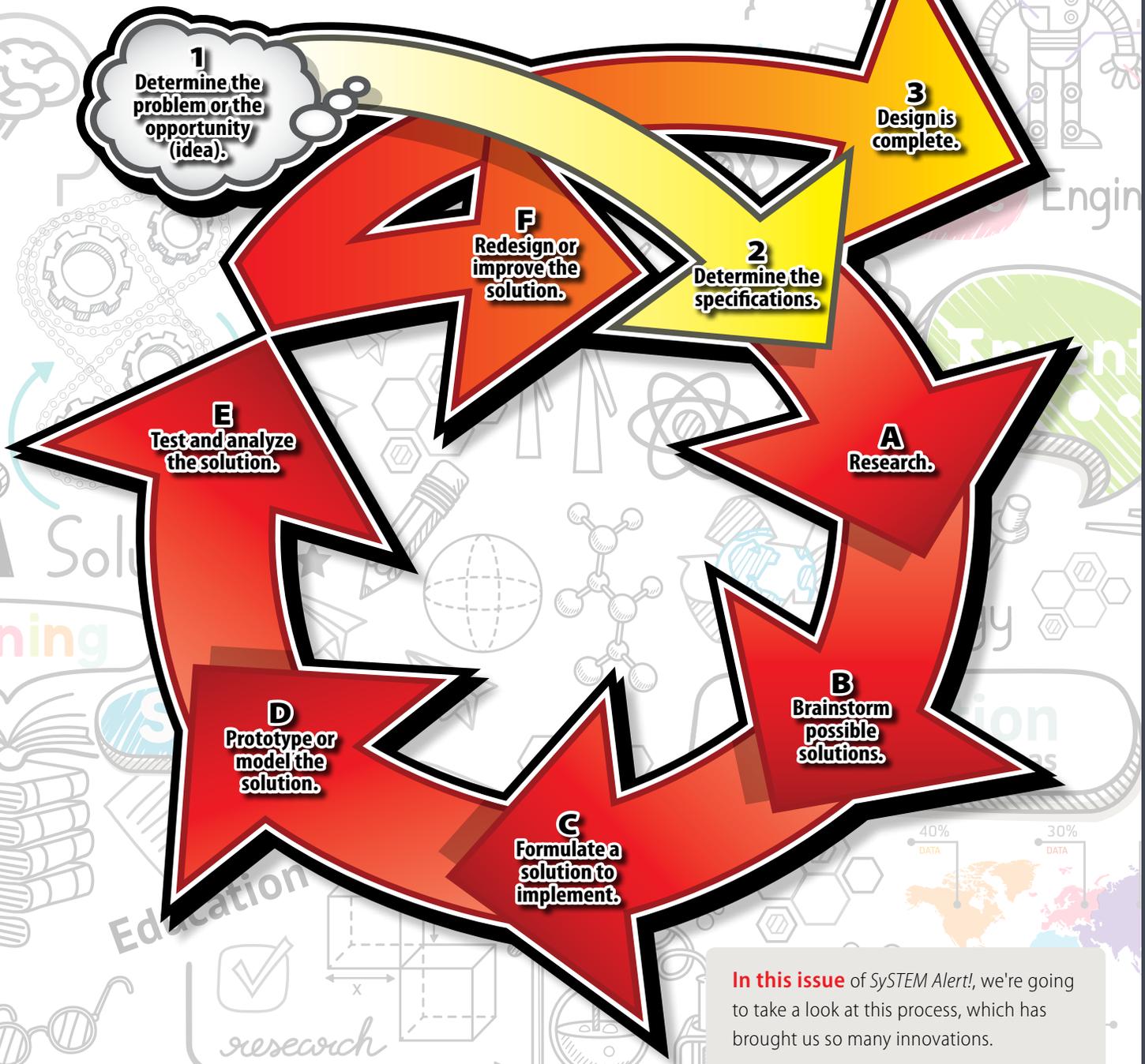


# SYSTEM ALERT!

Tomorrow is almost here.

