Quantum Computing & Station B: Reducing Our Vulnerabilities by Building a Platform for Programming Biology

We are vulnerable.

If humanity figured out one thing from the COVID pandemic, it's that we are vulnerable.

Despite all the advancements of our modern age, the entire world was drastically and inequitably impacted by something that is 1000x smaller than a strand of human *hair*.

In fact, author and mathematical biologist Christian Yates calculated that *every* Sars-CoV-2 particle in the world would fit in one single soft drink can.

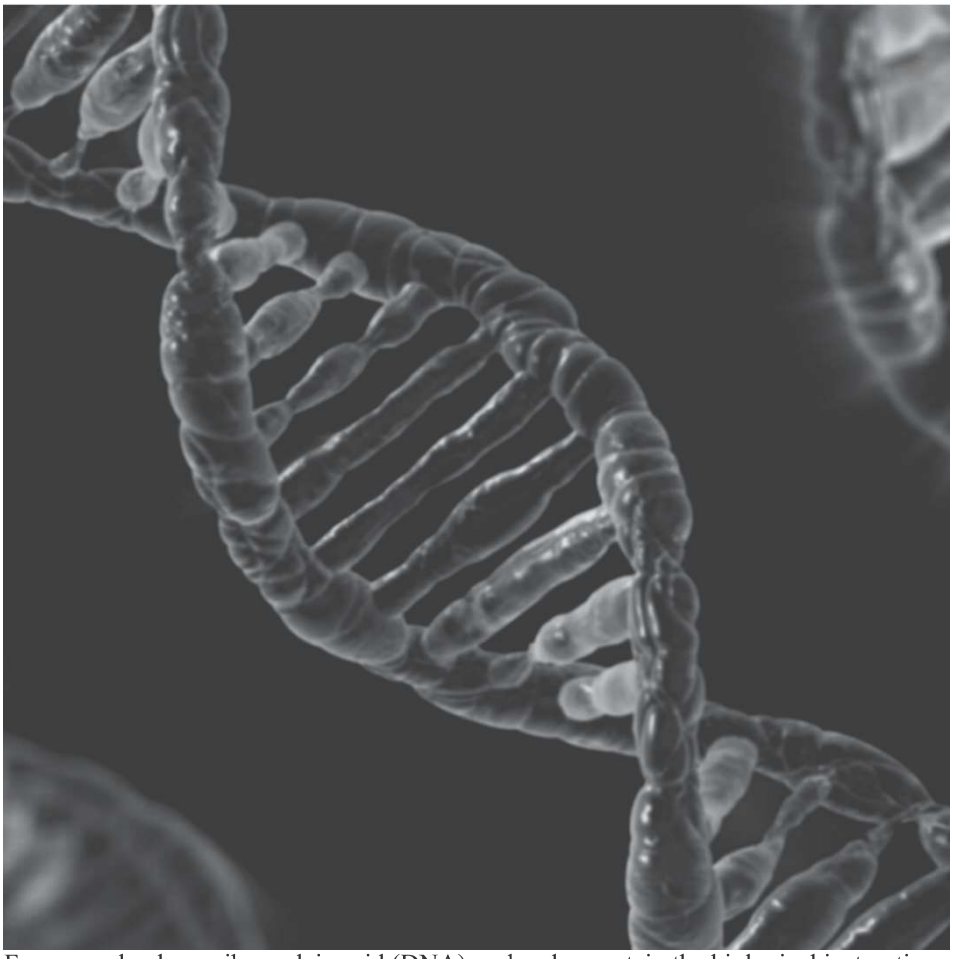
We still have a large amount to learn about the small things in our world which brings me to my topic today: Station B. One of the most amazing programming platforms of the future being developed by Microsoft.

