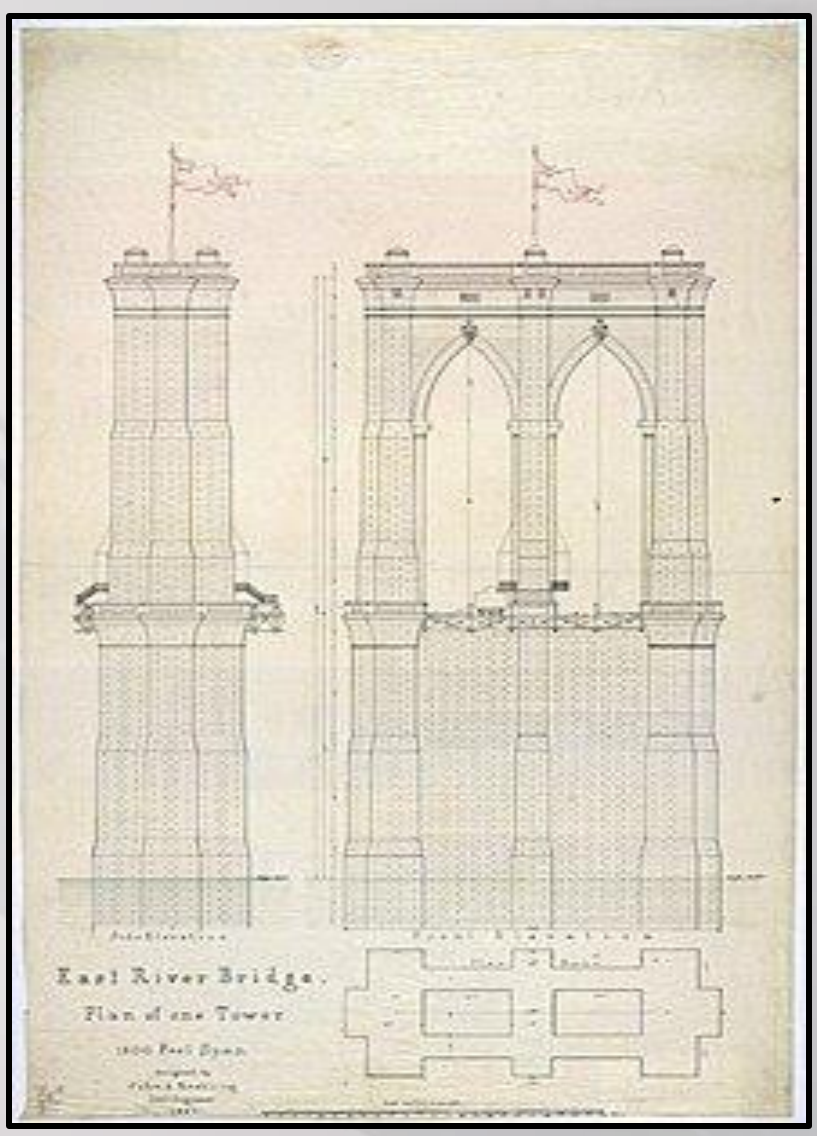
Bridging Our Way to Civil Engineering

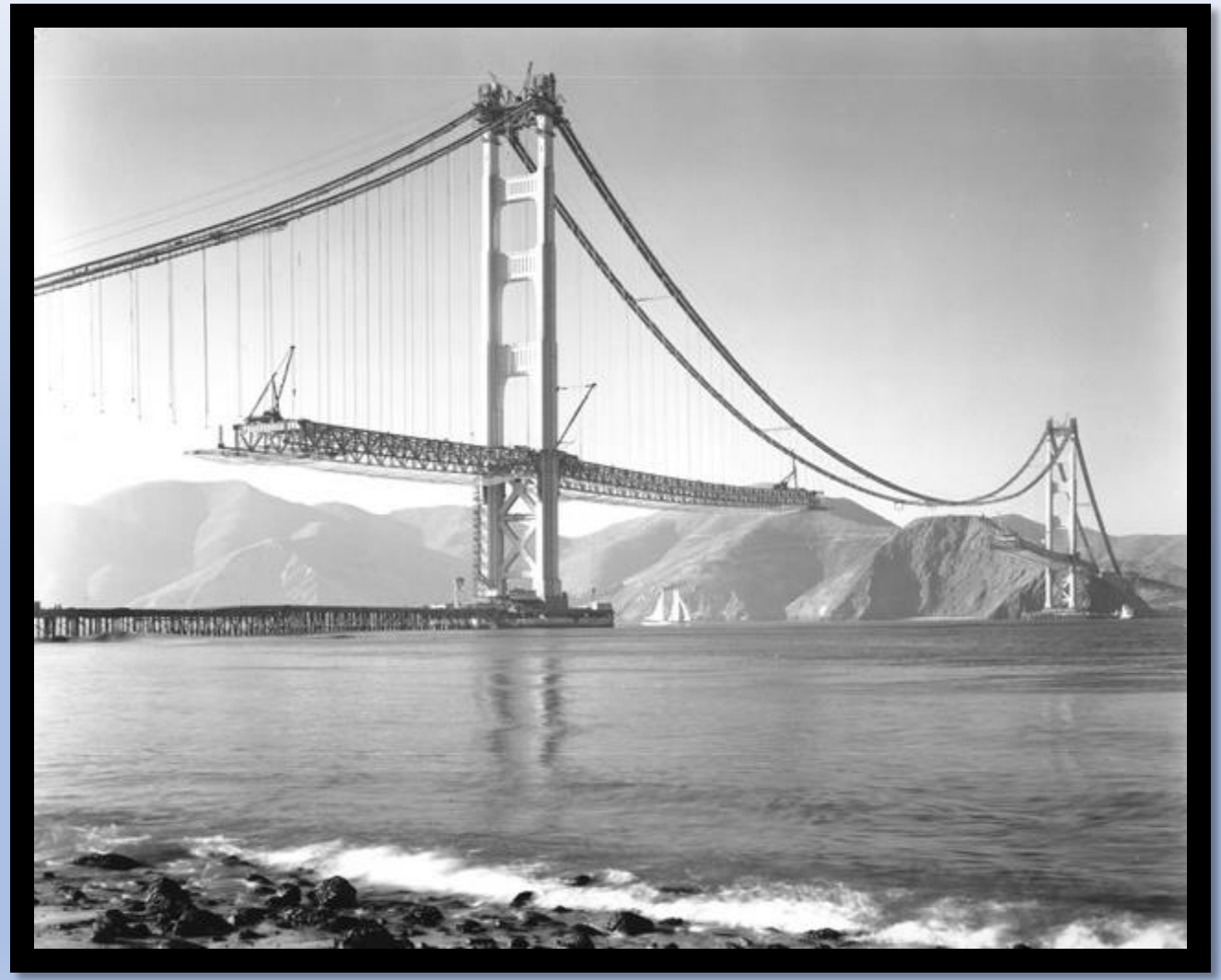
Team 6855C – Warrior Engineers

[1] I-395 Miami Rendering
(http://www.i395-miami.com/project-rendering/)

The STEM career of Civil Engineering appeals to our team the most because we like math, science, and we like watching construction. Civil Engineers work in designing, constructing, and improving the world we live in. Not just anyone can become a Civil Engineer. It takes a lot of hard work and studying. You must earn a bachelor's degree in Civil Engineering, have on the job experience, and take a very long hard test to become licensed. You must take classes in English, Chemistry, Physics, and Computer Technology, but be especially strong in Math and Science. You must be able to work well with others and be open for feedback, both positive and negative. Good writing and presentation skills are important because many times you must compete for work or make big presentations. It is a rewarding career and the medium salary is $86,640 (1).



