenbrook North High School's SciTech Curriculum balances theoretical science and practical manufacturing technology.

Science and technology courses at Glenbrook North High School (Northbrook, IL) in the suburbs of Chicago have become extremely popular over the past decade. During that time, numerous graduates have gone directly into manufacturing jobs. Even more students, almost 50 young men and women, have gone on to pursue college degrees in engineering.

The projects undertaken by students of the SciTech course have yielded significant results in terms of student achievement and national recognition. For example, one of the projects, a miniature roller coaster designed by a student, was exhibited in the Museum Of Technology in Toronto.

Today, when there is an open house at the school, the carpeted tech lab with its 22 CAD/CAM (computer aided design and manufacturing) workstations is one of the first stops on the tour. That's a sharp contrast from twelve years ago when there was no SciTech course, and the high school's conventional metalworking shop appeared to be on the verge of extinction.



Lightweight Monthly Challenge. Students designed and built lighter-than-air vehicles. The challenge involved trials in which students competed to see whose vehicle could be navigated around a pole and back in the shortest time.



RIFED AGAIN?

During the late 80's, Jim Howie was a shop teacher in an affluent school district north of Chicago. Education generally was doing well there, however his career had taken a big hit. Few college-bound students considered traditional vocational courses relevant to their needs or interests. Consequently, Howie became the victim of a "Reduction In Force." He was determined not to be "RIFed" again if he could help it.

He realized that his subsequent position on the Applied Technology faculty of Glenbrook North High School would be tenuous at best, unless he could make a course in manufacturing technology fun, interesting, and relevant to the students of this suburban community. He knew that the merger of science and technology held great promise, so he came up with a curriculum where "applied technology and pure science butt heads on a daily basis."

According to a web site posted by one of the student teams enrolled in this program: "SciTech is a project-based course designed to have students learn the science behind a series of hands-on technology related activities. Problem solving is utilized to overcome problems of design, development, production, and testing of a product. Topics are from both applied technology and science including: robotics, pneumatics, hydraulics, computer design, computer controlled machining, optics (including laser technology), mechanics, electricity, and magnetism. Students work in design teams and present their results and achievements to the class."

Howie describes it more succinctly and colorfully as "Toys'R'Us® in the classroom."

POINT COUNTER POINT

Howie and his teaching partner, Jeff Jordan, a science teacher, are now in the 12th year of teaching this course together. In the SciTech class, instruction moves between the presentation of scientific principles and supervising students in the creation of unique (perhaps even wacky) artifacts that rely on or represent the principles.

The entire year is punctuated with weekly problems and monthly challenges such as building and testing shampoo bottle vehicles, rocketing eggs to the height of skyscrapers and bringing them down again without breaking, and navigating their own lighter-than-air vehicles around obstacles. The monthly challenge typically culminates in a competition in which the teams test their inventions to see which travels the farthest or works the best. Some very entertaining movies of these successes and failures may be found on web sites developed by some SciTech students. These include:

SRV Gone Bad

<http://gbn.glenbrook.k12.il.us/academics/science/SciTechWeb/srvgonebad.mov>

All Time High Launch

<http://gbn.glenbrook.k12.il.us/academics/science/SciTechWeb/real-rocket.mov>

Lighter Than Air Vehicle

<http://gbn.glenbrook.k12.il.us/academics/science/SciTechWeb/ltav.mov>

Each challenge actively requires the student to understand a specific set of scientific principles and apply them to achieve some real world result. Winning or losing a challenge does not exempt the student from learning something. In every case, he or she must report on why the project behaved the way it did. Howie said that some of the subsequent "back-to-the-drawing-board" experiences of students are among their most instructive.

CAD/CAM TIES IT TOGETHER

The place where practical and theoretical sciences come together most frequently in the SciTech curriculum is in the CAM laboratory, where students learn how to automatically manufacture objects on CNC (Computer Numerical Control) manufacturing equipment. Glenbrook North owns small CNC machines (lathes and mills) suitable for classroom use.

Each of the computer workstations in the lab is equipped with Mastercam CAD/CAM software, which not only allows students to design parts in a simulated graphic environment, but generates machine code telling the CNC equipment how to automatically manufacture them. This is the very same software that is widely used in industry to generate programs for much larger and more sophisticated manufacturing systems. CNC Software, Inc. supports teachers through a dedicated Educational Division, which provides curricula, teacher training opportunities, project ideas, and Web-based Internet support. Mastercam has even volunteered its

Basic R&D for darts designed and programmed by students and manufactured on the school's lathe, involves throwing the end product at a target to see if it flies straight. If it does not hit the dartboard, then it's back to the drawing board for the student.



services to manufacture unique student parts that were beyond the capabilities of the school's equipment.

