iLabs
and Curriculum Enhancement
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Experimentation Support

Experimentation support in curriculum review vital

For:

a. Illustrating experimental methods.
b. Supplementing theory.
c. Stimulation of independent thinking.
Deficiencies in experimentation

Possible causes:

- Bad course design.
- Experiments that do not address real life problems.
- Inability to purchase expensive equipment.
- Inadequacy of qualified staff to use equipment.
- Inadequate semester weeks.
Disadvantages of traditional labs

Problems with;

• Scheduling
• Cost
• Laboratory space
• Staffing
• Training
• Safety concerns
One Possible Solution

- **iLabs**
  - a new concept in: virtual laboratories

which is a set-up in which a student carries out laboratory experiments by manipulating hardware or software that is located in a physically or temporally different zone.
What is ilab?

• **A new platform** in the emerging field of Virtual Laboratories.

• **An online laboratory** that can deliver many of the educational benefits of hands-on experimentation (Del Alamo, 2005)

• **An architecture first developed at MIT** and being shared with collaborators all over the world.
What is iLab? (cont’d)

The Topology of the MIT iLab Batched Experiment Architecture.
MAIN COMPONENTS

• **A. Client Machine**
  – This is the user’s machine. -Needs a browser.
  – Experimenter opens an appropriate website and using his Java applet interface clicks on an experiment of choice.
  User does not interacts with the hardware directly; only through a machine called the SERVICE BROKER which is a kind of Proxy Server.

• **B. Lab Server**
  - Machine that actually communicates with the experiment hardware.
  - Operates by constant connecting and reconnecting of a finite set of switches that alter circuit configurations.

**C. The Service Broker (SB)**
  - The go-between from Client machine to the Lab Server which talks to the experimental set-up.
  All user accounts created by an administrator reside on the SB.
Basic iLab Services

- User authentication (and registration)
- User authorization and credential (group) management
- Experiment specification and result storage
- Lab access scheduling.
Benefits of iLabs

- Ability to perform experiments on equipment one may not have the resources to possess.
- More students can perform more experiments.
- Experiments can be performed at any time of the day.
- Possible collaboration between universities and on-line sharing of expensive experiments.
- Creates a need for regular curriculum review.
- Minimum staffing requirements.
- Little user safety concerns.
- Engenders staff development in hardware and software.
Curriculum development

- Essential for global academic and industrial relevance.
- Cannot be done in isolation in a global world.
- Industry, academia must collaborate.
- Must consider immediate post graduation relevance to economy.
- Engenders challenge to slower-moving institutions.
- Collaboration through ilabs jumpstarts curriculum review.
Problem areas and cautions

• Industry and post-graduation needs may differ from country to country.
• Curriculum sequence spread and teaching approach may differ from one institution to another. MIT-OAU Example in “digital-analogue conflict”.
• Sometimes, great inertia to changes.
• Required changes not matched by staff development!!
OAU’s Initial iLab Objectives

- Contribute to iLab development

- Fruitful collaboration between staff and students in Nigerian and African Universities on one hand and MIT on the other

- Get more students perform more experiment.

- Enhancement of Curriculum development in OAU

- Manpower development
The OAU approach to Ilab

Our ilab program has the following prongs:

- **Utilization for curriculum development**: Get alumni in academia and industry involved. 
  OAU-MIT-EEE experience (Prof Akinwande and others).

