Internet Virtual Classrooms and Labs: Opportunities for Microelectronics Education in Developing Nations

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ABSTRACT

Microelectronic technology remains the most pervasive technology of the 21st century through its influence on shaping modern commerce and industries. From medicine to finance, it continues to influence innovation through higher computing power, image and signal processing capabilities, among others. In the developed nations, microelectronics education has continued to produce new vista, while in the developing nations, many challenges have practically stalled it. Internet Virtual Classrooms and Labs offer the prospect to make this education available to all by harnessing the power of the Internet to bring world-class instructors to students.

1. INTRODUCTION

Advances in information and communication technologies (ICT) are becoming central to the social and economic developments of nations. ICT has offered means to transact businesses and transformed nations and organizations into knowledge based economic structures and data societies with electronically linked interdependent relationships [1]. Education in the 21st century is best positioned to utilize these evolving opportunities to lift a higher percentage of the global population out of illiteracy and poverty. Through Internet, the international boundaries have shrunk and the movement and transfer of ideas across nations by industries, academia and individuals sky-rocked. For UNESCO and other organizations focused on facilitating global literacy especially in the developing nations, Internet Virtual Classrooms and Labs (IVC) would be pivotal to realizing their objectives faster and with lesser resources.

Specifically, semiconductor technology has remained pervasive in shaping all aspects of modern commerce and industry. Being pivotal to many emerging industries in the 21st century, it occupies a central position in the global economy. Because Internet, medicine, entertainment and many other industries cannot substantially advance without this technology, it occupies a vantage position in engineering education in many developed nations. These nations invest heavily in microelectronics education as in the United States where the MOSIS [2] program enables students to fabricate and test their integrated circuits (Figure 1) to enable full cycle design experience. On the other hand, developing nations increasingly lag behind in developing and diffusing this technology in their economies owing to many factors which include human capital, infrastructure, among others. Notwithstanding, the Internet offers opportunities to bridge this widening gap by using IVC to harness the skills of experts in the developed nations and virtually export them to the developing ones. This paper describes the IVC challenges and opportunities in the developing nations.

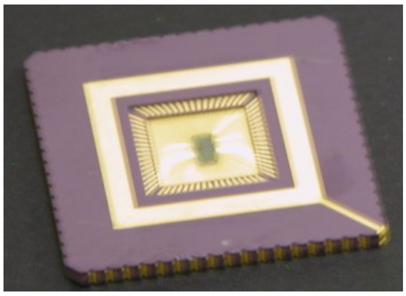

Figure 1 Integrated Circuit

2. WHAT IS INTERNET VIRTUAL CLASSROOM AND LAB (IVC)?

This is a 'classroom' on the Internet where instructors and students interact via computers. Besides lecture notes, VOIP (Voice over Internet Protocol) [2] phone, live-chats and online-conferencing are vital components of this classroom resources. The motivation is to create a virtual traditional classroom on the web and educate students separated by physical distance from the instructors. Many US and European universities use IVC to coordinate their satellite campuses and distance education programs.

A. The merits/drawbacks of IVC

- IVC is not limited by distance, allowing lectures to be delivered across national and continental boundaries.
- IVC offers the platforms to harness the brightest minds to teach a larger spectrum of students globally.
- At the long-run, the benefits of IVC supersede the cost of implementation.
- The main drawback of IVC, though video conferencing is eliminating it, is the impersonal delivery method which could be challenging to some students.
- The courseware and labware could be reused over time towards saving cost in the long-term. IVC offers a good archival capability to store and disseminate materials developed by leading experts.
- Another is the investment required from poor nations to fund high speed communication systems needed for IVC.
- To the developing nations, it provides a framework through which they can tap the pool of their experts in Diaspora which increasingly prefer to live in the developed nations.

3. CHALLENGES OF IVC DEPLOYMENT IN DEVELOPING NATIONS

There are many challenges to the deployment of IVC in the developing nations. Some are:

- Electricity
- Telephone facilities
- Broadband telecommunications
- Computer systems
- IVC Accessories
- Lack of adequate manpower

Though these problems are widespread in the developing nations, some of the schools, especially the private ones which are better managed have good facilities. Consequently, they are well positioned to benefit through IVC the expertise and skills of experts across the globe. This opportunity is strategic considering the lack of enthusiasm from top global scholars in traveling to these regions owing to their high crime rates, transportation safety problems and incessant political instabilities. Besides, The One Laptop Per Child Initiative which is poised to make laptops available to students will certainly help to improve some of these conditions over time.

4. DESIGN AND DEPLOYMENT OF IVC

The Internet offers the core platform in designing the IVC. As shown in Figure 2 [3], IVC is a network of Internet-connected computers which have been tailored for learning. These computers are equipped with audio, video, test-messaging capabilities with huge storage systems. In designing this system, quality is important to facilitate efficient transfer of ideas between the parties.

5. EXPERIENCE

As an experimental approach to test the effectiveness of IVC in teaching microelectronics in the developing nations, we developed a program to educate a small segment of students who showed interests in our movement for quality microelectronics education in Nigeria. We developed the courseware and labware upon the Internet. The students accessed our instructional materials and interacted with us through their local Cyber Cafés and school labs. While watching our educational videos, the students could ask questions. Because it was not a formal school course, we focused only on the practical components of their university courses teaching them how to do simulations, layouts and testing integrated circuits (Figure 3). Our motivation was to supplement the class works with labs (virtually) which are usually lacking in these schools.

Our program is based on the use of freeware CAD tools which we documented in [4]. The operational paradigm enables us to deliver these tools to the students without the associated licensing and purchasing costs which naturally, neither the students nor the schools can afford. One major difficulty was the issue of bandwidth and that affected adversely the quality of students' experiences in using some of our materials. Despite the poor Internet connectivity, we obtained positive feedbacks from the students. One way we plan to overcome this speed problem is to physically stay two weeks with the students at the beginning of their semesters. This will enable us install and teach them the CAD usage. Accomplishing these would enable us to focus on the microelectronics design during the semester. Our experiences show that prior interaction would help towards facilitating better learning process.

Our next phase is to push for schools to incorporate our program and offer a model which could enable Nigerian experts in Diaspora to make academic contributions to these schools to help mitigate the impacts of African brain-drain. We will seek for standardizations towards implementing a system which would facilitate faster and efficient diffusion of the semiconductor and microelectronics technology.

Figure 2 IVC Network

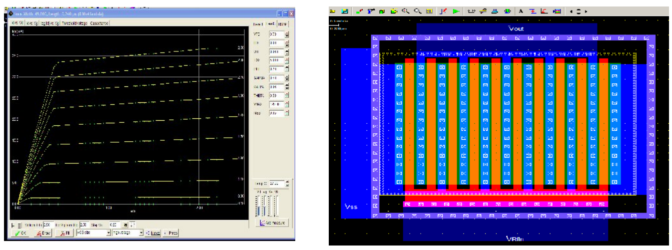

Figure 3 Training: MOS simulations (L) Opamp layout (R)

6. CONCLUSIONS

As information and communication technology continues to shape all aspects of human endeavors, its application in education in the developing nations would be vital. These regions lack the human and institutional capabilities to deliver some of the emerging concepts to their teeming student populations. IVC if properly implemented will offer a highly needed solution to access the global pool of top scholars for these nations. Though complex, appropriate IVC deployment would facilitate semiconductor technology acquisition and diffusion into these economies via sound microelectronics education.

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