# Appropriate Technology:
# Engineering for the 21st Century

**Carl A. Erikson, Jr.**
**Messiah College**
**Engineering Department**
**Grantham, PA 17027**

## Abstract

According to the ABET Engineering Criteria 2000, engineering graduates of the 21st century must demonstrate eleven important attributes of an engineer. This paper deals with one of them: "the broad education necessary to understand the impact of the engineering solutions in a global/societal context"[1].

The engineer of the 21st century must be an appropriate technologist /engineer to succeed in the global environment, whether it be in a city in the Western World or a Third World rural area. Several specific examples will be given to demonstrate what appropriate technologists/engineers do to meet the needs of the global village. These examples are taken from two Appropriate Technology courses, one which fulfills part of the General Education requirements under the Science, Technology, and the World framework for non-technical majors, and the other is an engineering major elective.

## Introduction

The first step in the engineering design process is finding and defining a need to solve. One does not have to look very far to find the many needs of the global village we live in; building adequate shelter, overcoming hunger, providing health services, purifying drinking water, supplying alternative energy in an economical way, building economical transportation devices, etc. Many people think that sophisticated technical solutions are the only way to solve a real need. However, in many countries, social, cultural, political, and economic inputs can override any elegant technical solution and prevent the solution from being implemented or used at all. For example, the lack of and cost of batteries in much of Africa makes portable radios of little use to its rural inhabitants. However, hand-cranked radios which use a mainspring to drive a little dynamo are highly functional and desired because of their low cost. These radios allow a circle of mud huts to "zip back into the Information Age with a twist of the wrist"[2].

The engineer of the 21st century must be an appropriate technologist /engineer to succeed in the global environment, whether it be in a city in the Western World or a Third World rural area. What are appropriate technologies? They are "local, self-help, self-reliant technologies that local people choose, which they can understand, maintain, and repair. They are generally simple, capital saving, labor enhancing, and culturally acceptable. Ecologically, appropriate technologies are environmentally sustainable, as much as possible using renewable energy, and limiting atmospheric, chemical, and solid waste pollution"[3]. In other words, appropriate technology /engineering is a holistic approach to engineering which views design not only in the light of technical considerations but incorporates social, political, cultural, environmental, economic, and human empowerment issues as central elements to the process.

Looking at some relatively simple problems with which appropriate technologists/engineers are confronted with everyday will allow one to see how appropriate technology's principles might be applied to some of the major global needs facing society today.

## Sample Appropriate Technology Solutions

Dr. Bill Zuspan, a retired engineering professor from Drexel University and my mentor in Appropriate Technology, tells this story of a project that he gave to his engineering students after visiting Haiti. The problem: a small village's bridge kept being washed away by rising waters after major rain storms. His students quickly said that they could build one with steel beams, concrete, etc. that could withstand hurricanes, floods, etc. Bill stated that only local materials could be used. The students after being disappointed asked what was available. He said," Stones, dirt, wood, vegetation." Again, the students' initial ideas were frustrated. "By the way," Bill mentioned, "the village has only $60 to spend on the project!" Well, the students took the project in stride and became very creative. They developed a bridge with the local materials that could be swung on a pivot to one side of the river when the waters rose. The project cost came in around $56, the metal pivot pin being the most expensive part. This was appropriate technology /engineering at its best.

Another story Bill tells of his Haitian visits relates to his desire to introduce more protein into the diets of the local people, especially children. His idea was to have the people raise rabbits. Rabbits are small and reproduce quickly, and rabbit-raising could form a small business for the Haitians. However, when he introduced the rabbits into the locality, no one seemed to be interested in raising or even eating them. He found out later that in the ceremonies of the voodoo religion, which is prevalent in Haiti, rabbits are sacred. Thus, the Haitian people did not want to eat them. Bill, still wanting to help the people's nutritional needs, developed a dumpling soup made with high protein wheat flour. This was now a culturally acceptable solution.

These two examples begin to illustrate some of the appropriate technology principles which can be applied by the graduate engineer to global needs. One such need is urban transportation.

