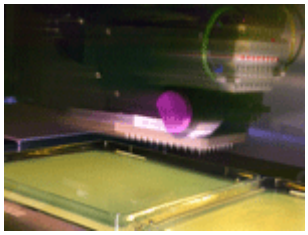
LLNL Newsline: Process Management: Sidebar

**Improving the Future**

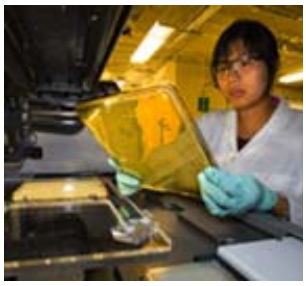
*In June, 2007, three LLNL employees, Cathy Aaron, Steven Grace, and Michael Mosby, were selected to participate in Bechtel Six Sigma Black Belt training. The training included five weeks of intensive classroom training and testing from June through October. In addition, the training requires participants to demonstrate practical application of the concepts and tools learned in the classroom by initiating and leading two process improvement projects. This article is the first in a series highlighting these projects and their results.*

**Joint Genome Institute Improving Colony Cloning Process**



The U. S. Department of Energy Joint Genome Institute (JGI) provides high-quality DNA sequencing to the greater scientific community in support of the DOE mission areas of clean energy generation, global carbon management, and environmental characterization and clean-up. The JGI Production Genomics Facility (PGF), located in Walnut Creek, California, offers integrated high-throughput sequencing and computational analysis that enable systems-based scientific approaches to these challenges.

To this end, researchers submit DNA to JGI from target organisms that they are studying for genome sequencing. The Sequencing Department clones the organism's DNA into a sequencing vector, transforms the cloned vector into *E. coli* bacteria, and then multiplies the bacterial clones via a "plating process". Consequently, the number of viable clones produced (also known as colonies) is a mission critical success factor. Given the opportunity to improve the effectiveness of the bacterial plating process that produces the colonies from which DNA sequencing data is generated, JGI Production Sequencing Manager, Susan Lucas, enthusiastically agreed to champion the project.



Production Sequencing's goal is to produce 1200 (+/- 100) colonies per bioassay plate that contain the target DNA and can then be further conveyed down the production pipeline. The bioassay plating process that produces the colonies currently operates at 9.8% efficiency. This means that only 9.8% of the bioassay plates on which colonies are grown, or "plated," yield a number of usable colonies that fall into the target range (1200 +/- 100.) Sub optimal colony count increases demand for additional transformation stock and increases the risk of failing to provide sequence data that collaborators require to conduct their research in a timely manner. Producing too many colonies is a symptom of waste in the process and is a variation that wreaks havoc for project planning.

To advance the "Increase Usable Colony Rate" Process Improvement Project (PIP), Susan Lucas worked with Steve Grace, LLNL Continuous Improvement and Six Sigma Black Belt candidate, to define the team's problem statement and specific objective: increase the current bioassay plating process success rate from 9.8% to 25%. It is estimated that achieving this objective will result in a $150,900 annual savings for the JGI.

To launch the effort, subject matter experts were interviewed to ensure the team had identified a real problem and to add their perspective. Additionally, some who are actively engaged with the current plating process were asked to participate as PIP Team members. After the team's initial meeting in August, 2007, members met regularly to identify the possible factors that affect the desired outcome of 1200 (+/- 100) usable colonies. These possible factors were ascertained through a combination of facilitation and tools specifically designed to move the effort forward and identify the possible causes. These possible factors were then analyzed to determine the amount

of impact they have on the usable colony count per bioassay plate. This analysis determined the factors that had the highest potential impact. To narrow the potential causes to the most significant factors, the rigor of statistical analysis was applied and four critical factors were determined. The four critical factors are: the amount of transformation stock used, whether or not the transformation stock was properly mixed, the amount of plating stock that was applied to the bioassay plate, and the number of glass beads used to inoculate the bioassay plate with plating stock.

To understand the impact of each of these factors upon the desired colony rate count, the team conducted a controlled "Design of Experiment." The results of this experiment showed the effect and interactions of these four factors upon the process output. Even more importantly, the results focused the team on specific areas to improve the process. With these results the team is equipped to identify how to implement improvements the design of experiment data indicated will have an impact on the number of usable colonies produced by the plating activity.

Efforts are underway to determine the various ways that specific improvements can be put into place. These improvements will be presented to the project champion in an "Improvement Plan" which will list all of the one time actions that are required to successfully change the process.

The team will complete its charter by creating a written "Control Plan" that will provide the champion and process owner with a written road map that includes specific activities and data control charts. The team is emphasizing the role of the "Process Owner," as it is this person who will be responsible to use process output data to monitor the process health and ensure this process activity continuously improves.

Once these actions are accomplished the team is confident that an even more consistent plating process will be in place, and the plating process will be capable of accomplishing the team's first objective of 25% of all bioassay plates yielding 1200 +/- 100 usable colonies. This increase in colony count yield reliability will not only improve overall production effeciencies and decrease costs, but will better serve internal and external customers while providing a successful model for future process improvement projects.