## Engineering Design Process

The process of **engineering design** can basically be described as a series of steps. But that doesn't mean the process is always orderly or clean cut. Sometimes, it takes numerous people years to complete the process of engineering design. The following steps may be repeated any number of times. If at first they don't succeed, engineers try try again. Read about these steps and then turn the page to see them in action in the real world.



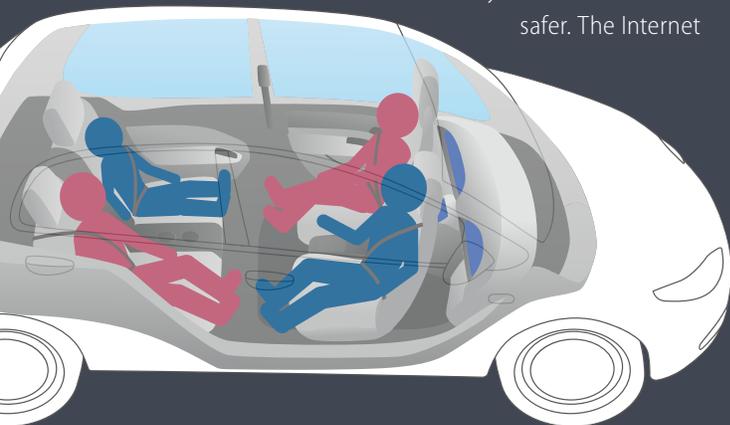
In this issue of *SYSTEM Alert!*, we're going to take a look at this process, which has brought us so many innovations.

# Road tested:

## Autonomous cars driving your way

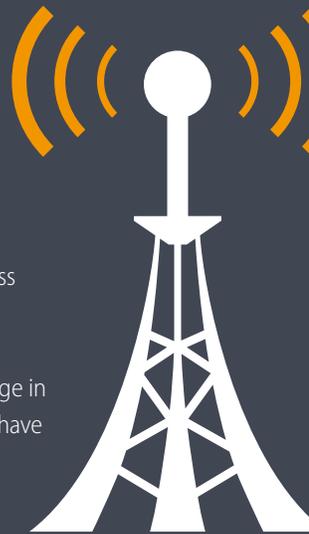
It has been predicted that 10 million self-driving cars will be on the road by 2020. Many are already being live tested in locations around the world.

Though there has been at least one fatal crash involving a self-driving car, it is believed that the technology will eventually make the roads safer. The Internet



giant Google has begun to test self-driving vehicles. Its fleet of cars has been involved in more than a dozen accidents so far, but according to the company, all of the accidents were caused by drivers of other (non-self-driving) vehicles.

The National Highway Traffic Safety Administration provides a classification system that helps gauge the success of self-driving cars. Vehicles are given a rating from 0 to 4, representing a range from completely driver controlled to completely automated. This technology is now at a late stage in the engineering design process – our highways and roads have become the laboratory for testing. ⚠️



CHECK OUT:

[www.pitsco.com/TETRIX\\_PRIME\\_Robotics\\_Autonomous](http://www.pitsco.com/TETRIX_PRIME_Robotics_Autonomous)

## Prototype suggests a vision of the future

Programmable matter is a hot idea that has futurologists practically drooling. What if your items could change their shapes to become other items as you needed them? The fulfillment of this big idea is a long ways off, but we are moving toward it in small steps. Cubimorph is one such step.

Essentially, Cubimorph is a series of small cubes connected by hinges. The hinges enable the cubes to move into different configurations, changing the shape of the overall object. Each cube has a touchscreen on each of its six faces to allow user interaction. Cubimorph's creators imagine numerous possibilities for their creation. For example: a mobile phone that could reshape itself into a game controller.

But Cubimorph isn't a finished product coming to a store near you soon. It is still a prototype. Actually, it is three prototypes, each designed to explore a different facet of the technology. One prototype models the hinges that such a product might use, another explores the miniaturized touchscreen technology, and the third looks at the process of reconfiguration itself.