## Urban Transportation

One may question looking at urban transportation systems when one should be more concernd about overcoming hunger or reducing population growth in the cities around the world. However, if you have flown into Los Angeles or Caracas and seen the sickening layers of "smog", you would quickly believe in the appropriateness of improving urban transporattion systems. It is estimated that by the year 2010 three out of every four people on the earth will live in cities. In particular, as the Third World countries become more developed, strategic planning for their cities must include a look at transportation alternatives if the world is to survive ecologically.

Engineers working to help solve the urban transportation problems will need to look at each city uniquely, since each city and its needs would be different.

## Effects of Automobiles on Urban Transportation Systems

Transportation is vital to urban life. However, some of the methods now used to move around cities cause many serious problems. Fossil-fueled cars, trucks, and buses produce poisonous air. In addition, harmful noise, increased soil salinity, toxic wastes, overdependence on imported oil, and (for cars) high injury and death rates are a few of the deleterious effects created by vehicles in and around cities. The many streets and freeways, gas stations, and parking lots consume too much paved land in addition to disrupting communities and businesses excessively during construction or repair.( The damage to highways due to the earthquakes in Los Angeles(January 1994) and Kobe, Japan(January 1995) has vividly demonstrated this.) Moreover, the present means of urban transportation have often neglected the needs of non-drivers as well as the poorer residents of cities and suburbs. The overall quality of service, especially that offered by public transportation, is too often substandard.

Originally the mass-produced automobile of Henry Ford promised speed, freedom, and convenience for its owner. However, these benefits are now dwarfed by the many problems created by the number of cars in and around cities, especially those in industrialized nations.

There are approximately 600 million automobiles in the world, and they form the largest source of air pollution[4]. The costs of vehicle-generated air pollution -- in damage to human health, materials, crops, and forests-- add up to billions of dollars per year[5]. It is interesting to note that the automobile "was initially praised as solving the serious pollution problem caused by horses.... In New York at the beginning of the 20th century, this meant 2.5 million pounds of horse manure and 60,000 gallons of urine each day. The manure littered the streets and provided a breeding ground for disease-carrying flies. Thus the automobile was viewed as a far less-polluting form of transportation" [6].

Another drawback of a car-centered transportation system in cities is congestion, vividly expressed daily by massive traffic jams which "have stretched rush hours to 12 hours in Seoul and 14 hours in Rio de Janeiro. The Confederation of British Industry estimates that higher freight costs, lost work time, and other results of congestion cost England $24 billion each year"[7]. In Bangkok, "officials estimate that the typical motorist spends a total of 44 days a year just idling in standstill traffic"[8].

Air pollution, congestion, and overdependency on imported oil only begin to reflect the magnitude of the transportation problems in present day urban areas that engineers need to resolve. With appropriate technology approaches in mind one can suggest ways that the 21st century engineer can use to provide far more convenient movement of its residents and commuters as well as more livable surroundings for its occupants.

## Strategies for Ending the Dominance of the Car in Urban Areas

The magnitude of the problems caused by a car-centered transportation system can not be addressed exclusively by technical fixes or improvements in automotive technology, but must include and serve the transport needs of the majority of humanity who will never own a car. Three general areas which an engineer should consider will be mentioned and briefly discussed;

1] technical improvements which will help reduce air pollution and overdependency on imported oil;
2] improvements in urban planning of mass transit systems to minimize congestion;
3] non-technical ways to end the dominance of the car.

Over the last decade car manufacturers have initiated and implemented technical changes in their automobiles in order to reduce pollutants responsible for urban smog and to improve fuel economy to cut emissions of carbon dioxide. Other items such as alternative fuels and electric cars have begun to attract considerable interest of urban transit planners. Improvements in electronics such as infra-red cameras and on-board computers may allow future cars to drive themselves with the potential of saving many lives from serious injury or death.

It is estimated that only 3% of the people in USA urban areas use mass transit. Higher energy costs and greater traffic congestion around cities have created public pressure for more mass transit systems. Multimodal systems that offer greater transportation options to the public need to be considered. Traditional forms of mass transit such as buses, railways, and subways are considered vulnerable to replacement by trams, light rail systems, and automated people movers due to the high labor costs to operate, new or replacement construction costs and unsafe/uncomfortable riding conditions.

In many Western European countries, planned and regulated land use has led the way to minimize urban sprawl and protect valuable agricultural lands from becoming "concrete jungles". However, "outsiders" including politicians and technologists often impose non-effective solutions because they don't listen well and try to understand the real needs or communicate effectively with urban dwellers and workers. Successful appropriate technologists/engineers need to be good listeners, first to the people living in the city and then those who travel to and fro each day.

