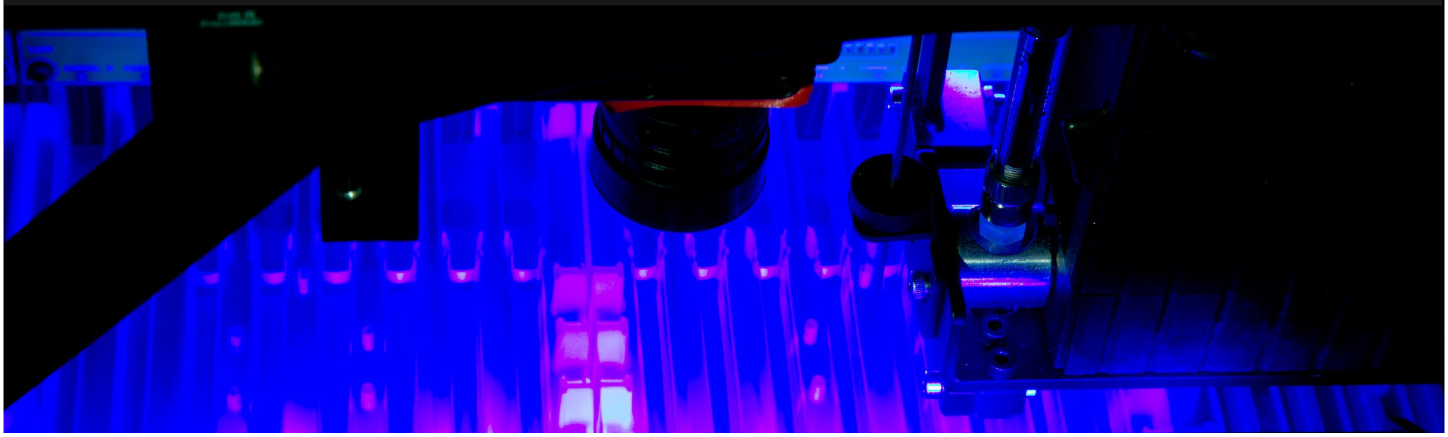
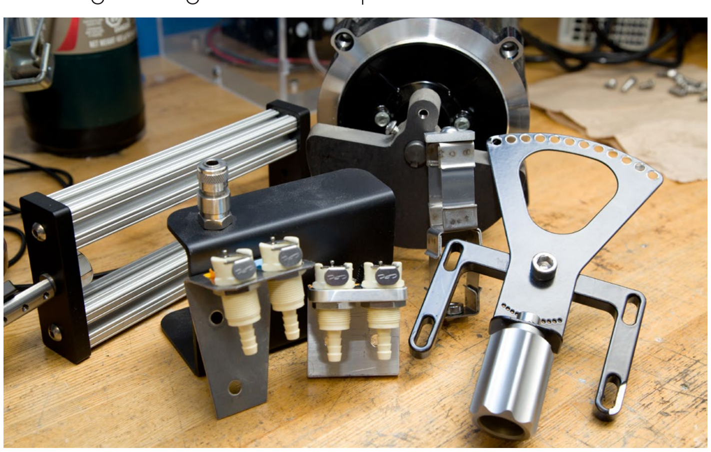
Prototyping DNA Research Equipment With OMAX Abrasive Waterjets



Starting in 1990, the Human Genome Project drove the international science community to explore innovative DNA sequencing methods for efficiently decoding the complex base structure of the human DNA. Taking advantage of technological advances in computing, robotics, chemistry, and DNA biology, scientists and engineers developed the first generation of automated capillary sequencing machines. These machines could decode or "sequence" about 700,000 DNA bases in 24 hours, and once they became available in about 1998, the first human genome sequence was completed by multiple international laboratories in about three years. New techniques were subsequently found to decode DNA sequences, and today the latest generation of sequencing machines can sequence 60,000,000,000 DNA bases per day and sequence a new human genome in a few hours. This holds the promise of revolutionizing cancer treatment, industrial agriculture, and our understanding of biological life in general.

The BC Cancer Agency Genome Sciences Centre (GSC) a research institution in Vancouver, British Columbia, revels in creating their own automated tools for DNA sample preparation and other lab equipment for their scientific research needs, and they push their inventions to new levels with the capabilities of an OMAX® Model 2652 in their engineering machine shop.



