بسم الله الرحمن الرحيم

"In the name of Allah, the Most Gracious, the Most Merciful."

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TECHNOLOGY TRANSFER

by

Engr. Syed Sarfaraz Ali

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Dedication

To my beloved wife, Rafat, who selflessly sacrificed her career of teacher as well as a lawyer to dedicate herself to raising, guiding, and nurturing our children. Her unwavering love and commitment have been the foundation of our family. She is my lifeline, and our children are my strength.

Without her constant support and encouragement, it would not have been possible for me to perform my professional obligations, have free time to pursue my passion for presenting the result of my work experiences and research in my field of specialization in the written form and travel the world for seminars. This book, a compilation of my lectures and articles, would not have been possible without her. For that, I am forever grateful.

Engr. Sarfaraz Ali Syed

Engr. Syed Sarfaraz Ali

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Sindh University
Engineering College

ABOUT AUTHOR

Syed Sarfaraz Ali, a distinguished electrical engineer, has made impactful contributions to the energy sector over several decades. He holds a Bachelor's in Electrical Engineering from Sindh University, Pakistan, and an MBA from PW University, USA. Beginning his career in 1967 with Pakistan's Water and Power Development Authority (WAPDA), he gained vast expertise in planning, design, erection, supervision, testing, and commissioning of electrical systems. His contributions to the energy sector in Saudi Arabia, working with Al-Jazirah Consultant Group and Saudi Electricity Company, further underscore his global influence.

Mr. Ali has received specialized training in complex power systems from Pakistan, France, and Austria. From 1990 to 2001, he served as a System Study, Planning & Project Engineer at Saudi Electricity Company. He is certified in Power Protection Planning from King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia, and Project Management from George Washington University, USA. His training spans high-voltage power systems, project management, and environmental control at consultant levels.

A member of prestigious organizations like IEEE, CIGRE, and the Chartered Institute of Quality Assurance (IQA) UK, Mr. Ali has published over 30 technical articles in leading international magazines and conferences. His work addresses technology transfer, economic aspects of power plants, environmental impacts, and emerging technologies. His high-level roles, including Director of Commercial Operations and Project Director at WAPDA, highlight his influence in the global energy sector, where his dedication to sustainable energy solutions continues to shape the future.

Engr, Syed Sarfaraz Ali is an Electrical Engineer but he has a vast knowledge of International Standards and Specifications which help him in analysing and solving the technical issues.

He explains the highly technical issues in very simple English during Technical Exchange Meetings. Similarly his lectures makes him popular and appreciated by the audience of Seminars organised by IEEE, CIGRE and KFUPM.

This book is a collection of his Lecture, Articles and Essays published in International Journals and Seminar Proceedings. I hope Engineering community will appreciate this book and will look forward for another endeavour.

Engr. Mohammad Ameen Qasim Thabet
Rtd. General Manager,
Saudi Electrcity Co

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HITACHI
Inspire the Next
Hitachi Energy

HITACHI
Inspire the Next
Hitachi Energy

Engr. Syed Sarfaraz Ali is a well-known personality in the field of electrical engineering, having extensive experience working with multinational contractors and consultants. Throughout his decades-long career, he has delivered lectures at notable universities as KFUPM in Singapore, Portland State University, and Boðaziçi University in Turkey. His writings and papers have appeared in a variety of prestigious international magazines, as well as technical seminars hosted by IEEE, CIGRE, and IEP. He explores the complex balance between engineering skill and managerial intelligence in this book, providing vital insights on how to shift from a hard-working engineer to a successful manager. His ability to communicate complicated technological issues in understandable terms has garnered him aÊconsiderable reputation and respect in the engineering community. This book is a testament to his contributions and is sure to be a valuable resource for both aspiring and seasoned engineers.

Sincerely,
Najeeb Ahmed
Project Director HVDC
Easten Green Link-2 (EGL2) Project

Alpha Tower, 24th Floor Suffolk Street,
Queensway, B1 1TT, Birmingham

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FACILITIES ANALYTICS PLATFORM

A Legacy of Innovation

Throughout his career, Mr. Syed Sarfaraz Ali has worked on high-profile electrical projects across multiple continents including Europe, Asia, the Middle East, and North America. His work has addressed some of the most pressing issues in modern industry, including the integration of economical, ecological, and digital technologies. The writings in this book, drawn from his lectures at universities and publications in international journals, provide a window into his deep expertise and the lessons he has learned over decades in the field.

As you read this book, you'll gain insights not only into the technical challenges of our time but also into the mind of a man who has been a beacon of inspiration to many, including myself. Mr. Ali's work continues to set a high standard in the field of electrical engineering, and I am confident that the knowledge shared in these pages will inspire you as it has inspired me.

Sincerely,
Ray Kamal
Co-Founder and CEO
Entronix
Facilities Analytics Platform

Dallas, TX USA
7920 Belt Line Rd, Suite 215, Dallas, TX 75254

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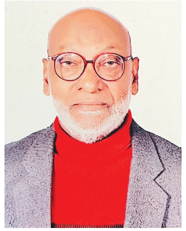
INTRODUCTION



Sarfraz Ali is a scholarly individual who, as an engineering student, sharpened his intellect by generating numerous innovative concepts, engaging with theoretical frameworks, machinery, and peers to acquire practical knowledge and enhance his ability to achieve time-efficient, effective outcomes.

His efforts to elaborate university periodicals with innovative arrangements of concepts demonstrated his vibrant and budding potential.

While working as a Grid System Construction and Power Distribution Engineer for WAPDA, the innovative ideas for increasing the department's profitability that he proposed were recognized and implemented by the department. Further, remodeling of stores and warehouses and improvement in the logistics of store material from store to worksite was sponsored by US Development Plan during 1986 – 1987. His work in creating brief, multifaceted articles and their essential points was found to be helpful for junior engineers.

His successful accomplishments in planning and establishing grid stations (500kv Jamshoro and Dadu) in rough terrain and the challenging job of establishing 66kv transmission line and station in the desert of Sindh (Chachro, Diplo and Islamkot) proved instrumental in the s/selection of experts by Saudi Electric Company to utilize his experience in Medina, Tabuk, Jeddah and Riyadh areas. As an asset to the parent company, his talent posed a challenge for him in seeking a well-deserved deputation to the Saudi Electric Company.

It is to his credit that even after serving the Saudi company for an additional 10 years, he was engaged with the consultant group of Aljazeera Saudi Arabia.

His dedication to the assigned tasks resulted in international awards and recognition from manufacturers of international repute such as ABB. His technical papers and articles were accorded special allocation in well-regarded journals.

As I observe the professional and research endeavors, I offer my heartfelt congratulations on the publication of this book comprising of lectures and articles by Engr. Syed Sarfaraz Ali and hope it will be a source of knowledge for future of electrical engineering.

Muhammad Sharif Ansari,

Former Caretaker Minister, Environment & Alternative Energy, Govt of Sindh

(Rtd) DG Monitoring & Surveillance WAPDA

(Rtd) Chief Engineer Power Distribution HESCO, SEPCO, LESCO & GEPCO

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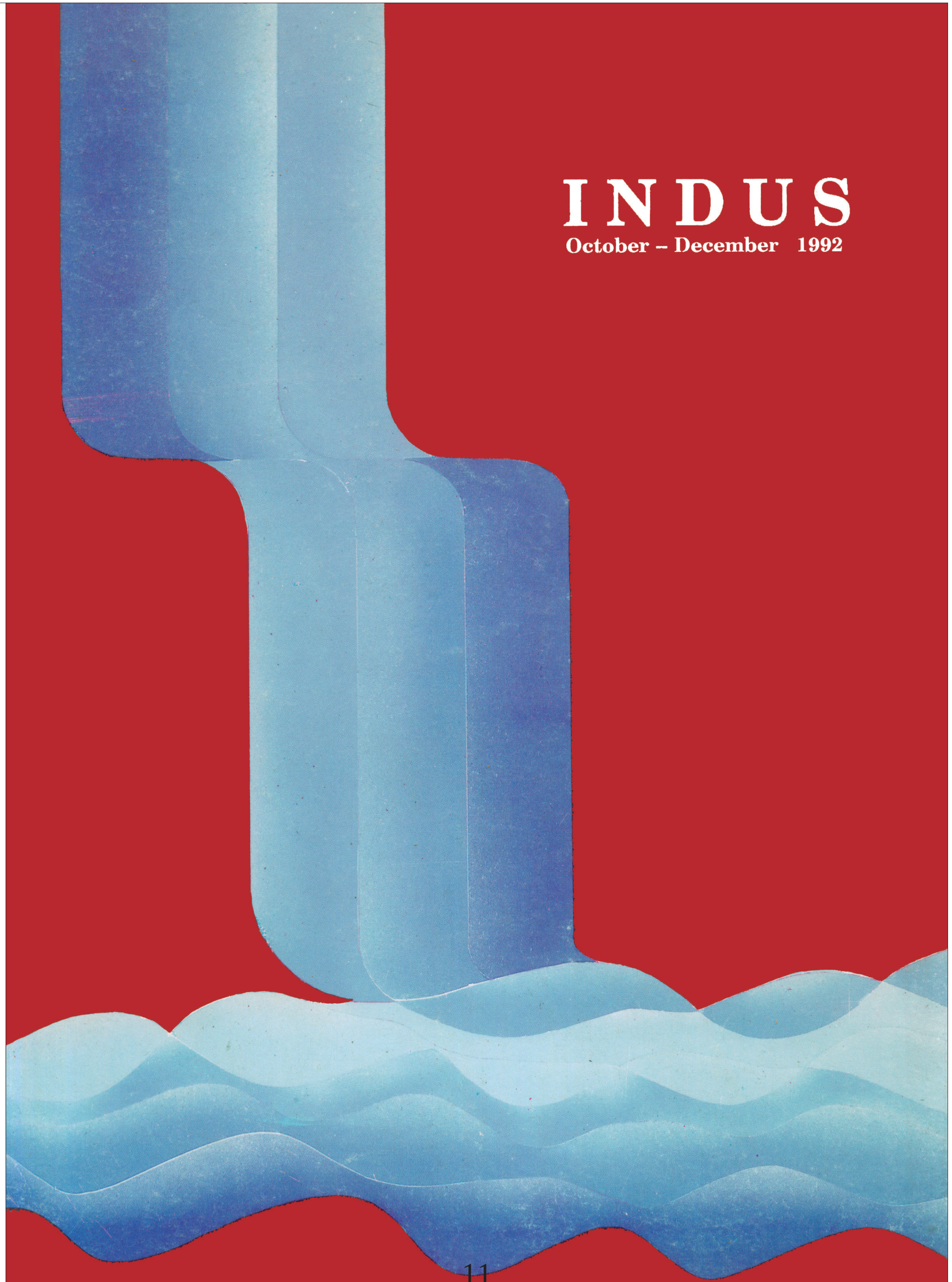


JOURNAL OF THE PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

From left to right: Syed Sarfaraz Ali, SDO Sukkur; Mirza Hussain Ali, P.D Guddu Power Stn.; I A Khan, Chairman WAPDA; Ch. Hussain Muhammad, Chief Engr. Hyd.; G.M Malik,G.M Planning; Fakhr-ul-Islam, XEN Sukkur

QUALITY IN ELECTRICITY

Engr. Syed Sarfaraz Ali

WAPDA took over the task of generation, transmission and distribution of electricity in 1959 from the existing government departments. As such the organization came into direct contact with the general public, being responsible for providing them the most important utility service efficiently by reliable supply. In this article, Syed Sarfaraz Ali, a WAPDA engineer currently on deputation to Tabouk, Saudi Arabia, has discussed some important aspects of power distribution.

The idea of introducing 'quality concept' in engineering design manufacturing and services has gained profound interest in developed countries. In United Kingdom, it dates back to the years of the World War I, when it was felt necessary to check the specifications of defence-oriented material and spares to ensure safety, interchangeability and economy. This resulted in formulating rules for inspection during manufacturing and before shipment. An Institution of Engineering Inspection was formed in 1919, which later became the Institute of Quality Assurance.

Quality is a word which has many meanings depending on the context in which it is used. The British Standard definition of quality according to BS 4778: is "The Totality of features and characters of a product or services that bear on its ability to satisfy stated or implied needs".

However, in this article we are talking about quality in services of electric utility – WAPDA.

WAPDA AS ELECTRIC UTILITY

In Pakistan electric utilities companies started with many small enterprises serving cities and small towns with various types and magnitudes of voltages and frequencies. The event which brought these holding companies to a close was the promulgation of Wapda Act 1958.

Wapda was made responsible for all the Water and Power Development activities in the country besides sale of Electricity to the consumers. Wapda took up the challenge and erected a large network of transmission lines, distribution mains and developed the generating capacity. Today Wapda is the only agency in Pakistan which is responsible for generation, transmission, distribution and sale of Electricity.

The electric utility industry has unique technical characteristics which makes it different from other business utilities.

1. Electric utility must create its

product simultaneously with its use. There is no storage facility. This requires as system capacity to meet the load demand at whatever moment it occurs.

2. The product itself (Electricity) can only be detected through special devices i.e. it is intangible.

DISTURBANCES IN DISTRIBUTION

Although electricity is intangible, it can be measured in quantity as well as in the quality. The quantity is measured by machines only (Meters) but quality can be measured by Man and Machines both. In electric supply, the quality can be measured by the following:

1. Service continuity
2. Reliability
3. Uniform and proper voltage
4. Uniform and proper frequency

In technical terms, the shape of voltage time curve, its smoothness or wave shape is a measure of quality. Disturbances in electric supply not only causes public hue and cry but it also adversely effects the power system itself. Apart from the outages due to failure/tripping of machines, breakdown in the network and load shedding for any reason, various other types of disturbances may affect the quality of electric supply at the consumers end. Few are quoted from personal experience.

Increasing use of convertors thyristor controlled devices, induction furnaces and welding transformers causes' interference and disturbances.

Similarly railway traction loads are not only large in magnitude but are accompanied by phase unbalances in the system effecting other consumers and communication system in the vicinity.

These disturbances as seen through recording Instruments are shown in Fig A. The adverse effects on the power system due to these appliances can be listed as under:

1. Overheating and over stressing of insulation
2. Interference with communication, protection and signaling circuits
3. Errors in metering
4. Lamp flickering

> The most important duty of power wing engineers of Wapda is to provide electricity to the consumers in a cheap and reliable way. These two factors i.e. price and reliability are competitive as increase in reliability requires more capital investment. This is where an engineer has to assume the role of an economist. He has to come out of the "Machine Atmosphere" and face the public. He should listen as attentively to the complaints, suggestions and academic advices as he listens to hum of generator

5. Machine vibration
6. Burning out of small auxiliary components like fluorescent lamp capacitors

The failure of supply, outages short or long in plants or networks can be attributed to the poor operation and maintenance on the part of engineers/technicians. But the outages due to load shedding (shortage of generating capacity) can not be attributed to the operating personnel.

In Pakistan there is a shortage of power. Our demand is less than the generating capacity by almost 2000 MW. For that we have to change our generating pattern and try to explore other re-newable and non re-newable sources of energy. This require a separate and detailed discussion but we could at least improve our present situation by adopting an efficient quality control system in accordance with the International standards and practices.

