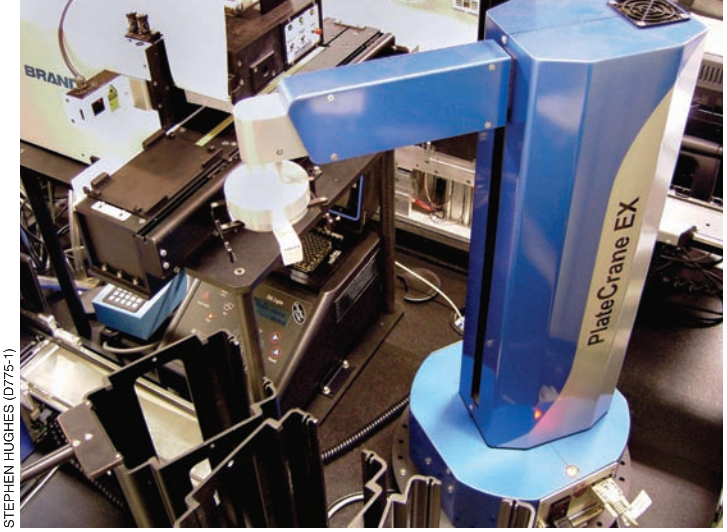
Robot-Controlled System Speeds "Designer" Yeasts for Making Ethanol



STEPHEN HUGHES (D775-1)

The blue robotic arm shown here moves plates of samples during automated tests.

A robot recently reported to work at ARS's National Center for Agricultural Utilization Research (NCAUR) in Peoria, Illinois, and its arrival was met with enthusiasm by many scientists there.

The robot in question doesn't walk or talk, however. Rather, it's the centerpiece of an automated system called the "plasmid-based functional proteomics work cell." The system's inventors expect it will greatly streamline studies aimed at harnessing the power of proteins for industrial applications, like making fuel ethanol from sugars in corn fiber.

ARS molecular biologist Stephen R. Hughes and Peoria colleagues developed the system, starting in 2004, with an engineering team at Hudson Control Group, Inc., of Springfield, New Jersey. Hudson president Philip J. Farrelly led the team.

Ask Hughes about their patent-pending system, which was published in the May 2006 issue of *Proteome Science,* and you'll likely get a rapid-fire narration of its history and capabilities.

One thing is clear, though: It's the first system of its kind to fully automate several laboratory procedures that have traditionally been done one step at a time, by hand.

A short list of them includes: extracting genetic material from the cells of animals, plants, fungi, and bacteria; making DNA copies of these genes; inserting the copies into plasmids of *Escherichia coli;* culturing the bacteria so they'll multiply and can be stored; making "cDNA libraries" from these plasmids; plucking *E. coli* libraries of interest from plates on which they're grown; sequencing the nucleotide bases comprising the plasmid-bound cDNA copies; identifying these genes as well as the proteins they code for; and inserting desirable genes into *Saccharomyces* and other yeasts for improved fuel ethanol production.

Yes, the ARS center's robot does all that. Thanks to the fast, precise movements of its mechanized arm and computerized plate tracks, the robot will carry out these tasks hundreds or thousands of times faster than a human. That will prove critical in searching for genes to lift the yeasts over a major hurdle that's kept them from reaching peak performance as ethanol producers: their inability to metabolize sugars locked up in corn fiber.

Hughes, who's in NCAUR's Bioproducts and Biocatalysis Research Unit, says the system will also "allow us to build genes from scratch and mutate them—for example, to obtain enzymes with higher temperature stability."

Of particular interest is developing genetically engineered yeasts that can survive conditions inside the large industrial vats where corn-fiber sugars like xylose are fermented into ethanol. At the same time the yeast is fermenting the sugars, it could also be making other valuable products, such as pesticides, building blocks for biodegradable plastics, and anticancer compounds.

"What makes this effort unique in the ethanol-for-fuel research field is that we're using genetics to make a new organism that fits into existing processing plants, rather than developing a whole new process built around the organism, as everyone else is doing," comments Farrelly. "In other words, we're making a 'bug' to fit the process, rather than making a process to fit the bug."

Currently, only corn's starch component is converted. With the *Saccharomyces* yeasts now used, this equates to 2.8 gallons of ethanol from a bushel of corn. Developing the fiber-hydrolyzing strains, however, could realistically help squeeze 10 percent more ethanol from the grain crop by 2013, the researchers say.

Besides engineering the yeasts to do such work at high temperatures, the researchers are also looking to develop strains that tolerate lower pH levels or other ethanol-plant conditions.

"Using the robot to isolate improved yeast strains will benefit not only commercial ethanol partners," says Hughes, "but also farmers, by increasing the markets for agricultural commodities."—By **Jan Suszkiw,** ARS.

This research is part of Bioenergy and Energy Alternatives (#307) and Quality and Utilization of Agricultural Products (#306), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

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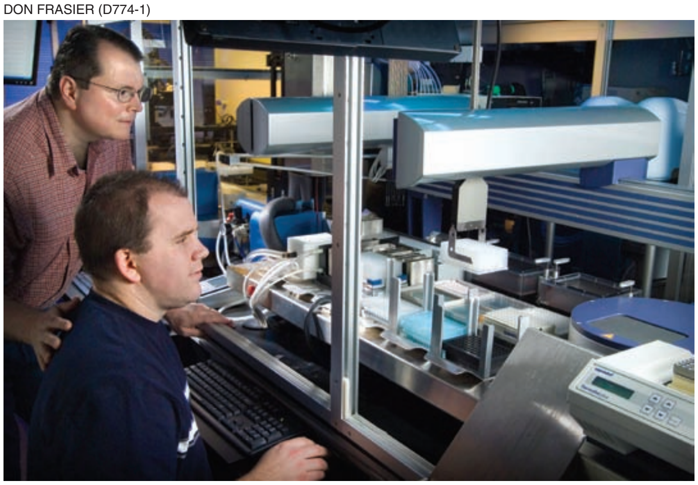

Molecular biologist Stephen Hughes (left) and technician John Jackson use the automated "plasmid-based functional proteomic work cell" that may help them develop yeast strains to improve ethanol production.