Feature — **Science and Technology**

Electrical Lights for Every Home in Bangladesh — A possibility?

by Muhtasham Hussain

The present scenario

In Bangladesh electricity at home is available only to the relatively richer section of the population. Most villages are yet to be electrified, and even the well to do households there do not have the privilege of electrical lighting. Further, around 50 per cent of dwelling units in Bangladesh use straw and bamboo for walls and roofs (1981 data), and thus are totally unsuitable for electric power due to fire hazards. For Bangladesh as a whole, out of 194 lakhs of houses of which 21 lakhs are in urban areas there were only 15 lakhs of domestic customers of electricity in 1991-92 or around 8 per cent people had electricity at their homes. In 1981 we had electrical lights in only 44 per cent of urban houses and the figure can not be expected to have changed much by now as the influx of poverty stricken people to cities has been continuing unabated. Under such a situation, even if electricity distribution of REB (Rural Electrification Board) covers all the villages in Bangladesh, as planned by the government, the majority of homes may still remain in the dark.

For people without electricity at home, one portable electric lamp, to provide light for 3-4 hours every night, may bring a revolution in the life style of the common man. Let us examine the capability of an alternative technology for achieving this end.

Technical developments

Recently, compact and highly efficient florescent lamps have been developed which give a light output equal to, or more than, that of 40 watt 220 volt ordinary electric bulbs but with a consumption of 7 watt of electric power only. The low consumption along with long life of the lamps, improvements in low maintenance rechargeable batteries and developments in electronics allow highly efficient portable lamps to be designed and built which may be charged during the daytime at service centres using ordinary mains supply, if available, or photo-voltaic solar cell modules to provide lighting for 4 hours or so every night in cities, towns and the remotest villages.

The lanterns are similar in appearance to the familiar Emergency Lanterns which if charged with A/C power work when electricity fails for short periods at night. These have been in the market for years, but these are not designed to give sufficient light output for 3-4 hours every evening.

Highly efficient portable lanterns can be locally designed and produced in the country if R & D activities are taken up in earnest and if entrepreneurs get attracted.

The service stations for charging the lamps may be run by NGOs' local bodies or private entrepreneurs, and in the initial phase in cooperation with research organisations. They should also carry on maintenance of the lanterns and replace lamps and batteries when required. They need to collect a small charging fee to make the service stations self sustaining.

Financial investment required

A big advantage for the portable lantern is that service stations will use power from the mains supply to charge the batteries of the lanterns, and the investment required is very small for the equipment and accessories. The stations may be housed in any available room at a school, madrasha, or a tin-shed built for it.

For villages where electricity is not available, PV (photo voltaic) generating stations of 1/2 to 1 KW-peak may be installed for charging 50-100 lanterns. Solar cell modules will cost around 1-2 lakh Taka and the overall cost may be double the amount or so for a station. The capital investment on service stations should come from the development programmes of the government. Even if we take the cost to be 5 lakh taka for a photo-voltaic service station for 100 lanterns, the amount is very small compared to that invested on the average by PDB (Power Development Board) and REB (Rural Electricity Board) for electrify 100 homes. The REB alone has spent 500 crores of Taka and supplies electricity to only a small fraction of rural households. An amount of 5 crores of taka per year (0.1% of A.D.P) should allow an extension of facilities for electric lights every year to 10000 homes. The figure is comparable to the number of domestic connections given annually by REB, PDB and DESA (Dhaka Electricity Supply Authority) together (13,000-14,000).

This technology, however, will not compete with REB and PDB, and their development programmes should go on as already planned by the government. This relatively low cost approach should complement and supplement electrification programmes to people who can not afford normal electricity and to those who live in remote areas where electrical distribution lines can not be extended in the near future. It must be remembered that without REB activities we can not power rural industries and agriculture.

The lanterns themselves should cost below 2000 taka each. Most house owners may find it beyond their means to make an outright purchase of the lamps; they ought to get hire purchase facilities. For some people it may be necessary to buy smaller lanterns with 5-watt compact lamps at about half the price. Subsidies may also be considered so that almost any home owner can afford one electric lantern. A monthly charge of Taka 60 only should be adequate for the maintenance and charging of lamps at the service stations. This is an amount similar to that spent on a kerosene lantern.

Advantages and disadvantages

The biggest advantage of the lanterns is that they can be used in thatched cottages and structures or carried anywhere by shopkeepers, hawkers or guards. Fire hazards will be prevented.

