Evolving a Laboratory from hands-on, to virtual to remote. A Remote Photovoltaics Laboratory

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“We fired all the troublemakers six months ago... around the time this company generated its last original idea.”

Are you a troublemaker?
Outline

• Background laboratory pedagogy
• Existing physical laboratory
• Virtual laboratory
• Remote laboratory
• Student Journey
• Lessons Learnt
• Student experience study
• Demonstration......
The programme

- MSc in Renewable Energy Systems Technology
- Mode of delivery
  - Full-time on campus – 20 years
  - Part-time distance learning - 10 years
- 600+ students from over 30 countries
- Student type: primarily full-time professionals and/or planning career change
Background laboratory pedagogy

- **Labs central to science and engineering programs**
  - ✔ Physical labs provide real hands-on experience
  - ✗ Limited by time-tables, cost and technician

- **Virtual labs provide simulations**
  - ✔ Cheaper, can be repeated, good for distance learning, not limited by time-table
  - ✗ Simulations, not real, may lack the unexpected

- **Remote labs access real experiments**
  - ✔ Access kit at distance, sharing of resources, not limited by time-table
  - ✗ Extra cost, must be well designed, may need technician

***Extensive literature and practice can be found in M. Abdulwahed. Towards Enhancing Laboratory Education. PhD Thesis. Loughborough University***
Existing physical laboratory

- Coursework assessment in REST MSc since 1993.
- Teaches students about the operational performance of PV cells under different environmental conditions:
  - Temperature
  - Irradiance
Existing physical laboratory

On-Campus Setup
Virtual laboratory

- An experimental simulation
- Same learning objectives
- Provides different experience

Distance learning programme
Developing the Remote Laboratory

**Objective:** Develop a remote laboratory for full-time undergraduates and part-time distance learning postgraduates.

**Task:** replicate the physical apparatus:

- Hardware
- Software
- Login and booking system
The Rig

Turntable – PV selector

LED Light System

Webcam-Student view

Hardware

Front panel-student interface
This is the booking system for the Photovoltaic Remote Laboratory Experiment. You need to reserve a time slot in order to carry out the experiment. Each time slot is 2 hours and we estimate this is sufficient time to complete the experiment.

First time users need to register before booking a slot. Any username or password can be used.

If you forget your username or password, please email to s.r.williams@lboro.ac.uk

If you want to repeat the experiment you are allowed to book another session. You will only be able to access the laboratory during the period you have booked.

N.B. You need to have read the remote laboratory instruction script, the photovoltaic lecture material, slides and watched the lecture videos prior to starting the experiment in order to get the most out of the experience.

We also recommend you complete the PV lab simulation.
STEP 2

Login to Lab

Welcome to the Photovoltaic Remote Laboratory Experiment.

This laboratory has been developed by CREST and the School for Electronic, Electrical and Systems Engineering at Loughborough University, with the support of an award from a university Distance Learning Enhancement Fund.

Publications about this innovative development can be found here: http://www.lboro.ac.uk/departments/eeose/research/energy/crest/rpl

Log in using user and password selected at booking page. If current time contain your timeslot you will be connected to Remote Solar Laboratory.
STEP 3
Conduct Expt.
Lessons Learnt

The Pain!
- Dedicated team
- Resources (money, time, people)
- Skills required
  - mechanical, technical, hardware and software design, management
- IT challenges
- Lead time/learning curve

The Excitement!!
- Pushing the boundaries
- Exciting experience
- Creating a real experience for students
- Good resource for school
- Potential to be used by other institutes
What now?

- S-Lab 2014 awards – shortlisted
- National Instrument – Case study
- Loughborough Teaching Innovation Award
  - Effectiveness of remote lab compared to hands-on or simulation labs to student learning.
The Team

**Project Managers:**
Dr Sheryl Williams and Dr Richard Blanchard

**Hardware & Software Designer and Consultant:**
Dr Martin Bliss

**Mechanical Workshop**
Mick Clowes and Mark Whale

**Electronic Workshop:**
Ramesh Pancholi

**W2.04 (Technical Support):**
Mark Snape.

**Current Student:**
Asif Mohammed

**Former Students:**
Adam Lee, Srikanth Eluri, Tim Seabrook, Jerome Corroller

**Special thanks:** DL Development fund, MEGS, IT Services and SCITEK.
Demonstration

- Here it all goes horribly wrong.....
- Never work with children, animals or computers...
- Remote Lab Video
So come and join us troublemakers!!!