



What is ISEN?

The purpose of *Indiana Science and Engineering News* is simply to create awareness about current advances in the State of Indiana to help promote interest in these subjects among students, teachers, parents and the general public. The focus will generally fit the K-16 level. Some articles and features will be specifically designed for younger students. All fields of science, mathematics, technology and engineering will be represented.

We are looking for articles of 500 to 1500 words with one or two tables and figures (must be black and white). We welcome participation from schools, colleges, universities and companies. We are interested in news related to doing science and engineering, not news about fund raising, new buildings or academic programs, and we ask those who submit material to minimize the use of obscure jargon, or at very least, define it when used.

We want articles that create curiosity and have broad interest about science and engineering in Indiana and all the neat things we are doing here. Our thesis is that Indiana newspapers do not cover science well. For example, when was the last time a chemical structure or a mathematical expression appeared in an Indiana newspaper?

Articles for consideration may be sent to Alice Schwind (alice@bioanalytical.com), Debra Robertson (drobert@iupui.edu), Peter T. Kissinger (pete@bioanalytical.com) or William Gilmore (wkgilm@ameritech.net).

A Matter of Opinion: Find more money for science education.

The state and local school boards recognize that teaching science requires more resources than teaching other subjects. But how much more? Students' enthusiasm and learning are influenced dramatically by their being exposed to modern tools and instruments, not the Bunsen burners of the past. The technology that enables science evolves very rapidly. If students can't use it, at the very least they should see it and hear about it and know what it can do.

Ideally, teachers should have some recent experience in science beyond having been students themselves. While we realize this is not practical on a large scale, it should be encouraged through summer opportunities and by adding teachers who have real world science/math experience. Indiana's Transition to Teaching program is one that clearly recognizes this need and should be supported with enthusiasm.

Science teachers should get credit for operating after school science clubs, just as teachers get credit for coaching the marching band or the baseball team. Science Fair participation should likewise be encouraged and visibly recognized, but not forced.

Sharing resources among schools via Instrument Vans is a very economical way to give both teachers and students more exposure to science as it is actually practiced in the real world. It spreads cost that could not be justified by one school, or even one school district, among many schools. This approach has proven successful in Indiana for well over a decade. It should be made statewide, or at the very least be implemented in metropolitan areas where many schools are easily accessible.

Businesses should be encouraged to show their facilities to students, starting at the middle school level. It is proven that when students see science and engineering as they are actually practiced, they become much more motivated to learn from their textbooks. They can see a goal. They can sense excitement. We have many science-based businesses in Indiana that could help in their own communities in this way. In our business at BASi, we have found that Junior Achievement, Boy Scouts and Girl Scouts are good vehicles to bring young people to us.

In economic development, we frequently talk of creating jobs. I'm not sure anyone other than customers can create jobs. On the other hand, satisfying the innate curiosity of students by exposing them to modern science and engineering in Indiana can help them see the opportunities right here, right now. (Peter T. Kissinger, pete@bioanalytical.com)

33rd Annual HASTI Convention

Don't miss the 33rd Annual HASTI (Hoosier Association of Science Teachers, Inc.) Convention coming up February 18-21, 2003 at the Indiana Convention Center in Indianapolis. The convention theme is "Do More! Teach."

For complete information, visit www.hasti.org/convention/convention.html

15th Annual Indiana Science and Engineering Fair

April 4, 2003 in Indianapolis

The 15th annual Indiana Science and Engineering Fair, sponsored by the SEFI, will be held in downtown Indianapolis, April 4, 2003 in Union Station and the adjoining Crowne Plaza Hotel. Students who were winners at regional science fairs throughout Indiana will compete for more than 200 prizes and scholarships. The one-day event will include science fair exhibits, judging the student research in each exhibit, and an award ceremony. Special functions and speakers are being planned to encourage students toward opportunities in science, engineering and technology, to attend Indiana universities and colleges, and to practice their careers in the state.