The greatest disadvantage for the scheme presented will be that the lanterns will have to be carried to and from service stations every morning and afternoon. However it should not be difficult to make an arrangement, for employing a person collectively for the purpose, at a small additional monthly charge by those who can afford.

Again, one lantern may prove insufficient for some households. These can opt for additional units. Those who prefer may install their own 10-12 watt-peak PV module for one lamp at the present cost of 10,000 taka or less (which should get lower if duty free import of solar panels is allowed). For affluent people living in remote areas 1 or 2 lanterns may not satisfy their needs. They may install their own PV panels for lamps and if desired for fans, TVs or refrigerators. Portable lanterns may also be used in community centers, primary schools or mosques, particularly for adult education at night.

A special advantage would be that for areas where normal electricity is available, a service station will consume electricity during the day time only, that is, during hours when the electrical load for PDB or REB is low. This will mean that no capacity increase will be needed for generation or distribution of electricity for the service stations. For 1 lakh homes, a power of 1-2 MW only would be needed during off peak periods which is very small compared to off peak load of PDB.

It may be mentioned that photo voltaic systems will have little loss of load probability that is, these will work satisfactorily even during rainy months under our solar radiation regime. Our radiation availability is ideal for the purpose.

In the early next century solar cell cost should fall and photo-voltaic power may find wide use as our natural gas and coal resources get depleted. Experiences with photo-voltaic lanterns and charging stations will help in cost effective design and operation of larger PV systems.

Creation of employment opportunities for a large number of people, 50000-100000, for service stations and possibly, a good number of skilled personnel in the manufacture of lanterns by private enterprises, will be an added bonus. Conservation of energy due to high efficiency of lamps and utilization of clean solar energy through solar cells would benefit the environment.

Conclusion

People who can not afford normal 220 volt electricity and also those who are away from electricity supply lines need not be denied electrical home lighting any longer, as the technology for portable electric lanterns can meet the minimum needs for them at a reasonable cost to the exchequer. Pilot projects should be started as soon as possible to popularise portable lanterns and to develop management techniques and expertise. Research and development activities for continual improvement of technology should be pursued. The Renewable Energy Research Centre, University of Dhaka, has initiated R & D activities but with financial handicaps.

The import duty on solar cell modules and accessories must be abolished immediately, as in neighbouring countries. This would reduce cost of PV generation for rural enthusiasts and for service stations which should be set up in the near future. A start for local production of efficient lanterns should be made immediately.

Demonstrations to planners and administrators have to be made to impress upon the government machinery the advantages and utility of well designed electric lanterns. A programme for the production of 1 crore of PV lanterns has been taken up by India, and the prospect for electric lanterns should be very high in Bangladesh as well. NGOs and research organisations ought to initiate projects to demonstrate them to the public. If suitable steps are taken, it is likely that a vast majority of homes in Bangladesh will have electric lighting in the near future.

The writer is a Professor in the Physics Department, Dhaka University.

Evolution of Fibre Optic Communications

by Aref Chowdhury

IN the field of communications today, the state-of-the-art is considered to be fibre optic communications. However, the rapidly developing field of fibre optics has had a very long and interesting history. The first attempt to develop an optical communication system goes as far back as the last century. In 1880, Alexander Graham Bell was issued a patent for his device called the "photophone." The photophone was based on the principle of modulating reflected sunlight by causing a mirror in the device to vibrate. This communicating device could transmit voice over several hundred metres. In spite of its operational success, it did not gain commercial success.

