LOW COST PHYSICS: « USING CREATIVITY FOR DEVELOPMENT »

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LINKING PHYSICS AND DEVELOPMENT

- ✓ How to make physics a tool for development?
- ✓ Which physics?
- ✓ Which development?

OUTLINE

- Science strategy in developing countries
- Experimental Physics needs Instruments for experiments or measurements
- What to do then :
- Slow technology » initiative : a reverse approach from that of "modern" physics
- Taking advantage of new low cost components : ex LED's as light source
- Networking (increasing critical mass of people and ideas)
- Education (also needs instruments)
- South South cooperation (cooperation between developing countries)

Strategy for science in developing countries

- Besides education science should "also" tackle issues of interest for the country (societal challenges):
- Environmental issues :
- Water purification, control of pollution, Safe Recycling, etc..
 - Filter for drinking water (prof.F. Togue Kamga Cameroon)
- Monitoring vegetation stress (fluorescence measurements in the field + satellite images)
- > Energy :
- Generating energy through sun and biomass, enabling use of energy in the field
 - Photovoltaic water pump (Prof. M. Kamta Cameroon)
 - Controlled Solar drier (Prof. G. Tchaya Cameroon)
- > Health :
- Counterfeit medicines: detectors of specific substances
- Critical lack of doctors -> create automats (hard + soft) for "analysing" X-rays, microscope slides, etc..
 - Automatisation for mamograms interpretation (Prof. A. Tiedeu Cameroon)
 - Microscopy with multispectral imaging (Prof Svanberg Lund university) future application to malaria
- Create jobs for young scientists (in oder to impede brain drain)
- How to do that with reduced cost?
- Besides knowing the real state of university physics carreers what is needed?
- Needs both basic science and technology knowledge !! And a good dose of creativity!!! With some pinch of serendipity, being humble and open minded.

Experimental Physics needs Instruments for experiments or measurements

- Instruments are a way to give access to science in a « touchable » way.
- Starting from instrumentation and going back to science basic concepts
- Instruments are important for developing applied research
- There is a real need for miniaturized instrumentation to make measurements in the field in remote areas. This should be adapted to each country environment.

"Despite the overwhelming importance of scientific research in the quest for the sustainable development of modern societies, universities and research institutions in developing countries continue to suffer from inadequate scientific equipment. The scientific workforce cannot be trained and research cannot be conducted at a level comparable to that of other similar institutions worldwide if the essential instruments, equipment, and facilities are unavailable or are not maintained. This situation must be acknowledged as one of the major reasons research output from certain countries is only a fraction of global scientific productivity." **Cecilia B. Öman** International Foundation for Science (Sweden) Karniyus Shingu Gamaniel University of Maiduguri (Nigeria) Marian E. Addy University of Ghana Analytical Chemistry August 2006 p 5273

What is « Slow Technology »?

The basic concept is to find high technology components in different kind of mass produced appliances and to use these component for other purposes, in particular to build small scientific instruments. It also enables to find another ways to obtain simple and rugged instruments.

Pertinent for:

➢Basic education

➤University

>and even basic research (in the case of laboratories with limited funding)

Providing low cost high tech components for physics

➤What is needed? :

➢Breaking the black box syndrome (knowing what is inside the balck box and how it works)

>Find which instrument is needed and look for the necessary components.

Contribution to sustainable development (through intelligent sorting and recycling)

Where to find high tech components? Computers, Printers, CD-ROM drive, scanner, sameras, mobile phones,video projectors, cars (modern one's), etc...

Examples of Slow Technology





"Popular" use of CD as scarecrow

More "Creative" use of CD (Peru)



"Good" Slow Tech.

Slow tech used in basic research: OD-ROM optical pick up translation re-used for sample translation under vacuum in a cavity ringdown experimental set-up coupled with laser ablation





Courtesy: M. Arold from lena University (Germany) From computers :

- 1 : sound board (audio board)
- Provides low cost ADC for digitizing analog signal



2 : Hard disk



turning disc + two powerful magnets

- **Applications:**
- Spin coating
- Polishing

Hard Disk Polishing Application (used in some French universities)



In this case it is a new tool not an instrument !

Source: http://metku.net/index.html?path=mods/hdd_grinder/index_eng2

From CD ROM Drive (it is a treasure « tout est bon »)



Optics, low voltage motors, detectors, laser, mechanical components, cog-wheels, gears, etc.... Even new it is inexpensive !!!



