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Educating engineers in appropriate technology for development

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ABSTRACT: Appropriate technology (AT) encompasses a diverse set of tools, processes and technologies that are focused on development. AT is, in general, characterised by small capital requirements, the use of local materials and resources, and is usually relatively labour intensive, small scale and affordable to individual families. The core principle of AT is to include local communities in technology selection and development, innovation and implementation, all in an environmentally sustainable manner. In this paper, the authors discuss a course offered for undergraduate engineering students that focuses on AT and is centred around development. The course material is situated in the broad global context in general, and in rural and agricultural settings in particular. After an adequate theoretical and philosophical introduction, the course is developed through specific and illustrative case studies. These include country-specific case studies, including those that have been developed outside the global capitalist mainstream, such as Cuba and Zimbabwe, as well as technological development in countries like India, China and Brazil. The discussion also centres on the various broad categories of technologies, with specific focus on health, water, agriculture and the environment.

INTRODUCTION

Appropriate technology (AT) applies to the broad and diverse set of technologies developed and implemented to facilitate development. Although there is much debate about what constitutes appropriate technology and it may be difficult to define, a general operational definition might be those technologies that are developed and implemented to satisfy the needs of the local population [1]. It is generally held that appropriate technology should require only small amounts of capital, emphasise the use of locally available materials and be relatively labour intensive. Appropriate technology tends to be small scale and affordable to individual families. Most importantly, appropriate technology implies that the technology should be understood, controlled and maintained without high levels of education and training. If the appropriate technology is an item, it should be manufacturable in small shops and villages. Finally, appropriate technology must be adaptable, flexible, and include local communities in the innovation and implementation of the technology, while it should have no adverse environmental impact [2].

Development needs that are met through community education and empowerment tend to be sustainable. Professionals in development agencies and organisations agree that the local community is the key stakeholder and will have the most positive impact in addressing their own needs. These technologies should extend human labour, not replace it. The scale of activity should be controllable, and a primary objective should be the minimisation of financial, energy, transportation and management costs and services. This will contribute to the engendering of self-sustaining and expanding reservoirs of skills within a community. The result should be an increase in the economic, social and political independence of the community, as well as the move towards sustainable development.

This course is a follow up to an earlier course developed and offered two years ago, which focused on the philosophy and ethics of appropriate technology [3]. The focus of this course is development, and the major theme of the course is appropriate technology and its implications for development. At the outset, students learn about the history of development and the ethics and philosophy behind the growth of the *development ethos*, as well as what the real impact and result of the past five decades of *development efforts* are. A comprehensive philosophical and ethical overview and discussion lead to the discussion of developmental needs and, hence, technologies. Appropriate technology is then introduced within the context of these development needs.

Students participate in readings and seminars on philosophy and ethics. The philosophy of technology is introduced and students are then provided with case studies of different appropriate technologies and the big impact that these have had on development. Development in various socio-technological and politico-economical models are studied using the case study model, with particular attention focused on appropriate technology in Cuba and Zimbabwe.

COURSE OUTLINE

The course was configured as a 3-credit seminar course where students met for two hours each week. The course outline is shown in Table 1. Beginning with an introduction to development, the first seminar focuses on the development of the idea of *development*. The philosophy and ethics of this concept and ideology are discussed and dissected. This discussion is followed by seminars on appropriate technology, as well as appropriate technology's rationale and characteristics. Students engage in the seminar-type lecture-discussion structured learning environment. Various case studies from the appropriate technology literature are

described, both of successful and unsuccessful implementations of appropriate technology. Potential project topics are also discussed.