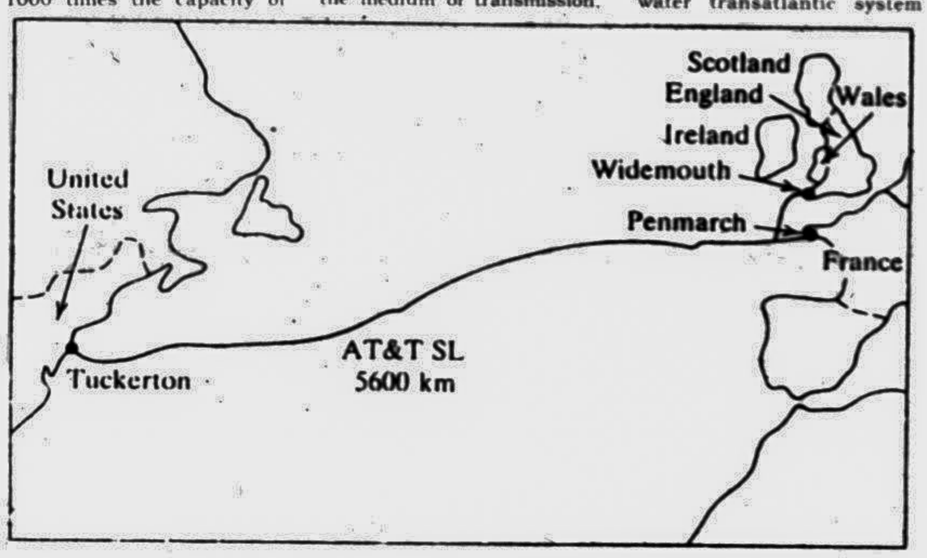
In 1960, TH Maiman invented the first laser. The word "laser" is actually an acronym for "Light Amplification by Stimulated Emission of Radiation." It was the development of the laser that created interest in the prospect of optical communications. But the development of the laser is only half of the story; there was a lack of an efficient medium of transmission. However, subsequent developments of relatively low-loss optical fibres revolutionized optical communications and gave birth to fibre optic communications.

For those well-versed in optics, the optical fibre is classified as a dielectric waveguide. If light is launched into a fibre at one end, it can travel a distance of up to 100 km without any intermediate amplification depending on the type of fibre. The two main types of fibre materials seriously considered to date have been plastics and glasses. Plastics can only be used for short-range applications because of their high transmission losses — this is an unfortunate fact because compared to their glass counterparts, they are much more cost-effective and easier to manufacture. The materials for fibres currently used are silica materials, essentially glass but very high-quality glass.

The main advantage fibre optic links provide as a medium of transmission include low attenuations, high bandwidths which means the ability to transmit more data (over 1000 times the capacity of telephone coaxial cables), small physical size, immunity from "tapping", and immunity from electrical interference. Tapping phone lines is a serious problem, especially where confidential and sensitive information is involved such as in the defense sector. Immunity from electrical interference is very important, particularly in electrically noisy environments such as densely populated urban areas and locations such as power plants and substations. Though it is true that fibre optic cables are more costly to produce than copper-based cables, this situation will probably change as the increasing demand for fibre will lead to increasing manufacturing efficiency.

A typical fibre optic communication system consists of an emitter, optical fibres as the medium of transmission, receiver, and repeaters (if the transmission is over a very long distance such as 50 km). For the sake of simplicity, assume that we want to transmit a voice signal through a fibre optic system. When the voice signal is fed into the emitter, the emitter converts the voice signal into a light signal, which travels through the fibre optic cables. If repeaters are present in the system, their function is to restore the light signal to its original form. When the light signal finally reaches the receiver, the receiver converts the light signal back to the original voice signal. This is the principle of any fibre optic communication system.

An example of a sophisticated fibre optic communication system is the TAT-8 SL Undersea Lightwave System, developed by AT&T Bell Laboratories. This system was designed to be the first deep-water transatlantic system spanning a distance of 5600 km from the United States to Britain and France with a total data-rate capacity of 577 Mb/s. The SL system has three pairs of single-mode fibre of which one pair is for standby redundancy, and about 100 repeaters with each repeater possessing six receiver-regenerators, including two standby regenerators for redundancy. The technological problems this system has faced include the light-wave cable requirement and the environmental hazards of the sea that the cable and repeaters must accommodate.



The TAT-8 undersea cable system.

Other applications of fibre optics include video transmission, computer communication and, in the military sphere, missile guidance. Fibre optic experts believe that the concept of "fibre to the home" is not too far away from becoming a reality. The concept is that there will be a fibre optic communication network which will be connected to every home. The fibre branching to any particular home will handle all the communication needs of that home including telephones, faxes, computers and TVs. This will rid society of the need to maintain separate infrastructures for telecommunications, cable TV, and satellite transmission. One should not think that the capacity of fibre optic systems will become limitless. Some current researchers predict that fibre optic technology will surpass the capacity of electronic devices to receive and transmit data. Thus, there may be an "electronic barrier" which will render higher data rate fibre optic systems useless.

It is true that we cannot say for certain what the future holds for us, but we can say for certain that fibre optic communication is a significant technical and commercial success (unlike the photophone) and the growth of its industry in the future is assured. With all this in mind, Bangladesh should seriously consider the pros and cons of implementing fibre optic communications in its telecommunication sector so that we may take advantage of the "Technological Revolution" in the field of communications.