BASICS OF A QUALITY SYSTEM

In this article we have discussed the disturbances in the distribution mains only because the general public is not interested in what type of generation strategy is being followed or weather he is getting supply from Tarbela or Kot Addu. All the hard core planning, tight maintenance schedules and computer aided studies are of no use if we fail to provide electricity to the consumers to their satisfaction. In the early development stage our senior colleagues developed certain ways of doing the things and stuck to them until they became traditions. Situation is quite different now. The public mood is different and advocates of "Market Economy" are attacking the basic authority of Wapda.

We are being thrust into a market economy and the privatization of energy sector will bring more competition, so it is necessary to act with vision and wisdom. To move forward as an industrial and commercial organization in the changing circumstances a complete and total quality management system in accordance with the principles of BS 5750-Qualtiy system which is identical to the ISO 9000 series, should be adopted.

An effective quality management system to satisfy the consumers needs and expectations while serving to protect WAPDA's interests may be devised. A well-structured quality system is a valuable management resource in the optimization and control of quality in relation to risk, cost and benefit considerations. Factors affecting the quality of the services should be carefully studied and brought under the control of quality circles at all levels. All such quality circles should be established under each General Manager/Chief Engineer and made responsible to watch and control the deficiencies which are affecting the quality of our services.

Management should provide sufficient and appropriate resources to implement the recommendations of quality circles. The most important resource in service oriented organization like Wapda is the personnel involved. Because the behavior and performance of individuals directly impacts the quality of services. In fact every employee whether in generation, transmission, distribution or corporate planning contributes to some degree to the achievement of quality. For instance if there is no procedure for load-forecast and future extension in the network what hope is there that Wapda can supply electricity to a prospective consumer. If the duties and job description are properly compiled and maintained they can provide management with a good means of clear and un-ambiguous communication with personnel at all levels.

Some may say that all this is not new and has already been tried in Wapda, they may be right to certain extent because Wapda has never remain immune of the genius and innovative engineers, but what we need today is calculated, coordinated and joint effort to face the coming days of tough competition.

We are now in a transition stage. Gone are the golden days when customer/consumer was content with the quality, degree and adequacy of electric supply and its charges. Today we are facing an educated and agitated consumer, who takes for granted the supply of electricity at his door step. Public now questions the development plans, challenges the tariff, protest against fuel adjustment charges and take out procession against loadshedding. Finding creative solutions to the problems arising in the fast changing economic situation needs "Continuous improvement" in the system.

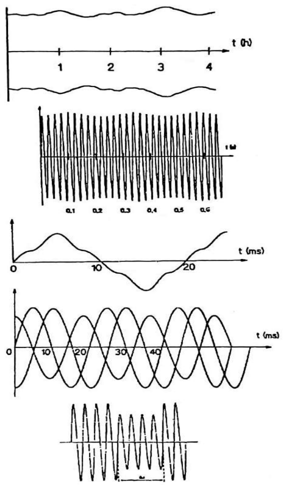
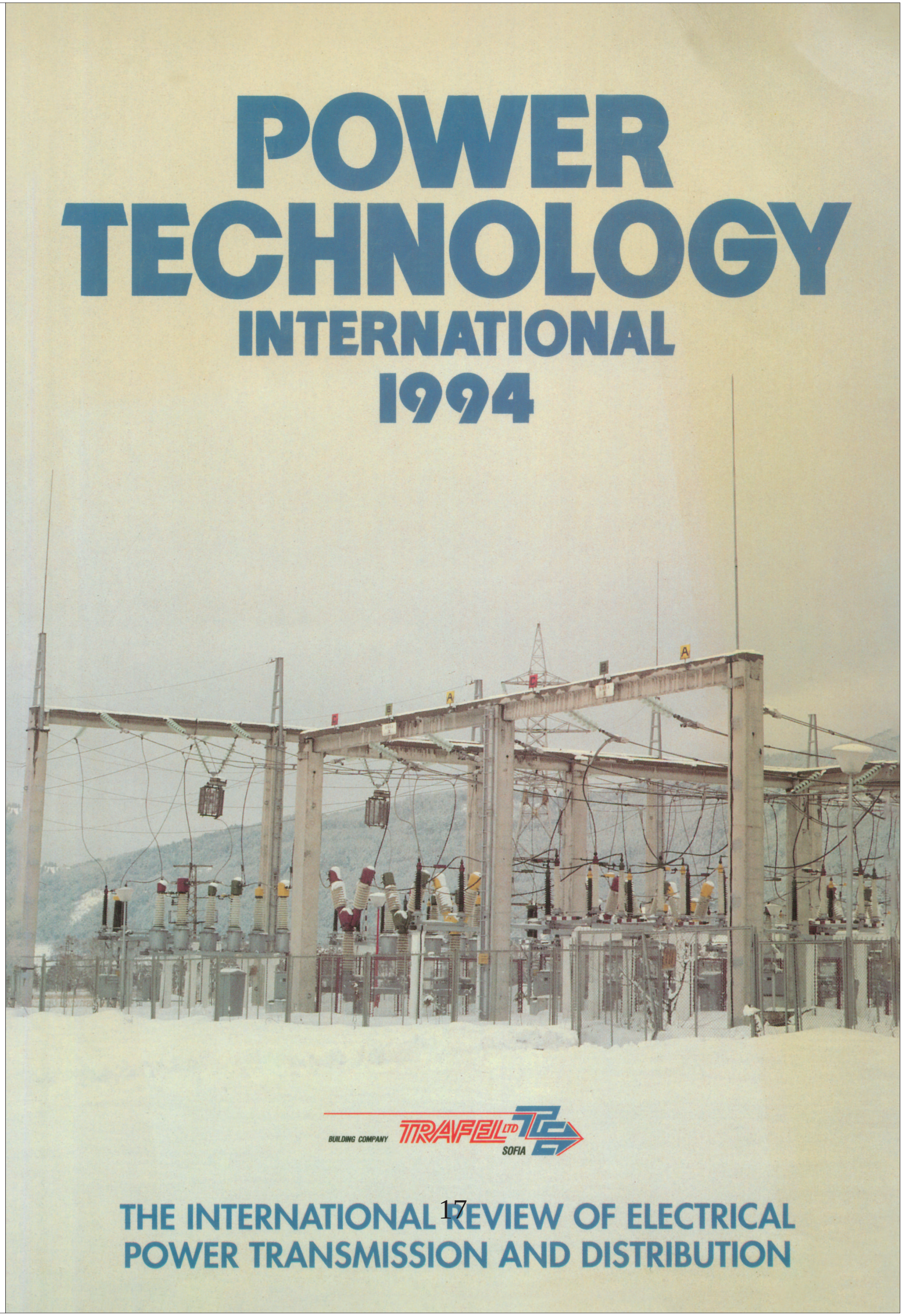
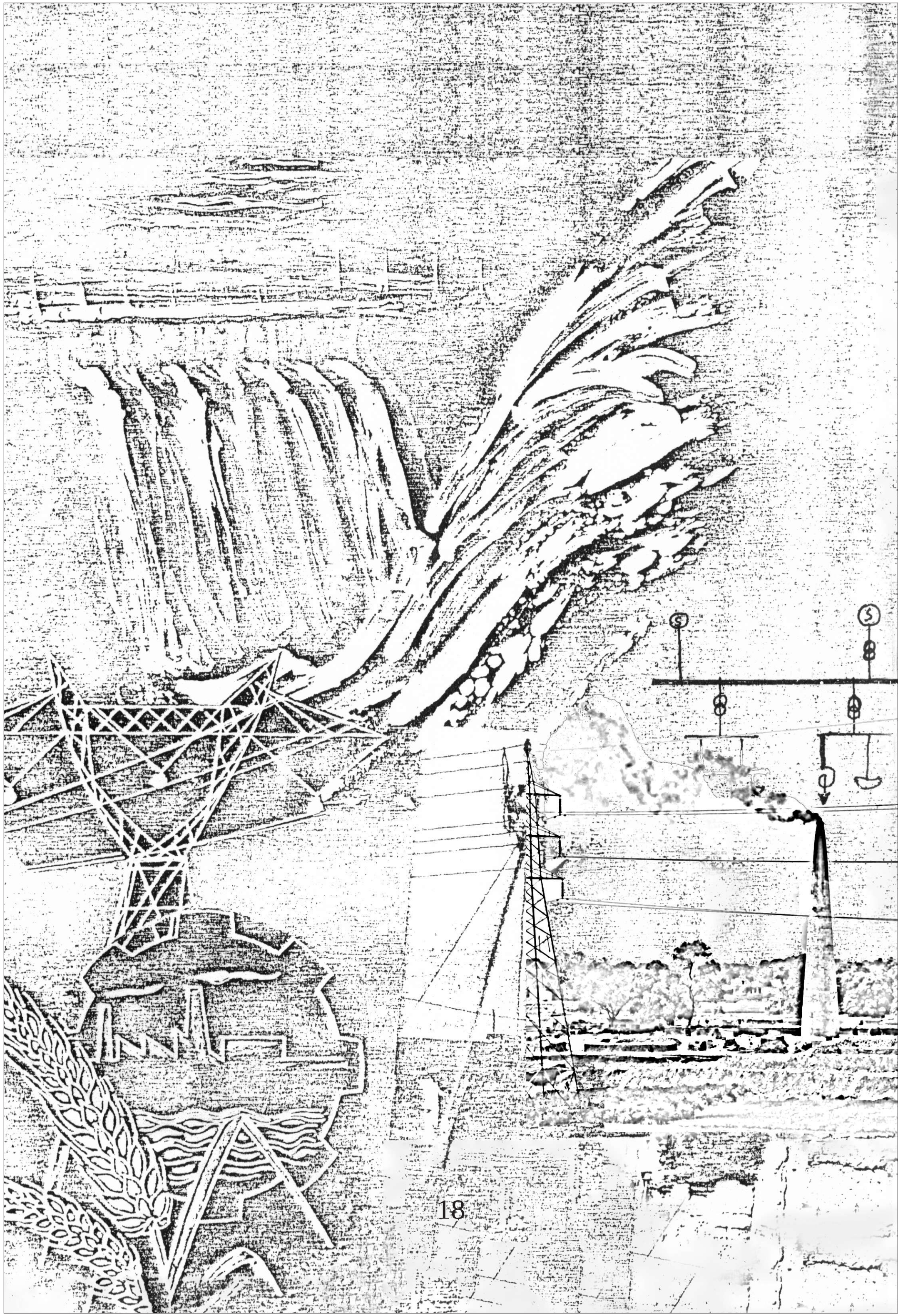


Figure 1. Top to bottom show voltage variations, voltage fluctuations, harmonic unbalance, voltage dips





ECONOMIC ASPECTS OF VILLAGE ELECTRIFICATION IN PAKISTAN

Engr. Syed Sarfaraz Ali

Introduction

Pakistan is basically an agricultural country, more than 70% of our population still lives in the rural areas and depends on the income from farm land. One of my Professor of Economics used to say that "Our Culture is Agriculture". The primary economic problem in many villages in Pakistan is that the majority depends on marginally productive, small parcels of land. The best agricultural land is used for export and cash crops, which generally benefits a wealthy few. The poor must scrape a subsistence living from the rest. This is mostly steep, water logged, eroded and far from the irrigation canals. As the twin menace of water logging and salinity is damaging the land and deforestation proceeds at an alarming rate, rural poverty is increasing and ecological crisis threatens.

The solution to these problems, and to the low living standards they impose, must involve providing rural populations with better means of production – Primary land, credit, technology, and an affordable and reliable supply of ENERGY.

Supply of cheap sources of energy including Electricity to these areas will solve the problems of low income and low rural employment (hence income distribution) by increasing productivity. It also directly addresses their manifestations by providing Electricity to households, health clinics, schools, and for public lighting – to name the most important uses.

Electric Power is a vital engine for development, not only in the urban – industrial context, but also in rural areas. Many of the changes that are transforming the societies from agriculture to industrial economy, can no longer be ignored if we want to compete in International Markets.

George Stephenson prophetically saw this as early as 1847 and said that: "Electricity would become the greatest motive power of the world".

Whereas the famous writer Emile Zola wrote in 1901:
"The day must come when electricity will be for everyone, as the waters

of the rivers and the wind of heaven. It should not merely be supplied, but lavished, that men may use it at their will, as the air they breath".

In the long run, this vital force must reach the VILLAGES. The main topic of this article is that the potential for rural electrification in removing the basic structural causes of poor living conditions has not been fully realized. Village electrification is a critical element of efforts to stimulate agricultural production, agro-based industry and other employment opportunities.

Rural Energy

Village electrification must be seen within the context of the overall rural energy sector because rising fuel prices are very important. In the rural areas all over the world non-commercial energy sources (wood, cow dung, dry stems of crops) are being widely used. According to the World Bank Report 1979, and World Bank Atlas 1981, the total energy requirements of the developing countries were about 18 million BPDOE (Barrels a Day of Oil Equivalent). Over all about half of this was met from non-commercial sources, mainly in rural areas. Oil supplied about one third of the commercial energy. In 1979 these total energy requirements were about 23 million BPDOE, with a larger percentage of oil. In 1990 it was about 42 million BPDOE, with only 60% from commercial sources.

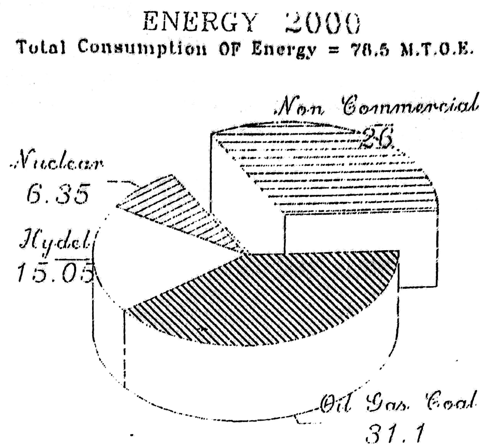
Similar studies have been carried out in Pakistan by the Ministry of Petroleum and Energy Resources, according to the statistics provided in the Energy Year Book 1986 (Govt. of Pakistan) our total requirement of energy in 1986 was 25.35 MTOE (Million Ton of Oil Equivalent), and the annual consumption growth rate (ACGR) was 7.83%. Keeping in view all the relevant factors i.e. population explosion and ever growing trends in the standard of life, development of industrial and agricultural sectors, extensive use of electronic gadgets, the requirement of energy at the beginning of 21st Century would be around 78.5 MTOE, out of which 26.0 MTOE will still be provided by the Non-commercial resources. See figure 1 & 2.

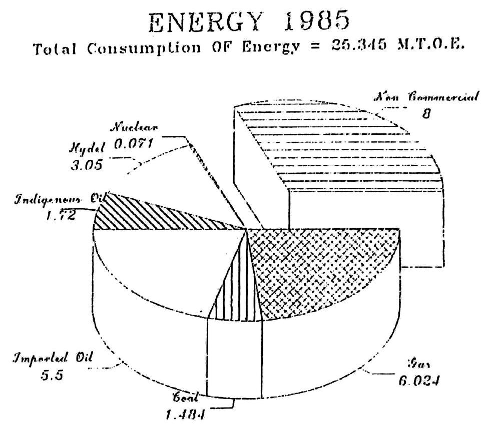
For the majority of the people living in villages, non-commercial energy resources will continue to play a dominant part in their lives, at least for the next two or three decades.