Lead researcher Dr. Anne Roudaut admits that "much work still needs to be achieved to put such devices in the end-user hands," but says she hopes her team's work will create fruitful discussion among other experts in the field. ⚠️

1 Determine the problem or the opportunity (idea).

F Redesign or improve the solution.

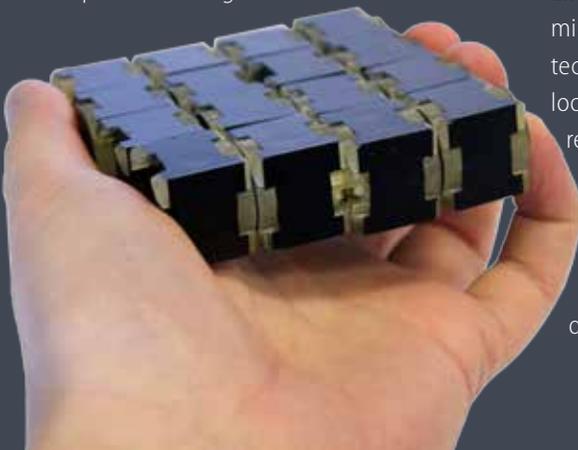
2 Determine the specifications.

E Test and analyze the solution.

D Prototype or model the solution.

C Formulate a solution to implement.

Brain possible solution.

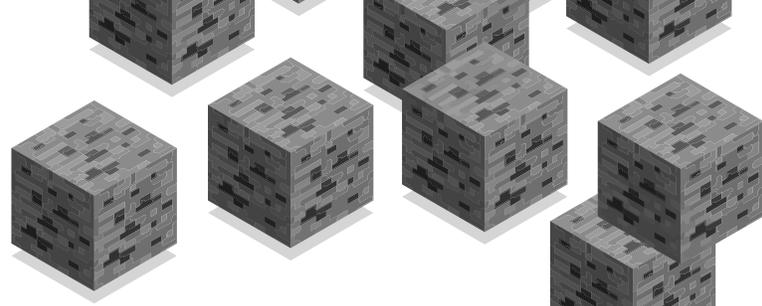


# Set in stone but still up for grabs

Concrete is the most common human-made building material. A product in such widespread use must be past improvement, right? At least one team of researchers at the Massachusetts Institute of Technology sees it differently.

The team is reconsidering the recipe for concrete, this time taking a few tips from nature's cookbook. When the team looked at the properties of objects such as bones and shells, they found that living organisms often produced materials that have strength and durability advantages over traditional concrete.

Concrete is traditionally produced with a mix of crushed rocks and cement paste. The issue is that the internal molecular structure is chaotic and random. Perhaps a more organized, less porous structure might be a key to greater strength.



Consider the microscopic brick- and mortar-like construction of nacre, a material found in some shells and on the outer layer of pearls. Could the recipe for nacre and other biological materials enhance the recipe for concrete? The team thinks it might.

The team is producing a set of guidelines engineers can use to create the concretes of the future. It might be time to look again at this everyday product.

"Hopefully this will lead us to some sort of recipe for more sustainable concrete," team leader Oral Buyukozturk says. "Typically, buildings and bridges are given a certain design life. Can we extend that design life maybe twice or three times? That's what we aim for." ⚠️

## Long-shot idea proves a surprising success for wind energy

**CHECK OUT:**  
[www.pitsco.com/  
Eco-Wind\\_Generator\\_II](http://www.pitsco.com/Eco-Wind_Generator_II)



Sometimes, it pays to keep an open mind! When researchers from the Argonne National Laboratory and the University of Akron decided to test an existing coating on the inner components of a wind turbine, they didn't necessarily have high hopes for its effectiveness.

They knew that the coating, called N3FC, had low friction and could shape itself to the dynamic environment in a wind turbine's drivetrain. On the other hand, N3FC hadn't been designed for wind turbines. It was originally intended for use in natural gas compressor sealing applications – quite different. And the team also believed the coating wouldn't be hard enough to protect the steel parts.