[2] Early Brooklyn Bridge Tower Plan, 1867 (https://en.wikipedia.org/wiki/Brooklyn_Bridge)



[3] Golden Gate Bridge Under Construction (https://www.goldengate.org/historic-photos/)

There are many areas of civil engineering. Some examples include structural, geotechnical, environmental, water, construction, and transportation. Our team chose to focus on structural engineers relating to bridges. Great bridges and other structures do not just happen. Engineers work with large teams to brainstorm how to design these large structures and make them structurally stable. It takes a lot of creativity to develop amazing structures like the Golden Gate Bridge, the Brooklyn Bridge, and the Gateshead Millennium Bridge. It also takes a lot of brains to make them withstand cars and the environment!

Competitive robotics has prepared us for a career in civil engineering in many ways. Just as a civil engineer needs to brainstorm solutions for complex problems, our robotics team uses brainstorming to create our robot, find solutions as we run into problems, and determine the best plan to compete in challenges. We use teamwork like a civil engineer works with their team of engineers and/or construction workers to build whatever job they have designed. We have learned to weigh alternatives, come up with a model, construct a design, make enhancements, and then improve the design to make it better. These are all tasks that civil engineers perform in their job each day as they work on projects.

Westminster Christian School
Team 6855C – Warrior Engineers

Another skill we have learned in competitive robotics that has prepared us for a career in civil engineering is leadership. We have all learned to take on leader roles in different aspects of the process to compete in robotics. Whether it be designing, building, driving, or journaling, each of us has needed to step up to succeed. Civil engineers are the leaders improving buildings, roads, the environment, etc. They need to be able to determine a problem and lead to find a solution. We are well on our way to becoming successful, future civil engineers and have learned valuable skills through robotics!

[4] Rendering of I-395 Bridge in Miami (http://www.i395-miami.com/project-rendering/)

Danny Raymat is a civil engineer and Vice President of BCC in Miami, FL. He has helped design over 50 very large bridges. Growing up he liked to draw and enjoyed math. He excelled in both through college and found a career in civil engineering. He attributes his success to a "want to improve society" and "find solutions" in infrastructure. Throughout his career he has learned that you must work hard and work well with others…never giving up! He inspires our team by showing us pictures of cool bridges that we one day could design. He was one of the designers that worked on a big bridge that is currently being built in our hometown…how cool is it to design a city's landmark?

According to an article published for the World Economic Forum titled, “Collaborating with Key Industry Partners to Advance On-site Fully Autonomous Robotic 3D Printing in the E&C Sector,” the engineering and construction sector has been hesitant to grow like many other industries in automation (2). In the next 10 years, civil engineering has a lot of room for growth and is just beginning to move into the robotic age. Currently, there are new technologies using robots that help civil engineers in their jobs. Some robots being used today in construction are the TyBot, Seekur Jnr (bridge inspection robot), and even 3D bridge printing robots! Civil engineers have begun to work together with construction workers and computer programmers to determine ways to increase productivity and improve safety.

In 2017, “with the vision that robots can seamlessly integrate into present day construction operations and work alongside crew members to complete the riskier, undesirable tasks, increasing overall productivity,” TyBot was born. TyBot is an artificial intelligent robot that ties rebar together for bridge building using only one certified person to verify the robot is working properly. It was designed to save time and money. Tybot finds the intersecting rebars and can tie up to 1,000 intersections per hour running day and night, rain or shine, with no breaks, or complaints (3). It is faster than construction workers and will not stop the job due to missing workers.

[5] TyBot Tying Rebar (https://www.tybotllc.com/get-tybot)

Actual Photos of TyBot Taken by Our Team

Team Members Christopher Wood, Ethan de Moya and Christian Newcomm on TyBot's Job Site

Another big advantage of TyBot is that it helps keep workers safe in bridge building. Tying rebar is a very dangerous job. Workers can fall in between the gaps of the rebar because the bridge has not been fully built. Jeremy Searock, an engineer, along with Stephen Muck, a businessman, determined a need to improve the field of engineering and construction to improve productivity and safety. Robots will continue to help engineers in this way.