Laser Diodes recycled from a DVD player (640 nm)



Basic circuit without « driver »



May be used to solder plastic sheets!!



From Scanner

• CCD (linear) detector





From slow technology to poetry!!!

→ Techno flowers



Yaoundé university physics department: Neon lamp obtained by dismantling a scanner

•Camera's could provide 2D CCD detectors (a lot of people have different models not used in their drawers!!)

The video projector: another real treasure for physicists !

Mirors Filters Lenses MEMS Motors Etc....



Raman Spectrometer without moving parts (taking the MEMS from a videoprojector)



Use of the Digital Micro mirror Device DMD

Dispositif de couplage avec la fibre optique

F.O. provenant de la Super Head

Boîter du projecteur

DMD

⊇i M∠

L4

🔁 L3

Réseau

MЗ

6

PM ፼+

F2

L5

piège à

lumiérz

Monochromateu

M1

L2

Projecteur & PM

(MEMS)





Spatial Light modulator from mobile phone LCD display



1 LCD display of a mobile phone converted to a SLM.



Fig. 5 Modulated laser beam.



Fig. 3 Schematic of experimental setup for recording variable data holograms.

Ref: Optical Engineering 472, 025801 February 2008 **P. T. Ajith Kumar**

Another interesting part in mobile phones is the vibrator that may have applications in physics and chemistry!!!

Using the "quartz" (tuning fork) found in computer "clocks" for microsurface characterization





Ref : Jean-Michel FRIEDT et Émile CARRY BUP 99 (879) 2005

Advantages

- Low cost: A bunch of interesting mass produced appliances are fully widespread even in remote areas, such as computers, mobile phones (applications to be explored!), etc.....
- Understanding of basic physics which are involved in the different appliances : leads to increase of science and technology culture :Technology ⇔ Science
- Develop creative skills: find other purposes or applications to part or whole appliances while also getting attached to simplicity and avoiding to develop applications or "tools" already available: In french "ne pas réinventer la roue ou le fil à couper le beurre"
- Contribution to sustainable development :
 - 1 Based on sorting out components from used appliances (good recycling)
 - 2 Development of small scientific instruments fully adapted to the country
- Ultimate goal: Development of small companies which may employ people which technical and scientific skills?

Problems !!

There is always a «time window » for using « old » technology (race against time, "fighting"against the Moore law!!)



- Dismantling instruments and using their « second hand » components is not very appealing for many scientists and students especially in universities.
- Using some functions of these components is not easy if the original company is not willing to provide the information. (ex. Samsung).

Networking: increasing critical mass of people and ideas

- Different scientist are already developing specific applications for developing countries:
- ✓ Need of a network to put together people and ideas
- ✓ Dialog between "northern and southern" scientists in order to
- A council of « senior » (respected!) scientists could be a solution for assessing the respectability and the importance of "slow tech"

Example of idea : continuous laser beam attenuator Ivan Alata (Syria) PhD student



Fig(1) : description of the experimental set up for the case of low absorption (A) and strong absorption (B)



Fig(2): picture of the experimental set up.

Taking advantage of "new" low cost components :

• ex LED's as light source:

now LED's are available for a large domain of wavelengths and then constitutes an alternative to traditional tungsten (visible domain) or mercury (UV domain) lamps for a very low cost and a simple wiring and voltage; LED's are beginning to be used as light sources for spectroscopy and constitutes an essential element of low cost spectrometers an enables miniaturisation.

Reversing the physics of LED's : they may also be used as detectors (not very good but when you have nothing else!!)

The cost of wide selling appliances (like DVD reader) is very low and even if you buy it new, you get the best bargain price for the components

Education and experimental sciences need instruments

Developping "kits" of instruments that may be built in every country – a good opportunity to increase technical and experimental skills



Multispectral imaging and scattering from opaque samples: Dr Mikkel Brydegaard (Lund university). Set up built with LEGO elements.

