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ERIC ALBRECHT | DISPATCH

Neil Thompson of Dublin-based DNV, the country's largest private corrosion lab, looks for ways to thwart rust.

"The problem is, once (rust) starts, it spreads like wildfire."
JIM PAJK | Franklin County bridge engineer

RUST

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investigate how corrosion weakens beams, pipes, jets and ships, and what can help delay the inevitable.

They warn that this country's bridges, bombers and high-pressure gas lines are operating on borrowed time.

But what is rust? In the simplest terms, corrosion is an electrochemical reaction, Frankel said.

"It's as if you hooked up the two ends of a battery with a wire."

To rust, a steel beam requires water, which contains electrically charged atoms and molecules, just like battery acid.

At one spot on the beam — think of the negative terminal of a battery — iron atoms release electrons and combine with oxygen, turning into rust. The electrons travel to another spot on the beam — think of the positive terminal of a battery — and combine with hydrogen ions and then oxygen, forming water.

How quick is the process?

Take the Golden Gate Bridge. When workers finish painting one end, it's time to start scraping the other.

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Neil Thompson, with Dublin-based DNV Columbus, the country's largest private corrosion lab, said there are some tricks that help postpone the rust process.

For example, the zinc coating on a galvanized steel bucket oxidizes, protecting the steel until the zinc is used up. Chromium in stainless steel helps protect against rust, but it, too, eventually wears out.

One of the best ways to stall rust is to place steel rods in a strong base, such as concrete. The steel could last hundreds of years, Thompson said.

But in bridges, chloride in road salt migrates into the concrete and jump-starts corrosion.

The Ohio Department of Transportation spreads thousands of tons of salt on the state's highways and more than 14,000 bridges each winter.

"About 80 percent of potholes on bridges are due to corrosion," Thompson said. "The product of corrosion is iron and oxygen, and that has six to eight times the volume of the steel."

"It expands and cracks the concrete."

ODOT calls it a "vicious cycle."

"We sacrifice structure but gain safety," said Mike Brokaw, a bridge inspection engineer with the department's central Ohio office.

If the department were to repair all corrosion on Ohio's bridges, it would need $4.2 billion, said Scott Varner, a department spokesman.

"The problem is, once it starts, it spreads like wildfire," said Jim Pajk, Franklin County bridge engineer.

Franklin County, which maintains 362 bridges, recently spent $3 million to replace the steel-reinforced concrete deck on the Greenlawn Avenue Bridge.

The state, county and municipalities strip and overlay damaged decks and seal them against salt penetration. With that, a well-maintained bridge deck will last about 40 years, Pajk said.

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Bridges are just a part of the picture. Water, oil and natural-gas pipelines crisscross Ohio and the nation.

Columbus owns about 3,000 miles of water lines and maintains an additional 1,000 miles in the suburbs, said Rick Westerfield, administrator of the city's Power and Water Division.

"Is corrosion the main issue for us? It may well be," Westerfield said.

The city repairs 500 to 600 water main breaks per year.

Westerfield said most underground water pipes are designed to last 60 to 100 years. New pipes are coated — inside and out — to keep corrosion away.

And the city's water plants add 1.5 milligrams of zinc orthophosphate to each liter of water. The compound, deemed safe by the U.S. Environmental Protection Agency, forms a protective coating in the lines and household plumbing.

Each year, Westerfield said, the water division spends $15 million to rehabilitate or replace less than 1 percent of its pipes.

"We're funded at a rate that's assuming the pipes will last more than 100 years."

Across the state, there are 7,670 miles of natural-gas transmission lines and 54,000 miles of distribution lines.

Columbia Gas has 19,161 miles of pipe in 60 counties.

"About 4,000 miles are pipes of steel or cast iron, put in the ground pre-1940 and are near the end of their useful life," company spokesman Ken Stammen said.

Columbia is in the midst of a 25-year, $2 billion program to replace the old lines with plastic or treated metal pipes.

The costs of dealing with corrosion are staggering. But the alternative is worse.

Corrosion has been blamed in natural-gas pipeline explosions, collapsed bridges and crumbling parking garages. Oil spills from ruptured pipelines have damaged wildlife, natural resources and drinking water supplies.

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The military estimates that it spends $20 billion to $30 billion annually to fight corrosion of its ships, planes and other machines.

Small wonder the Department of Defense has provided $1.9 million in grants to the University of Akron to create the country's first four-year undergraduate program in corrosion engineering.

The major will be offered as early as in the fall of 2010, said George Haritos, dean of the College of Engineering at Akron.

Meanwhile, scientists are continuing to seek better corrosion protection.

Battelle, for example, has made a coating of nanomaterials that, layered between the primer and top-coat on airplane skins, lights up when corrosion is present.

An early-warning system could enable airlines and the military to make cheaper repairs and reduce flight risk.

Doug Hansen, a senior scientist at the University of Dayton Research Institute, is leading an effort to grow the material that forms oyster shells on the wings of planes, artificial joints and implants.

His team has manipulated oyster blood cells to deposit a thin, salt-water resistant coating of mother-of-pearl on aluminum. At Sheffield Hallam University in England, researchers recently announced that they had encapsulated spores from certain bacteria in a coating that protects aluminum alloys from microbial corrosion, a particular menace for sea vessels.