Our team got the amazing experience to see firsthand TyBot tying rebar on a bridge currently under construction. We were given the traditional handheld device where laborers must bend down and manually tie each intersection of rebar of steel. This is a very dangerous, monotonous, and especially time-consuming job that the TyBot has made better. They have plans of improving other parts of the rebar process in bridge building using robots in the future and we hope to have another opportunity to see how robotics improve engineering.

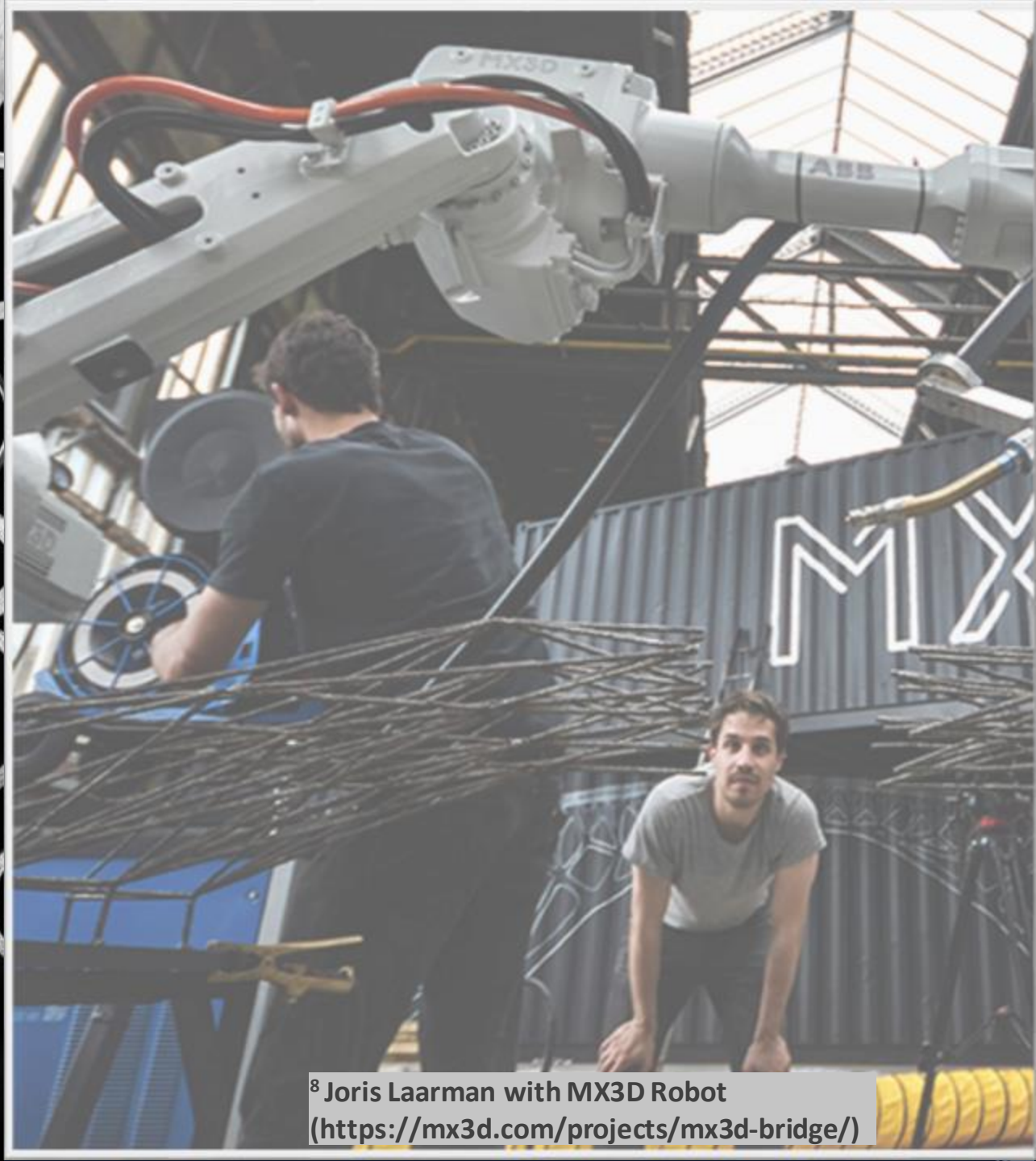
Team Members Ethan de Moya, Christopher Wood, and Christian Newcomm Trying Out a Traditional Rebar Tying Device

