March-May 2020 • Volume 8, No. 4

SYSTEM ALERT!
Tomorrow is almost here.

FIRST® Tech Challenge team creates a **ventilator** prototype with **TETRIX®**

People around the world are waiting out the COVID-19 pandemic. In every time of crisis, there are those who step forward and work together to help.

One challenge our society is facing is that our doctors, nurses, and emergency responders are short of key supplies and tools. One device being used to help sick people is a ventilator. A ventilator is a machine that provides breathing assistance by moving air into and out of the lungs.

Medical professionals currently have some ventilators but not enough. Maybe this is one situation where innovators can step forward to help.

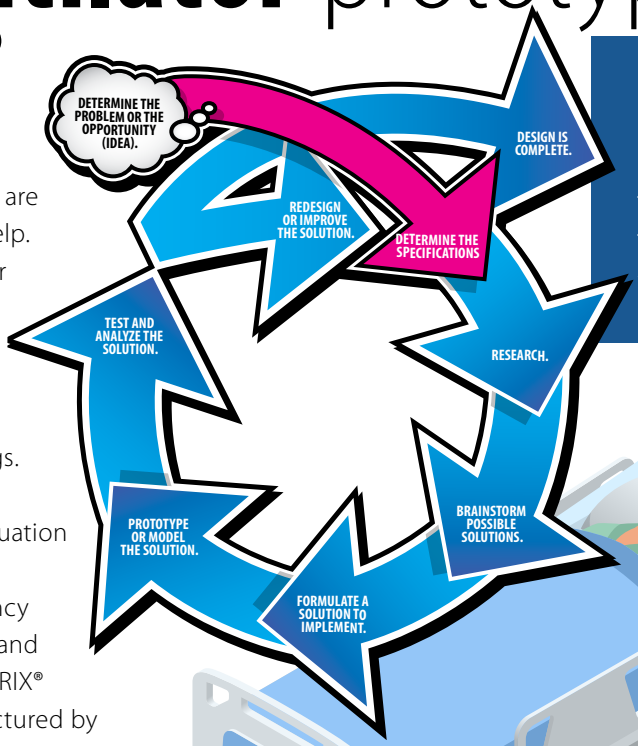
One team in the Chicago area feels the urgency of this call. The team has collaborated to design and build a portable mechanical ventilator using TETRIX® robotics components. (The TETRIX kit is manufactured by Pitsco Education and used by many schools' robotics programs.)

The design team is led by Kenny Bae, a teacher and *FIRST*® Tech Challenge robotics coach at Wolcott College Prep in Chicago, Illinois. For Kenny, the project is personal; his sister is a nurse practitioner who works with patients. She and other medical professionals have provided guidance and feedback for the device.

Kenny also called upon his robotics students to help design and build the TETRIX device. "We are handing the next generation of students the opportunity to step up and be leaders in STEM technology," explained Kenny.

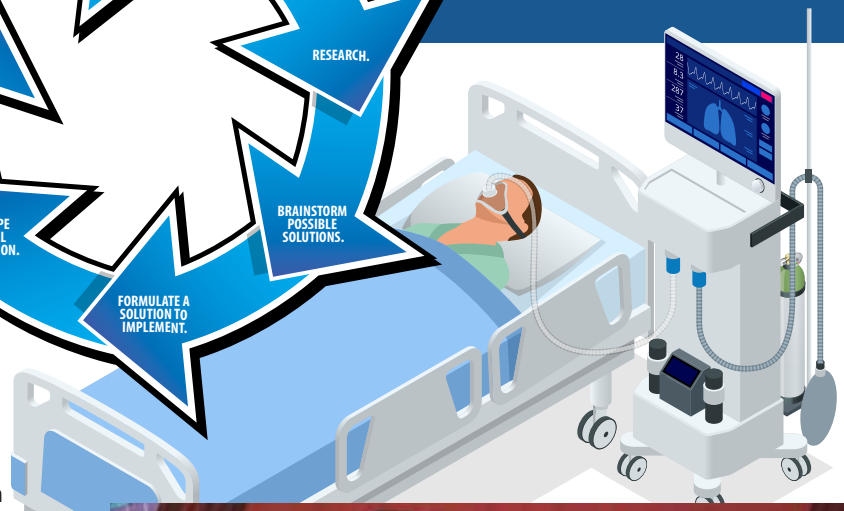
The group has been working rapidly. Even though they can't meet in the same room because of social distancing, they've collaborated over the Internet.