Table 1: Course outline of *Philosophy and Ethics of Appropriate Technology for Development.*

Week	Seminar Discussion Topic
One	Development: What is Development?
Two	The Philosophy and Ethics of Development
Three	Appropriate Technology
Four	Appropriate Technology and Development: Projects
Five	Engineering Ethics and AT
Six	Case Study 1: Zimbabwe
Seven	Case Study 2: AT in Cuba
Eight	Case Study 3: Local and Global Issues
Nine	Case Study 4: Transportation and Development
Ten	Student Major Project Presentations

The assessment and evaluation of student performance in the course focused on three components. Students were evaluated on their class attendance and participation (20%), were required to research, write and submit one short paper (20%), and were also required to research, write and submit one major appropriate technology and development design project. Students had to submit a Final Project Report for their major project and present their projects in seminar. Two-thirds of the student's major project grade was based on the written report and a third on the students' presentation.

Seminars were presented by professors with research interest and expertise in the particular discussion area. Faculty seminar presenters and primary discussants came from the Colleges of Arts and Sciences, Engineering, Architecture and Computer Sciences encompassing a broad array of disciplines. These included philosophy, chemical, civil and electrical engineering, biology, anthropology and sociology, and science and technology studies.

Students were provided readings prior to the seminar and the readings, course syllabus and various other Internet resources have been placed on the course Web site. At the end of each seminar presentation and discussion, the seminar material was also placed on the course Web site, giving students continuous access to the issues discussed.

PHILOSOPHY, ETHICS AND DEVELOPMENT

It is beyond the scope of the course or this article to engage in an extensive discussion of ethics, philosophy or development. Faculty from the Department of Philosophy introduced students to the schools of philosophy and to different ethical models. Development was technically defined as *expansion by the process of growth*, but has many different connotations and implications that are highly dependent upon the context, and on the goals and objectives in a developmental situation.

The original Marxian concept of development is a progression from *primitive* to more complex and developed societies through the expansion of capitalism that would eventually result in the construction of a communist utopia. The general idea is the improvement of the quality of life and the standard of living within a community.

There are metrics that are traditionally used to assess the state of development and these typically include things like infant mortality, life expectancy, literacy, both in general and gender-based, availability of and access to clean water, energy, sewage and waste treatment facilities, and to employment and income. No metric is perfect and it does happen that a given indicator may be high in one country with no concomitant amelioration of the development index [4].

APPROPRIATE TECHNOLOGY (AT)

The introductory seminar on appropriate technology set out to define and characterise it, and provide illustrative examples of technologies that are considered *appropriate*. A clear assessment strategy has been developed in order to provide students with a methodology for the evaluation of a given technology. This is especially important since there are many examples of technologies once considered appropriate, but later demonstrated to be unworkable.

Appropriate technology can be broadly conceptualised as arising out of the necessity to make use of the available means of production in such manner as to be able to meet and satisfy the elementary needs of a community. This has often led to confusion and a misconception of appropriate technology as necessarily *low-tech*. This notion is historically embedded in the initial development of *appropriate technology* as being *intermediate*, and bridging the gap between developed westernised nations and undeveloped and underdeveloped African, Asian and Latin American countries.

Of late, this has changed as 21st Century technologies become necessary across the national socio-economic spectrum. Thus, there are efforts in *developing* nations focused on *high-tech* applications that can also be considered appropriate. These advanced (but nevertheless appropriate) technologies include solar and other alternative energy sources, overall energy consumption analysis, dry land farming and other agricultural techniques, food preservation and processing, and information and communications technologies [5]. More recently, the development of a rural wireless Internet that focuses on accessibility to the World Wide Web (WWW) as a critical component of development, has also been hailed as an appropriate technology.

The underlying concept that is emphasised and underscored is appropriate technology as context- and situation-specific. Geography, culture, location and economics are but a few of the variables that can determine the success or failure for the implementation of any particular appropriate technology.

APPROPRIATE TECHNOLOGY AND DEVELOPMENT: PROJECT TOPICS

Students are introduced to various possible appropriate technology topics and the connection that these have with development. Successful appropriate technology projects are discussed and outlined. These include the deep-well hand pump, oral re-hydration therapy, bamboo reinforced rainwater storage tanks, rural access roads, plus indigenously produced toolbar ploughs and carts.

Students are provided with broad topic areas to focus their project papers on. These general topic areas may include agriculture, water, energy, transportation, health care, education, small business, communications and workshops,

although students are encouraged to conduct the research necessary to develop their own major project topic.