This fact is often overlooked and in our enthusiasm for development, we often compete village electrification with non-commercial energy resources.

Pattern of Energy Use In the Villages

The pattern of energy use in the villages in Pakistan is quite different from that in the cities mainly because life in rural areas is intensely agricultural, which is unfortunate for financial and economic viability of all village energy projects, since it leads to low utilization of most energy production equipment; as low as 10%, particularly where cooking is done by non – commercial fuels like wood.





The primary energy sources available and in common use in the rural areas of Pakistan are given in the following chart for comparison.

Measured, therefore, in terms of willingness-to-pay, economic benefits might be small for a very large capital outlay in village energy projects, e.g. private diesel-electric generators, private diesel motors, grain driers, etc., as has been the experience in Pakistan. However, patterns of rural energy use and the rural ways of life are beginning to change, as communication improves and the world becomes smaller, towards the pattern of urban areas. This is a long established trend in developed countries and it is becoming apparent in developing countries, where the rural population is demanding and starting to receive larger quantities and higher grades of energy than one would have considered possible even twenty years ago. The rapid increase in the quality of life which goes with higher expectations makes the case for improved energy projects in the coming years, much more plausible than in the 1970's and 1980's, especially in the villages where little commercial energy is being used.

The following factors will force the use of higher grade energy in villages:

1) The use of fire-wood causes deforestation with its disastrous effects.

2) The use of dung deprives the land of much needed fertilizer, the artificial forms of which are very expensive.

3) Up to two-third of a working day can be spent gathering non-commercial fuels which leaves less time for other works.

Rural Electrification

It is hard to define rural electrification precisely, as it has been given different meanings in different times by different governments in different countries according to their socio - political conditions. In general it is defined as the electrification of the basic administrative unit mainly for the convenience of identification. For example, Indonesian government uses the term "Kabupaten" (provinces) as the basic geographic unit, broken down further into three types of rural agglomerations; (i) Swaembada, (ii) Swakarya, (iii) Swadaya. Similarly there are "Thanas" in Bangladesh, "Douars" in Moroco, and "Barrios" in Philippines.

In Pakistan we call it "village". In the revenue records of local civil administration such group of population ranges from 10 or more hutments, but unfortunately detailed survey of all villages in Pakistan has not yet been carried out with the result that different definitions is given for

villages in the four provinces of Pakistan. Chak in Punjab, Goth in Sind, Killi in Frontier, and Dera in Baluchistan, all have different meanings according to the socio-political situations. The migration of rural population to big cities in search of employment has not only resulted in mushroom growth of settlements (Kachi Abadies) in and around cities but the old pattern of rural life has also disturbed. This may be one of the reasons that the economic gains of village electrification schemes are not visible.

Under a broad brush approach, however "Village Electrification" schemes generally covers areas where agricultural activities (however small it may be) dominant, the ratio of labor to capital in production is high, and incomes are low as compared to cities.

Electricity can be introduced into rural areas in several ways:

1) Isolated generators powered by a variety of means, including diesel, mini – hydro, solar plant, wind turbine, etc., serving single consumer (for example, a flour mill, water pump, a business).

2) Isolated generators serving several consumers who are connected by a local network, (for example inhabitants of a small community like two or three villages near Islamabad have been supplied through a Solar Plant).

3) Public supplies from a regional or National grid, (like WAPDA in Pakistan).

Typically these are not the only ways but usually it happens like that, or they might occur in this sequence. The process can be thought of as an initial building up of demand, by means of self or auto-generation, to a point where it becomes economically feasible to connect to the central grid. It will not be proper to say that the most economical method for electrifying the villages, is from the National grid. In the developed countries while electric supply from the National or in some cases International grids continue to expand wherever appropriate, decentralized electric power generation is playing an increasing role in some areas through mini-hydro plants, wind power generators, and solar power devices. Neglected resources such as low grade coal and agricultural waste, like cotton sticks and sugar-cane buggas is also being used. The conversion of solar energy to electricity is being investigated through a variety of techniques, ranging from photo-voltaic cells and conventional mirror concentrators to greenhouse-type evacuated tubes. Other alternative technologies include gasifiers, biogas units, and thermal units utilizing solid waste.

Role of WAPDA

WAPDA is the only agency responsible for the generation, transmission, distribution, and development of Electricity in Pakistan as such the responsibility of providing electricity to the villages under the National Development Plan is also one of its important duty.

Village electrification has played, and will continue to play a major role in the development and uplift of the rural areas. Rural people, conservative by nature, were slow at first to take the electricity but today they can be seen pursuing their application for electrification and sometimes fighting over the priority list of the villages approved by the government for electrification.

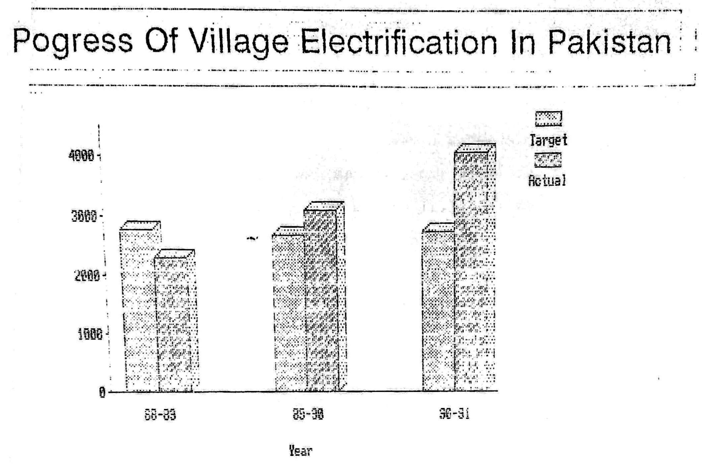
The phenomenal increase in crop production in many parts of the country which has made Pakistan almost self-sufficient in food could not have occurred without the extensive use of electricity. Village electrification is becoming a reality. Unfortunately, this reality has yet to reach many areas. Many villages still cannot enjoy the benefits of electricity because of the shortage of funds and electricity.

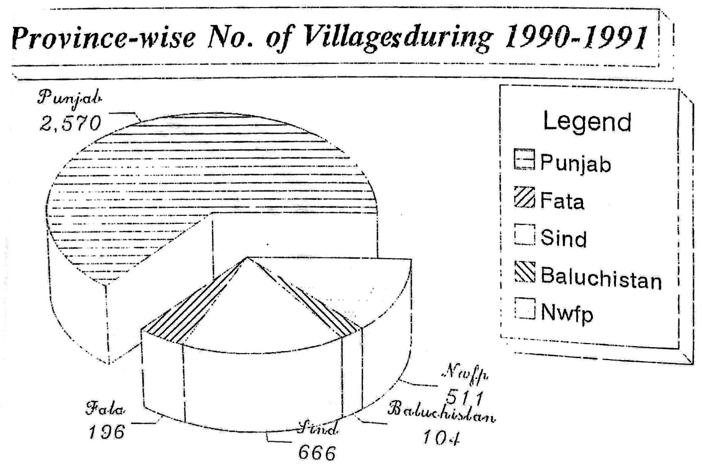
The details of the number of villages electrified by WAPDA as per WAPDA's Annual Reports 1988-89, 1989-90, and 1990-91 is given as under:

YEAR	TARGET	ACTUAL VILLAGES ELECTRIFIED
1988-89	2771	2301
1989-90	2698	3096
1990-91	2734	4047

Although WAPDA's power supply position during these years remained under constant pressure, coupled with the industrial and agricultural sectors largely exceeding their targets for power connections, yet the democratically elected government gave further boost to the agricultural sector and WAPDA accomplished the job. The details on graphs is shown on next page. According to the WAPDA ANNUAL REPORT 1990-91 the total numbers of villages electrified by WAPDA upto 30-6-1991 is 37,135.

While significant progress has been made, it is still slow. There are many reasons, including low population density, terrain features and even the lack of a felt need for electricity. But aside from geography and apathy,





there are other problems encountered during the process of village electrification. Political and economic struggles are found in all stages of financing, design, material procurement, construction and maintenance of village electrification schemes.

WAPDA and especially the power wing engineers should be proud of its achievements in attaining the targets of village electrifications set by the Government during the last two decades despite all these difficulties.

Economic Aspects of Village Electrification

Although rural electrification, like rural water supply, is not necessarily meant to be viable commercially either to the Government or to the Electricity Department (WAPDA), it must always prove to be CHEAP and RELIABLE. The limited post-evaluation work of the late 1980 and early 1990 shows that the economic benefits seems to be poor, poorer than the expectations.

Rural communities have not been improved economically, even under the best possible efforts and conditions. In my view this was more likely because of other infra-structures failing to develop rather than failure of the rural electrification schemes.

Engineer Mohan Munasinghe, Division Chief with the World Bank has summarized this in one of his research studies as under:

"Rural electrification benefits are best realized where there is already a certain level of development. It may be prudent to delay electrification of a village until other infrastructure is in place or local incomes have risen".

Up till now proper attempts have not been made to justify financially or evaluating technically any village before electrification in developing countries in the manner other developed countries in the West and Europe are doing. In the developed world all potential rural consumers have been connected. In other developing countries, village electrification is proceeding rapidly as a matter of government policy to connect up all but the most inaccessible hamlets, but no hard and fast rules are normally being followed and every country has adopted a policy according to its political situations, social structure and economic conditions.

State Electricity Board Tamil Nadu (INDIA) presented a novel idea of rural electrification by providing free electric lights (Single Bulb in each hut) to 900,000 huts and free electric irrigation water pumps to 400,000 small farms in drought-prone areas. This complicated the issue, though meant to benefit the poor, wound up in political debate and even well-to-do farmers, arguing that they do not receive fair prices for their crops clamor for further reduction in the electricity tariff. This opened up a pandora box and now government is in fact facing a demand that electricity should be supplied free of cost to all farmers, not simply hut-dwellers and small farmers. If granted, the cost will be staggering. By itself, the provision of

free electricity to huts in Tamil Nadu costs Rs 390 millions a year, and the figure is likely to rise more in the years to come with no upper limit. It is necessary to have economic justification of village electrification schemes in the developing countries especially where capital is short and funds are arranged through International agencies like World Bank or other Development Funds, because:

1) Village electrification requires a great deal of capital investment per consumer.
2) The low revenues from rural-electrification schemes reduce the possibility of economic "take-off".
3) Remote locations and inaccessible villages make it difficult to maintain the supply and taking meter reading and collecting revenues.
4) The rules of the loan giving agencies stipulate investing only in economically justified projects.

These basic characteristics make difficult demands on the Electric Utility (WAPDA) and the Government are discussed briefly as under in the light of practical experience in the field of electricity development in rural as well as in urban areas. These are being submitted for further study and consideration to achieve maximum benefit out of village electrification as we are supplying electric power to villages when we need it badly for the industrial sector and we had to resort load shedding for hours in a day even in big cities like Lahore and Karachi.

1. Selection of Village

The selection of the village for electrification needs some rational policies and it must be clearly defined to avoid any possible increase in the losses in electricity which is already very high (in Pakistan) and to avoid corruption at any level in village electrifications.

There are many institutional problems also because many government departments and agencies are involved in different aspect of the village electrification projects, hence a National Policy should be formulated for village electrification schemes clearly defining the duties and responsibilities of each department and agency. The selection of village for providing electricity by a GOLD FINGER pointing on geographical map may be a good system from political point of view but the key to successful establishment and use of electricity for development in villages lies in an organized structure and well calculated efforts according to the socio-economic conditions and not on socio-political demands. Non-engineers take the extension of electric lines as extending a road, railway, or laying a new pipe line for water supply, and convince themselves that electricity lines can also be extended similarly. The electric networks in Pakistan have extended from Tarbela to Karachi and it is one of the greatest achievement of WAPDA, but the flow of electricity through a system follows the Laws of Physics, not the Legislation. In the evolution of a Power System, the extension of feeders and construction of Sub-Stations are properly designed to provide CHEAP and RELIABLE electricity to the consumers without jeopardizing the system itself. The selection of a Village for electrification needs carefull study by Engineers, Economist and Politicians so that the benefits of village electrification reach the grassroot level.

2. Type and Quality of Village Electrification

An extensive survey should be carried out of the rural areas concerned. Data are needed to find out the population level and growth; income level and growth; occupation; present means of providing essential services like lighting, cooking, heating, cooling, water supply, food preservation, communications, education, medical facilities, etc. The data are used for a rough macro-economic analysis to compare the area with other similar rural areas which have taken-off economically. The use of other indigenous resources of energy should be encouraged as far as possible. Only those villages should be connected with the electricity (National Grid) where benefit to the economy of being connected to national grid exceed the cost to the economy. This is very difficult job but when there is already short of essential power for other important works like defence and industry, this exercise is very necessary. Is it not a luxury that export oriented industries are being asked to run in two shifts only and all business centers in the cities are subjected to load shedding during peak hours whereas new villages are being connected adding more and more load on the already overloaded system.

3. Low Revenue Return

The low revenue return on the capital investment means that the Electricity Utility (WAPDA) or Government, both should consider subsidizing electric charges for the villages like the present scheme of special tariff for agricultural tubewell connections in Pakistan, for many years to come; possibly forever.

The long-run internal financial return on investment makes the village electrification project difficult to justify economically to the satisfaction of Economic Wizards as it is very difficult to quantify the economic gains and to measure the economic benefits in the absence of basic cost data.

Rural electrification promotes agricultural development only when certain complementary inputs, such as electric pumps and financial services, are available. However, subsidized power prices may conceal the reality that the costs of electric pumping often exceeds other alternatives especially in remote areas where there are no other facilities like roads, communication, education, health and even water; but WAPDA is forced to provide electricity by extending the grid supply. Such type of village electrification may costs millions in terms of capital investment, and extra line losses and operating and maintenance charges as recurring costs.

Load growth is often hampered by a failure to recognize the dynamic nature of village electrification. Poor planning, inadequate maintenance and follow up, over loading of existing systems, and poor quality of supply are some of the problems.

4. Development of Agro-Based Industry

Rural electrification seems to stimulate agro-industry and commerce, although the direction of casualty is not completely clear. (Rural areas that are ready for sustained growth are likely to be the ones chosen for early electrification, and they will show rapid growth in demand.) There has been a tendency to overestimate productivity gains in the industrial and commercial sectors in the appraisal of rural electrification schemes.

5. Development of Electrical Industry:

Large scale village electrification schemes have involved a lot of contracting between WAPDA and small and medium sized industries, and as a result it has acted as a catalyst for industry in the country. Industrial units manufacturing hardware and supply companies to supply line material, poles and cross arm, conductor and cable, insulators, meters and other necessary material have been developed in different parts of the country. In this process WAPDA has also improved its design, making it more reliable and economical using indigenous resources. Similarly race and competition among companies has produced innovation in the manufacturing and installation techniques.

6. Development in the Standard of Village Life

Agricultural is still the mainstay of Pakistan's people despite the developments made in the industrial sector and mass migration of population to the cities in search of work. Rural consumers see a major improvement in their lives, mainly due to the improved quality of lighting, for which they are willing to pay far more than their prior spending on Kerosene lamps. Access to entertainment through Radio and Television also contribute to this. However Electricity rarely replaces other fuels for cooking or heating, because of high charges.