Motorists in the USA do not pay the real costs of driving. Hidden costs are paid by society at large. For example, car-related costs such as road construction and services, free commuter parking, and the effects of air pollution amount to $300 billion per year[9]. If these costs were added up at the gas pump, motorists would be paying several more dollars per gallon. Shifting many of these hidden costs to motorists through user fees and other up-front charges would help reduce congestion, accelerate the demand for more efficient vehicles, and, most importantly, increase ridership on public transportation.

Fortunately for the world's polluted, traffic-clogged cities, there are models of success due to systematic, coordinated investments in vehicular innovations, public transport, bicycling, and traffic calming. For example, Vancouver and Toronto have combined dense, well-mixed downtown areas with several outlying, compact centers of activity -- all linked by an extensive public transport system. This way, people can walk, cycle, and take short public transport trips within a given area and can reach other areas via express bus or rapid light rail. The Brazilian city of Curitiba has a unique "surface metro" system[10] to transport its 1.6 million people. This system is a highly efficient network of fast-running buses, obviating the need for an underground system. The city has built high speed bus lanes that prevent buses being held up by car traffic. With bus stops every 400 meters people have convenient access to buses and cylindrical loading tubes allow passengers to pay their fares in advance to speed up the boarding process. 1.3 million passengers use the city's public transport system daily. The city also has an extensive system of cycle lanes and traffic calming in selected streets. Traffic calming uses ramps, humps, street-narrowing, tree planting, bottlenecks, and bends to slow down and discourage traffic. The aim is to reduce traffic to walking speed, making it possible for streets to be crossed safely and to be used as play areas again.

## Conclusion

This paper has suggested how appropriate technology/engineering techniques can be applied to both simple local problems as well as major global needs. Concerning transportation-related problems in urban areas, technological innovations alone will not solve these problems. Social patterns, economic realities, and political inertia need to be addressed as well at the local city level. Daring engineers and urban planners need to catch a vision for the future of their cities in which a coordinated, systematic and integrated approach to transportation will provide mass transit and livable conditions for all urbanites. Perhaps, it is not too late. As one visionary from Southfield, Michigan stated," This "downtown" will be bisected by landscaped thoroughfares and dotted with parks and plazas that encourage pedestrian traffic. The city envisions a vibrant center of education, commerce, culture, entertainment, and community activity"[11].

## References

1] "A Framework for the Assessment of Engineering Education", by the Joint Task Force on Engineering, ASEE Prism, May-June 1996, page 20.
2] "This $40 Crank-Up Radio Lets Rural Africa Tune In", Donald F. McNeil, Jr., Milnerton Journal, New York Times, February 16, 1996.
3] Appropriate Technology: A Focus for the Nineties, Edited by R.W. Stevens, Intermediate Technology Development Group of North America, 1991, page ix.
4] "Cities: Is It Time to Phase Out Cars?", USA Today, April 1991, page 15.
5] "The Real Costs of Driving", The Futurist, Nov/Dec 1992, page 59.
6] Palen, J.John, The Urban World, Fourth Edition, McGraw-Hill, 1992, page 185.
7] "Cities: Is It Time to Phase Out Cars?", USA Today, April 1991, page 15.
8] Transportation and Global Climate Change, edited by D.L. Greene and D.J. Santini, American Council for an Energy-Efficient Economy, 1993.
9] "The Real Cost of Driving", The Futurist, Nov/Dec 1990, page 60.
10] Cities: New Directions for Sustainable Urban Living, H. Girardet, Anchor Books, 1992, page 15.
11] "Smoothing Out Life in Edge City", A. Fischer, Utne Reader, Jan/Feb 1993, page 35.

### Biography

CARL A. ERIKSON, JR - Mr. Erikson is currently an Assistant Professor of Engineering. He obtained his BSEE degree from Rutgers University in 1969 and his MSEE degree from Purdue University in 1971. He has authored

many articles on microelectronics processing and components. Since 1990 Mr. Erikson has been interested in and been promoting the concept of Appropriate Technology. He has worked in Kenya, Bolivia, and Venezuela.