For more information: www.sefi.org

Contents

- Pg. 2 What is Chromatography?
- Pg. 3 Teacher's Resource Center
- Pg. 3 The Egg Came First
- Pg. 4 Self-Adjusting Headlights
- Pg. 5 The Amazing Tomato
- Pg. 5 Take Your Science Fair Project Seriously

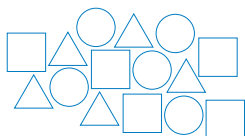
Executive Editor: Peter T. Kissinger, Ph.D.

Editor: Alice Schwind

Graphic Designer: Sara Goodnight

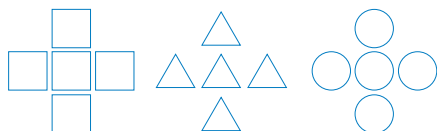
What is Chromatography?

Scientists are often interested in the physical separation of a single chemical from a mixture of chemicals (e.g. benzene from petroleum, chlorophyll from spinach leaves, Vitamin E from vegetable oil).



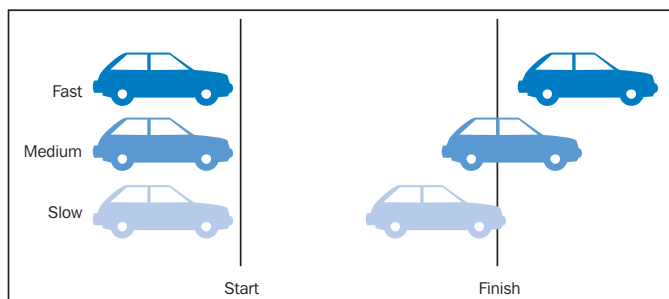
The Problem

A small trace of a substance in a mixture may need to be isolated from other components so the amount can be measured (*quantitated*) accurately. Typical problems would be to determine a drug or hormone in human blood, to separate a dye from a cosmetic, or to isolate a vitamin from food.



The Solution

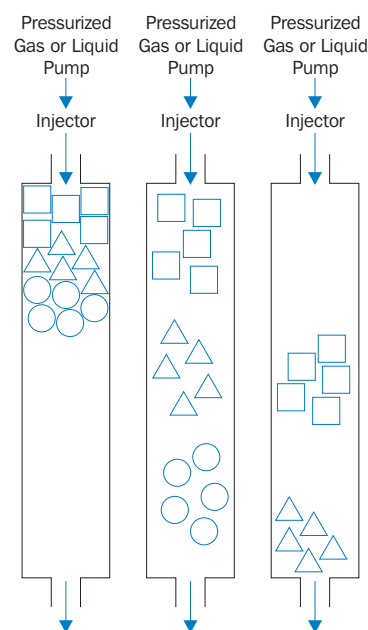
In life, if things we want to separate are large enough, like perhaps nuts and bolts, we can use a pick-and-sort method based on size, shape and color. If the items are too small to be seen, we need other techniques. In *chromatography* we separate invisible molecules by moving them through an instrument at different speeds. The fast ones come out first and are the first to be detected. Others take longer. *Chemicals of different types move at different rates, but each type of chemical moves at a constant rate.*



A mixture of racecars.

The mixture is now separated (resolved).

Unlike racecars, molecules don't have engines, so we must *carry* them through the system (*column*) in a moving fluid, or *mobile phase*. The column contains some big particles that cannot move and cannot dissolve in the moving fluid. These particles are called the *stationary phase*. The stationary phase is tightly packed in a metal or glass tube. Moving the molecules we want to separate (the *analyte* molecules) through the column, as pictured below, is called *elution*.



*The chemicals elute from the LC or GC column at different times.
(LC=liquid chromatography, GC=gas chromatography)*

Our analyte molecules will stick to the stationary phase particles in varying degrees (this is called *retention*) which causes some to move through the column faster than others. We can control retention by choice of *stationary phase*, choice of *mobile phase*, and choice of *temperature*. We also must control the *flow rate* since faster flows will clearly speed up the entire process. We must have a *detector* and a *recorder* to "see" what chemicals come out of the end of the column.

