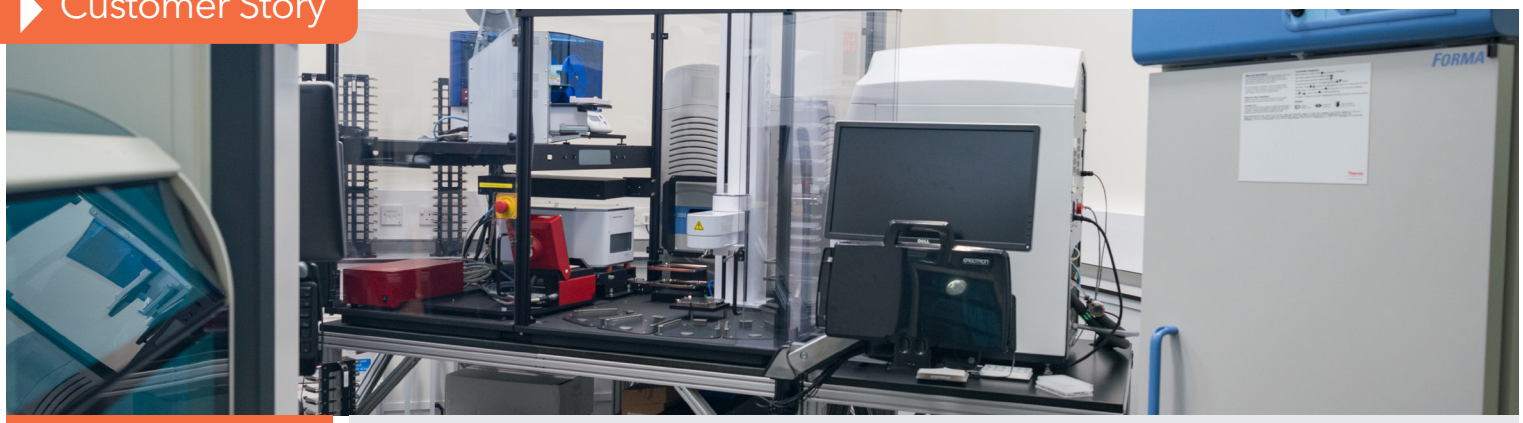
Customer Story



London DNA Foundry

Challenge

To deepen the statistical power of scientific research, replication is essential but time-consuming, particularly without a framework to guide the approach.

Robots speed innovation in engineering biology

The London DNA Foundry unlocks the power of automated experimentation with design of experiments in JMP®

Despite his prolific automation engineering and assay development expertise, Dr. David McClymont knows what it's like to juggle. As the head of automation at the London DNA Foundry, he runs multiple robotic systems in support of various synthetic biology projects, helping scientists prototype and commercialize innovative biological research. Specializing in the "design, assembly, verification and characterization of synthetic DNA," the Foundry gives scientists access to a suite of cutting-edge robotics, automated analytical equipment, mentorship and training – things that would otherwise be unavailable to them – with the aim of promoting the commercialization of synthetic biology research.

In his role as head of automation, McClymont acts as a consultant to the startup companies using the Foundry. "The goal of each startup is very different, but the standardized way of creating genes and genetic constructs are the same," he says. "So we built an essentially universal robotic platform for putting genes together that can be applied to almost any function. Using standardized DNA building techniques, we think design of experiments can fit almost any need for many different types of biotech applications."

Automation enables reproducibility

Reproducibility and statistical power in biology research is a pervasive issue, one that stems from the twin problems of: 1) The time it takes to conduct and reproduce experiments by hand and 2) Limited statistical training and support for biologists, leading to a minimal application of robust statistics to biological questions.

With increasingly stringent statistical requirements with the aim of increasing reproducibility, McClymont says, "a number of funders and journals are really starting to crack down. Particularly with in vivo animal studies, there is a push to carry out power analysis and ensure robust experimental design." Not only are journals pushing for deeper statistical analysis, researchers are realizing the need to design and reproduce experiments in such a way as to extract data more tailored to answer complex questions.

With the state-of-the-art resources available at the Foundry, scientists can overcome the first issue through the automated execution of big experiments, removing the need for large numbers of staff to carry out experiments by hand which introduces potential bias and inconsistency. "Automation essentially gives you extra replicates for free," McClymont explains. Furthermore, automation allows users to pass control of monotonous tasks to robots, freeing up time and giving scientists the opportunity to focus on big ideas.