Unfortunately it has been observed that there is marked tendency for the benefits of village electrification to accrue mainly to better-off and influential people (wealthy landlords, politicians, and local officials), unless the program is well designed and the benefits carefully targeted. Thus village electrification is generally not a good way to improve income redistribution or social equity. In addition, care must be taken to ensure that perverse effects do not occur, for example, the electricity revenues from the urban poor are used to subsidized the rural rich.

7. Energy Losses and Arrears

Despite all the pride of establishing a large network of power and providing electricity to the villages to the farthest corners of the country; during village electrification there has always been an element of false accusations undermining all these achievements.

There has been an inadvertent increase in the system losses, accumulation of arrears and reduction in the realization of revenue. This is a very complex issue and requires special expertise, strong will and cool patience in analyzing the issues and finding the solutions.

(i) System Losses

Sometimes an extra long feeder has to be constructed against standard design and specifications to supply electricity to a remote village under the instructions which result in extra voltage drop and line losses. In many cases adequate engineering is not utilized in the designing and planning of the rural feeder. Main feeders which were built to serve a significant town or tubewells are extended to the nearby villages then to the next village and so on. Very quickly consumers on the whole feeders are receiving low voltage and unreliable supply. Extending the

existing mains or low voltage supply lines to accommodate new consumers, use of under size cable, conductors, and other equipment increases the technical and non-technical losses. The combined technical and non-technical losses from such wrong practices and non-coincident metering and/or billing periods, human error, and pilferage can well exceed 30%. In 1983-84 WAPDA's losses were 29.3%. WAPDA has already taken up this issue of reducing system losses with the help of foreign consultant and has started a comprehensive Energy Loss Reduction program but it needs a joint effort of all concerned agencies and public.

(ii) Accumulation of Arrears

When a village is electrified, functions are held, opening ceremony is performed with great pomp and show, some words of praises for the Government and WAPDA Officials are spoken and news is flashed through media of the great progress. But after that, the operation staff (Distribution Engineers) of WAPDA is subjected to all sort of pressures, accusations, and intimidations. Nobody is ready to get the meter installed in a proper way, the internal electrifications are usually sub-standard and dangerous, meter reading is a problem and distribution of electric bill is still a bigger problem. The electricity charges goes on accumulating and sometimes the connection can not be disconnected due to law and order situations. Stories of such ordeal are often published in the press but who can imagine the plight of WAPDA officials who receives warnings and reprimands when the arrears are increased in his area, but disconnection of such consumers or premises is beyond his power. In some cases the local bodies or public service departments fall short of funds to pay the electricity bills. The electric connection can not be disconnected in the interest of public service and the arrears goes on accumulating in the account book of WAPDA for which somebody has to be blamed, and the WAPDA official seems to be the easiest target.

Everybody wants to enjoy the benefits and luxuries of electricity at the expense of the government and the electricity department. This attitude of a few is affecting millions who have not yet been provided with electricity, as all the progress and further village electrification schemes are delayed for want of funds. We need to educate the public and make some arrangement of collecting the electricity bills pertaining to public service departments directly from the source like Annual Budget, Grants or Loans.

Conclusion

1) Pakistan still lives in its villages and it is a fact that ELECTRICITY has played very important role in the development of agriculture and agro-based industry besides improving the living conditions of our rural folks. It is hoped that electricity will continue to play more productive role in the development of Pakistan as a whole, but the shortage of electricity and its resources compel us to use the available electricity more efficiently and economically.

2) The initial survey of all the villages and areas where electricity has not reached should be carried out.

3) National policy regarding village electrification may be formulated to provide electricity according to the priority and availability, choosing the most appropriate sources of energy, keeping in view the limitation of the existing power system, and following the standard International Specifications Of occupational Safety Health And Engineering. (ISO, IEC, & OSAH).

4) The recent policy of privatization of power may be extended to the rural electrification and substitution of electricity for other resources may be encouraged.

5) Small companies based on isolated system utilizing indigenous and renewable energy resources in the proximity to the rural communities will be more efficient and manageable.

6) Priority may be given to only those consumers whose benefit to the economy of being connected exceed the cost to the economy.

7) Village electrification schemes may be brought under the co-operative farming and loans may be provided for such uplift schemes to the farmers through Agricultural Development Bank or other loan giving agencies.

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Rural Electrification

Engr. Syed Sarfaraz Ali

The phenomenal increase in crop production in many parts of the country which has made Pakistan almost self – sufficient in food could not have occurred without the extensive use of electricity. Village electrification is becoming a reality. Unfortunately, this reality has yet to reach many areas. Many villages still cannot enjoy the benefits of electricity because of the shortage of funds and electricity.

Pakistan is basically an agricultural country, more than 70% of our population still lives in the rural area and depends on the income from farm land. The primary economic problem in many villages in Pakistan is that the majority depends on marginally productive, small parcels of land. The best agricultural land is used for export and cash crops, which generally benefit a wealthy few. The pour must scrape a subsistence living from the rest. This is mostly steep, waterlogged, eroded and far from the irrigation canals. As the twin menace of water-logging and salinity is damaging the land and deforestation proceeds at an alarming rate, rural poverty is increasing and ecological crises threatens.

The solutions to these problems, and to the low living standards they impose, must involve providing rural populations with better means of production-Primarily land, credit, technology and an affordable and reliable supply of energy.

Supply of cheap sources of energy including electricity to these areas will solve the problems of low incomes and low rural employment (hence income distribution) by increasing productivity. It also directly addresses their manifestations by providing electricity to households, health clinics, schools and for public lighting - to name the most important uses.

Electric Power is a vital engine for development, not only in the urban - industrial context, but also in rural areas. Many of the changes that transforming the societies from agriculture to industrial economy, can no longer be ignored if we want to compete in International Markets.

Village electrification must be seen within the context of the overall rural energy sector because rising fuel prices are very important. In the rural areas all over the world non-commercial energy sources (wood, cow dung, dry stems of crops) are being widely used. According to the World Bank Report 1979 and World Bank Atlas 1981, the total energy requirements of the developing countries were about 18 million BDOE (Barrels a Day of Oil Equivalent). Overall about half of this was met from non-commercial sources, mainly in rural areas. Oil supplied about one-third of the commercial energy. In 1979, these total energy requirements were about 23 million BDOE, with a larger percentage of Oil. In 1990, it was about 42 million BDOE, with only 60 percent from commercial sources.

Similar studies have been carried out in Pakistan by the Ministry of Petroleum and Energy Resources. According to the statistics provided in the Energy Year Book 1986 (Government of Pakistan) our total requirements of energy in 1986 was 25.35 MTOE (Million Ton of Oil Equivalent) and the annual consumption growth rate (ACGR) was 7.83 percent. Keeping in view all the relevant factors, i.e., populations explosion and ever growing trends in the standard of life, development of industrial and agricultural sectors, extensive use of electronic gadgets, the requirement of energy at the beginning of 21st century would be around 78.5 MTOE, out of which 26.0 MTOE will still be provided by the non-commercial resources.

It is hard to define rural electrification precisely, as it has been given different meanings in different times by different governments in different countries according to their socio political conditions. In general it is defined as the electrification of the basic administrative unit mainly for the convenience of identification.

In Pakistan, we call it "village". In the revenue records of local civil administration such group of population ranges from 10 or more hutments, but unfortunately detailed survey of all villages in Pakistan has not yet been carried out with the result that the different definitions are given for villages in the four provinces of Pakistan. Chak in Punjab, Goth in Sindh, Killi in Frontier and Dera in Balochistan, all have different meanings according to the socio political situations. The migration of rural population to big cities in search of employment has not only resulted in mushroom growth of settlements (katchi abadis) in and around cities but the old pattern of rural life has also disturbed. This

may be one of the reasons that the economic gains of village electrification schemes are not visible.

Under a broad brush approach, however, "Village Electrification" schemes generally covers area where agricultural activities (however small it may be) is dominant, the ratio of labour to capital in production is high and incomes are low as compared to cities.

Electricity can be introduced into rural areas in several ways:

1) Isolated generators powered by a variety of means, including diesel, mini-hydro, solar plants, wind turbine, etc., serving single consumer (for example, a flour mill, water pump, a business).

2) Isolated generators serving several consumers who are connected by a local network. For example inhabitants of a small community like two or three villages near Islamabad have been supplied through a solar plant.

3) Public supplies from a regional or national grid, like WAPDA in Pakistan.

WAPDA is the only agency responsible for the generation, transmission, distribution and development of electricity in Pakistan as such the responsibility of providing electricity to the villages under the National Development Plan is also one of its important duty.

The phenomenal increase in crop production in many parts of the country which has made Pakistan almost self-sufficient in food could not occurred without the extensive use of electricity. Village electrification is becoming a reality. Unfortunately, this reality has yet to reach many areas. Many villages still cannot enjoy the benefits of electricity because of the shortage of funds and electricity.

The details of the number of villages electrified by WAPDA as per WAPDA's Annual Reports 1988-89, 1989-90 and 1990-91 is given as under:

Year	Target Villages	Actual Electrified
1988-89	2,771	2,301
1989- 90	2,698	3,096
1990-91	2,734	4,047

Although WAPDA's power supply position during these years remained under constant pressure, coupled with the industrial and agricultural sectors largely exceeding their targets for power connections, yet the democratically elected government gave further boost to the agricultural sector and WAPDA accomplished the job.

According to the WAPDA ANNUAL REPORT 1990-91 the total numbers of villages electrified by WAPDA upto 30-06-1991 is 37,135.

While significant progress has been made, it is still slow. There are many reasons, including low population density, terrain features and even the lack of a felt need for electricity. But aside from geography and apathy, there are other problems encountered during the process of village electrification. Political and economic struggles are found in all stages of financing, design, material procurement, construction and maintenance of village electrification schemes.

Conclusion

1) Pakistan still lives in its villages and it is a fact that electricity has played very important role in the development of agriculture and agro-based industry besides improving the living conditions of our rural folks. It is hoped that electricity will continue to play more productive role in the development of Pakistan as a whole, but the shortage of electricity and its resources compel us to use the available electricity more efficiently and economically.

2) The initial survey of all the villages and areas where electricity has not reached should be carried out.

3) National policy regarding village electrification may be formulated to provide electricity according to the priority and availability, choosing the most appropriate sources of energy, keeping in view the limitation of the existing power system.

4) The recent policy of privatisation of power may be extended to the rural electrification and substitution of electricity for other resources may be encouraged.

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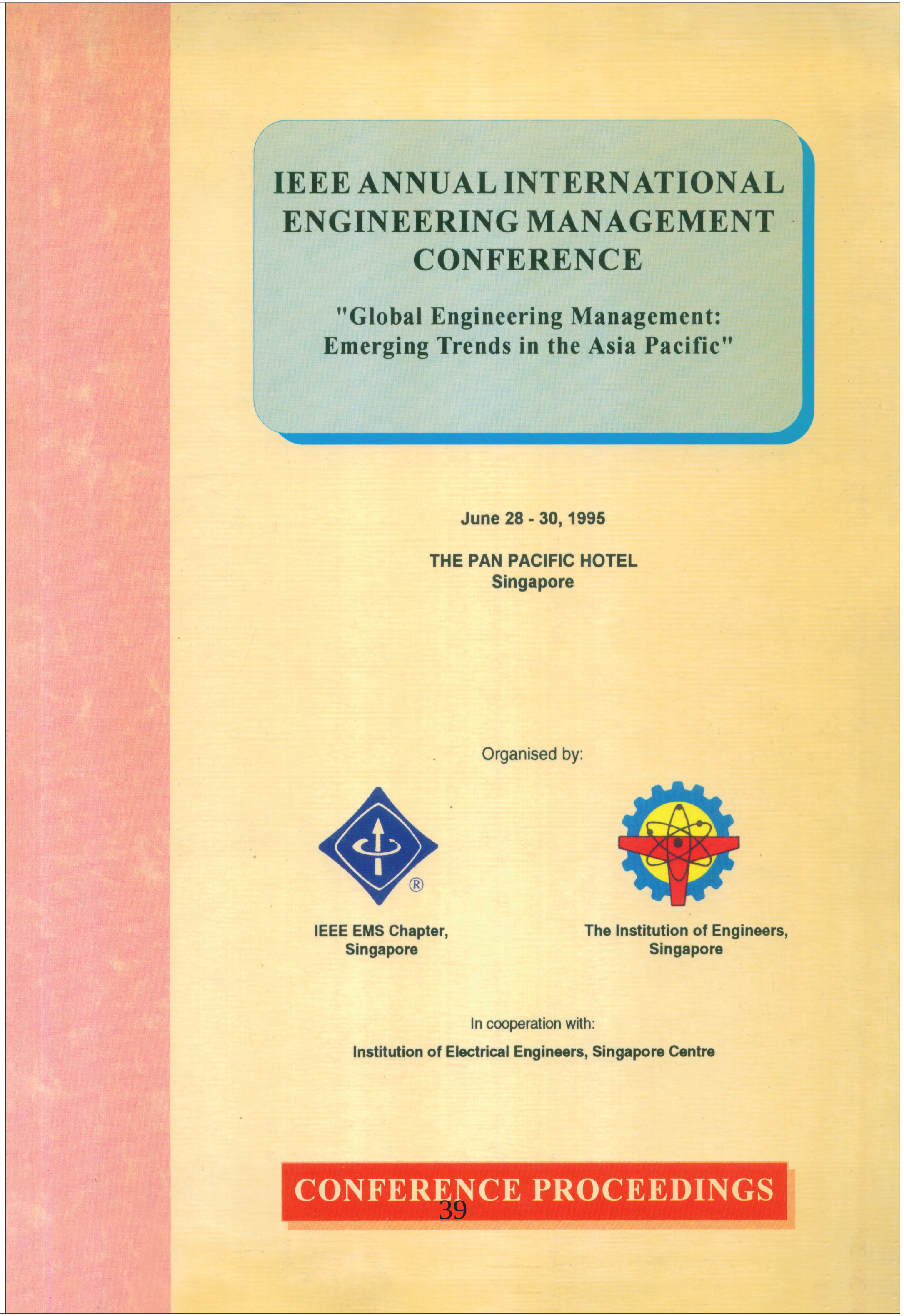
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Transfer of Technology

Success Story of Pacific Rim Countries

Engr. Sarfaraz Ali Syed

Abstract – Transfer of technology means transfer of knowledge or services from one place to another place or any geographical shift in this world. At first glance Technology transfer seems a simple process depending on the market and profit but successful process depends on proper identification, correct evaluation, true partnership and successful commercialization. This article focusses on the successful transfer of technology in the Pacific Rim Countries. This article is divided into different chapters that describes the global situation, comparative study of ASEAN countries and factors that brought this change.

I. INTRODUCATION

We are living in the age of science and technology. Every new day brings a new invention to the service of mankind. With the advancement of communication and international understanding the world has shrink.

Today research results belong to no single person, company or country. It is shared by all, knowledge is spreading almost instantaneously. That leaves no room for ethnocentrism in technology.

A global market place is establishing. The forces of technology and economics are out pacing both current management thinking and traditional politics. The standard Geo political map and the emerging techno-economic map are out of synchronism.

