

ARJUN GOPALRATNAM
SOCIETY FOR BIOLOGICAL ENGINEERING



A Long-Distance Lab Affair

The third-year students file into their 9 a.m. lab, notebooks and pens in hand. They gather in small groups around their lab benches and begin to review the pre-lab activities. In class, they learned that cell growth can be affected by controlling temperature, pH, and dissolved-oxygen levels, and they are excited to apply these principles to a real cell culture.

This will be the first time they have been entrusted with expensive, professional lab equipment, and they are ready to take advantage of the opportunity. The instructor arrives and reviews the general plan: “Take your time to play around and get comfortable with the equipment. Then, measure the effect of your assigned control variable and report back with your results. We’ll combine results, and you can then evaluate the rates of reaction as a part of your lab reports.”

Although this may sound similar to the lab classes you and your colleagues have taken while you were undergraduates, it is very different in one way. The lab equipment these students are working with is located thousands of miles away, and every bit of control they have over the reactor involves a computer interface. This is the dream of the Society for Biological Engineering’s (SBE’s) Web-Lab Initiative.

A few years ago, SBE’s Managing Board envisioned a remote bioengineering lab — students would use lab equipment to learn by experimentation just as they do now, but the equipment would be located in a different facility owned by a university in a different city, state, or country. The lab activities would complement teachings on the same topics as current labs: separations, mass transfer, and heat transfer. But the remote technique for accessing labs would drastically reduce the cost of educating a student, while improving the availability of equipment and the ability for students to practice or review material on actual reactors.

For this to succeed, students need a constant, high-quality video feed of the actual reactor at its remote location as well as complete control over as many aspects of the reactor as they would have if they were actually in the same room as the equipment. In 2010, SBE received a grant from the United Engineering Foundation and has worked with the Golden LEAF Biomanufacturing Training and Education Center (BTEC) at North Carolina State Univ. and



▲ SBE’s Web-Lab Initiative aims to enable students anywhere to be able to access this reactor setup at North Carolina State Univ. Photo courtesy of BTEC. Copyright 2010 NCSU.

several other engineering societies (IEEE’s Engineering in Medicine and Biology Society; American Society of Mechanical Engineers; Minerals, Metals, and Materials Society) to make this dream a reality.

Last fall, chemical engineering undergraduates at the Univ. of Arizona, Massachusetts Institute of Technology, and Rensselaer Polytechnic Institute demoed the first of many Web-Labs. In this experiment, the students operate a bioreactor that alters the growth rate of *E. coli* cells genetically modified to produce green fluorescent protein. They see a schematic of the reactor with displays for every thermocouple and flowmeter, as well as a live video feed of the reactor itself. They can then measure the

optical density of their culture to estimate the concentration of cells within.

Lab instructors can design experiments to take advantage of the equipment’s capabilities and use the Web-Lab to help students learn. As additional experimental modules are built, instructors can include Web-Lab in a variety of classes from the newest theories in biotechnology to traditional unit operations.

The eventual goal is for Web-Lab to democratize learning by providing students from Alaska to Zimbabwe the opportunity to work in a laboratory setting. Imagine a catalog of potential experiments with instructions, pre-labs, post-labs, and more, available to every student. A class can choose a time that fits its preferences (and time zone), and SBE’s partners at BTEC will set up the experiment with the necessary reagents. After signing in at their appointed time, the students will have full control over the equipment. When they are finished, the students and instructors will receive every piece of data recorded, and the students can complete their lab reports.

Although Web-Lab has made enormous strides since it was first conceived, much work remains to be done. If you think that Web-Lab would be useful for your classroom, company, or lab, we want to hear from you and perhaps include you in this spring’s project.

For more information on this and other SBE Foundation projects, visit <http://www.aiche.org/SBE/Education/Web-Lab.aspx>.

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