South-South cooperation (cooperation between developing countries)

Health application : blood sampling Cuba + Mexico



Fig. 1: View of laser skin perforator. (a): Power supply, (b): Laser head







Fig. 2: Photograph of the internal laser parts. (a): Laser rod, (b): Reflecting cavity, (c): Power supply board



Fig. 6: View at microscope of perforation of finger made by Er: YAG laser. Diameter of perforation 0.2 mm

Er: YAG Laser Device for Taking Blood Samples

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High tech science from Slow Tech approach: Lab on a CD: Analysis from standard CD Drive



Figure 1. (A) Schematic representation of the detection system. The set of servo systems (spindle and stepper motors) of the CD drive keeps the laser beam focused on the spiral track, allowing disc rotation and laser scanning. The transmitted light through the disc is transformed by the photodiode into an analog electrical signal (rf signal). At the same time, the photosensor detects the trigger footprints, starting the data collection on disc. The DAB is integrated into the CD drive unit and contains the planar photodiode and the photosensor. DAB brings the rf and trigger signals to the DAQ. The DAQ digitizes the analog signals and transfers them to the computer for processing. The CD drive is controlled by software and connected to the computer by USB2.0 interface. On the disc, three different detection areas are represented, simulating the arrays corresponding to each studied analyte. (B) Picture of the CD player used in this work.

Microimmunoanalysis on Standard Compact Discs to Determine Low Abundant Compounds S. Morais, J. Carrascosa, D. Mira, R. Puchades A. Maquieira Departamento de Química, Instituto de Química Molecular Aplicada, and Centro de Tecnología Nanofotonica de Valencia, Universidad Politecnica de Valencia, Anal. Chem. 2007,79,7628

GOING FURTHER

- Building a strategy for information exchange and sharing
- What level ? International Journals? Is as example « Review of scientific instrument » a good tool for that?
- > Or a dedicated Internet web site could be better, \rightarrow ICTP?
- A strong problem is that internet access at reasonable speed is very seldomly available in Africa (personal experience in Yaoundé University!)
- Creation of a network of european scientist interested in this activity:
- Tentative members:
- Marc Antoine Dubois, René Farcy, Sune Svanberg, Ludger Woeste
- Ismael Moya, Nguyen Dao,
- Training and support may be provided by scientists about to retire or already retired willing to still contribute to developement of science.
- Achieving a critical mass is essential!!
- Organizing workshops in different regions
- Creating an instrumentation award for Africa

Low cost initiatives examples in Software, Computers and Pharmaceuticals

- « open » or « free » software enabled **low cost access** to different type of computing programs (some of them of great interest in Physics)
- Initiative of different foundations (Bill Gates!!) or governments (India) resulted in computers with very low prices (100 to 200 \$)
- For pharmaceuticals, the emergence of Generic Medicine enabled emerging and third world countries to access to many medicines
- These three examples that the emergence of « generic » scientific instrumentation which in part could be based on "slow tech" should not be an utopia. But there is a need for working structures and strategies.
- Easiest strategy → Relying on Chinese industry?
- Even MIT has this kind of reflexion :
- → International Development Design Summit (IDDS) One complete month workshop at MIT for developping simple devices!!!
- <u>http://www.iddsummit.org/</u>
- <u>http://www.iddsummit.blogspot.com/</u>

Physics for blind people



Developed by prof. René Farcy (Paris XI University)

Distance to obstacles is measured by a system using a diode laser and is then transformed into sound.

It is now developped in different countries: France, Vietnam, Peru, Colombia.

CONCLUSION

- Slow technology" is by no means an ultimate solution to the instrumentation problem of developing countries (it could evidently not be used for building very huge instrumentation such as mass spectrometers), but it constitutes a valuable help in many domains
- It also ,constitutes a very good opportunity to train people on science and technology at a reasonable cost,
- Applicable to every country from primary school to university
- It triggers creativity
- May result in instruments adapted to the rough climate of some countries
- ✓ But: there a need of structure, strategy, communication!!!
- ✓ Such an approach is by essence multidisciplinar:
- ✓ We need solidarity and cooperation : european physicists should get involved !!

Web sites where information may be found

- http://www.hackaday.com (forum)
- <u>http://www.evilmadscientist.com</u> (forum)
- <u>http://spritesmods.com</u> (forum)
- <u>http://www.kalanda.com/</u> (individual-spanish)
- <u>http://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html</u>
- <u>http://felesmagus.com/pages/lasers-howto.html</u>
- <u>http://inventgeek.com/Projects/alpharad/overview.aspx</u> (alpha radiation vizualizer)
- L'application d'une science à une autre est à la fois un moyen heuristique et un instrument de réorganisation de la connaissance.

d'Alembert, (Traité de Dynamique (1743))