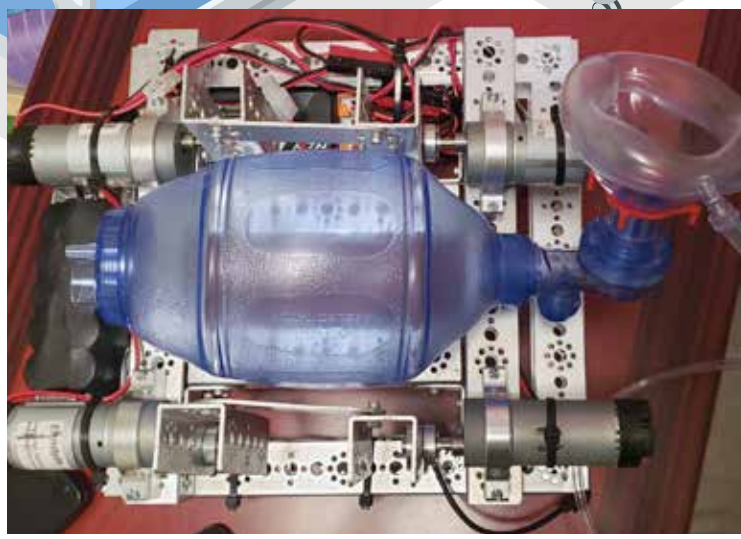
The team had a great reference point for their design – another prototype ventilator created by researchers at MIT. That device, called E-Vent, was designed as a low-cost solution. Kenny's robotics team has purposely made their TETRIX model similar to the E-Vent. Their hope is that when the E-Vent is approved for use, the TETRIX Portable Ventilator can be put on the fast track for emergency approval. Then, perhaps teams around the world can create more.



Learn More

To learn more about the TETRIX® Portable Ventilator, visit TheRisingDroid.com.





An FTC coach, his team, and a group of medical professionals collaborated to create the TETRIX® Portable Ventilator. Their hope is that it can be used to help save lives.

ENGINEERING THE TETRIX PORTABLE VENTILATOR

During product design, creators often use an engineering design process. This is a series of steps that leads a project toward completion.

After the team understands the overall goal, the first step is to describe the needs as specifically as possible. These descriptions are called specifications. For this project, they include the ability to control the rate of the machine, a good battery life, and a way to keep the device sterile. Another specification is that it would use available materials, including TETRIX pieces already on hand.

After research and discussion, the team began to brainstorm solutions. Kenny's team worked out a plan and, over a few hours, built their own prototype. The TETRIX Portable Ventilator uses end effectors to grip and squeeze a bag valve mask to move air. Smartphones are used to control the ventilator.

The next steps are analyzing, testing, and improving the device. It hasn't been tested on a patient, but medical professionals have evaluated it and pointed out areas for improvement. For example, the team made a plastic case to keep the device sterile, but medical experts advised that simply wrapping the machine in plastic wrap would work better in a crisis situation.

Members of FIRST team #8728 from Wolcott College Prep in Chicago, Illinois

IMPLICATIONS

Kenny's team realizes their device might not be approved, but they are taking the chance because of their wish to help others. Has the team created a simple design that other robotics teams can duplicate with pieces already in their supply closets? Could these devices be provided to hospitals to use when manufactured ventilators are not available? That is their hope.

"There are so many phenomenal students out there," said Kenny. "If we can share this idea and inspire them to work together, it is worth doing."