Transfer of technology means transfer of knowledge or services from one place to other place or any geographical shift in this world on government to government level, government to private, private to private or vice versa. [1] In this article the problems and some possible solutions have been given in the perspective of economy and trade.

At first glance technology transfer seems a simple process depending on the market and profit but successful process depends on proper identification, correct evaluation, true partnership and successful commercialization.

Impediments are always present to

one degree or another but they should be taken as challenges that can be faced and controlled provided there is a will.

II. GLOBAL SITUATIONS

During the last century our world has changed beyond recognition. With the advancement of knowledge technology is improving, business are becoming global, political arrangement are becoming more co-operative but the condition of poor countries (Third world) is not improving. Millions die due to shortage of food or medicine, potable water is still a major problem and infant mortality rate is still very high. There is big gap between developed countries and under developed countries. Unfortunately this gap is increasing day by day.

Why the fruits of scientific research are beyond the reach of millions. The process of sharing of knowledge and transfer of technology can not take place unless the principle of economics and traditional trade are not studied. The lack of knowledge on the part of planners and the greed to earn maximum profit in minimum time results in total collapse.

Every product made is based on an identifiable engineering skill or what might be called technology [2]. Most products are in fact composed of multiple technologies, some of which are created in the country while others are imported or purchased as components. Some basic issues needs special attention like demand, source of technology and local resources available. The study of economic conditions and favorable environment are carried out to design a strategy.

The successful technology transfer is combination of aggressiveness and working smart to build a distinctive competence and profitable business. Conditions necessary for a successful technology transfer is the comprehensive way in which man, machine and material interacts in the presence of a catalytic agent. That catalytic agent is the rules and trade regulations.

The technological gap between the developing and more developed countries is increasing day by day. The poor and under developed countries commonly known as THIRD WORLD needs new technology to help them fight against shortage of food, scarcity of drinking water, health hazard, population explosion, education, communication and environmental problems. But unfortunately this process of technology transfer is being hampered not only due to some international restrictions

imposed by monopoly of big powers but the defective policies and immature actions of the leaders of Third World Countries. The developed countries are creating new technologies faster than the developing countries can absorbed. [3] Many developing countries are not even aware that a potentially useful technology exist. Computer assisted management technologies offers a good example. These provide guidance in all fields of industries finance and resource development. Often conveniently organized into computer programs they help decision makers work cost effectively. Even more crucially they help keep politics out of decision making. The problems with developing countries is planning and political instability. Each new regime brings its own philosophy. Due to low literacy rate and non-democratic type of system the bureaucracy has taken full control of planning. Basic infra-structure necessary for development of industry is not available and luxury items are imported at the cost of cash crops and indigenous raw material. As there are very few manufacturing units in the country, the un-employment is high. The few learned and skilled personnel look for opportunity to go abroad for better pay. This brain drain is aggravating the situation.

III. PACIFIC RIM COUNTRIES

The study of development of some countries who emerged as industrial giants belonging to Pacific Rim reveals that they took diverse approaches to competing successfully in the field of technology. Government usually played a strong role in guiding development, establishing the appropriate business environment, providing education and training for the work force. No single formula exist for success.

The key to success is trade with the world. The governments in these ASEAN countries orchestrated the acquisition and internal diffusion of foreign technology into its nascent high technology industries. At the same time they protected the domestic market from foreign competition. High volume, low cost, self-support and low lending rate contributed towards their leap to progress.

JAPAN

In 1947 the production of Japan was barely 1/3 of its pre-war level. By 1975 Japan has succeeded so well in modern technology and manufacturing techniques that it trailed only the USA and USSR in GNP. This success was mainly due to combination of free market and Government guidance popularly known as KIERTSU [4]. It is the

National Policy for economic growth that the Government and private sector hammered out together.

SOUTH KOREA

After world war-II South Korea adopted vertically integrated conglomerate called CHAEBOLS; rigid import barrier and the exploitation of an open USA market for export. South Korea moved up to steel, ship building and auto production and then to simple electronic products. More recently through joint venture and indigenous R&D, it has ventured into more advanced technology like aerospace and (VLSI) Very Large Scale Integration and industrial robots.

TAIWAN

Taiwan has achieved another spectacular success. Privatization of state industry plus corporate planning paved the way to industrial development. Political stability, cheap and disciplined labor and financial incentives attracted sufficient foreign investment for economic take off.

SINGAPORE

With only 2.7 million people become fully independent in 1965 and parlayed strategic port, ship building, and oil refining facilities into a diverse economy with per capita income second in Asia only to Japan. Plowing back revenues into education and physical infra-structure, it methodically progressed.

HONG KONG

Hong Kong has been an entrepreneurial heaven. It exploits its status as the regional, financial and an economic back door to CHINA. Hong Kong will return to CHINA's control in 1997. Its GNP per capita is at par with Singapore and is 37 times that of CHINA.

MALAYSIA, THAILAND and INDONESIA are following the same strategy.

Malaysia attracted foreign investments. It is World No. 3 producers and No. 1 exporters of Semi-conductor chips with an electronic sector employing more than 100,000 workers. Thailand attracted in 1990 about US$4 Billions in foreign investment from Japan Automakers. Indonesia new technology activities have been concentrated in its BATAM Island area and along Malaysia's border state of JOHORE.

Economic analysts see other small nations, VIETNAM and PHILLIPINES also on the threshold of economic development.

IV. DEVELOPMENT STRATEGIES

It is interesting to note that many under-developing countries like Pakistan, India and Brazil have a good record of acquiring of high technology and merging it with indigenous technology and to some extent developing new technology but not in managing it. At the core of the effective management of technology lies the critical need for devising viable mechanism for getting the product out of the laboratory successfully – that is, the effective transfer of technology for sustainable development.

In the present world of intensified competition, splintered mass markets, shortened product life cycles and advanced technology and automation, the developing countries should re-examine their development strategies. The success story vary from country to country and situation to situation. The most common factors that brought about this fast development in Pacific Rim Countries are described below and compared with some defects and inefficiencies in the policies in other Afro-Asian countries as a framework for further study, research and guidance. This framework is not the only path to success but it is surely one of the shortest. We can summarized these into five factors necessary for successful and economical technology transfer.

1) Identifications
2) Evaluations
3) Environment
4) Partnership
5) Commercialization

1. IDENTIFICATIONS

The developing country or the recipient party must clearly identify the need and carry out marketing survey of the product or services required. Nowadays, the developed countries or advanced nations are inventing new products and creating technology faster than the power and ability of developing countries to absorb it. Today you hear a machine able to perform 5 functions at the touch of your finger the other day you will know that an advance version with 25 functions and self-programming unit has been marketed by some other country or some international group and by the time you finish your formalities and arrange all the clearancs from Government controlling agencies you hear that now fuzzy logic has been introduced by a third country and the machine or equipment that you had planned to purchase and installed in your country has now become obsolete and no more in production. We all know the red tape of bureaucracy in detail but the choice of appropriate technology keeping in view the immediate demand of market is the first and foremost requirement.

The problem with developing countries is the lack of national spirit and education. As the literacy rate is low in developing countries the number of qualified persons to decide on the choice and value of technology is even less and the situation becomes all the more tragic when decisions are taken by bureaucracy without any scientific background and technical understandings. The decision are taken on whims and personal interests. Millions of dollars are spent on feasibility studies and foreign visits but the result are large sick units which needs regular transfusion of funds.

2. EVALUATIONS

The financial implications in taking up a project of new technology must be studied and arrangement for funding should be settled before execution. [5] It has been observed that big projects like Fighter Planes Assembly or Missile Production are taken up without proper guarantees from financial agencies and study of marketing potentials. Any delay on the part of funding agent may create time delays, payment problems and sacrifices on many national policies by the third world countries. The recipient must have enough funds to bear the expenses till proper marketing of product. Another financial risk which is not considered in the early stages of project evaluation is the risk of financial failure by any of the sub-contractors employed on the projects. In third world countries there are a number of conditions and restrictions regarding the use of funds and flow of currencies inside and outside the country. Some time a barter deal is made between the parties and usually the goods offered by third world countries is in the shape of agriculture produce like Rice, and Cotton, in such conditions the fate of the new product hangs in the middle as one can not guarantee bumper crop each year and Donor makes deliberate delay in supplying the required man and machine which ultimately results in overall delay in marketing the products. There are chances that some other competitor may bring his product in the market and take away the initial charm.

It is better to study the total value of the project including incidental escalation in the initial estimates so that the final product when offered for sale is at reasonable prices.

3. ENVIRONMENT

Transferring a technology from

developed country to a developing country and setting up a center, plant or a large industrial complex is like implementing a sapling in your lawn. You have to provide favorable environment, supply all essentials, keep regular maintenance and protect from any damage or harm till the small sapling is a tree and is able to face the gust of winds, suck the food and water on its own and can heal itself the small scars inflicted by children playing in the lawn. Similarly before planning to set up a plant or factory, a study of the essential needs is made and then the site should be finalized. You have to provide basic services like road, water, electricity and accommodations. It is unfortunate that for these services there is no single authority or agency in developing countries. The financier or investor has to go from door to door for each of these services. Sometimes the source of water or electricity is hundreds of Kilo Meters away from the site and a large amount is required to arrange for these services. Although much drum beating is done regarding “One window operation” by the governments of developing countries but the story is completely divorce of the facts. Arrangement of local labor and induction of local expertise in the manufacturing and assembly line is very important to keep the prices low and to acquire the technology. This can be done on government level. A chain of training centers for un-skilled labor and technical institutes for semi-skilled labor and skilled labor should be established so that young generations may get the basic educations and technical know how and are ready the learn new technologies from foreign experts in different fields. The setting up of industrial complexes by local or foreign investor will also provide employment opportunities for the locals. Well this is a matter of MACRO ECONOMICS.

The financier will earn when the finished product is sold but the government earns in the shape of reductions of un-employment. So it is also in the interest of third world countries and developing countries to invite foreign investors to install their plants and even if they take away big chunk of the profit the gain in the shape of employment and training of local labor will surely improve the economic conditions of developing countries. [6] As mentioned earlier the favorable environment is very necessary for successful transfer of technology this also include the trade union activities and labor laws.

Unfortunately trade union activities are not developed on healthy lines in some third world countries and some times, vested interest takes control of the labor union activities. The smooth and safe operations necessary for a building units are not available which results in extra demands, strike and lock outs. The management of new plant can not be absolved of their responsibilities of failure in handling the situations in certain cases but government should provide some protections against such activities upto a certain period or declare some technologies as essential and put ban on union activities for a certain period. We should remember capital is very shy. It flies away even with a slight change in economic conditions so it is the prime duty of government to provide favorable conditions so that local investor and foreign experts may work jointly for the transfer of technology and ultimately economics development.

The taxes, duties and tariff regulations in certain developing countries results in artificial boost in government revenues but in long term either the new plant goes in loss or adopts illegal means to evade taxes. In either case the process of technology transfer is hampered and such illegal activities results in blackmailing of management by labor unions and thus the quality goes down, prices goes up and the sale of products is decreased.

These are the conditions in most of the developing and third world countries and a new entrepreneur has to study the environment of recipient country and formulate a suitable policy before entering into contract with foreign firms for acquiring new technologies.

4. PARTNERSHIP

There has to be a true partnership in which the Donor, and the Recipient commit themselves to seeing the process of technology transfer through to success. This partnership can be on government to government or government to private investors or vice versa but the terms of references, scope of work and level of technology must be defined clearly. For sophisticated technology or large industrial complexes a third party such as consultant may be associated to supervise the final details of technical process till commissioning of the plant or upto the warranty period. For large industrial units public sector should play major role in this program and after successful completion and satisfactory running for 3-5 years, the plant may be sold to private sector. If the private sector is involved from the very start then public sector should take the responsibilities of identification

and environment and private sector may be left to deal with the financial and administration matters. In some third world countries industrial development boards have been setup and they have obtained very good results. But in those countries where public sector has assumed full powers or in other words where industries are under estate control or nationalized as a result of political process the inherent red tape and lethargic attitude of bureaucracy has destroyed the whole process. When the affairs are in the hand of an industrialist, he manages the system on efficiency and economy. He is worried about the annual profit and loss account, balance sheet and dividends to be distributed to share holders. He links wages with quality and quantity. He is worried about the refund of loans and accumulated interest. But a bureaucrat or manager of public sector has no such worries. He is worried only when there is news of change of government. He is not concerned with the quality or quantity of product or the labor and management relations. Because the wages are increased by the government without considering the output of the plant. This is true in all cases of state run enterprises, weather it is Russia or Asia. But the problem is that poor countries of third world can not have this development of technology 100% in the hands of private sector. Some check has to be made in the interest of country and National policies. So a proper balance is required in partnership in the development schemes for transfer of technology so that the essential technology is obtained at competitive rates and without jeopardizing the national policies.

5. COMMERCIALIZATION

Other Afro-Asian countries must look at the Pacific Rim countries – especially Japan and Singapore with an eye towards learning from these countries approaches and methods of successful commercialization. Even after acquiring a new technology they should take steps to update the manufacturing process to improve quality, reduction in wastage, reduction in energy consumption, and ultimately reduction in cost. One of the most important characteristics of the countries successful at commercialization is their tendency to plan for the long term. How do Pacific Rim countries develop new product faster than other countries do? They identify emerging technology and nurture it to commercialization. They see innovative technology in its infancy stages and dare to dream what it can become Countries that ignore this long-term planning and wait for technology to come to them will have to spend out of their hard earnings. Technology today is a global commodity, it is being developed, refined, bought, sold and traded, around the world at unprecedented speeds. Countries willing to improve their economy should acquire new technology, adopt it as their own and selling it back to other countries at competitive prices.

A great deal of Research conducted in the universities and government laboratories primarily sponsored with government funds is being developed with little thought given to its value in the commercial marketplace. Technical impediments must be eliminated so that product or services based on these researches can be marketed. Governments can be more supportive in identifying these technologies to the private sector that will create market in the future. The joint action taken by both government and industry might spur commercial development in the country. To a great extent, the key to success of The Pacific Rim countries was successful commercialization. That was demonstrated in the consumer electronics and computer industries.

In the next decade, global competition will be more formidable but not invincible. Our challenges will be great, but our opportunities will be even greater. These conditions are not directly related to technology. They do however promote a desire for new technology and atmosphere in which it can grow. These conditions for a successful transfer either existed or were created by the newly developed countries like Taiwan, Singapore and Malaysia.

A proper blend of the strategies in accordance with the culture and tradition can bring very good result but what work well in a developed country may not be suitable for a developing country. In some cases primitive techniques may be the best and the cheapest solution.

Probably one of the most difficult thing in this study is that each developing country is unique with its own priorities and idio-syncracies.

V. CONCLUSION

Technology transfer takes time and money. A transfer generally implies a change in procedure, product, material or system. People normally resist change and technological change is no exception. With many reasons why technology transfer may not be as successful as we like our job as Engineering Manager is to suggest improvements.

The policy needs to be made on economic principle rather than wishful thinking. Right man for the right job and hunt of talent without any quota or reservation will bring excellent results. The present system of red tape, lethargic attitude and supremacy of bureaucracy over professionals should be amended.

The progress of Japan, Taiwan, and Singapore and other Pacific Rim countries can be taken as glaring example of hard work dedication and successful policies. They have managed to stabilize population. It is the ripple effect of regional cross investment that accelerate the development of economy and technology.