Team Members Christopher Wood, Christian Newcomm and Ethan de Moya on TyBot's Job Site

[7] Seekur Jnr (https://www.digitaltrends.com/cool-tech/robot-bridge-inspector-sensors/)

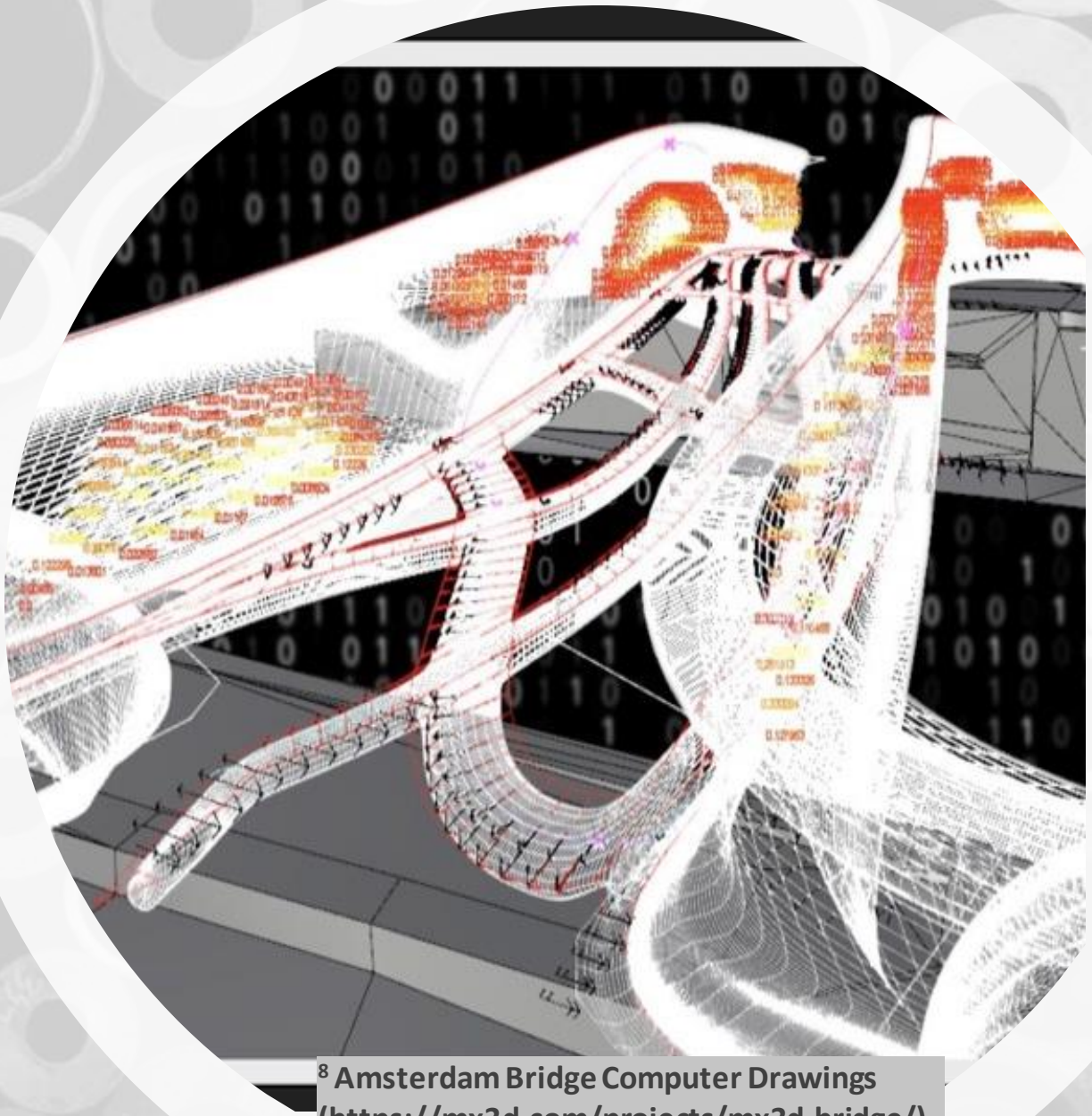
The Seekur Jnr Bridge Inspection Robot is another advancement in technology created by the University of Nevada. Bridges can deteriorate quickly and become structurally poor. Most safety inspections on bridges can be very dangerous. Equipped with 3 different sensors, Seekur Jnr can search under the surface of the bridge for problems, scan for decay of steel and cement, and use a camera to find cracks in the bridge's surface. According to Spencer Gibb at the University of Nevada, "The robot takes the same amount of time to physically scan the bridge as a human inspector, but it processes the data in minutes instead of hours." It is a rugged and weatherproof robot that does not put humans at risk (4). Seekur Jnr is another example of how the future of engineers in bridge building will be improved by robots.