"We came to the realization that waterjet was a critical tool for efficient prototyping for several reasons," GSC Engineering Group Leader Dr. Robin Coope said. "It's faster, easier to set up and operate and handles more materials than traditional machine tools. Waterjet capabilities can be extended substantially for prototyping with the application of some inexpensive related tools, notably a press brake, a spot welder, and in-house powder coating."

Before the BC Cancer Agency's Joint Engineering Center acquired their OMAX abrasive waterjet through funding from Genome BC, Dr. Coope and his research colleagues made prototypes the classical way machining blocks of material, primarily aluminum. If they wanted a prototype to look aesthetically pleasing, they would anodize the end product. However, anodizing material can accentuate machining flaws as Coope discovered, and requires an external shop, adding to lead times.

In the past, Dr. Coope rarely worked with sheet metal, as the only tools available were hand shears, punches and bending brakes. He admitted he didn't have the ability to build complex or intricate designs this way and therefore didn't think of using sheet materials in many situations.

"As soon as you have a waterjet, you can get out of the aluminum block paradigm. You can do a lot more work with sheets and steels, which we never historically used for prototyping," he said. "You can also extend that functionality dramatically if you use sheet metal bending brakes to turn your 2-dimensional structures into 3-dimensional structures."

He transformed a 2D design into a 3D design when he created a detachable plate holder out of an 18-gauge steel sheet. He created a 2D box design from a DXF file; cut the overall pattern, added slots and hole patterns with the OMAX; bent and shaped corners through a press brake; and spot welded specific areas to strengthen the frame. After the first iteration, he discovered he needed to modify the lid shape. With easy access to the OMAX JetMachining® Center, he changed the DXF file on the fly, cut a new lid, and completed the well plate holder assembly within two hours. If Coope had submitted the modification to another team and relied on an outside machine shop schedule, it might have taken three days before he could acquire the updated component for re-assembly.

The waterjet dramatically extends the power of an underappreciated but critical philosophy in prototyping: Engineering design experts should actually be involved in the production and assembly of the entire prototype. This practice speeds up the prototyping and design cycle and reduces part rejections from the machine shop team, he said. "While we send lots of jobs to the machinists in our shop, it's extremely valuable for my team members to be able to do the jobs themselves as well. Often it's while you are making the prototype that you realize how you are going to make the next version better," said Dr. Coope. "The OMAX with the Intelli-MAX Software is by far the easiest machine application to learn that I've ever seen. Relying on broad oversight from our machinists, we can train a new team member to make parts without direct supervision in as little as an hour. You would never attempt this with a conventional CNC machine."

"If I'm the design engineer, and I decide to make it myself instead of the shop – the time I actually spend producing and assembling the prototype is the time I can think about the design in a way that is more concentrated, than the time I could be spending at my desk modifying the drawing."

One of his successful inventions involved both waterjet cutting and CNC machining. He developed a tiered aluminum plate for robotic pipette sampling out of a 96-tube DNA sample preparation plate. The plate in question had individual glass tubes each capped by a rubber septum, a slit membrane designed to protect the sample. The challenge was the septa tended to stick to the pipette tips to the point that the resisting movement was enough to break the pipetting robot's Z-axis. Dr. Coope's solution was to develop a plate with a stepped underside that would hold the tubes in place. When the robot withdrew pipette tips from the sample preparation plate, the robot arm pulled out the outer two rows of eight tips first, followed by the next two rows, and so forth, which varied in height by a couple of millimeters. This force was spread over a larger distance and allowed the robot to get in and out of the tube plate without damage. The outline of the plate and some of the holes were cut on a waterjet and the step structure was CNC machined.

The waterjet and CNC equipment combination works extremely well as the waterjet reduces the need for multiple CNC fixtures, and the CNC can actually chamfer the edges cut by the waterjet. Most of the group's parts are also powder coated in-house, a rapid and beautiful finishing technique that is extremely fast.

In line with the Agency's vision and mission statements, the Genome Sciences Centre is pushing DNA sequence pipeline development for all their research projects by timesaving innovation and well-designed devices. As DNA sequencing becomes more and more of a standard part of medical care, the need for robust and efficient automation solutions continues to increase. The OMAX JetMachining Center will stay at the heart of these developments and continue to contribute to outstanding prototyping and device development in the future.

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SPECIALIZES IN: Large-scale genomics and proteomics research projects

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