The following guidelines are given as a summary:

1) Technology transfer is essential for economical development.

2) Direct person-to-person contact is the most effective means of transferring technology.

3) Governments should supports and formulate the corporate technology strategies and give their accompanying transfer actions with inputs from industry.

4) Indigenous technology should be improved and merged with the imported techniques.

5) Training of local talents in all aspects of the business, technology, management sciences and human behavior should be arranged.

6) Japanese and European culture does not punish individuals for failure, with the result that failures can be lessons, in other countries, on other hand, failure is punished so that mistakes get hidden, thereby adding to production cost and slow progress.

7) A sense of participation should be created in the personnel by giving them incentives and bonuses tied to corporate financial performance.

8) Rather than providing detailed directions governments should see that the resources are available.

9) Private enterprise should be encouraged to develop links with the foreign firms and government should act as guardian not as a profiteer. Experienced business executives can be utilized to act as internal consultants and auditors to watch the progress of state enterprses.

10) Strict quality control should be exercised and efforts should be made towards continuous improvement in process development.

The under-developed and

developing countries should re-examine their traditional approaches and techniques of technology development and transfer, and look for lessons to be learned from PACIFIC RIM countries.

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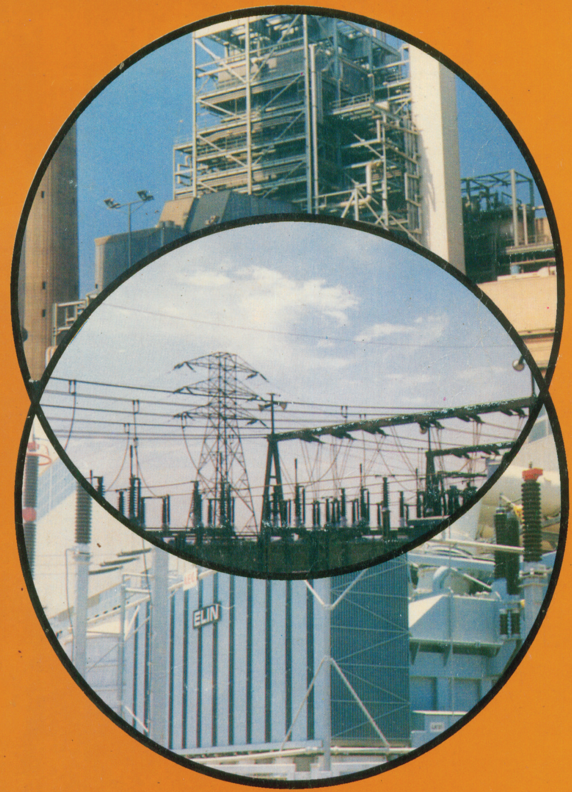

دور الكهرباء فى التنمية الإقليمية للوطن العربى

ROLE OF ELECTRICITY IN THE DEVELOPMENT OF ARAB COUNTRIES

Visiting a stall at Electrical Exhibition during CIGRE First Regional Meeting of Arab Region, Cairo, 1995

ELECTRICITY AND POLLUTION IN GULF COUNTRIES

Engr. Sarfaraz Ali Syed

INTRODUCTION

Electricity is the most important commodity of the modern world. But nowadays the electric industry is facing one of the greatest challenge in its history. After more than a century enjoying the safe heavens of public admiration, it is being blamed for polluting the environment. Not only the emission from the chimney is being objected but the installation of transmission and distribution lines are also blamed for adverse health effects on all type of lives on this earth. These changes represent the major challenges. What are the implications of all this to run a power plant and to lay the network of the transmission and distribution of electricity? This has become a very complex issue. In fact we are at one of those rare moments when social and technological forces are combining with the regulations to create incredible pressure on Electric Industry.

In general there are many forms of Pollution. Pollution of air, destruction of Ozone layer, change of climate, greenhouse effect, toxic chemicals, hazardous wastes, Nuclear radiation and disposal of nuclear wastes, adverse effect of electromagnetic and radio frequency waves, and many other known and unknown hazards. Some of these pollution effects have nothing to do with the Electricity. But Electric Industry can not absolve itself of the responsibilities however small it may be in increasing the environmental pollution and disturbing the natural ECOSYSTEM of our planet.

As an Electrical Engineer by profession and as a student of Environmental Pollution, I have tried to summarize the environmental impacts of electric industry with special reference to the development of Electric Power System in GULF countries for further study and research. Can we control it more precisely? Can we monitor it more closely? Can we reduce it or eliminate it completely, efficiently and economically?

We have to find answers to these questions in the light of practical experience and the new technologies now available before it is too late.

GULF COUNTRIES AND ELECTRICITY

Gulf Countries are trying to diversify the economy from Oil to Agricultural and Industry, this means fast development in Industrial and agricultural sectors, which require more Electricity. The per capita consumption of Electricity in Gulf Countries is already very high and not less than those of the most developed countries of the world.

To cope with the increasing demand of electricity the electric industry in Gulf Countries is growing at a very fast rate and most modern technology is being utilized for the generation, transmission and distribution of Electricity. Establishment of a Regional Grid is also under active consideration for economic utilization of the generation facilities.

The main fuel which is used in the generation of electricity in Gulf countries is PETROLEUM PRODUCTS. It has been relatively easy and cheap to release energy from petroleum products. All that is needed is to ignite them and then to control, store and manage the newly created form of energy. The prices we pay include air pollution, water pollution, workers occupational diseases, radiations, carcinogens and many still unknown hazards.

To burn or not to burn. That is not the question. The most important questions are; how to burn, and how often to burn? Usefull energy (Electricity) upon which our life depends, must be extracted, generated, stored and transmitted or transform from one form of energy to another in the most efficient manner so that natural life cycle or ecosystem is not disturbed.

There are no Nuclear Power Plant and no Hydro Electric Plant in these countries as such big problems of Nuclear safety and other related sources of pollution like Nuclear waste, Nuclear radiation, Water pollution, Solid wastes are not found.

The main source of electricity generation in Gulf Countries is THERMAL. The three main types of electricity generating plants are

(i) Gas Turbines,

(ii) Steam Turbines, and

(iii) Diesel Units.

The following is the detail of generation expansion plans and the electric

generation production per capita (kwh) of Gulf Countries [1].

Name	Electrical Energy per capita (KWH) Production	1990 (MW)	2000 (MW)	2010 (MW)
Saudi Arabia	3712	15813	27657	42055
Kuwait	9390	7067	9219	14662
Bahrain	6640	982	1941	2710
Oman	2596	900	2369	3075
Qatar	12162	1066	2507	3291
U.A.E	8219	4701	5776	7275

The share of each according to a rough estimates and their combined possible pollution effects are given as under [1,2]

S. No	Mode of Generation	Approximate Share	Combined Pollution Effects
1	Gas Turbines	70%	(i) Air
2	Steam Turbines	20%	(ii) Radiation &
3	Diesel Units	10%	(iii) Noise and Vibration

ELECTRICITY AND POLLUTION

Following are the THREE major pollution problems and brief description of each which has been noticed by scientist and engineers by now. Although all possible efforts and legislation are being made to counter these adverse effects by the governments in the GULF countries but these still require detailed engineering, medical, social and economical studies.

1. AIR POLLUTION
2. RADIATION (ELECTRO MAGNETIC POLLUTION)
3. NOISE AND VIBRATIONS

Air Pollution

Air is said to be polluted when it contains enough impurities or it is hot above normal range which could adversely affect the health, safety or comfort of living things in the surrounding areas or shared atmosphere. The impurities, or pollutants, could be tiny particles of matter, or gasses not normally found in air. The heat energy or excess temperature of the air may be due to many reasons but in this article we will concentrate on the rise of air temperature above normal limits due to the heat lost from thermal units.

When people breath in this polluted air, pollutants in the air may deposit in the lungs or absorbed into the body. Polluted air can harm animals, plants as well as human beings.

This rise in the atmosphere temperature is also termed as Thermal Pollution by some environmentalists. We as Electrical Engineers take this as one form of the pollution of air. Thousand Tons of OIL is being burnt daily in Gulf countries in different Power Stations to generate ELECTRICITY and all emissions from the exhaust of gas turbines and chimneys of boilers are adding very dangerous pollutants in the air besides raising the atmosphere temperature of the air in which we breath.

Fossil fuel combustion produces some of the gases that might raise the atmospheric temperature to dangerous limits. These emissions from the exhaust of power plants not only create the ACID RAIN and SMOG [5,7], but is a threat to the health of human being as well. To a certain extent control of emissions is being achieved through the use of modern technology but the complex subject of airborne emissions is taking on increasing importance nowadays.

Gulf countries have many gas turbines in operation and many new units are under construction. According to Annual Report of the Ministry of Industry and Electricity of Saudi Arabia [2] the actual share of generation from gas turbines was 71.2 % for the year 1991. That is why it needs more attention from economical and technical points of view. This problem of air pollution due to gas turbines required broad base regulations on regional level, while allowing local regulations for specific areas and according to the size of gas turbines based on either heat input or power output. We can divide the air pollution in following two types:-

(a) Pollution due to particles and gases

Emissions from the exhaust of chimneys of power plants is a heterogeneous category, comprised of at least five different pollutants [3];

- Nitrogen Oxide

- Carbon Oxide
- Un-burnt Hydro Carbons
- Fly Ash
- Sulfur Oxides

Nitrogen Oxides (NOx), decomposes in the presence of sunlight to yield a free atomic Oxygen and Nitrogen Mono Oxide. Atomic Oxygen combines with Oxygen molecules to form Ozone, a lung irritant and corrosive agent [3]. The stories of Ozone depletion and hole in the upper atmosphere must be fresh in the minds of engineering community. Nitrogen Mono Oxides recombines photochemically with Hydrocarbon pollutants, the third type, to form compounds like Ethyl alcohol and Formaldehydes, which constitute SMOG. Hydrocarbons, especially polynuclear hydrocarbons are entrained with fly ash. NOx is also implicated in acid rain. A second pollutant, Carbon Oxides have well known poisonous effects. Carbon Mono Oxide is released when combustion is incomplete or inefficient. Relatively very little Carbon Mono Oxide is produced by the power plants, but other industrial units and cars produce large quantities of Carbon Mono Oxide.

Carbon Di Oxide produces the greenhouse effects which is very hot topic of research among scientist, geologist and agriculturist of the world.

The fly ash (soot) has always been a hazard in fuel combustion. Fortunately no coal plant is in operation in GULF countries but the small amount of carbon particulates emission from the exhaust of diesel generators, gas turbines and chimneys of other steam boilers is producing emissions of unburnt hydrocarbons and other dangerous by-products. Other air pollutants are gaseous and invisible.

Sulfur Oxides, however small quantities they may be, causes direct biological damage. Sulfurous pollutants can be catalyzed in the presence of sunlight into sulfurtrioxide SO_3, which turns into Sulfuric acid on contact with water [4].

(b) Pollution due to heat (Thermal Pollution)

Thermal pollution occurs because all the heat energy produced in thermal power stations can not be converted into electricity; some results in unconsumed heat (waste). Although there are no liquid wastes produced by the power plants in Gulf countries, but the rise in temperature of air during cooling process of machines and other equipment of power plant is a constant source of disturbance. The maximum efficiency of steam turbine is about 40%. Thus the amount of waste heat produced is about 60%. Water is used as the coolant so the heat is dissipate to the atmosphere through evaporation. Approximately 60% of combustion heat is lost through different cooling processes [5].

Elevation in the Air and water temperature due to the waste heat removal is the thermal pollution. The effects of thermal pollution fall into three categories; (i) Economic, (ii) Physical, and (iii) [3] Biological. Cooling water is a consumptive use so the cost of water required for cooling and the expenditure involved in different cooling systems in use in different power stations in GULF countries is an economic and comparative study.

Similarly if water is to be used repeatedly for cooling (closed cycle operation) the atmospheric temperature and pressure is very important, because Turbine becomes less efficient as the cooling water temperature does not fall appreciably. Thus the operating cost of power station increase slightly.

Water is also changed physically by thermal pollution. The viscosity of the water decreases, which increases the rate of evaporation and the rate of flow. Because heat reduces density, thermally polluted water floats on the surface. It can form a thermal boundary or contribute substantially to temperature stratification [3]. Perhaps the most important physical effects, however is the increase in dissolved mineral concentration in the water due to evaporation loss.

Disturbance in the mineral concentration due to thermal pollution effects the aquatic and marine life if it is discharged. This is very important aspect of thermal pollution and require a thorough research and study of the marine life especially on the sea shore where large steam power station are working.

In the case of Gas Turbines the temperature of the exhaust gases ranges from 4000 C to 5000 C [4,5], whereas in the case of Diesel Generators the temperature of the exhaust goes upto 3500 C [4,5]. These hot emissions from the exhaust of gas turbines and diesel generators is not only a big source but is a constant source of heat to the normal air of the surroundings. Imagine the amount of heat energy lost through the exhaust of all gas turbines and diesel generators which is about 80% of the total power plants operating in the Gulf Countries. Technologies have been

developed to extract this heat from the exhaust and to utilize it in a more usefull work. Boilers have been designed to run on this waste heat and now Combined Cycle Plants are being installed in many places, but still the magnitude of the heat energy lost and the rise in the atmospheric temperature requires the attention of engineers and scientists.

Combined cycle power plants are additional units which utilizes the waste heat from the exhausts. Instead of simply being discharged into the atmosphere, the gas turbine exhaust gas heat is used to produce additional output in combination with a heat recovery steam generator (HRSG) and a steam turbine. This is a good technique to reduce the emission and to increase the efficiency of thermal plants upto 55% [6].

The Oil Market of the Gulf Countries received a set back during the Gulf War, which results in change in the policies of Gulf Countries in their production, export and domestic uses of oil. The oil has to be used as wisely as possible, and generating electricity economically and ecologically.

In accordance with this policy The Rabigh power plant near Jeddah (Saudi Arabia) [2] has been converted into a combined cycle power plant. Waste heat from the eight gas turbines in the existing power station is fed to heat recovery steam generators which runs two new steam turbo-generators. This combined cycle operation increases the electricity generating capacity of Rabigh Power station to about 260 MW, besides reducing the adverse pollution effects. In Bahrain [1] a new 900 MW Combined Cycle Power Plant has recently been installed with high efficiency and lowest emission levels. Similar projects are under active planning and different study stages in Saudi Arabia as well as in other Gulf Countries.

(2) Radiation (Electro – Magnetic Effect)

After years of paying little or no attention at all to the Electro Magnetic Fields created by the electrical machines, installations, gadgets running on electricity; Electric Industry of the world has started to show some concern on the invisible but possibly most dangerous forces that surrounds power facilities. Uncertainties abound, but risk from electrical appliances and wires can no longer be ruled out now. Scientists still are not certain whether relatively faint electromagnetic fields, of EMF as the force is called have serious effects on human health.

Recent researches make an increasingly compelling case that some defensive steps should be taken. The problem is figuring out what steps are required when the effects could range from insignificant to giant, and with implications for decades to come.

Electromagnetic field emanates from every wire that a current runs through. But unlike nuclear radiation or X-rays, electromagnetic fields can not be absorbed by any shield like lead. They diminish only with distance. Any electrically charged conductor generates two kinds of invisible fields, Electric and Magnetic. Taken together they are electro magnetic fields. The electrical field can be blocked with shielding to some extent, but the associated magnetic field can not easily be blocked [7].