- **Agree on curriculum review that will result in common experiments**. 
  (Use of the MIT OCW)

- **Contribution to iLab architecture development**

- **Popularization of the platform**

- **Get more universities interested.**

- **Get industry interested**
History of iLab Shared Architecture

- **9/02** iLab design begins
- **7/03** 1st batched experiment prototype (Microelectronics WebLab)
- **11/03** 1st batched experiment implementation with administrative functionality
- **2/04** 1st iLab use in a large MIT (100 student) class (iLab 3.0)
- **8/04** 1st non-MIT involvement, Albert Lumu, and MIT Service Broker at Makerere Univ.
- **9/04** “for comment” release of batched architecture (4.0); 2nd MIT iLab, the Dynamic Signal Analyzer used in MIT course
- **1/05** 1st iLab training course and 2nd non-MIT developer, Philip Jonah from OAU
- **10/05** 1st test of iLab interactive architecture in an MIT course
Other Experiments

- **Shaketable experiments** for the study of quakes.
- **Recrystallization** of polymers.
- **Heat Exchanger**.
- Op Amp experiments.
- Logic gates experiments.
- Etc.
Implementation Details: OAU Team

- **The Experimentation Subgroup (E-group)**
  - utilize the existing MIT WebLab experiments and OAU version for training students. Other experiments are being developed.

- **Architecture Subgroup (A-group)**
  - implement the hardware/software needed to duplicate and adapt the MIT experimental setup and design new experiments, and eventually work together with others to develop an alternate/hybrid architecture.

![Diagram showing the relationship between E-GROUP and A-GROUP with stages of duplication, adaptation, and feedback.]
Separated into unit depending on applications

- Physics
- Electronics
- Hardware and Software Design group
- Chemical Engineering
- Mechanical and Civil Engineering

**PRINCIPAL INVESTIGATOR**  
- Engr. Professor. L. O. Kehinde

**For better coordination,**
Physics and Electronics are chosen as focus of Phase 1 (2005-2007)  
Chemical, Mechanical and Civil Engineering are in phase 2 (2007-2009)
Other fields will be added in the future as the needs arise.

- Support from an MIT–Carnegie Corporation subaward.
Implementation details: OAU’s Experiments

- **Operational Amplifier**
  
  We recently completed the first phase of our Operational Amplifier experiment, which allows students to set up six Op-Amp circuits and interact with them.

- **Logic Gates**
  
  Also being developed simultaneously with the Op-Amp.
Op-amp experiment

The Dozen Experiment circuit
(L.O.Kehinde, IJEEE Vol. 26, No.3, 1992)
Other experiments

- The dozen Op Amp circuit encapsulates most Op-Amp circuits of interest to the experimenter, including integrators and differentiators. Etc.

- Other future options are Instrument amplifier etc.
Op Lab User interface

- allows students to wire and test Opamp circuits using the interface below:
Remarks

- **Possible interface Connectivity:**
  - USB
  - Ethernet
  - Firewire
  - GPIB
  - RS 232
  - PCI
  - And a mix of any of the above interfaces

- Although most iLabs use GPIB, the OAU OpAmp lab used USB as the interconnectivity standard

- Commands to control devices sent by low-level C# or C++ command from an API set provided by device manufacturers (in this case, National Instruments)
**Our Observations So Far:**

**cost**

- some of the devices and software needed are expensive.
- ELVIS from N.I and donated to OAU by MIT presents a cheap solution.

**The possibility of developing devices in-house**

- There is good possibility that some parts can be developed in-house.
- Of course we have to look critically at accuracy concerns (instrumentation grade items...)}
Future Thrusts:

some future work should be kept in focus:

- **GUI improvement**
- **Development of cheaper items by ourselves (MINIS)**. Less hardware and more software.
- **Full cross-platform/platform-independent system** (both server, broker and client).
- **Web cam visualization of remote experiment**
- **Any future thrusts will fully cooperate with MIT for properly coordinated development.**
Need For More Inter-University Collaboration

- Virtual labs hold great promise for third world nations.

- The Nigerian and African partners need to forge a common front to investigate how this platform can be used to correct some deficiencies plaguing the academic system.

- Need to work together to best complement MIT’s efforts under an ilab Africa Forum.

- Need for regular workshops among academia and with industry.

- Need for inter-University students’ workgroups and interactions.
Concluding remarks...

- More Nigerian Universities should come on board.
- Industry should get interested.
- More software and...
THANK YOU

Prof. L. O. Kehinde