But if N3FC worked, the benefits could be great. So, without much expectation for success, the team tested the coating's ability to preserve the expensive wind turbine components from wear and tear.

And after 100 million testing cycles in their test apparatus, N3FC has held up, protecting the parts. Often, the high stresses

within a wind turbine's drivetrain causes micropitting, or cracks, on the surface of the parts, which causes failures over time. However, the parts treated with N3FC didn't show any significant micropitting.

In fact, the team isn't entirely sure why it worked so well. But not knowing why your idea works is a great problem to have. Further tests might clear up this question and lead to optimized versions of the coating, which could in turn lighten the cost of maintaining the expensive machines. Lower costs mean more viability for clean, green, wind-powered energy.

If the team hadn't been willing to take a risk on an unlikely coating, the effect would not have been discovered.

According to Ali Erdemir, who worked on the project, researchers should be open to surprise discoveries. "Putting things in action is the key. You may be surprised by what you see (not by what you think or believe)." ⚠️

## Tribology keeps the world running smoothly

Friction is caused when two surfaces move against one another. This causes wear and tear. Tribology is a scientific field that investigates this friction and also how to overcome it.

Ali Erdemir, president of the Society of Tribologists and Lubrication Engineers, reminds us of the many ways tribology is part of our daily life. "Every time we hop in a car or bus to reach our destination, safe, smooth,

efficient arrival is due to advanced tribological principles and technologies employed on numerous moving parts/surfaces of those cars/buses."

Erdemir cites other examples such as artificial hip and knee joints that give mobility to senior citizens. "These joints are designed and engineered using advanced tribological tools and materials to function smoothly and last very long (20 or more years)." ⚠️

**3**  
Design is  
complete.

**A**  
Research.

**B**  
Custom  
solutions.



# STEM FORCE

ASTRONOMERS HAVE DISCOVERED AN ASTEROID ON A COLLISION COURSE WITH EARTH! STEM FORCE IS ALREADY LAUNCHING INTO SPACE TO INTERCEPT.

IT'S HUGE! IT IS AS BIG AS THE CHICXULUB ASTEROID, BELIEVED TO HAVE WIPED OUT THE DINOSAURS.

SPACECRAFT ARE PLACED IN FORMATION AROUND THE ASTEROID. THEY ARE EQUIPPED WITH LASERS THAT VAPORIZE THE ASTEROID'S MATERIAL.

TWO DEGREES TO THE RIGHT . . . PERFECT!

THIS REMINDS ME OF A VIDEO GAME I PROGRAMMED WHEN I WAS A KID.

THE HEAT CONVERTS THE MATERIAL FROM A SOLID TO A GAS. THE PARTICLES FLY AWAY FROM THE ASTEROID. WHEN MATTER GOES FROM SOLID TO GAS WITHOUT PASSING THROUGH A LIQUID STATE, THAT IS CALLED SUBLIMATION.

I DON'T PLAN ON GOING EXTINGUISHED. LET'S GET TO WORK, STEM FORCE.

JOB WELL DONE, STEM FORCE. IT'S TIME TO GO HOME.

THE ESCAPING GAS PUSHES THE ASTEROID JUST LIKE EXHAUST PUSHES AN AIR ROCKET OR A CO<sub>2</sub> DRAGSTER. OVER TIME, THE ASTEROID IS PUSHED OFF COURSE. DISASTER IS AVERTED.

Storyline: Cody White | Artwork: Jason Redd | ©2016 Pitsco Education

LEARN MORE ABOUT THE ELITE TEAM OF HEROES IN STEM FORCE BY VISITING [WWW.PITSCO.COM/SYSTEMALERT/STEMFORCE](http://WWW.PITSCO.COM/SYSTEMALERT/STEMFORCE). DISCOVER CHARACTER BIOS, PREVIOUS ISSUES, AND MORE.

## Inside view of the Wind Turbine Experimenter's Kit

New Pitsco products are created by the company's Research & Development department. At Pitsco, as elsewhere, the engineering design process guides their development. Here is a quick rundown of the creation of one new product, the Wind Turbine Experimenter's Kit.