Laboratory experiments with human cells and animals suggest that the Electromagnetic fields can interfere with the functioning of DNA and RNA [10], the controllers of cell reproductions, cell to cell communication, flow of Calcium across the cell membrane and even can alter the action of Hormones.

Although electromagnetic fields at these low frequencies do not produce the same dramatic effects on the body as are produced by the two other commonly used forms of electromagnetic radiation, both at much higher frequencies i.e., (i) X-Ray (which breaks DNA), and (ii) Microwaves (which cause damage from heat) [10]. Still, because these EMF are everywhere in our modern society; the public health consequences of even a slight danger to the individual should be significant.

Nearly 30 years ago, Soviet research raised concern about the electromagnetic fields. Investigation in Denver (USA) during the late 1970s found a correlation between childhood leukemia rates and electric power lines, a finding reinforced by more recent research in Los Angles (USA) [11]. Recently few more articles have been published on the effects of Electromagnetic and Radio Frequency fields initiated by the claims linking Tumors and Leukemia in the persons living near the big electrical installation. Similar studies were carried out with New York telephone workers at John Hopkins University (USA) which showed high cancer incidence not only for leukemia (seven times that in nonline workers) but for all cancers, including those of the gastrointestinal system, prostate, and brain in particular, the cable splicers – the group with the highest exposure. Still doubts persist about how and how much electromagnetic fields affect health.

While International regulatory agencies and I.E.C. are having difficulty deriving reasonable limits from the scientific researches carried out so far, the pressure is mounting on Electric Utilities for more carefully design of transmission and distribution system and siting of power stations and substations.

Some countries have already adopted national electric and magnetic field exposure standards for ELF (extremely low frequency fields) based on the magnetic field limits from World Health Organization guidelines drawn up in 1984 [7,12].

In Gulf Countries almost all the distribution system is underground, high power transmission lines passes across desert and barren land, and power station are sited after very carefull study there seems to be no possible danger from this EMF Pollution in the near future as each Gulf Country is following the guidelines and rules of WHO and IEC in addition to their own Safety Standards [12].

The ongoing research in this area has yet to find any sufficient evidence supporting these concerns. Unless research proves conclusively or establish a link in the health hazards and the Electrical Fields due to Machines or other installations there is no need to fear, it involves comparing these risks already being taken in everyday life. Some are avoidable, e.g. smoking, eating fast food, too much fat, etc. other risks are more difficult to avoid without drastically changing your life style. These include the risks involved in working in Electric industry or living near electrical installations.

Meanwhile, public concern about electromagnetic fields is building up. As it does, the EMF will become one of the biggest environmental challenges that Electric Industry must face. Some Electric Utilities are doing what they can do to prepare themselves. But this problem needs big research and big program to respond to consumers concern.

(3) NOISE AND VIBRATION

Since the beginning of the Industrial revolution, workers in power houses have endured the noises and vibrations of mechanical monsters, but today noisy Gas Turbines and Boilers have mushroomed throughout the Gulf Countries. Today the danger to hearing is no longer contained within the walls of power plants.

The power plants are always constructed outside the city limits and away from the residential areas but nowadays cities are growing at a faster rate and the power plants in some cases have come very near to the residential areas or we can say that residential areas reached to the vicinity of power plants. Many examples can be quoted where power plants have been surrounded by residential and commercial areas, and nowadays not only the engineers and technicians working in Electric Industry but general public is also exposed to the adverse effects of Noise and Vibration.

Exposure to vibration is frequently associated with exposure to noise in Power Plants since the two often originate from the same operation. However the adverse effects resulting from exposure to noise and vibration are quite different in nature, the former having a more substantial basis than the later for establishing a cause and effect relationship both qualitatively and quantitatively.

The effects of exposure to noise have been thoroughly investigated and the results of these studies are reflected in current standard and specification for electrical machines adopted in Gulf Countries. Although a significant amount of research is underway on the relationship between exposure to vibration and the health and well-being of the workers exposed, sufficient evidence for the establishment of occupational health standards has not yet been developed. In their studies of noise and vibration pollution researchers have found the most frequent causes of complaints. It appears that, whatever your attitude towards noises and vibrations, that does not fit in with your individual and physical activities are a Nuisance. Why? Because they distract your attention and interfere with what you are doing.

Noise

The most immediate and obvious danger of NOISE POLLUTION is its threat to hearing. Quite a few number of operators of power plants are already suffering a hearing loss as a result of over exposure to noise, but today many innocent peoples now live in communities where noise levels are higher enough to interfere with communication and causes annoyances. Annoyances always turned inward and pass on to body, where it shows up as tension. A growing body of evidences suggests that noise can lead to aggravate headache, digestive problem, ulcer and asthma [10]. Ears have very little control over what goes into them. Unlike eyes they can

not blink or close. Defenseless eardrums pick up sounds arriving from all directions pass them on to the brain. The brain treats every sound as a message. It has to sort through the incoming messages, judge whether or not they require attention, and decide what to do about them, your mind quickly become exhausted.

Almost anything that moves can produce sound and vibration. You may not like the actual sound and vibration of Gas Turbine or Boiler or Diesel Generator, but you have to accept it because of its benefits.

“Loud noise, regardless of its benefits is damaging to the ear”, said Dr. Robert Harrison, Professor and Head of the Department of Audiology and Speech Pathology at the University of Miami. “Once incurred the damage is permanent and irreversible”. The dB (deci bell) is commonly used to describe the level of acoustic intensity and it should not be more than 55 dB [5, 12], but unfortunately the ordinary industry and even small generators deliver 90 to 114 dB to the operators ear. The boiler chimney delivers more than 120 dB [5, 12].

Vibration

The human body is composed of an extremely complex physical and biological systems. On the basis of experimental studies, as well as documented reports of industrial experience, it is apparent that exposure of workers to vibration can result in profound effects on human body, mechanically, biologically, physiologically and psychologically [10, 12].

It should be noted that relatively few studies of industrial exposures to vibration have been conducted in the Gulf Countries, most of the available literature on documentations of effects of vibration in industrial situations has been published in European countries.

When considering the effects of vibration on man, it is necessary to classify the vibration exposure into two categories on the basis of the means by which the worker contacts the vibration medium. The first category is referred to as “whole body” vibration and results when the whole body mass is subjected to the mechanical vibrations, for example, from a supporting surface of the turbine or generator floor. The second category is usually referred to as “segmental” vibration and is defined as vibration in which only part of the body, for example the hand or finger is in direct contact with the vibrating medium and the bulk of the body rests on a stationary surface. This classification of vibration does not necessarily mean that parts of the body other than those in direct contact with the vibrating surface are not affected.

There are pronounced physiological and psychological effects resulting from exposure to whole body vibration. Although these effects are rather complex and usually difficult to measure, the subjective response of man to whole body vibration have not been studied in Gulf Countries as has been done in other Countries.

A few casual relationships between the bio-mechanical effects of whole body vibration and consequent physiological changes in the body are apparent. These physiological observation have included evidence of a slight acceleration in the rate of oxygen consumption, pulmonary ventilation, and cardiac output. There is evidence of an inhibition of tendon reflexes and an impairment in the ability to regulate the posture, possibly by actions through both the vestibular and spinal reflex pathways. Alterations have been recorded in the electrical activity of the brain and there has been evidence of effects on visual activity and performance at various levels of motor activity and task complexity during exposure to whole body vibration. Whole body vibration have effect on the endocrinological, bio-chemical and histapathological systems of the operators body.

The best example of segmental vibration is found in the hands of the operators who frequently uses handled power tools which incorporate fast rotating or reciprocating parts of machines.

The Reynaud's Syndrome, or White Fingers Disease occurs mainly in the fingers of the hand used to guide or control a vibrating tools. The appearance of this occupational disease appears to be a function of the accumulative absorption of vibrating energy, its harmonic contents and on personal behavior. Vibrations in the frequency range of 40 – 150 Hz has been implicated most frequently in reported cases of vibration disorders [5, 10, 12].

Uptill now we were discussing the effects on human being whether in the power plants or living near the power plants, but the visible effects of vibrations and noises are clearly visible on civil structure and main buildings housing the boilers, generators and heavy auxiliary equipments. The nearby houses and structures are all subject to this pollution and such damages can be seen on the structure of buildings near these power plants. Many examples can be quoted and observed in our daily life. It

is now high time that proper attention is given to reduce Noise and Vibration due to Power Plants.

MANAGING THE RISKS

Protecting the environment involves managing the risks and it requires judgment about what we want to protect and how important it is to protect. It is a process of utilizing new scientific knowledge to improve the old systems and practices used in electric industry so that the risk of possible harm to operating personnel and environment is reduced to safe limits, if not eliminated completely.

As a result of present knowledge of possible health and ecological effects associated with both existing and new power projects for the generation, transmission and distribution networks in the Gulf Countries, the governments of the region have already made a major commitment to ensure ENVIRONMENTAL PROTECTION [2].

America celebrated century of legislations against Air Pollution in 1994 [11]. EPA (Environmental Protection Agency) of America gave a novel idea of emission credit – trading scheme to curtail pollution by literally requiring utilities to pay for the right to pollute Air beyond a certain level. An auction of such rights was made in Chicago on 29/3/93. Rights to emit 1 Ton of SO_2 were sold at prices ranging from $ 127 to $ 450 [11]. For comparison scrubbing a Ton of Sulfur from chimney is estimated as about $ 500 [7, 11, 6]. In June 1984, the E.C (European Countries) introduced a directive to combat Air Pollution which called for the use of (BATNEEC) Best Available Technology Not Entailing Excessive Cost) [11].

Regional and International Clean Air directives are forcing Gulf Countries to reduce emissions from Power Plants. All possible efforts and legislation are being made so that the natural environment and human health are protected. Abatement techniques now in use have reduced emissions from the chimneys but heightened awareness among the Gulf countries continue to generate tighter legislative controls and the development of environmentally friendly electric power plants and networks.

Engineers, scientists and economist have a big role to play in Gulf countries in the future to help achieve these commitments. Since many of these problems are long term, engineering institutions like CIGRE must help in developing the health, environmental and engineering data base necessary to support technology based standards to control pollutant discharges.

The lead times for impact assessment and control technology development are such that research programs must continue to implemented now if electricity development is to be compatible with environmental protection.

A systematic approach will produce better results than piecemeal efforts. An essential first step is a comprehensive POLLUTION AUDIT. The pollution audit should systematically evaluate opportunities for improved operating procedures, process modifications, process redesign and recycling.

To conduct POLLUTION AUDIT, following footsteps are suggested which can be modified or further improved according to the geographical, social and local conditions of each country.

1. List all general pollution.
2. Identify the composition of the waste and the source of each substance.
3. Identify options to reduce the generation of these substances in the production or manufacturing process.
4. Focus on wastes that are most hazardous and techniques that are most easily implemented. Compare the technical and economical feasibility of the options identified.
5. Evaluate the results and schedule periodic reviews of the program so it can be adapted to reflect changes in regulations, technology, and economic feasibility.

Setting up a pollution prevention program does not require exotic or expensive technologies. The ultimate price impact of abating pollutants produced by the electric industry amounts to a small percentage of the cost of electricity.

According to an economic study carried out at the Harvard University during 1971 – 72 under National Science Foundation increase in the real prices of electricity (due to abetment of pollutants) will not be more than 3.8 % [3, 7, 8]. This increase is insignificant when compared to potential increases in health hazards.

CONCLUSION

The study of Pollution Effects tells us what has happened and what's about to happen to our shared atmosphere. As Engineers we should have exact knowledge of new complex, and quickly growing technologies which could reduce the adverse effects due to Electric Industry on health, and welfare, including injury to agricultural crops and livestock, damage to

and the deterioration of property and hazards to air and ground transportation in the Arab Peninsula.

A safe and substantial Electricity generation, transmission and distribution networks is crucial to sustainable development in Gulf Countries. We have to find it out to reduce the pollution effects of fuel burning which seems to be low at present but are increasing daily and the adverse effects are posing a challenge to our habitat and environment. Till now the population density of Gulf countries is low and consequent damages to environment and ecosystem are not yet so visible hence one may consider it as a futile exercise to watch and control the emissions from power plants. But it will not be a scientific approach indeed.

Fossil fuel combustion produces some of the gases that are dangerous to all sort of life and some of the bi-product of these chimney exhausts may be destroying our already meager forests, and crops. There are other potential dangers to the old historical monuments and buildings. Our hosts EGYPTIANS are already aware of the pollution effects on the PYRAMIDS. If you have ever checked and cleaned your car in the morning you will find a fine layer of black soot. Well this all is not due to the electric industry but we are at least responsible for contributing to it however small percentage it may be. The most dangerous of all threats is to health of human beings. Even the Engineers and technicians working in the electric generating stations, persons living near these plants and millions of citizens using modern electric and electronic equipment in daily life are all prone to some degree of biological disorders. How much can you figure the environmental movement will impact your company or the industry as a whole over the next 10 years or 20 years?

Today's environmental pressures are not going to disappear. Pressure may vary with the changing times, but overall for the rest of our lives we are going to see tougher laws and stricter enforcement in every area of air, water and soil protection. This has been the pattern since the First International Conference on Environment held in Stockholm and all signs point to its continuing. What is needed today is to streamline and coordinate the efforts in a more rational way, and try to utilize the new technologies to monitor, control and reduce the pollution effects of these big electricity generating plants and large networks in Gulf countries to save the environment from pollution.

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Receiving award at a Conference from Chairman Saudi Electricity Company

ENERGY CONSERVATION

EFFICIENT USE OF ELECTRICITY

Engr. Sarfaraz Ali Syed

INTRODUCTION

Electricity is the most important commodity of the modern world. We cannot imagine to live without electricity. We aspire jot higher and higher standard of living – which is possible only through an even higher production of electricity. Thermal unit (Oil and Gas) can be put into operation within 5 years, Gas turbine plant can be operative within 3 years but by the time we add another 100 to 200 MV to the generating capacity our demand rises by 500 MV.

To meet this fast growing demand of power, Electric Utilities are increasing their generating capacity each year. This race between demand and supply is going on and the gap is increasing day by day. We need to have some breathing time in our planning process.

Electrical Engineers in particular and Economic Planners in general should also look on the other side of the Electricity Meter.

What is happening beyond the meter connection in consumer`s premises?

Consumers are becoming wasteful and inefficient. What can be done to change the behavior of the Electricity Consumers?

Are there benefits in doing so?

The answer lies in efficient use of the electricity or adopting measures to manage the load on the consumers end economically and reliably.

How to use the available Electricity more efficiently within our limited resources, how to convince the consumers to change the habits and how to brought this change of culture is the main issue.

In Electric Industry these measures are being termed as Demand Side Management or Demand Side Measures or DSM in short.