During the first semester, students learn how to use the design software, design a cylindrical artifact and manufacture it on the CNC lathe. During the second semester, they design and manufacture an artifact with 2D or 3D engraving using the CNC milling machine. Students also work in teams on a comprehensive yearlong project. This year, about 3/4 of the students enrolled in SciTech will be designing the components to be used in their projects and programming them to be manufactured on the school's CNC equipment.

SCITECH TOYS

Howie said that teachers can use the Internet to find dozens of projects that are both fun and instructive. Here's what he has to say about some of his favorites:

Darts. "The first semester, we use design software and a CNC lathe to design and manufacture pub tip darts. R&D is pretty easy: hang a dartboard on the wall and go over and throw it. If it sticks, you have a pretty good design. And if it doesn't, you have to redesign. It's small and inexpensive and some of the designs our students come up with are amazing."

Magic Tricks. "We use the same design software and our CNC equipment to reverse-engineer cheap plastic tricks and make them out of a more substantial material like wood, aluminum, or brass. Everyone likes a magic trick and the neat thing for teachers is we can use it for kids to get them fired up. We redesigned and reworked the old disappearing quarter trick - the thing that slides in and the quarter disappears. I preload a penny inside that thing and I get the quarter from the kid. I ask them what happens and he says it disappears. But I open it up and out comes a penny."

BattleBot Chassis. *Instructor Jim Howie said he was "aces" when it comes to helping a student design a chassis for this combat robot. As for the radio control electronics, he got to learn alongside his students.*



Bowls, Cups and Candle Holders, programmed in Cadmaster and made on a CNC (Computer Numerical Control) lathe, are highly prized by parents and also make great items to sell at fundraisers.

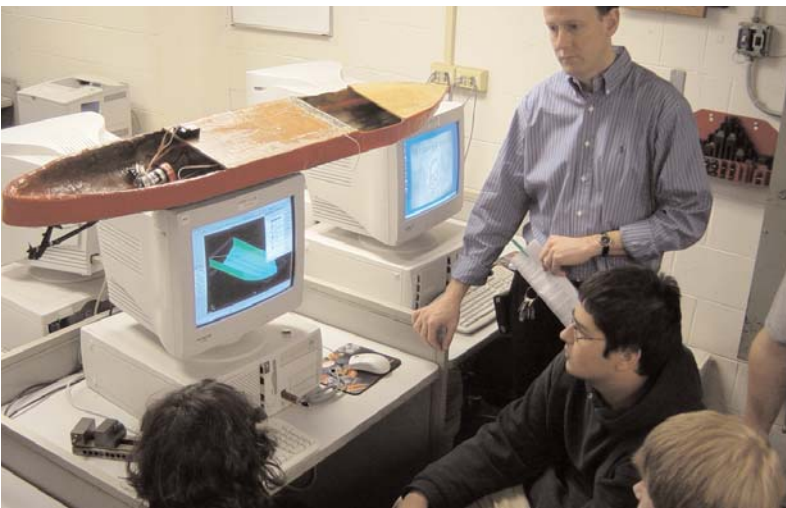
Bowls, Cups, Candle Holders. "Put a square piece of stock in the machine and it automatically cuts the student's design and engraves the bottom. They are beautiful. We had Parent Night here and a mother asked, 'Will these be made in class?' And I said 'ABSOLUTELY.' She was delighted. These make great gifts or sale items for fundraisers."

Gears. "We wrote a 'gear train' curriculum module for the state of Florida. The gear train you design uses a 12-volt hobby motor to drive the train, which is used to lift more and more weight as gears are added. Jeff created a physics component, which teaches the student how to calculate the mechanical advantage for various gear combinations. The challenge at the end is for students to work in teams to design a final gear that will lift the most weight. At a more advanced level of this curriculum, students design and make all of their own gears."

Combat Robots. "We had two groups build BattleBots combat robots last spring. They designed the robots and programmed CNC manufacturing of the chassis and other robot parts. One of our students is in the BattleBots business. He has a big arena that he set up at the school and the robots were put to the test during our Spring Fest. It was great."

"We cut some of the parts on the robot from titanium—a very interesting material. One robot was a spinning drum with sharpened titanium teeth, the other a 'spinbot' with a titanium blade. Both were whirring at 13,000 RPM. They don't have the weight to take a lot of impact. When they collided, white-hot sparks came off and they both flew back. It was a great visual experience. This summer, I showed the movie to a couple of MIT professors who were taking a class I taught in Boston. They asked, 'This is a high school class?'"





Titanic Student Engineering Team and instructor Jeff Jordan gather around the Mastercam computer model of their hull to consider potential modifications.

(For more information on these and other projects, see the Resources listed at the end of this article.)