If we control a chromatography experiment properly we can expect certain chemicals to come out of the column at the same time, regardless of the sample that contains them. We can also expect that the size of the "peak" representing each compound on the chromatograph will tell us *how much* was present in the injected sample. Again, we determine *what kind* of chemical is in the sample by the length of time between its injection and the appearance of its peak. We determine its *amount* by the size of its peak. The resulting chromatogram is a helpful pictorial representation of the compounds, but we like to tabulate the results in a convenient numerical report. To do this, a *computer* or *workstation* is used.

Because the column resists the flow of the mobile phase, it has *backpressure*. This backpressure makes it difficult to apply a mixture (*sample*) to the top of the column and makes it difficult to pump liquid through the column. We therefore need a high-pressure *pump* and a high-pressure sampling *valve*.

We need *frits* to keep the stationary phase in the column (or it would squeeze out like toothpaste) and to filter particles (e.g. dust or lint) from the mobile phase. Unfiltered mobile phase might clog the column and cause its backpressure to rise.

Columns, temperature controllers, detectors, recorders, computers, pumps, valves and frits all must work together to provide a reliable chromatogram.

Teacher's Resource Center

The Teacher's Resource Center (TRC) at IUPUI makes it easy for K-12 teachers to include hands-on laboratory experiences in their classrooms. Free delivery of this "lending library" of lesson plans, lab equipment, reagents, supplies and worksheets makes this program impossible to refuse. Teachers can visit our website at www.cln.iupui.edu, click on *Community Outreach*, then select *Teacher's Resource Center*. This new and improved site contains information about our program, kit descriptions, and instructions about how to order and use the kits. Each of the 91 kits listed has a scheduling calendar so teachers can select titles that complement their curriculum timeline or to adjust their schedule slightly to coordinate with kit availability.

Ordering kits online is easy and convenient. Each kit title is correlated with the Indiana Academic Standards. These spreadsheets are available and organized by grade levels and subjects. We also use our website to thank our sponsors and let others know who is providing

the financial support that allows TRC to offer these FREE resources to public, private, home and charter schools, as well as to all youth organizations in Marion and the contiguous counties.

Kit of The Month: **Oobleck** What Do Scientists Do? (GEMS)

Students investigate and analyze the properties of a strange green substance called Oobleck, said to come from another planet. The class holds a scientific convention to discuss experimental findings critically. Students design a spacecraft to land on an ocean of Oobleck. In the final session, the methods the students used to analyze Oobleck are compared to those of professional scientists, such as those on the Mars Viking mission. A large poster illustrating the Mars Viking mission is included.

One of the most popular GEMS guides, *Oobleck* is not only a great hands-on experience for all ages; the unit provides

students with authentic insight into the real work of scientists. Many teachers have used this unit as a compelling opening activity for a semester's science curriculum. Its level of student interest is justifiably famous, and just as amazing as the substance itself is the tremendously positive experience students have by doing what scientists do.

Time: five or six 20- to 45-minute sessions
Grades: 4 - 8 (can be adapted for grades K-3)
Subject Areas: Scientific methods (solids and liquids, properties of substances, space probes)
Skills Developed: Experimenting, recording data, engineering, communicating, group brainstorming, decision making

To reserve a math/science kit or to find out more, visit our web site. Use the *Contact Us* link if you have additional questions. Think about including more educational activities in summer youth programs and use TRC kits this summer. (*Deb Robertson, ddrobert@iupui.edu*)

The Egg Came First

Hatched from a young Hoosier's dreams of spaceflight



As an eighth-grade student in Lafayette, John Vellinger had an idea for a science project - to send chicken eggs into space and study the effects of microgravity on embryo development. Vellinger entered his project in a science competition called the Shuttle Student Involvement Program (SSIP), sponsored by NASA and the National Science Teachers Association. He received the district award in three consecutive years, finally becoming a national winner in 1983.

In 1985, after his freshman year at Purdue University, NASA paired him with Mark Deuser who then was working as an engineer at the headquarters of Kentucky Fried Chicken (KFC) in Louisville. Through a grant from KFC, Deuser and Vellinger set out to develop a flight-ready egg incubator. By early the following year, their completed "Chix In Space" hardware was launched aboard the space shuttle Challenger during its ill-fated mission on January 28, 1986. Matching the teacher/astronaut with the students' experiment, Payload Specialist Christa McAuliffe had been trained by Vellinger and Deuser to operate the hardware while in orbit.