Thirdly, we see a lot of opportunity for engineers in the new technologies being developed in 3D bridge printing. Can you imagine a robot "printing" a bridge? Two processes have been developed to "print" bridges, one in concrete and one in steel. In October 2015, Joris Laarman launched the MX3D Bridge Project in Amsterdam after an idea to bridge "the technology of the future with the beautiful city's past in a way that would reveal the best aspects of both worlds." Laarman, a Dutch designer, pulled together a team (MX3D) to design and build his idea.



[8] Joris Laarman with MX3D Robot (https://mx3d.com/projects/mx3d-bridge/)

The team included his design company, engineers, and software companies. This is something that had never in the world been done before. Engineering and design often clashed. They had to do many revisions before coming up with a final design that would be structural safe and hold pedestrians. It was very important for engineers to be involved through the whole design process which took 18 months (5). MX3D built the first steel bridge using a robotic arm in the world. It took 6 months, 4 robots, 9,920 pounds of stainless steel to "print" the 41-foot pedestrian bridge (6). This was a huge accomplishment and is the beginning to many things that are possible for the future of engineers.



[8] Amsterdam Bridge Computer Drawings (https://mx3d.com/projects/mx3d-bridge/)

[9] MX3D Robot Printing Steel Bridge (https://www.jorislaarman.com/work/bridge-update/)

[10] MX3D Robot Printing Steel Bridge (https://www.jorislaarman.com/work/bridge-update/)

[11] The First Tests of the MX3D **Robot** Printing (https://mx3d.com/projects/mx3d-bridge)

[12] Finished Amsterdam Steel Pedestrian Bridge Before Being Put in Place (https://www.jorislaarmaPcom/work/bridge-update)

[13] Securing a 3D Concrete Bridge Support (https://www.foxnews.com/tech/marines-3d-print-amazing-concrete-bridge)

[14] 3D Concrete Printed Foot Bridge (https://www.military.com/dodbuzz.com/dodbuzz/2019/01/31/marines-just-3d-printed-entire-bridge-california.html)

In December 2018, the fastest built 3D printed bridge was built by the marines at Camp Pendleton, CA. They built a concrete footbridge in 14 hours (over the course of 3 days) and then took 4 hours for them to glue the bridge parts together (7). The Marines worked with the Army Corps of Engineers to make sure it was structural safe. Working with engineers, they hope to expand the use of 3D concrete printing to increase productivity in their operations (8).

In conclusion, civil engineering is a very exciting career that will continue to grow in the next 10 years. Advancements in technologies to improve productivity and safety will help engineers be more effective in their jobs. By using what we are learning in robotics, we will be more prepared for the advances that are being made in civil engineering with the use of robots. We are very excited to take what we are learning to better the career in the future!

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