TILTING THE TITANIC

The yearlong projects chosen by student engineering teams frequently take the instructors beyond their own level of knowledge and experience. Radio control of the BattleBots robots is a prime example. Another is a model of the Titanic that one team is working on this year. In addition to computer-aided design and manufacturing of components, it will take students and teachers into the realms of buoyancy and buoyancy force, pumps and pressure systems, electronics, servomotors, radio control, and many other systems.

The four-foot working model of the Titanic will be capable of radio, remote-controlled operation. The hull has already been constructed. Students designed the mold for the hull and cut out wood on a CNC mill. The equipment was too small to make the mold in one section, so it had to be done in two and joined together. The hull itself was made by layering fiberglass and epoxy into the mold. Other components will be added to the deck to make the ship look pretty much like pictures of the Titanic.

And now comes the interesting part. In addition to its remote navigation capabilities, the team of students hopes to replicate the ill fated vessel's sinking action by having it take on water and tilting to the classic 45° angle moviegoers are so familiar with. Then, upon remote command, the vessel will right itself again.

The students have taken their ship down to Glenbrook North's swimming pool for a first-hand investigation of buoyancy principals. They want to know how much water and additional weight it will take to achieve the classic tilt. Can this be done simply by opening a door in the hull and letting it flow in or does the water have to be pumped in?

Once tilted, what mechanisms must be used to get the water out so that the ship will once again float on its water line?

"Right now," said Jeff Jordan, "we really don't know the answers. The students have done a lot of research, particularly on the Internet. They have some interesting ideas that we are helping them evaluate. We will have to test the most promising of these before deciding how we will do it-- but we know it can be done."

Last week, one of the students on the Titanic team emailed Jordan the URL for a Web site (www.sio.ucsd.edu/voyager/flip/) that shows a real-world application of their concept. It is a five-story ship that morphs into an oceanographic research platform by taking on water from the stern to stand itself upright like a giant buoy.

OUT IN THE WORLD

Jordan and Howie have a lot to tell about students who have taken some of what they learned and applied it outside the walls of Glenbrook North. They tell the story of how the parents of one of their first students begged him not to take SciTech because they didn't want him involved in some greasy shop course. He went on to win second and then first place in Mastercam's Wildest Part Contest and is now a teaching assistant and PhD. candidate in engineering at Notre Dame. The parents now have a very different opinion of the program.

Another student built a scale model roller coaster complete with a camera that allows full-size people to enjoy all the ups and downs remotely. Howie was choked with pride when he saw this creation exhibited at the Museum of Science and Technology in Toronto.


Buoyancy 101. At the Glenbrook North pool students ponder what it will take to get their model of the Titanic to automatically take on water and tilt as if it were about to sink.





Safety and Teamwork are among the important life skills students learn in Glenbrook North High School's SciTech course.

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One college student came back to visit his SciTech teachers during a vacation. He said there was a CNC machine in his engineering lab but it was not being used because students and teachers thought it was too complicated. “I can show you how to use that,” he said. And he did. Then there is the 2004 graduate who is now putting himself through college - by working in a machine shop.

Both Howie and Jordan agree that one of the most important things their students learn is how to work in teams. The first year they taught the class together, they decided to be good guys and throw out what they thought would be an easy question on the final exam—“Name the other members of your engineering team”.

Jordan said, “We were astounded when we got answers like ‘the guy with the hat.’ They had been working with each other for a school year and didn’t even know each other’s names. It was a red flag for us.”

Since then, a generous amount of team building has become part of the curriculum. “We want our students to know how to handle it when another team member is not pulling his weight,” said Jordan. “They should also appreciate how people with skill sets different from their own can make an important contribution to the team and their project.”

Even Howie and Jordan have very different skills and temperaments. “Jim is an engineer who wants to roll up his sleeves and jump right in,” said Jordan. “As a scientist who prefers to test one idea at a time, I sometimes think he’s all over the highway. I think it is very good that the students can see us disagree on how to approach something and also that we are not turning it into a conflict.”

In SciTech everyone is taught that people can look at things differently and still get along well with each other. For example, 12 years ago, when Howie and Jordan taught their first class together, they hardly knew each other. Now, outside of class, they are good friends. When they are not busy with their families or coaching sports, they sometimes enjoy going bird hunting and camping together. Their differing viewpoints make for very interesting conversation around a campfire.

ADDITIONAL RESOURCES:

For more information on science & technology curriculum development, classroom projects and inexpensive, user-friendly supplies, Jim Howie and Jeff Jordan have created their own web site: www.truedeucation.com.

For project kits, teachings aids, free instructor book an online forum and other educational resources offered by Mastercam, visit www.emastercam.com.

To see BattleBots in action and get information on the BattleBots high school curriculum and student competitions, visit <http://www.battlebotsiq.com>. 