Regrouping after the tragic loss of the crew, Deuser and Vellinger founded a company they named SHOT and continued developing the payload for a subsequent

flight. More than three years after the Challenger accident, Chix finally reached orbit successfully aboard space shuttle Discovery. Together the pair designed, fabricated and integrated the flight hardware, coordinated the project with NASA and assisted the scientific team. The results of the experiment were so significant that the project received worldwide interest from gravitational and space biologists and established a strong reputation for the company as an innovative developer of spaceflight hardware.

Since that mission, SHOT has developed, integrated and flown five other biotech microgravity payloads, and the scope of the company has continued to expand. On shuttle mission STS-95 in the fall of 1995, John Glenn, the first American ever to orbit the Earth, operated SHOT's Advanced Separations (ADSEP) payload on his long-awaited return to space.

The most recent SHOT payload in space brought Vellinger and Deuser back to the roots of their company. In December 2001 space shuttle Endeavour carried their Avian Development Facility (ADF) aloft with 36 Japanese quail embryos for experiments related to the effects of long-term spaceflight on humans. The mission was a complete success, and it represented only the second U.S. avian space shuttle experiment - their original Chix payload

being the first. The mission also served as an evaluation of some of the new technologies that later may be incorporated into an egg incubator for the International Space Station (ISS). A piece of companion hardware, the Avian Hatchling Habitat, also is currently in development, and along with partner Star Enterprises in Bloomington, SHOT has a contract to build a facility called the Advanced Animal Habitat that will house several rats in the station's Centrifuge Accommodation Module.

This year SHOT expects to see its ADSEP biotechnology research facility launched on two more shuttle missions. By the end of the year the company also plans to be nearing completion of beta testing a suite of Earth-based research devices derived from its space hardware.

Hoosier Space Portal

In 2001 NASA signed a Space Act Agreement with SHOT which allows the company to function as a portal to commercial spaceflight opportunities. Companies from anywhere in the world now can work with SHOT directly to design, build and fly commercial microgravity payloads on the space shuttle. The pair of ADSEP missions in 2003 will each carry experiments for commercial customers in addition to those for NASA-funded investigators.

Guide Corp. drives forward with self-adjusting headlights

System reacts to road curves, hills, weather, even on-coming traffic

Guide Corp.'s new self-adjusting lighting system can almost read a driver's mind, according to industry sources. While Guide Corp.'s AutoGuide isn't exactly telepathic, it is a significant advance over today's stationary headlamp, which is based on technology that has seen little modification in more than two decades. Guide's self-adjusting system reacts to information gathered through a vehicle's steering wheel, suspension, accelerator and brakes. It also has the potential to adjust to road elevations, weather conditions, oncoming traffic and road obstacles.

AutoGuide will make auto travel significantly safer, company officials said, but will also give the Pendleton-based manufacturer a leg up on competition. Guide's primary manufacturing plant is in Anderson. "In this industry, you lead by millimeters," said Jeff Hutson, Guide's director of corporate communications. "You have to look for the next and best innovation to stay ahead in the game. This is an important development for us."

Guide Corp. was spun off from General Motors Corp. in November 1998. The company was founded in 1906 in Cleveland as the Guide Motor Lamp Manufacturing Co. and began producing the first successful electric headlamps for automobiles.

The brains behind Guide's adaptive front-lighting system is its electronic system, which piggybacks off a vehicle's existing digital network, industry sources said. The information is measured and transmitted to a controller connected to the lights. The system is so compact drivers won't be able to see any hardware. AutoGuide resets automatically to a standard position and its response time can be fine-tuned for various car types, Guide officials said—faster for sports cars, for example.

Preston Tucker's 1948 Torpedo featured a third headlight that moved from side to side in conjunction with the steering wheel, and Masarati experimented with self-adjusting headlights in the 1970s. But new electronic capabilities make the AutoGuide significantly better, industry sources said.

