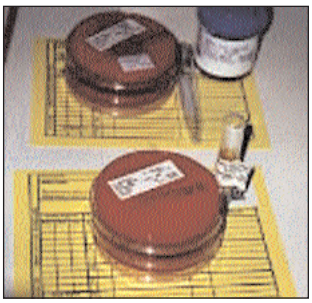
ZEBRA CASE STUDY



Bar Codes Help Celera Map Human Genome

From Sampling to Sequencing, Bar Coding Helped Celera Discover First

For some companies, asset tracking is simply a way to save money by using bar code labels to keep tabs on computers and other company equipment. But for Celera Genomics of Rockville, MD, using bar code labels to keep track of DNA samples and test results is an absolute necessity. Celera, the first company to sequence and map the human genome (the genetic blueprint of humanity), was managing procedures, critical machinery, raw materials, and data long before their scientific breakthrough.

"From the onset of our mission to genetically define 'human,' we realized that keeping tabs every step of the way was a must to ensure our results and validate our findings," says Celera Genomics' director of quality systems, Peter Amanatides. "Coming from a logistical background, I was familiar with the benefits of bar code printing and scanning. We decided to implement the technology here to drive our sequencing process and structure the procedures around it."

Celera's first challenge was to find a label that would withstand the unusual conditions of a gene-sequencing lab. The labels needed to be water- and chemical-resistant, heat- and cold-tolerant, and maintain visual and scanning readability while staying affixed to the plates and equipment.

"The harsh conditions of our lab and storage facilities necessitate a durable label that is long-lasting," says Amanatides. "We tested numerous labels over the course of several months, and all but one of them peeled or failed a readability test. Zebra's Z-Ultimate® label was the only survivor."

Likewise, Celera needed top-of-the-line bar code printers that could handle the same unusual conditions in a lab while taking the abuse of novice users, since Celera's staff is primarily comprised of scientists, lab technicians, and software developers. Celera chose Zebra's *Xi* series printers.

"I have used Zebra printers in the past so I am very familiar with their rugged, 24-hour continuous duty cycles," says Amanatides. "I chose an all-metal Zebra printer because we need a reliable solution that is flexible for our various printing applications."

Using about 30 of Zebra's *Xi* series printers, Celera is able to print 300 dpi (dots per inch) labels containing bar codes and text. With the superior clarity of these labels, employees can print small labels for DNA samples or strand labeling without sacrificing readability or scanning quality.

"We have an unusual need to label very small items, and can't risk sacrificing print quality," Amanatides says. "With the *Xi* series printers, our labels come out sharp, remain clear through our processes, and scan accurately every time. In our business, that is the kind of reliability we depend upon."

At Celera, virtually everything is bar code-labeled, including machinery, employee badges, samples, plates, back-up tapes, and legal files.

"We developed the software in-house to monitor our entire system, basing it on the accuracy of bar code label scanning," says Amanatides. "From the first step to the final stored, sequenced code, bar code scanning drives the procedures."

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When Celera receives samples of DNA (deoxyribonucleic acid - the building blocks of genes) from vendors, an employee immediately prints a label and affixes it to the container. The label has both a bar code and human-readable text detailing the contents. Samples are moved to the storage labs until needed for DNA testing. When production requests a sample, a Celera technician scans the bar code label and updates the database to show that the sample has been moved from storage into production. Next, the sample is prepared for duplication. The technician places the DNA into a bio-acid dish, where it is inserted into bacteria and grown.

Once the lab has a sufficient amount of replicated DNA to begin testing, the technician puts the DNA samples onto plates similar to large petri dishes—each tagged with a bar code label. The bar code on the original sample container and the plate labels are scanned, automatically notifying the system of the sample transfer.

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The technician scans the plates one at a time into a Q-bot, a machine driven by a Celera-developed software program that strategically chooses the most viable and concentrated strands of DNA and places them into a Tomtech pipeting liquid instrument located within the Q-bot. The Tomtech instrument transfers the selected DNA onto a new plate, then the technician removes the original plate and scans the bar code on the new plate as the superior DNA is removed from the machine.

"With bar codes to track the DNA through technologically advanced machines such as the Q-bot, we have found that humans contain about 30,000 to 35,000 genes—only twice as many as a fruit fly," says Amanatides. "Humans are also 99.9 percent genetically identical, differing only by approximately 2.1 million genetic letters."

Once the technician removes the new plates from the Q-bot, he or she thoroughly cleans the DNA and removes all bacteria. The clean DNA is transferred to the plasma lab, again through bar code scanning, where a technician purifies it and transfers it to a new plate. The technician scans out the new plate and sends the DNA to the sequencing chemistry lab, where it is scanned in and the cycle sequencing reaction begins.

The DNA is sent through a formide lab for further cleaning, after which a technician scans it into the sequencing machines to complete the three-hour-long process of analyzing all of the strands and putting them in order. With a Celera-created software program driving the sequencing procedure, all the data is collected and sent to the data center for assembly and code sequencing.

"We currently run 300 automated sequencing machines non-stop, enabling us to sequence about two billion base pairs of DNA per month," says Amanatides. "In the past, it took scientists all over the world decades to manually uncover only a small portion of this data. With bar code technology to track the procedures and results, we were able to super-charge the process and quickly finish sequencing and assembling the human genome in only nine months."

After sequencing, the technician scans the plates out of the machines and sends them to the storage facility. Most sequenced samples are stored at -88° F (-67° C) for a minimal time period while the data is verified.

In the data center, Celera employees assemble the collected DNA codes from the sequencing machines and complete the final sequencing. The results containing the final data are saved on tapes that are bar code-labeled and scanned for backup storage.

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"Because of the efficiency of bar code labeling and scanning, Celera has successfully jump-started the gene sequencing process," said Amanatides. "With our winning combination of Zebra printers and supplies, we can accurately record, store, and recall all our data—a vital tool in our business as we race to uncode the human genome."

Celera's next project is working with the National Institutes of Health to map the laboratory rat genetically. With these results, Celera hopes to give scientists a clearer view of drug reactions, as rats are widely used in research on high blood pressure, cancer, and brain disease.

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