McClymont and his team at the Foundry are addressing the second issue by integrating statistical techniques like DOE directly into the design of the robotics and the systems that support them, lowering the threshold of knowledge required to use these analyses and helping scientists learn statistics while they conduct their research.

Building a powerful framework for statistical integration

Using DOE, a statistical method to establish cause-and-effect relationships in multifactor opportunity spaces, researchers can evaluate multiple parameters in the same experiment, speeding the research process and generating consistent, high-quality data; this is particularly important for the entrepreneurial goals of the Foundry. "The data that [entrepreneurial biologists] generate must convince investors to invest in their company. There can't be any doubts about [the science]," stresses SynbiCITE CEO Dr. Stephen Chambers.

jmp® Statistical Discovery.™ From SAS.

> We have an interface that … enables a high level of experimental design and statistical analysis in JMP. The system makes it easier to across the board increase standards, reproducibility and data interpretation for genetic engineering applications.
>
> David McClymont, Head of Automation

Instead of a scattershot approach, wherein researchers simply do as many experiments as possible, DOE adds a robust framework that guides study design and execution, allowing them to harness the power that end-to-end automation offers. As McClymont describes, "It's not just doing more replicates, but doing smarter replicates and building models which have much more value."

So how is DOE integrated into robotics systems? "We had to build a layer of software that can essentially take the description of the experiment, produced by JMP Custom Design, and convert that into something that could be run in the robot," McClymont explains. "JMP allows you to describe what the experiment is [to the robot]. It's a case of translating the language that JMP uses into the language the robot uses, and building the software to do just that."

Combining DOE with robotics is exceptionally powerful because it releases researchers from the burden of managing the mundane, tedious tasks of repetitive wet lab experimentation, letting them spend their energies elsewhere. "When you can take a process that may take weeks – [not to mention] all the thinking and focus that it requires – and you turn that into a 'click and go' operation, it's such a liberating thing for us as scientists. You can focus your mind on more important things like interpretation, modeling, thinking of your next experiment. And you can essentially let the software and the robots do all that for you." This "click-and-go" aspect of automated DOE also allows scientists lacking sophisticated statistical expertise to continue their research while their statistics knowledge catches up.

Intuitive software for statistics-naive scientists

Initially, the decision to use JMP for DOE at the Foundry lay firmly with Chambers. However, McClymont had for some time been interested in learning about this approach and was enthusiastic about applying statistical modeling to robotics. "Working on re-engineering microbes, I felt that just screening wasn't really going to be enough, that the DOE approach from the genetic level was absolutely the right way to go," he says.

Having used many statistical packages in the past, McClymont found the JMP interface uniquely suited to his needs. "[JMP] is based on how scientists or biologists would interact with it. I really liked the way it seemed to be aimed at getting things done rather than spending all your time trying to figure out what the software is trying to do. [JMP] did what I wanted it to do and we just jumped straight in."

By letting users look at the experimental space as a whole, JMP lets them envision new ways to approach their research while supported by a sturdy, yet simple, statistical foundation. "I've not seen something that is as simple to use as JMP. The DOE [applications] and the Custom Design are really intuitive, and the fit model platform as well. I haven't seen anything as intuitive and powerful as JMP in any other software that I've used previously." And particularly useful for researchers at the Foundry, JMP provides a comprehensive statistical suite that supports the full life cycle of their projects. "We can do the DOE and modeling within one piece of software, which I think is a real strength for encouraging people to use it."

McClymont is so convinced of the importance of DOE and utility of JMP that he strongly encourages all Foundry startups to follow his lead. By building JMP software into the lab's robotics systems to facilitate the implementation of DOE in automated experiments, it's harder for researchers at the Foundry to not use JMP – which is kind of the point.

"We have an interface that works within many different ways biologists will want to interact with a robotic system and it does that well, which in turn enables a high level of experimental design and statistical analysis in JMP," says McClymont. "The automated system makes it easier to across the board increase standards, reproducibility and data interpretation for genetic engineering applications."

Solution

The design of experiments (DOE) method provides a statistical structure to ensure efficiency and focus in the design and execution of automated study replication.

Results

Automation releases researchers from monotonous tasks, enabling greater reproducibility and freeing more time to focus on high-level ideas and challenges.

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