The writer is an electrical engineer specialized in fibre optic communications.

A Microchip Which can Taste and Feel

by Ruth Henke

SENSORS are to technology what sensory organs are to humans. However since the human senses are still vastly superior to their artificial counterparts Professor Meinhard Knoll decided to model his design of a substance identifying sensor on the human tongue. For the development of a favourably priced sensor suitable for a diverse range of applications in medicine and environmental protection Knoll was awarded the 1994 Philip Morris Research Prize.

Sensors are high-precision measuring instruments and can be used, for example, to identify different substances in liquids and determine their concentrations. By virtue of this capability they can be compared to the taste buds on the human tongue — although until very recently this represented the full extent of similarities between the artificial and natural sensors. Meinhard Knoll, Professor at the Institute for Chemo- and Biosensor technology at the University of Munster took his substance-identifying sensor a step further and developed a novel sensor concept modelled on both the functions and morphology of the human tongue.

The general practice in the past has been to coat or glue the sensor surface, comprising generally a synthetic membrane or a gel with active components, to the flat surface of a silicon chip. However, this type of bond did not prove particularly durable and raised other problems. For example, only very few sensors could be assembled on the tiny surface, and the sample fluid flowing past tended to rapidly wash out the active components of large sensors.

In developing his fundamentally new concept, Knoll studied the structure of the human tongue, where the "substance-identifying organ is not positioned externally, but internally, thus ensuring good protection". Accordingly, in Knoll's technical solution the substance-identifying layers were assembled in, the interior of the silicon chip. In one particular process, the electrical engineer burnt hollow spaces into the silicon and then poured the sensory membrane or the gel into these the funnel-shaped "containments". An electrical insulation layer separates the substance-identifying agent from the silicon and the active substance is only permitted to come into contact with the measuring fluid via a small aperture a few thousandths of a millimetre wide. "Compared to the planar sensors, the leakage in our containers was several thousand time less", reports Knoll proudly.

This porous chip, which has the world's smallest membrane surface, can be mass produced for just one D-mark per unit and is suitable for application in a diverse range of sensors in the fields of environmental protection and medicine. The sensor is capable of tracing pollutants in water or identifying substances in the blood in clinical diagnostics. Equipped with a synthetic membrane which is only porous for specific electrically-charged particles, it can determine the concentrations of potassium, calcium, sodium, nitrate, ammonia or heavy metals in a liquid, or its pH value. The membrane or gel can be fitted with a biological molecule, such as the enzyme glucose oxidase, to form a biosensor which — in this case — can measure blood sugar levels. By employing a space-saving vertical layout, a whole series of various sensors or a complete mini-laboratory can be accommodated on a single chip. Only two square millimetres in size, this tiny analysis system is equipped with a pumping device, a reaction chamber and a one-metre long tangle of capillary tubes through which the measuring agent or the calibrating liquid flows past the sensors. — *dt*

Cyberdad Joins the Throng on the Superhighway

by Arlene Getz

WELCOME to the first wedding in cyberspace. The bride and groom are in New York, the judge performing the service is across the continent in California, and the guests are at home elsewhere around the United States.

Move next door to see a doctor diagnosing pneumonia in a young boy. It may sound routine, but hundreds of miles separate the physician from his rural patient.

The scenes are not some science fiction vision of the future, but items from a new $2 million "Networked Planet" exhibit at the Computer Museum of Boston designed to demystify one of the most overused, little-understood cliches of the decade: the information superhighway.

"The information superhighway is really a term being used to try to capture the increasing digitalisation of our society in everyday lives," says David Greschler, the museum's director of exhibits.

The Networked Planet offers a glimpse of the profound upheaval wrought by the revolution in communications technology. "The world isn't run by money any more," a character in the Hollywood film *Sneakers* explains in a clip shown at the exhibition. "It's run by ones and zeroes, little bits of data. There's a war out there... and it's all about information."

One of the main thoroughfares for this information highway is the Internet, an international network allowing 30 million people in 150 countries to communicate through computers linked to various types of telephone line. The system, which grew from the 1977 linkage of a number of computer networks, was made possible by the development of a technique allowing computer files to be divided into small parcels of data for transmission around the world.

This technique — coupled with the use of fingernail-thin fibre optic ribbons able to carry over 144,000 telephone calls simultaneously — ultimately led to Internet, an interactive medium which differs from television or radio by allowing users to pursue their own choices or add their contributions to the data.