David A. Stivers, an auto industry consultant in West Palm Beach, Florida, said Guide Corp. is among the first to attempt mass production of such a system. "These systems are getting to the point where they can read outside [stimuli], things like oncoming traffic," said Stivers, who has worked in the auto industry three decades. "That's significant. The question is, 'How much will this innovation affect the price of a vehicle and how deep can they penetrate the market with their product?'"

Guide Corp., the largest headlamp and turn-signal producer in the United States with \$401 million in revenue last year, has been working on AutoGuide since mid- to late-1997, said Guide's senior project engineer, Joseph Jaklic. Guide is currently demonstrating models to the world's major automobile manufacturers. "We're getting positive feedback from the manufacturers," Jaklic said. "We don't have an announcement [of who may use the system] yet, but we expect we will soon."

The system could debut in high-end automobiles, Guide Corp. officials said, then as it proves its worth be mainstreamed into all vehicles. But they concede price initially could be an issue. Stivers thinks AutoGuide could boost the price of a car more than \$1,000, but if it's a feature automakers think has potential to enhance brand loyalty or lure new customers, the product could take off. "If they're selling safety, it could be a tactic that works, especially for a certain niche," Stivers said. "Mercedes and Volvo have proven that safety sells."

While AutoGuide was developed to help Guide Corp. gain a better foothold in the European market, company officials said the most intense interest is coming domestically. "We're really not making projections on the potential right now," Hutson said. "We have had significant interest, both domestically and internationally. And we think as people see this technology driving down the road, they're going to want it. AutoGuide is impressive to see, said Eric Mayne, of *Ward's AutoWorld* magazine, adding that it gives

the impression of bending light to allow a car to "peer around corners."

A push by the National Highway Traffic Safety Administration to reduce the number of drivers blinded by oncoming headlights could help Guide. But the onus will be on Guide to demonstrate to the driving public AutoGuide is a feature they can't—or shouldn't—live without.

Industry consultant Stivers pointed to the differing receptions of two industry developments as case studies. "You wouldn't dream of buying a car without dual-sided air bags. It's something you do for yourself and your family," he said. "But ABS [antilock] brakes in some models were deemed too expensive and not in every case an absolute necessity. So carmakers started removing that option to offer a vehicle at a lower price."

"There's no doubt this is a good idea," he added. "But in the end it has to sell automobiles, and Guide will have to keep costs under control." (*Anthony Schoettle, aschoettle@ibj.com*)

Reprinted with permission from the *Indianapolis Business Journal*.



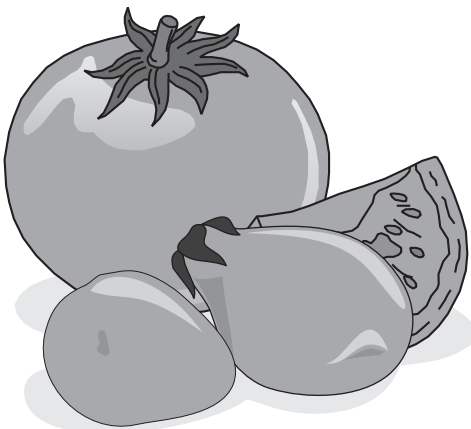
The Amazing Tomato

Much of what happens in science is a surprise. Researchers begin work with one thing in mind and in the process, often discover something very unexpected. And so it was when scientists at Purdue University and the U.S. Department of Agriculture's Agricultural Research Service were working to develop tomatoes for food processing that were of higher quality and would ripen later. They accomplished that, but in the process they discovered that the new tomatoes also had as much as three and a half times more of the cancer-fighting antioxidant lycopene than conventional tomatoes.

The discovery was a happy accident. "We were quite pleasantly surprised to find the increase in lycopene," says Avtar Handa, professor of horticulture at Purdue. Increasing the nutritional value of foods is the goal of so-called second-generation biotechnology products, but there have been few successes. "This is one of the first examples of increasing the nutritional value of food through biotechnology," Handa says. "In fact, it may be the first example of using biotechnology to increase the nutritional value of a fruit."