APPROPRIATE TECHNOLOGY AND DEVELOPMENT IN CUBA AND ZIMBABWE

Two case studies employed in the course focus on technology and development in Cuba and in Zimbabwe. These countries present excellent opportunities for students to examine and investigate economic and social development, as well as the progress and evolution of technology, in a state-dominated economic setting where most basic services are public and privatisation has only recently made inroads.

Zimbabwe

Since independence from the United Kingdom in 1980, Zimbabwe chose a socialist, state-controlled economic development programme, while at the same time, maintaining private enterprise in other natural resource industries. Land reforms have been continually implemented to correct inequities from a racially segregated history; however, its implementation and negative impact on the minority white farmers brought condemnation and isolation from the world capitalist system. Isolation forced reliance on internal resources for development, and this is where appropriate technology is linked to the control of national resources in the context of a developing nation.

Specific attention is focused in the course on how appropriate technology can impact the reclamation and redistribution of land. Technology transfer, the impact of politics and the power of external multilateral financial institutions on internal development are presented and discussed [6][7].

Cuba

Cuba has been under a US-imposed trade embargo since its independence, and there has been a long tradition of self-reliance and the development of internal resources. With the collapse of the Soviet Union, this became critical and, in the early 1990s, a *special period* was declared focusing on internal resources and more efforts to harness and develop these resources. With Cuba's intense emphasis on education, this transition was made easier with the large pool of technical and scientific personnel [8].

Cuba continues to invest in educating its children and making itself self-sufficient in food production, developing and providing adequate housing and in preparing each of its citizens with adequate job-training. Cuba's economic priorities have shifted, from mainly sugar and tobacco – which are still a good third or more of economic activity – to biotechnology, tourism, historic preservation and higher education.

Cuba's achievements are impressive: despite a GDP per capita of only $5,200 (the USA is $34,320 by comparison), Cuba's quality of life indicators, including life expectancy index (0.86, world highest is 0.94), education index (0.90, world highest is 0.99), and human development index (0.806, world highest is 0.944) are all at the high end of the scale. This suggests that there is something to be learned from the social and economic development models and emphases that Cuba adopted through its history. This is a necessary part of any discussion of appropriate technology for development.

CONCLUSION

Students from all disciplines at Howard University, Washington, DC, USA, were eligible to take this seminar course. Interest in the course is high, and the seminars were also well attended by faculty with interests in the intersecting issues of science, technology and development. The faculty team plans to offer this course, or the earlier version, on a regular basis. It is envisaged that student interest and enrolments will increase as awareness of the course spreads through the campus.

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REFERENCES:

1. Rybczynski, W., *Paper Heroes Appropriate Technology: Panacea or Pipe Dream*. New York: Penguin (1991).
2. Darrow, K. and Saxenian, M. (Eds), *Appropriate Technology Sourcebook: A Guide to Practical Books for Village and Small Community Technology*. Stanford: Volunteers in Asia Press (1986).
3. Tharakan, J., Castro, M., Trimble, J., Schwartzman, D., Stephenson, B., Broome, T. and Verharen, C., Broadening the horizons of students: an elective seminar course on the ethics and philosophy of appropriate technology. *Proc. 8th UICEE Annual Conf. on Engng. Educ*,, Kingston, Jamaica, 353-356 (2005).
4. Verharen, C., Can we all get along? Multiculturalism and social justice. *American Philosophical Association Newsletter on the Black Experience*, 00:2, 23-29 (2001).
5. Thomas, J. (Ed.), *Applications of High Technology for Rural Development*. Madras: MCRC Press (1988).
6. Muchena, O., Africa urged to harness science to fight poverty. *Chronicle*, Bulawayo, Zimbabwe, 15 March (2005).
7. Trimble, J. and Mahalanga, S. (Eds), *Proc. 1st Inter. Conf. on Appropriate Technology*. Bulawayo: NUST Press (2004).
8. Granma International, Education in Cuba. November (2004).