Internet is growing by 750,000 users a month, with subscribers daily developing innovative uses for the system.

The system can be used to play chess, socialise through bulletin boards, search library catalogues, read the newspapers or, most popularly, send messages through electronic mail for a fraction the cost of a letter or long-distance telephone call.

"E-mail messages have become the equivalent of notes on the refrigerator door," Victor B Godin, a professor at Northeastern University's College of Business Administration, wrote recently in the *Boston Globe*.

Godin, who dubs himself Cyberdad, used the system to stay in touch with his young sons when they moved from Boston to Philadelphia after his divorce: "These daily communications have provided an intimacy and currency to our relationship. In a way, we have created our own secret meeting place with our own private language. We can 'talk' without worry of being overheard."

For less developed countries, the burgeoning of the information superhighway has the potential to improve the lives of the poor. Dr John Coonrod, director of programmes at the New York-based Hunger Project, told a recent conference of the World Peace Foundation that while the establishment of a conventional wired telephone circuit costs $2,000, a cellular circuit can be installed for only $300.

This should have a direct impact on countries like South Africa, where President Nelson Mandela's government has promised cellular telephones to isolated residents in impoverished black townships. Other countries may also be able to reap financial benefits. India, for example, exports computer programmes worth $200 million a year to the US and is training computer technicians to do programming currently done in wealthier nations.

Another potential is the opening of new frontiers of education. In China, where the average length of schooling is only six-and-a-half years, televised courses have provided learning opportunities for at least 30 million Chinese. At the university level, the State Education Commission says the annual cost of a TV university student is a third that of a regular student, partly because TV university teachers can reach 19 times as many students as their colleagues at formal universities.

"Multimedia gives the world the opportunity to share its meagre supply of great teachers," says Coonrod. "While the Internet was originally designed to share computers, its real contribution is in sharing people — in allowing experts around the world to solve problems together, forming a virtual community of shared interests, passions and commitments. Hundredfold increases in the speed of scientific progress are not unheard of."

Improved communications also have played a role in mitigating the impact of natural disasters.

According to Fred Cate, senior fellow at the Annenberg Washington Programme in Communications Policy Studies, satellites and other information technology have succeeded not only in maintaining communications links for relief workers at disaster sites, but in providing early warnings of weather hazards.

Consequently, when Hurricane Gilbert hit Jamaica in 1988 it claimed a far lower death toll than a similar 1951 hurricane, despite the doubling of the Jamaican population.

"Fifteen years ago, there were advance warnings for only 45 per cent of tornadoes. Today the figure is 89 per cent and growing," Cate told the World Peace Foundation conference. "Equally significantly, these communications resources are used to predict weather patterns that contribute to slow-onset disasters such as droughts."

Politically, the new technology's ability to diminish geographical barriers has played a significant role in exposing government repression. Fax messages sent by Chinese students during the massacre at Tiananmen Square and electronic mail transmitted by dissidents from the former Soviet Union played a significant role in informing the world about the democracy movements in those countries.

But many developing countries lack the infrastructure and Internet is not always easily accessible even for those where private citizens have the telephones and computers necessary to use the medium. Subscribers from India, for example, complain inadequate phone lines often mean they can "log on" only in the early hours of the morning.

In other countries, government monopolies over telecommunications — often because they fear the political consequences of opening the airwaves — make it impossible for residents to obtain the necessary hardware.

Nor is the system likely to remain cheap as it moves out of its infancy. Cate notes that Internet presently is funded by a combination of subscriptions, advertising, and government and institutional support. This means that few users pay the actual cost of their use and it costs as little to send message half way around the world as it does to the building next door. (A one-page electronic letter from California to New York, for example, costs only two US cents, compared with the 29 cent stamp needed to post it.)

This, says Cate, is likely to change. "As the Clinton administration and other national governments move to privatise the Internet and eliminate government subsidies, more costs will almost certainly be passed onto users."

In developing countries this may put Internet permanently out of reach of many aspirant users.

Perhaps more importantly, the creation of an electronic elite may widen the gap between wealthy and poor countries, further marginalising those from regions excluded from the information highway.

"We find Internet a tremendous help," Mehr Khan, New York-based director of information for the United Nations Children's Fund (Unicef), told Gemini News Service in an interview. "We get a good response when we put out papers on it and e-mail helps us communicate with our people in the field.

"But in Africa, where people don't have access to the technology, people are being left further behind. And that's a problem."

— Gemini News