### DETERMINE THE PROBLEM OR OPPORTUNITY

Pitsco had already produced a wind turbine kit. However, as Mechanical Designer Gary Jones observed, the design couldn't be varied much. This meant that the experiments that could be done with the kit were limited. Jones wanted to produce a kit that would serve experimenters.

### DETERMINE SPECIFICATIONS

Among other things, Jones wanted experimenters to be able to change the number of blades and adjust the gear ratios.

### RESEARCH

Jones looked at other wind-generation kits to ensure Pitsco was putting out a quality and unique kit.

### BRAINSTORM, FORMULATE A SOLUTION

He developed a clear vision of the wind turbine kit he wanted to build.

### PROTOTYPE, TEST AND ANALYZE

Using mostly parts that Pitsco produces in-house, a prototype was built. Jones tested it in a variety of scenarios and discovered that it produces about twice as much power as the previous Pitsco kit.

### REDESIGN OR IMPROVE, DESIGN IS COMPLETE

When Jones and others were happy with the new flexible, efficient kit design, the product was declared complete.

The Wind Turbine Experimenter's Kit is now available for sale on [www.pitsco.com](http://www.pitsco.com). ⚠️

**CHECK OUT:**  
[www.pitsco.com/  
Wind\\_Turbine\\_  
Experimenter's\\_Kit](http://www.pitsco.com/Wind_Turbine_Experimenter's_Kit)



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Student name: \_\_\_\_\_ Class/Hour: \_\_\_\_\_

## ***SySTEM Alert!* Quiz (Volume 5, Number 1)**

This quiz covers the information in *SySTEM Alert!* Volume 5, Number 1. Circle the letter of the correct answer or write the letter by the question number.

1. What is tribology?
  - A. the study of tribal peoples
  - B. an ancient fossil
  - C. the last phase in the engineering design process
  - D. the study of friction and how to overcome it
2. According to one estimate, how many self-driving cars are predicted to be on the road by 2020?
  - A. 1 million
  - B. 5 million
  - C. 10 million
  - D. 20 million
3. How was N3FC originally used?
  - A. as a protective layer for smartphone touchscreens
  - B. as a chemical additive to preserve nutrition in foods
  - C. as a coating for natural gas compressor sealing applications
  - D. as a binding agent for concrete
4. The engineering design process is \_\_\_\_\_.
  - A. a series of steps that guides engineers in the creation of new products
  - B. a method of evaluating whether a new product is successful
  - C. the only way a product can legally be made
  - D. an outdated technique no longer used by engineers
5. What is a prototype?
  - A. a variation on an existing product, such as an alternate color or size
  - B. a model made to test an idea before the final product is made
  - C. a sensor in a self-driving car that detects the nearness of other vehicles
  - D. a small motorized hinge that enables blocks to rearrange themselves



6. Friction is produced when \_\_\_\_\_.
- A. any two objects are in contact
  - B. two surfaces move against one another
  - C. a wind turbine's drivetrain is running
  - D. both B and C
7. What is the name for an envisioned technology that would enable products to change their shape to fit the needs of the user?
- A. morphing matter
  - B. programmable matter
  - C. fluid form
  - D. variable design
8. What is a name for tiny cracks on the surface of mechanical parts?
- A. micropitting
  - B. frictional cost
  - C. minifissures
  - D. wear tracks
9. When matter goes from solid to gas without passing through a liquid state, it is called \_\_\_\_\_.
- A. sublimation
  - B. ossification
  - C. putrefaction
  - D. depressurization
10. In the Cubimorph prototype, each cube face has a \_\_\_\_\_.
- A. temperature sensor
  - B. touchscreen
  - C. magnetic fastener
  - D. coating of N3FC

**Bonus question:**

A prototype robot that sorts pills for hospital patients has been developed. The robot must be tested before it can be used in real-life situations. Describe a test to make sure the robot functions properly.