Station B

For those of you who follow quantum computing, you may be aware of the innovation going on with Microsoft's Station Q research. Station Q is a research lab created in 2005 at the University of California, Santa Barbara to nurture collaboration

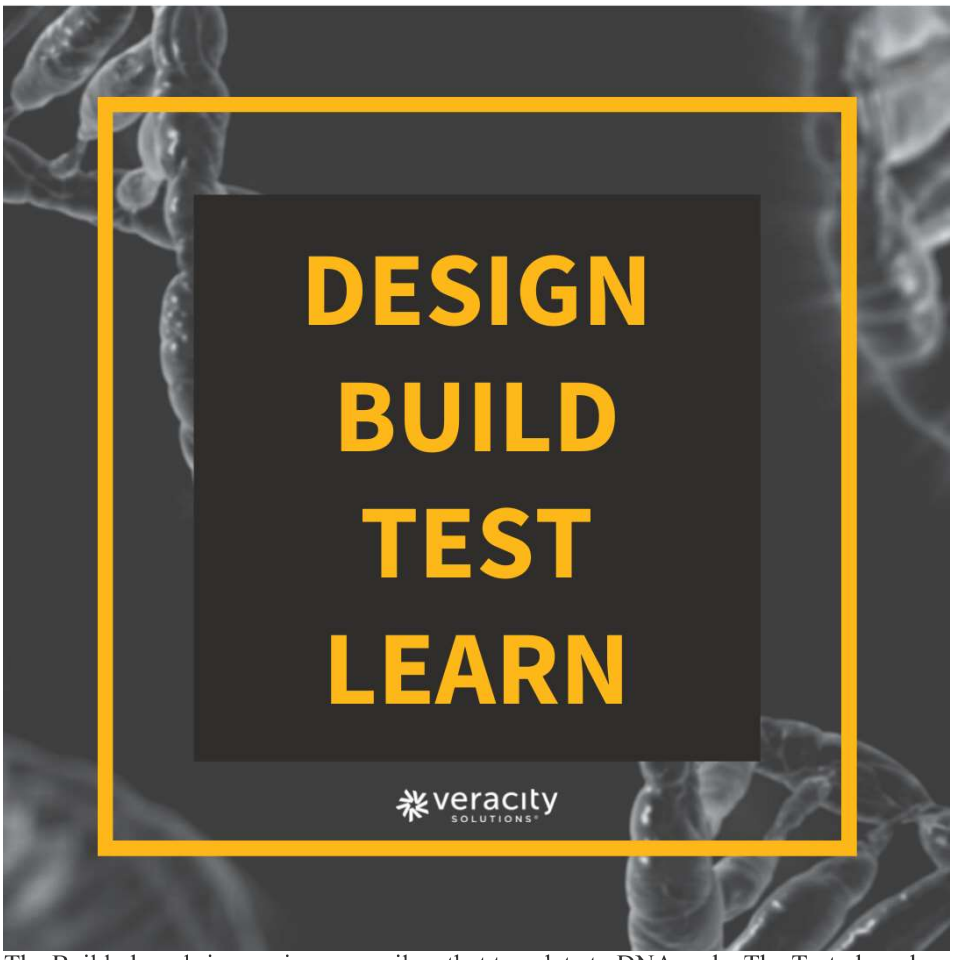
between theoretical physicists. Once that team got started, it became *very* evident that the old programming paradigm of "1's" and "0's" was not going to cut it anymore and they were going to have to create new programming methods to work in the quantum space. Exploration of quantum computing really exposed the limits of our current computer processing technology. However, quantum is not the *only* complex world that exists.

Doctors and scientists have for years expressed their desire for computational systems that can better mimic structures we find in nature. It must be better than "1's" and "0's." If only nature was that simple. Imagine if biology had a core set of components that could be represented repeatedly like "1's" and "0's." But wait, biology *does* have core components!



For example, deoxyribonucleic acid (DNA) molecules contain the biological instructions that living organisms need to live. If you think of a DNA double-helix strand as a ladder, phosphate and sugar molecules would be the sides, but four types of nitrogen bases make up the rungs: adenine (A), thymine (T), guanine (G), and cytosine (C). “A’s,” “T’s,” “G’s,” and “C’s.” If these basic components could be arranged similar to the way we use “1’s” and “0’s,” then it *would* be possible to “program” biological elements like a computer. At Microsoft Research in Cambridge, UK, that is exactly what a team has set out to do.

