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Abstract

Technology transfer to developing nations has been mainly in the form of finished products such as equipment that are sold to developing nations. These products are designed primarily for applications in the nations that developed the technology, and these nations are mostly in the temperate regions. For this reason, the environmental conditions that are considered as part of the design criteria, and are well suited for the application of the technology, are those of the temperate regions.

Many of these equipments operate in remote rural areas where they may remain unattended for significant lengths of time. Some of these environments present extremes of weather conditions during the day and night times. Extreme humidity may also be a factor in the operational environment. While such technology work reasonably well in equatorial regions when they are operated by well trained technicians, technologists, and engineers, incorporating equatorial regional environmental conditions as part of the design criteria may extend the life time of equipment that are intended for use in such regions. It is essential that engineers, technologists and technicians receive an education that includes a consideration the effects of environmental conditions on the proper functioning of technology in developing nations where they may be deployed.. This paper discusses, and presents some efforts that need to be directed at the design of technologies that may be employed in equatorial regions. It also addresses the educational implications that need to be considered for those who may operate and maintain the equipment.

I. Introduction

The development of any technology from the inception of the idea through the prototype phase to a fully accepted and applicable state is a costly venture and the capital outlay at the beginning of the process can be very high. For this reason, there are not many companies that are able to undertake such a process from the beginning. Many companies will therefore jump in when the technology is established as a viable application. This indicates that it will be even further out of reach for a developing nation to undertake such a process. Developing nations are therefore generally user nations that depend on technological developments from manufacturing nations, and at best, developing nations can be service nations when their technicians, technologists and engineers are trained to operate and maintain the technology.

Technological development and hence the design criteria have advanced to the state where researchers and developers need to apply critical and well-defined design criteria and specifications to achieve the best results for the applications. While this applies generally to all technological developments, it may be more crucial in some cases. To cite

an example, in cases where temperature effects may be of concern, particular attention has to be paid to environmental conditions. In this case, technology that has been designed with criteria developed for temperate zones may have specifications that will need to be adjusted to achieve equivalent operability when used in the equatorial region, or for that matter in the polar region where frigid temperatures are experienced. Another example is where the incidents of rainfall, and hence humidity, may be a factor, or in dry arid areas where pollutants such as dust become of concern.

If the application is contained within an enclosed space such as in a building, the conditions within the enclosure can be controlled. However if the application is open to the environmental elements, atmospheric and environmental conditions can adversely affect the technology to the point where its performance, and hence life span for instance, will fall below expectations.

II. Specific Applications

One area of interest is in broadcasting, where both radio and television are involved. In this case, the pieces of equipment being used are housed in broadcast stations and hence the efficiency of air conditioning equipment can impact the performance of the equipment. Of more interest is the radio or television propagation that has to go through the atmosphere to reach the intended receivers.

Another area of interest is in telephony, both wired and wireless. Here again, the switching equipment would be housed in switching station, or base station buildings with environmental controls. However, some equipment such as radio relay equipment and remote base station equipment, may be located in areas where it is not possible to provide the necessary environmental controls due to lack of adequate power sources. Some of these equipment will therefore become exposed to the local environmental conditions at those locations.

As previously stated, the equipment in use would all be manufactured in temperate regions, and it is very likely that these would not be preconditioned to be operated in an equatorial region. In this region, excessive heat and dust are a problem during the summer months, and humidity is a problem in the rainy months when heavy torrential rainfalls are experienced.

III. Technological Considerations

The engineering considerations of the technology cited come in various forms, and one is the temperature effect. For a place such as Accra, the capital of Ghana[1], the average daily temperature is about 86^{o} F, and there are periods during the year when the temperature can be as high as 100^{o} F. Rainfall is listed as 43 inches in the north and 83 inches in the southeast annually. Humidity is listed as 79%, and the dew point as 75^{o} F. Similar

environmental conditions can be found in many of the capitals of West Africa and parts of South America.

The effects of the environmental data above can be presented in various forms. One of these concerns the periods when there is high moisture content in the atmosphere. This can adversely affect equipment both indoors and more particularly when the equipment is outdoors. If this is not properly dealt with, it can cause a thin film of moisture to form on components within the equipment. The dimensions of the water particles in the atmosphere can make the particles behave as scatterers, when they are comparable to the wavelengths of the radio or TV propagations. This will therefore affect radio and TV receptions. During the periods when the atmosphere is dry, dust particles in the atmosphere, with comparable dimensions to the signal wavelengths, will behave as crystalline structures that will reflect, deflect and scatter the radio waves. The constant high temperatures will also affect the performance of the equipment at the component level.

IV. Educational Implications

All the factors discussed above have serious implications in the design and manufacture of equipment intended for use in electromagnetic propagation applications, or in telephony. This suggests that these factors should be given consideration in the design specifications employed. It is therefore essential that the engineers, technologists and technicians involved in any aspect of the manufacture and testing of the equipment be aware of these factors. This can be achieved through dissemination of information, and the time honored approach to dissemination of information is through education. The ideal scenario would be for the manufacturers of the equipment to be aware of all the pertinent factors and to include them in their design parameters. Whether this is the practice or not, it is important for the user to understand the need for adhering to these parameters in operating the equipment. It is therefore a necessity that the engineers, technologists and technicians who will operate and maintain the equipment receive instructions that incorporate the physics and technological aspects of the factors mentioned above. These will include[2] but are not restricted to;

- Temperature effects on equipment
- External and internal noise
- Stray capacitances and inductances
- High frequency effects on stray capacitances and inductances
- Testing procedures for specific equipment
- Error detection and correction
- Appreciation of manufacturers' specification sheets

Another aspect that deserves study is the implication of cloud cover and its effects on electromagnetic propagation. This part of the instruction[3] will cover aspects such as ducting, reflections through the ionosphere and distant points at which radiations can be received. Topics could include;

- Atmospheric impact on electromagnetic propagation
- Wave attenuation and absorption
- Optical properties of radio waves
- Terrestrial propagation of electromagnetic waves

When put together, the points raised above lead to a critical aspect of all technology that rely on the propagation of radio waves, and that is Standards. In a developed nation such as the US for example, all operators adhere to the Standards administered by the Federal Communications Commission (FCC). Standards are formulated to be used to control the use of radio space (electromagnetic spectrum) by operators to ensure that all operators adhere to regulations that guide their functions. The FCC oversees functions such as allocation of frequency of operation and power levels for propagation. The need for this is to ensure that all operators are accommodated, and also that each operator respects the other's business. They also ensure that specialized operations such as emergency services are not disrupted. In third world nations however, such operational oversight is generally in their infancy. As these nations gain recognition in the global community, it becomes important that they conform to both national and international rules of operation. The education and training procedures that are employed in academic institutions in developing nations must therefore also include an understanding of environmental effects of equipment, as well as training on international as well as national Standards.

V. Conclusion

The need for adequate education and training of engineers, technologists and technicians to operate and maintain technical equipment that have been manufactured in temperate regions have been discussed. The approach adopted is that most developing nations are in the equatorial regions and hence the atmospheric conditions will be different from the temperate regions where the pieces of equipment are manufactured. The education and training procedures intended for academic institutions in developing nations will therefore have to prepare the graduates to effectively and professionally operate and maintain the equipment, with the hope that the equipment will function properly throughout its life span.

References

[1] URL: www.ghanaweb.com

[2] Sergio Franco, *Design with Operational Amplifiers and analog Integrated Circuits*, McGraw Hill, 3rd Edition.

[3] Wayne Tomasi, *Electronic Communications Systems, Fundamental Through Advanced*, Prentice Hall, 5th Edition