Lycopene is a pigment that gives tomatoes their characteristic red color. It is one of hundreds of carotenoids that color fruits and vegetables red, orange or yellow. Of these pigments, the most familiar is beta-carotene which is found in carrots. In the

human body, these pigments capture electrically charged oxygen molecules that can damage tissue. That's why they are called antioxidants.



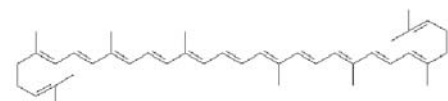
Lycopene has been the focus of much attention since 1995, when a six-year study of nearly 48,000 men by Harvard University found that men who ate at least 10 servings per week of foods containing tomato sauce or tomatoes were 45 percent less likely to develop prostate cancer. The study also found that those who ate four to seven servings per week were 20 percent less likely to develop the cancer. As an antioxidant, lycopene is able to capture twice as many oxygen ions in the body as is beta-carotene.

When it comes to lycopene in tomatoes, cooked tomato sauces are more effective

than raw tomatoes. This may be because cooking breaks down the cell walls of the tomato, releasing more of the lycopene. Or it may be that cooking oil allows the lycopene to move more easily into the body.

Despite the apparent benefits, it's been difficult to increase the amount of lycopene in the diet, says Randy Woodson, director of Agricultural Research Programs at Purdue. Studies have found that taking purified antioxidants as a dietary supplement doesn't work. In fact, one study found that giving beta-carotene to smokers actually increased their chances of developing cancer.

To develop the lycopene-rich tomato, the researchers inserted a gene, derived from yeast, into tomato plants. The yeast gene produces an enzyme that affected the production of growth substances called polyamines in the plants that are known to help prevent cell death. Handa says the technique used in this research might also be used to increase the amount of other antioxidants in fruits and vegetables. How can you find and determine lycopene in a tomato? Use chromatography as described on page 2. *(This article courtesy of the Department of Agricultural Communications, Purdue University.)*



Lycopene chemical structure.

Take Your Science Fair Project Seriously

Some of us continue to work on our science fair projects long after graduation. One of us is still working on technology he learned in his 1961 science fair project that used electrochemical principles to do analytical chemistry. Some 42 years later, the company he started based on this technology is called BASi and has laboratory operations located in West Lafayette and Evansville, as well as in Oregon and the United Kingdom.

The other of us developed an idea in the eighth grade for experiments on the Space Shuttle. It involved sending chicken eggs into space to study the effects of

microgravity on embryo development and eventually evolved into a project widely referred to as "Chix in Space." It, too, later resulted in the formation of a company, named SHOT, located near Greenville, Indiana, which continues to be involved in Space Shuttle launches. (You can read more about SHOT in "The Egg Came First", on page 3.) Meanwhile, back in West Lafayette, that science fair project resulted in technology to revolutionize the determination of neurotransmitters in the brain, antioxidants in polymers and agricultural products and many other things.

Often in science many surprising and totally unanticipated things happen. The consequences can be far reaching, even for a simple Science Fair project. We hope students and teachers will read this and get engaged in science and engineering. It can lead you into surprising directions like how the brain works, and even into zero gravity environments. *(John Vellinger and Peter T. Kissinger, Ph.D.)*

SEFI

c/o BASi (Bioanalytical Systems, Inc.)
2701 Kent Avenue
West Lafayette, Indiana 47906

About SEFI

The Science Education Foundation of Indiana began in 1965, for the purpose of helping to organize science and engineering fairs throughout the state. SEFI sponsors travel of Indiana science fair winners to the Intel International Science and Engineering Fair, held each year in the late spring. In 2006, the Intel International Science and Engineering Fair will be held in Indianapolis which will be an opportunity to showcase Indiana. SEFI is broadening its franchise to include all aspects of science and engineering education and will play a leadership role with the many other professional groups in Indiana who have advancing education on their agenda. These include the Indiana Department of Education, Hoosier Association of Science Teachers, Inc. (HASTI), Indiana Health Industry Forum, the Indiana Academy of Sciences, the Girl Scouts and Boy Scouts and others.

More about SEFI can be found at [*www.SEFI.org*](http://www.SEFI.org).