Directly inspired by the work of Station Q, researchers at Station B are working toward developing a platform to improve *all* phases of biological computing. As Microsoft’s first molecular biology laboratory, they aim to create a platform to improve the four critical phases of Design, Build, Test, and Learn.

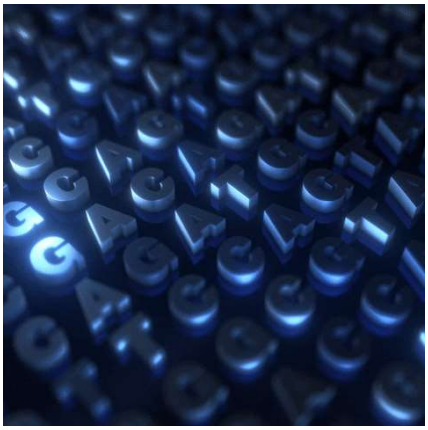


The Build phase brings unique compilers that translate to DNA code. The Test phase leverages lab robots using the state-of-the-art Antha program from Synthace and Azure's Internet of Things to control the experiments. Finally, the Learn phase encompasses deep learning methods and advanced reasoning to extract and learn from the results that are integrated with a biological knowledge base.

Dealing with research that has historically progressed using trial and error methods, Station B primarily focuses on programming languages that operate at the molecular, genetic, and network levels. Leveraging existing tools like the DNA Strand Displacement (DSD) tool, a programming language for designing and simulating computational devices made of DNA.

CRISPR

The first thing many of you may wonder is if this is even possible. Well, allow me to introduce Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR). CRISPR is one of the most advanced technologies in the world of gene editing. It works by using natural processes of the immune system and the bacteria that fight off invading viruses. When a virus attacks, the cell can produce a protective enzyme known as Cas9 which cuts out the infected DNA strands. If we could cut out, replace, or modify living cells we could revolutionize the medical field. In theory, more than 3000 genetic diseases that have the "A's," "T's," "G's," or "C's" in the wrong place could be repaired by reprogramming them.

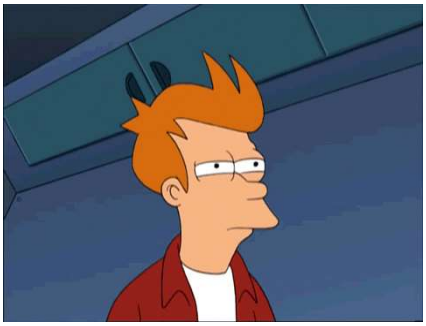


Real World

It sounds *an awful lot* like science fiction, but the results are real. Researchers are rapidly using these types of tools and discoveries to look at new ways to improve crop yield and harness the way we collect energy. Gene therapy is nothing new. As far back as 1990 gene therapy was used to treat ADA-SCID a congenital disease that severely affects the body's immunity. Layla Richards was diagnosed with an aggressive type of acute lymphoblastic leukemia. It is considered incurable cancer. In October of 2014, she underwent a last-ditch treatment using edited genes and create designer immune cells programmed to hunt out and kill drug-resistant leukemia. After multiple rounds of failed chemotherapy and a full bone marrow transplant, her life hinged on a tiny, one-milliliter infusion of genetically engineered white blood cells. That is 0.033814 of an *ounce*. One year later, Layla was cancer-free.

Already CRISPR genomic editing is being used in clinical trials for people with certain inherited blindness. Additionally, the U.S. Food and Drug Administration (FDA) has recently approved the first-in-human clinical trial of a CRISPR gene correction therapy in patients with sickle cell disease.

Summary



Now to address the other question that some of you are wondering: Is this... *okay*? I will be the first to admit there are some ethical and moral questions we will have to resolve here. This type of technology may not be right for everyone.

Yes, we still have a lot of questions.

Yes, things like CRISPR are still going through medical scrutiny.

Yes, there are ethical issues that must be addressed.

And yes, Layla Richards is alive today because of this type of research.

However, here is what I know: If we can create a way to repair the body, we could potentially defeat most cancers and HIV in a matter of a few short years. Why shouldn't we seek to eradicate them?