Kenny and his team are not seeking acclaim or recognition. Their effort is open-source, which means that anyone with knowledge is welcome to chip in and help. In this fast-moving situation, it is important that our responders are agile and inventive.

The TETRIX Portable Ventilator has received encouragement from Dean Kamen, inventor and founder of the FIRST® organization, as well as media attention.

Wolcott College Prep is a private, nonprofit high school for students with learning differences. The curriculum is tailored to the strengths of each student.

Kenny Bae received his bachelor of science in Physics, Radiation, and Applied Physics with a math minor from Eastern Illinois University as well as a master's degree in Atmospheric Science from the University of Illinois Urbana-Champaign. Kenny founded and currently coaches Wolcott *FIRST* team #8728, which has won numerous competitions awards from the *FIRST* Tech Challenge. The Wolcott robotics team was invited to the *FIRST* Championship event in 2016, 2017, 2018, and 2019 as conference speakers for their innovative projects. The Wolcott team was also featured in the *FIRST Inspire* blog in June 18, 2019. ⚠

This is the true story of a young person who was forced to miss school during a national crisis. Though he had no teachers and no assignments, he did have curiosity and creativity. Teaching himself, he was inspired to create an invention that made some wonder if he was going mad. . . .

Student's curiosity blows him onto the path of greatness

Fourteen-year-old William Kamkwamba dreamed of going to ninth grade. He wanted to learn about science and the world. In the African country of Malawi, schools charge tuition fees. William's mother and father were poor farmers, and William wasn't sure they could afford to pay his way.

He and his sisters helped grow food to eat and to sell. Even in a good year when crop yields were high, the Kamkwamba family could not afford running water or electricity. And in bad years, money became very tight.

The year 2001 was bad. Heavy rains flooded the countryside. Then there was a drought. Crops died. When William's family counted their small harvest of maize, they knew they must ration meals to survive. Many rural farmers in the country were in danger of starving.

William had been able to start the school year, but now his family could not pay. He was forced to drop out. This same fate was happening to many young people in his village and country. Many days William ate only one small meal. As his hunger for food increased, his hunger for knowledge grew as well.

William was fascinated with electricity. Some in his village had battery-powered radios they used to listen to sports and music. Taking them apart, he studied the wiring and mechanics.

Even though William wasn't a student, the school librarian was sympathetic to him and let him check out books. Here William discovered an American textbook called *Using Energy*. He was captivated and studied deep in the book's pages. When he couldn't make out the English, he used the illustrations to understand the concepts.

He learned about wind-powered turbines that generate electricity. William imagined creating a windmill of his own to capture the winds that swept over his family's land.

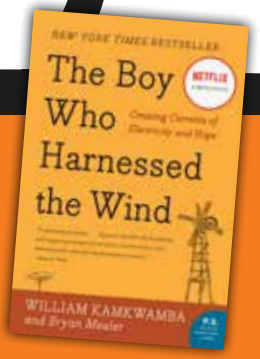
He decided to make a prototype.

And when his miniature model powered a radio on a breezy day, he knew his big idea would work.

With no money for expensive parts such as fan blades, a motor, and wiring, William looked to the scrap yard. William, his cousin, and a friend found a fan from an old tractor engine. The metal blades

Discover more

William Kamkwamba is the subject of a book, *The Boy Who Harnessed the Wind*, and also a film of the same title. You can learn more about his current projects at WilliamKamkwamba.com.



He dreamed, he learned, he built.

were strong but too short for William's design, so he made plastic blade extensions. For this, he used fire to soften and mold PVC pipe into shape.

He attached the fan structure to the axle of a bicycle. William got ahold of a device called a dynamo. A dynamo converts mechanical energy into electrical energy. In this case, the mechanical energy was to be supplied by the bike chain, which was driven by the blades, which were turned by the wind.

As he collected these and other parts, people in his village took notice. Some laughed. Some thought he was foolish. The people were not familiar with this technology, so they were skeptical.