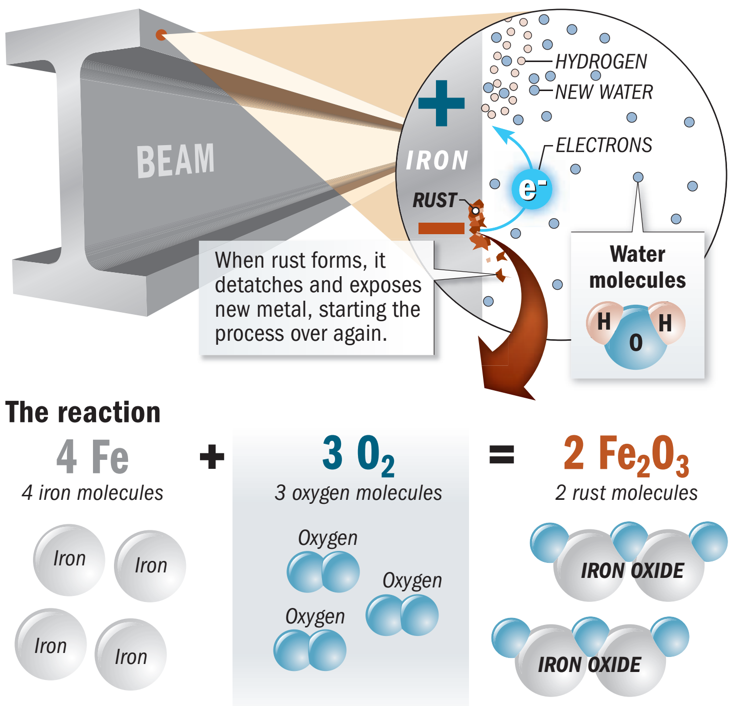
msomerson@dispatch.com

JEFF HINCKLEY | DISPATCH

State inspectors Matt Beedy, left, and Mike Brokaw check out a bridge on Rt. 315 over 3rd Avenue.

Rust happens

To rust, a steel beam requires water, which contains electrically charged atoms and molecules, just like battery acid. At one spot on the beam — think of the negative terminal of a battery — iron atoms release electrons and combine with oxygen, turning into rust. The electrons travel to another spot on the beam — think of the positive terminal of a battery — and combine with hydrogen ions and then oxygen, forming water.



Source: Ohio State University

TIM MEKO | DISPATCH

PEDIATRIC RESEARCH

It takes money to make 'big science'

Biomedical research is evolving at a bewildering pace. What was unimaginable 10 years ago now is achievable, and possibilities for breakthroughs are tantalizingly close for many diseases

A major factor in the escalating pace of discovery was completion of the initial version of the Human Genome Project in 2003. This effort facilitated our ability to determine billions of data points regarding the genetic makeup of each and every one of us.

JOHN BARNARD

The scientific term that refers to the specifics of our genetic makeup is our "genotype." We have become amazingly accomplished at determining our genotype in a detailed manner. We can also do it very quickly.

A detailed genotype is especially helpful when we also can accurately describe an individual's "phenotype." The phenotype is comprised of the outward characteristics of a person that result from a combination of their genes, their environmental and other influences.

Without good phenotype data, genotype data is potentially much less valuable than it could be.

The rapidly growing amount of detailed genetic information relating to autism is a clear example. Two recent research reports in the journal *Nature* describe a number of new genetic alterations in autism. The associations were discovered using highly sophisticated genotyping tools and thousands of patients and controls.

The list of altered genes discovered in recent years that are potentially associated with autism is growing. Unfortunately, though, no gene is so strongly associated that it can be considered a true "autism gene." We should not be surprised.

Autism is a complex neurobiological disorder beginning in early childhood that impairs communication and interpersonal interactions. There are many formally recognized varieties of autism, ranging from a mild form called Asperger syndrome to pervasive developmental disorders.

Autism experts suspect that even more subtypes exist, including those for people with prominent intestinal symptoms and those with prominent neurological features such as seizures.

For autism genetic studies to be as informative as possible, we need more sophisticated and detailed phenotype information. This requires participation of research teams made up of talented and experienced clinician scientists who understand the subtle nuances of the autism phenotype, an approach sometimes called "deep phenotyping."

Unfortunately, our ability to deeply phenotype is much less developed than our ability to genotype.

The most informative genetic studies also require development of sophisticated databases of phenotype information. Collaboration among multiple centers is needed to gain enough patients for statistical validity. Finally, sophisticated computational approaches are needed to manage the data and make statistically valid genotype-phenotype correlations.

These sorts of projects are sometimes called "big science," and they require big money. Autism is just one example. Many of our most vexing human health conditions will require the same sort of big science and big money.

Our society must have the will to invest in big science. We must make research careers rewarding for our best and brightest students. Barriers involving multidisciplinary and multi-institutional collaborations must be overcome.

If we do, we will most certainly be able to prevent many diseases by predicting them and intervening appropriately. We will be able to custom design treatments with a level of precision heretofore unimaginable, avoiding complications, achieving optimal outcomes and saving health care dollars.

Ultimately, this is the true dividend of the Human Genome Project and the exciting promise of personalized medicine.

Dr. John Barnard is president of the Research Institute at Nationwide Children's Hospital.
john.barnard@nationwidechildrens.org