



iLabs and Curriculum Enhancement “Engineering Africa” 4th-6th March, 2007

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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

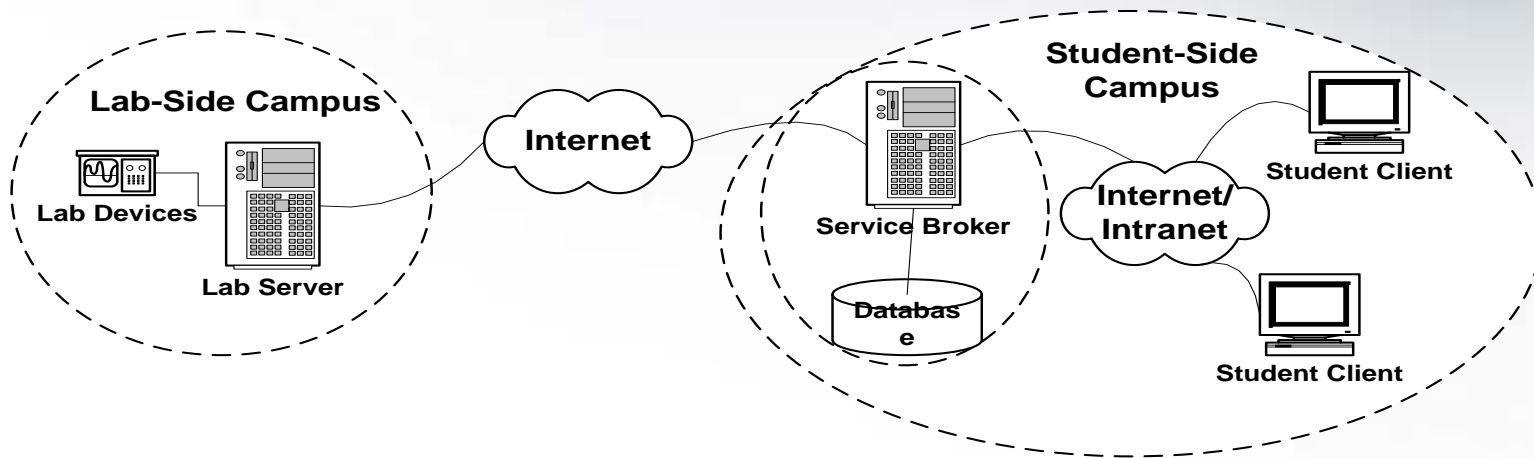
which is a set-up in which a student carries out laboratory experiments by manipulating hardware or software that is located in a physically or temporally different zone.

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 interact 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

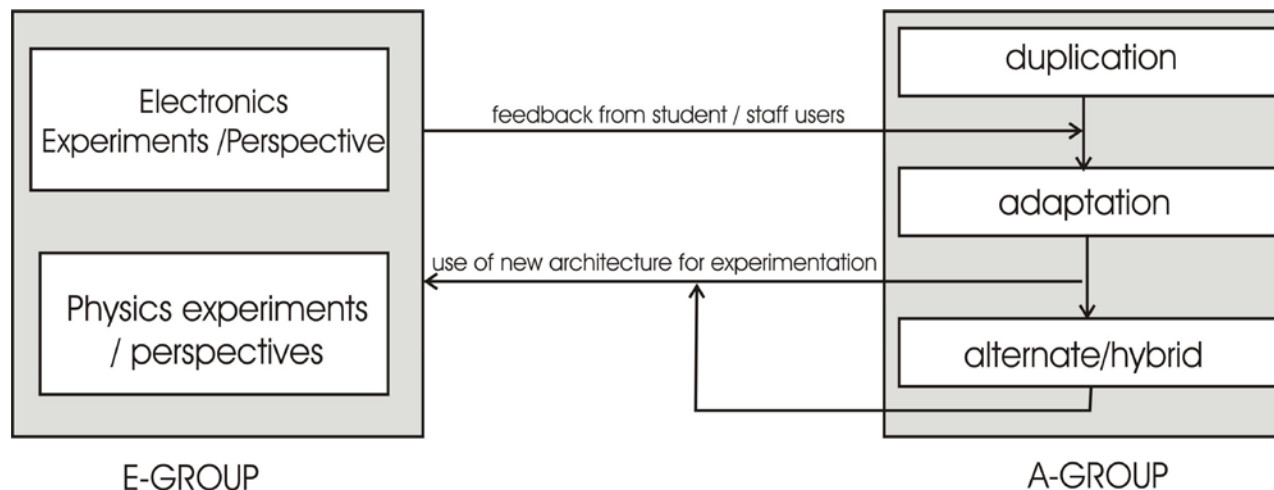


- Shaketable experiments for the study of quakes.
- Recrystallization of polymers.
- Heat Exchanger.
- Op Amp experiments .
- Logic gates experiments .
- Etc.

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.



OUR TEAM contd.