At last, his windmill was complete. It stood 15 feet high on tower legs made of local trees he cut down. With family and neighbors gathered, William unlocked the blades. They spun in the wind. A light bulb attached to the machine came to life.

The crowd gasped. "Electric wind!" announced William.

William used his machine to bring electric light to his family's house. Word of his surprising achievement grew, first through his country and then the world. With his new fame came resources for new projects. Since that time, William has also built other windmills, a solar-powered water pump, and an irrigation system to protect his family's crops from drought.

William Kamkwamba's drive to learn and create didn't end with his schooling, didn't starve with his hunger, and didn't shrink from doubters. What "crazy" big idea do you have to help your family and neighbors?

With bicycle parts, plastic pipe, and pieces found in a scrap yard, William Kamkwamba brought "electric wind" to his home in Malawi.

WIND POWER

We are surrounded by energy, but it takes know-how to capture and use it. Increasingly, our energy needs are met with wind turbines.

In a commercial wind turbine, wind rotates the enormous but lightweight blades. This rotation turns a shaft at the same speed. But this speed is not yet fast enough to generate electricity, so the rotating shaft connects to a gear box. Linking gears of different sizes, the speed of rotation is mechanically increased. Another shaft exits the gear box, now moving at a rate up to 100 times faster than the original speed of the blades.

The shaft enters the generator, causing coils to spin in a magnetic field. The interaction forces electrons to move along their path. This flow of electrons is electricity.

Do you like wind power but aren't quite ready to build a windmill to the scale of William Kamkwamba's? Pitsco's Wind Gen and Eco-Wind Generator II are the prototypes you need to get your project going. You'll get the components you need to convert wind from a fan into electricity to power a light. Learn the principles involved and explore the free PDF guide available on Pitsco's website.

Volume 8, No. 4

SySTEM ALERT!
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SySTEM Alert! is published by Pitsco, Inc. Information and articles are geared to middle-level students.

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Student name: _____ **Class/Hour**: _____

SySTEM Alert! Quiz (Volume 8, Number 4)

1. A _____ is a machine that provides breathing assistance by moving air into and out of the lungs.
   A. respirator
   B. ventilator
   C. decompression chamber
   D. defibrillator

2. When creating the TETRIX® Portable Ventilator, the design team referenced another device. What was it?
   A. wind turbine
   B. E-Vent prototype from MIT
   C. bike-powered dynamo
   D. smartphone

3. In the engineering design process, what step comes after formulating a solution?
   A. Research
   B. Brainstorm possible solutions
   C. Prototype or model the solution
   D. Determine the specifications

4. Descriptions of the specific needs of a project are called _____.
   A. specifications
   B. ingredients
   C. instructions
   D. definitions

5. What series of natural disasters led William Kamkwamba to create a windmill?
   A. pandemic
   B. earthquake and tsunami
   C. hurricane
   D. flood followed by drought

6. Where did William Kamkwamba discover the book that inspired his windmill project?
   A. on the Internet
   B. at a school library
   C. in a bookstore
   D. at a friend's house

7. What did William Kamkwamba and his friends salvage from a tractor engine?
   A. a fan
   B. a belt
   C. gears
   D. a dynamo

8. What is a device that links gears of different sizes to mechanically change the speed of rotation?
   A. ventilator
   B. drive shaft
   C. dynamo
   D. gear box

9. What is a device that converts mechanical energy into electrical energy?
   A. dynamo
   B. gear box
   C. TETRIX Portable Ventilator
   D. defibrillator

10. What happens inside a generator in a commercial wind turbine?
    A. Batteries are charged through a chemical process.
    B. Rotation speed is increased by up to 100 times.
    C. Coils spin in a magnetic field, causing electricity to flow.
    D. Alternating current is converted into direct current electricity.

Bonus:
Research an inventor from your state or region. Describe what you believe motivated the inventor to create his or her invention.