

NI LabVIEW and NI ELVIS Help Support MIT's iLabs Architecture to Remotely Connect Future Engineers

Researchers at Massachusetts Institute of Technology (MIT) recently developed iLabs, a set of standardized software tools and services used to deliver physical labs via the Internet, to help augment engineering curricula at schools around the world, from Africa to Australia. Each of the institutions using iLabs, including MIT, found that providing educationally appropriate labs that explore real-world phenomena has become more difficult for reasons ranging from equipment costs to constraints on laboratory space to reduced course time available for meeting graduation requirements within a complete, accredited curriculum.

Using LabVIEW graphical programming software and the National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS), diverse teams from multiple continents have shortened the development time of engaging, software-controlled physical labs that can be plugged into the iLabs framework and delivered to students worldwide.

The Evolution of iLabs

More than a decade ago, Jesus del Alamo, Donner Professor and MacVicar Faculty Fellow in the department of Electrical Engineering and Computer Science (EECS) at MIT, was frustrated that MIT's courses on semiconductor devices did not contain a laboratory component. Traditionally, students in these courses were exposed only to theoretical device models presented in lectures and course textbooks, but del Alamo wanted to provide the regular laboratory access that students need to better understand difficult engineering concepts. In an attempt to form the basis of a valuable student lab, del Alamo had the opportunity to implement an expensive but underused piece of research lab equipment; however, there was no available space to accommodate a large undergraduate class. He attempted to alleviate this situation by developing an Internet-based set of labs that enabled students to remotely perform measurements on real transistors set up for one of his courses.

The lab was used successfully and spawned a cross-departmental effort within MIT to put other lab experiences online for MIT students. These Internet labs were deployed in MIT classes and proved to be very effective for the students by providing 24/7 access to the labs. Next, the team decided to share existing labs with other engineering schools that were also interested in using remote, real-world laboratories to enhance their curricula.

With multiple development teams creating Internet-ready labs using different development tools, scheduling schemes, and security features, del Alamo needed to develop a scalable platform that supported these

experiments. With the assistance of several other professors and researchers at MIT, he started to develop the iLabs Shared Architecture – a framework of standardized tools and services for delivering physical labs that have been made Web-accessible using computer-based technology.

The iLabs Architecture

MIT developed the open source iLabs environment to provide a standardized gateway for the exchange of computer-controlled physical experiments between schools around the world. Within the iLabs framework, multiple universities with diverse network infrastructures can use a common set of services and development tools to further train future engineers and scientists.

To participate in iLabs, lab coordinators need to design a computer-controlled experiment with a user interface that allows a student to configure and run or interact with the experimental setup. This experiment is then “plugged into” the iLabs framework so that it can be made accessible to students throughout the university or around the world. In addition, the iLabs framework takes care of other workaday aspects of the lab experience such as managing user accounts, scheduling lab times, and storing data.

Expediting the Development of iLabs Using LabVIEW

Over the course of the project, MIT researchers noticed that developing the software connection to the user interface for the physical experiment consumes the majority of the effort expended to bring a lab online. They realized that having to learn and program these items with traditional tools was discouraging increased participation from partner institutions. Because faculty and researchers are generally familiar with the [LabVIEW graphical programming environment](#) and find it easy to use, LabVIEW has become a popular technology for shortening the development time of iLabs experiments.

As with any emerging technology, the more users and developers that employ the technology, the greater the impact it has. LabVIEW has played a significant role in helping developers bring labs online more quickly, thereby increasing the impact of iLabs on engineering education.

Increased Collaboration with iLabs and the NI ELVIS Platform

Developer collaboration is an important aspect of maximizing the impact of iLabs. Del Alamo’s team originally envisioned sharing experiments focused on electrical engineering through the iLabs framework as a way of providing access to MIT’s expensive research equipment, which was rarely available at partner institutions. However, the researchers found that because the partner universities – which include those in Africa such as the Obafemi Awolowo University in Nigeria, the Makerere University in Uganda, and the University of Dar Es Salaam in Tanzania – did not have access to similar equipment, the development teams could not fully collaborate due to a mismatch of resources.

In the past two years, the low cost and broad functionality of the [NI ELVIS platform](#) helped these universities create experiments that use identical systems. iLabs developers found that NI ELVIS is an excellent collaborative platform that all of the participants in iLabs can understand and afford to use on their own campuses. The general agreement among the developers is that NI ELVIS has helped foster an environment where ideas can pass freely between development teams.



Engineering students at Obafemi Awolowo University in Nigeria perform experiments using NI ELVIS and LabVIEW.

By creating labs using NI ELVIS, it has become easier for participants to share labs with each other and develop new labs based on this common design and prototyping platform. This increased collaborative flexibility has benefited all iLabs users including MIT as partner-developed labs based on NI ELVIS have become an increasingly valuable part of each university's electrical engineering curriculum.

The Value of iLabs

With iLabs, students can remotely conduct experiments and control instruments at flexible times and from remote locations. These experiments can be in a lab across campus at their university, or in a lab that is

thousands of miles away. This is critical because it helps time-constrained, space-limited, or under-resourced universities significantly increase the number of hands-on learning experiences and research tools available to students. Additionally, because students can access the labs at their convenience and are not constrained by the hours of operation associated with a traditional lab, they can spend more time working with a particular experiment and have the opportunity to explore beyond the bounds of the set lab exercise.



Mr. Olusoji O. Ilori, Instructor at OAU is developing a course using LabVIEW and NI ELVIS.

Another unexpected benefit to MIT of creating the iLabs framework has been the parallel creation of a growing community that shares teaching approaches and lab designs. As universities around the world use the framework to create their own labs, they have generated ideas that have come back to enhance the MIT curriculum as well as the curricula at all participating institutions.

The long-term vision for iLabs at MIT is to continue to provide a standardized framework for experiment sharing and open access to lab equipment and educational materials around the world within higher education and beyond. To help achieve this goal, researchers and developers use LabVIEW software as an enabling technology for improved lab development, as well as NI ELVIS as a collaborative platform for

implementing experiments at universities worldwide.

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