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



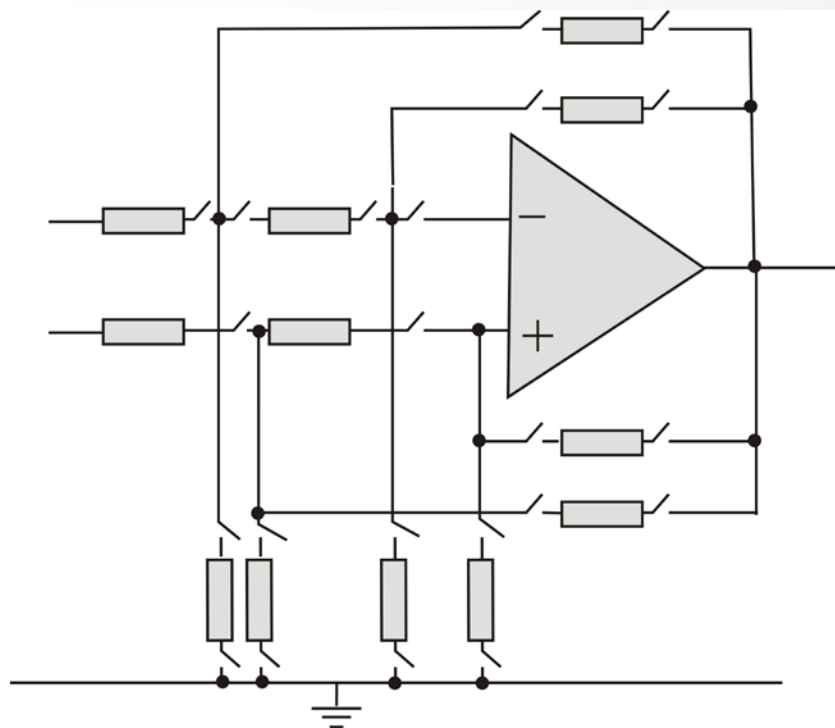
- Operational Amplifier

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.

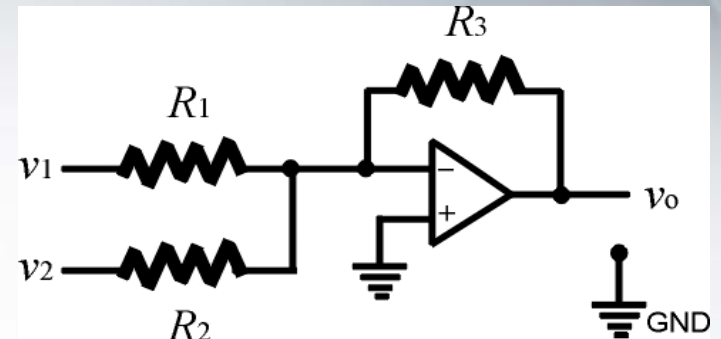
- Logic Gates

Also being developed simultaneously with the Op-Amp.

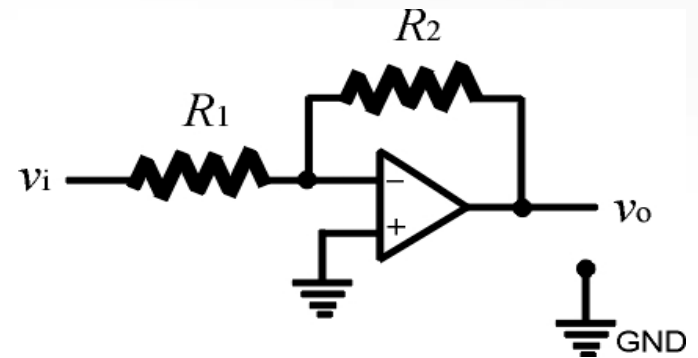
Op-amp experiment



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



Summing Amplifier



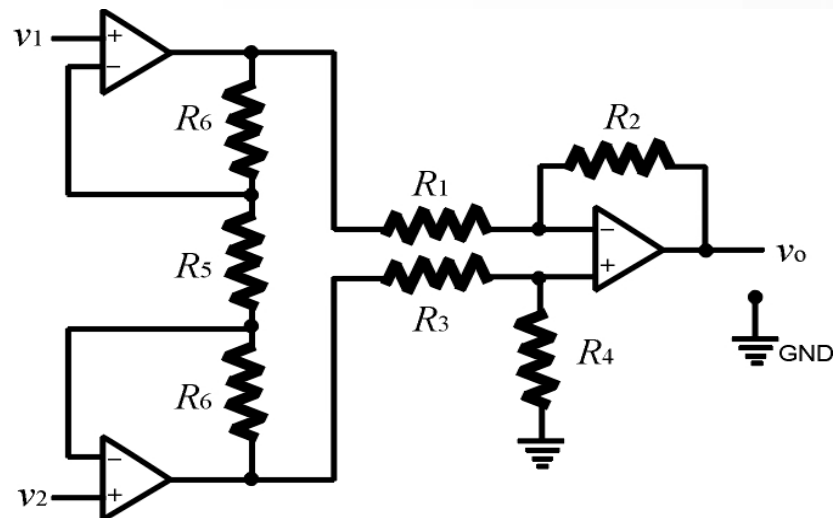
non-inverting Amplifier

Our Experiments (cont'd)



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.



Instrumentation Amplifier

Op Lab User interface



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

The screenshot displays the 'Operational Amplifier Weblab' interface. At the top, a teal header contains the title. Below it, a dropdown menu labeled 'Please select new Lab configuration here' is set to 'Inverting Amplifier'. The central workspace shows a circuit diagram: a 'Signal Source' is connected to a 39k resistor, which is in turn connected to the inverting input (-) of an operational amplifier. The non-inverting input (+) is connected to ground. The output of the op-amp is connected to an 'Oscilloscope'. At the bottom, there are three buttons: 'show display', 'download data', and a prominent 'run' button. On the right side, a 'Quick Hints' section provides four numbered instructions for using the interface.

Operational Amplifier Weblab

Please select new Lab configuration here
Inverting Amplifier

Signal Source

39k

Oscilloscope

show display download data run

Quick Hints

1. If the experiment area on the left is empty, you probably do not have the Microsoft .Net Framework installed. Please download it [HERE](#) and install it.
2. Ensure that you read the introductory document here before carrying out this experiment
3. To make a connection from a node, click on it and select "connect to". Then, click the node you want to connect to
4. To disconnect a connection between two nodes, click on either of them and select "disconnect from". Then click on the other node.

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.

CONCLUSION



Concluding remarks...

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



THANK YOU

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