Demand Side Measures

Demand Side Measures (DSMs) are defined as measures taken by the electric supply company and the consumers both to reduce the consumers demand for Electricity through improvements in the efficiency with which Electricity is being used. The implementation of DSM will usually involve the expenditure of capital in the consumer's premises to improve efficiency of use, with recovery of expenditure through savings in the cost of supplying electricity and through increased electricity prices. If the DSM is economic, it should be possible for the saving in consumption by the consumer to be greater than the effect of any increased prices, and for the supplier of the DSM to earn a reasonable return on the investment. It also includes measures to reduce electricity costs by transferring load from periods of higher electricity prices to periods when prices are lower. This price structure is becoming popular in Europe and America and Electrical utilities are offering a lower tariff in off peak hours. In addition to the benefits resulting from DSM or Energy savings, it cannot be overlooked that DSM can also yield significant environmental benefits through reduced emissions from power stations.

DSM and Electric Industry

1. Changing the shape of the daily and seasonal peak load curves:

Depending on the supply side resources, there can be significant savings in raising the load factor on power system.

2. Encouraging the use of more efficient industrial, commercial and domestic devices:

New design for lighting, motor and appliances are demonstrating that the same work can be realized with less consumption of electricity. Providing the capital cost is not appreciably higher than the less efficient alternatives, both utilities and customer benefits.

3. Eliminating waste:

Higher standards of insulation on houses and buildings can reduce electricity consumption for heating and air conditioning without impacting on creature comfort.

4. Conservation:

Beyond not wasting energy, there are some opportunities to reduce

consumption with only a negligible effect on our life style.

5. Substitution:

Less popular with electric utilities is the option to surrender certain markets to other energy forms.

Economic Benefits:

The expected economic benefits for the electricity industry of implementing DSMs will include:

1. A reduction in fuel burn at power plants.
2. The deferral of the capital and financing costs of new power station construction.
3. A reduction in distribution losses.
4. The possible deferral of distribution reinforcement.
5. A reduction in transmission losses.
6. The possible deferral of transmission reinforcement associated with both new power plants and increased loads.
7. A reduction in the emission of SO_2 and NO_x both of which are restricted by International and National laws.
8. In the longer term, there might be a scope for price reduction to the customer to be reflected in changes in the efficiency (“X”) term of the price control formula. In the western countries, the idea of introducing an efficiency factor in the electric charges is widely canvassed as an effective means of encouraging the introduction of DSMs.

In Pakistan consumer are being charged FAC (fuel adjustment charges) on electricity bills for running Diesel Generators by electric companies during peak load hours, this additional charges are like a penalty to be paid by every citizen if the total load increases beyond certain limit.

Cost of Energy Conservation Program:

In all the fast developing countries like SAUDI ARABIA, this is the main question for any new scheme. The financial justification or technical feasibility are not enough to convince the Financial Wizards.

While the potential savings due to DSMs can be readily identified, the difficulty with financing DSMs do not seems to flow back directly to Electric Company, or the consumer who makes this investment. In implementing any DSMs program it is of the utmost importance to be clear.

Who should make the investment?

What is the cost benefit ratio?

And if the balances between risk and reward are very less, what is the use of this investment.

According to the market theory, the end use customer should perceive the benefit associated with improved end use efficiency and make the appropriate investment. In practice there are many reasons why this does not happen. In order to achieve the benefits that have been achieved from DSMs, Electric Companies in the WEST have been encouraged to make an investment on behalf of the consumer.

If Electric Utilities in Gulf countries make the investment through DSMs, it will be a loss in the revenue (through reduced sales) and thus a potential reduction in profits. The cost incurred on introducing DSMs need to be recovered from the consumer otherwise this will be a drain on the economy.

There should a mechanism to recover this expenditure (DSMs costs) and some of its loss revenue. In recovering DSMs investments consideration must be given avoiding discrimination between consumers.

The following are possible objections from consumer’s point of view.

1. Extra expenditure
2. Rate of return on this expenditure (Benefits)
3. Ignorance
4. Risk

Before encouraging anybody to spend from his pocket, it is necessary to convince him, to educate him, whether he is a single light and fan domestic consumer or an industrialist, a big organization.

Energy efficiency does not mean simply using less electricity. It would be inappropriate to adopt as an aim in its own right, the objective of

preventing of discouraging the production or use of energy, regardless of other uses. As an ordinary consumer everybody probably use electricity where the value of goods and services thereby produced exceeds the cost of electric bill.

Framework for Energy Saving Scheme:

To achieve the maximum benefits out of DSMs the following are suggested which may be considered as important tools available to Consumers, Electric Companies and Government.

1. Physical controls.
2. Technical controls.
3. Direct expenditure.
4. Investment inducting policies.
5. Education and information campaign.
6. Organizing exhibitions of new efficient electrical equipment.
7. Arranging consultative centers for general public and industrial consumers.
8. Best practices survey of the industrial units and big consumers may be carried out inside and outside the country to evaluate the system most suitable to out requirements.
9. Awarding the most efficient user of DSM.

Since these measures are inter-related their use should be closely coordinated for maximum benefits.

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المحولات الكهربائية

POWER TRANSFORMERS

البحرين

١ - ٢ جمادة الثانية ١٤١٦هـ

الموافق ٢٥ - ٢٦ أكتوبر ١٩٩٥م

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1-2 Jumada II 1416

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TESTING & COMMISSIONNING OF POWER TRANSFORMERS BUYERS – PERSPECTIVE

Engr. Sarfaraz Ali Syed

ABSTRACT

Over the past two decades the GULF COUNTRIES have seen two Oil Crises. There is a remark going on in International Economic Circle that the Gulf Countries are sitting on Oil, surrounded by Water and purchasing everything that other countries are offering.

Gulf Society is becoming an expense oriented society. In pursuit of higher standard of living we are using more and more Equipment which consumes Electricity. Even in a kitchen of moderate house one can count more than a dozen items running on Electricity. The per capita consumption of electricity in Gulf Countries is among the highest in the world, to cope with the demand of electricity in Gulf Countries. New power stations of higher capacity and large network of transmission and distribution are being installed.

In any Electric Power System, right from Generation to Consumers' end there are several points where transformeation takes place. Transformer is basically a Static Machine used for transferring Power from one circuit to another circuit without change in frequency. Power transformers are usually the largest, heaviest and often costliest single piece of equipment in an Electric Utility as such it needs proper consideration before purchasing, vigilance during manufacturing and special attention during Testing and Commissioning.

The purchasing function is a critical component to overall success of an Electric Utility especially in case of Power Transformers, as these may become a constant source of recurring losses and may jeopardize the reliability of the whole power system.

INTRODUCTION

In any Electric Power System, right from Generation to Consumers' End, there are several points where transformers are installed. They may be small transformers for measuring current or voltage or medium size used in the distribution network of electricity or big power transformers used in power plants or transmission network. Transformer is basically a Static Machine used for transferring Power from one circuit to another circuit without change in frequency. Power transformers are usually the largest, heaviest and often costliest single piece of equipment in an Electric Utility as such it needs proper consideration before purchasing, vigilance during manufacturing and special attention during Testing and Commissioning.

The purchasing function is a critical component to the overall success of Electric Utilities especially in case of Power Transformers, as these may become a constant source of recurring losses and may jeopardize the reliability of the whole power system. In this Article, I have summarized the point of view of purchasing agencies and the difficulties faced during the testing and commissioning of Power Transformers and the problems that arises after the power transformers are put on commercial load for further study, research and discussion.

The Power Transformers in general have a very high efficiency as compared to other electrical equipment in a power system but as the total capacity of transformers used in a system usually exceeds the total generating capacity (it is almost 7 to 8 times) the cumulative energy losses are substantial. The construction of power transformers require large quantities of material like copper, aluminum, core and structure steel, cellulose insulation, mineral oil, etc. If we think about the shortage of resources and the increasing prices, similarly their impact on the generating cost and electricity tariff we have to change our attitude towards the design and the specifications of power transformers.

LIFE OF A POWER TRANSFORMER

A power transformer has practically no moving part except few occasionally moving component i.e., Tap changer, cooling fans, or oil circulating pumps. The chances of wear and tear are very small. If the windings, cores and other fabricated parts are properly insulated against corrosion it should last indefinitely. But as the insulating material is usually made of paper, cellulose and different polymers, which deteriorates from the effects of

heat, moisture and oxygen. If the temperature is kept under normal limits and an adequate protection is provided to prevent moisture and oxygen, the power transformer may attain a long life by human standard. We can say that the life of power transformer depends on the life of insulation. When insulation fails we can say that the life of power transformer has ended.

I will quote from Engr. D. P. Gupta of India: [1]

"POWER TRANSFER HARDLY EVER DIES. IT IS USUALLY KILLED BY SOME UNUSUAL STRESSES BREAKING DOWN A WEAKENED PART LEADING TO THE END OF POWER TRANSFORMER"

While Transformers seems to be simple static devices, a variety of complex theoretical problems must be considered and solved in their design, construction and must be proved by some test before commissioning to satisfy the buyer. This may include calculation programs for two – or - three dimensional electromagnetic fields. Thermal, mechanical and acoustic investigations complement the broad range of theoretical work which should be the basis of economical solutions, while at the same time quality control at all levels should be ensured. There are different stages in the whole life of power transformer.

(i)	(ii)	(iii)	(iv)	(v)	(vi)
Design -	Manufacture -	Testing -	Transportation -	Testing & Commissioning	- Commercial Operation

There are three types of tests which are carried out on power transformers as on all other electrical equipment [2].

1. ROUTINE TEST
2. TYPE TEST
3. SPECIAL TEST

But this testing in carried out twice on power transformers. First testing is carried out in factory after completing the assembly, the second testing is carried out after transportation and erection of power transformer at site. The important intervening stage between the first testing and second testing is the "Transportation". If the transportation is not carried carefully it may adversely effect the life of power transformer. It is advisable to install an Impact Recorder on the Power Transformer during transportation, to record any abnormal jerks or impacts on the windings and other assemblies. Second testing is carried out at site before putting power transformer on commercial load.

Some of the second stage tests are the same but the order of priority of tests is changed and these tests proves that the Power transformer although tested earlier is according to specifications and standards as ordered by the purchaser / Electric utility.

FACTORS EFFECTING THE PERFORMANCE OF POWER TRANSFORMERS

A Power Transformer should withstand, the stresses that arises from Ambient Temperature, Electrical Stresses, Mechanical Stresses, Magnetic Stresses and other operating conditions. As a BUYER (Electric Utility) you can not purchase a Power Transformer from off the shelf of a supermarket nor you can arrange it through Mail order service, rather pre – procurement stage is very important and one ought to consider the technical requirements, standards and specifications, the electrical parameter of the system and the finance involved in purchasing the standard make or getting it specially designed for you. Similarly as manufacturer one can not imagine to manufacture Power Transformers like standard Automobile Cars or any other household item and then sell it through a chain of stores.

Power transformers should be designed and manufactured taking into consideration that the characteristics of materials change during its operating life owing to applied stresses, therefore it is necessary to know the long term endurance of materials when submitted to various stresses; in particular the time stress curve should be determined for a given material and a given stress. In this way materials can be used within such stress limits that their effectiveness is secured for the expected life time, i.e. in such a way that they can fulfil the task for which they were chosen.

In this article, I have tried to give a summary of various stresses and life and endurance tests on the basis of existing IEC Standards or specifications of some utilities in Saudi Arabia and the information supplied by some manufacturer.

The main stresses to be taking into account are:

1. Thermal stresses
2. Electrical stresses
3. Mechanical stresses

A brief description of each of these stresses and the test procedure to ascertain the performance of power transformers is given as under.

1. Thermal stresses

Thermal stresses is an important degrading factor of materials. Thermal aging is determined by physical-chemical reactions, the rate of which depends on Temperature according to an exponential law; therefor life time is given by Arrhenius Law. [3] IEC Publication No. 216 1974 rev 1980 gives a description of test methods and instructions for the statistical treatment of data.

Experimental results have been obtained for many materials in standardized conditions; these data allow a comparison among different materials for a given application, so that it is possible to correlate them with service experience. Thermal stability can also be calculated by carrying out $\tan\delta$ measurements after a Temperature rise test [4] & [5].

These methods allow to asses an average value of losses and as, the dielectric dissipation factor is low, they permit the evaluation of apparatus thermal stability; nevertheless they do not give any indication about localized instability caused by uneven processing quality or by thermal and chemical materials incompatibility.

A Thermal Stability Test on power transformer appears to be the most obvious solution of the problem; however this method can be criticized because it can fail to showcase characterized by a limited initial extent and a slow progress; furthermore, this test is considered expensive and not easy to be carried out.

Anyhow these problems are to be solved by manufacturers by performing long duration laboratory tests on materials and setting up an adequate quality control plan. Cooperation between Manufacturer and buyers helps to reduce the risk. It would be advisable to agree upon an upper limit of the $\tan\delta$ value.

At the $\tan\delta$ value depends both on the type and design of the equipment, and on insulation, these limits can be different for each application. Moreover the $\tan\delta$ measurement, as an acceptance test, allows the uniformity of production to be checked; hence an average value and a tolerance should be given.

2. Electric stresses

Studies carried out on voltage endurance of organic insulating materials have let to the development of Partial discharge test. Experiments on samples of power transformer insulation [6] [7] have shown that the probability of partial discharges inception depends on applied voltage and test duration.

At present expert do not agree completely on the design of insulation on such probabilistic methods, in any case partial discharge test is necessary to ascertain that the insulation of power transformer is under satisfactory limits. Utilities prefer to adopt higher values of voltage and duration.

3. Mechanical stresses

A power transformer must be constructed so that it is able to withstand the mechanical stresses caused by external system faults. B.S 171 Section 8 specifies the duration of the short circuit fault currents. Although the provision of Section 8 do not necessarily correspond to service conditions, they form a satisfactory basis of mechanical design.

To the manufacturer, the problem has two aspects.

a) Calculation or measurement of E.M.F.

b) Mechanical design of transformer winding to withstand these forces. The latter requires a knowledge of properties of the material used in the construction which is copper and insulating materials.

There are no test prescribed to measure this and the purchaser / Electric Utility has to depend on the design skill of the Manufacturer.

REQUIREMENT OF BUYERS / ELECTRIC UTILITIES

In this article, I have tried to emphasized on a better understanding between the suppliers / Manufacturer of power Transformers and the purchasers / Electric Utilities, keeping in view the requirements of Electric utilities, the service conditions, the economic cost and the testing procedures that could prove that the power transformer is able to give a satisfactory service if put to commercial load. To begin with we should decide on the minimum service requirement that a power transformer should fulfil. They may be;

A) Long life
B) Reasonable losses
C) Adequate auxiliaries
D) Quality control
E) Environmentally friendly

A) Long Life

It is practically impossible to determine the probable period in which a power transformer will fail but this probability exists. Insulation as any other thing of the world is gradually deteriorating and losing its life all the time depending upon the Temperature at which it is operating. Therefore it becomes very necessary to understand the various UNUSUAL STRESSES [8] which contribute to the deterioration of insulation especially the Temperature and laws relating to aging of insulating materials so that power transformer could be tested for the satisfaction of both parties, i.e. Manufacturer and Buyer.

Now what are these unusual stresses. These unusual stresses are those stresses which leads to the eventual death of a power transformer. These are the same as explained earlier.

i) Thermal stresses

Deterioration of insulation over a span of time with temperature, moister and oxygen.

ii) Electric stresses

Overloading, over voltage, transient over voltage, switching and lighting impulses and other abnormal operating conditions beyond the designed limits or calculated values.

iii) Mechanical stresses

Stresses on the windings and cores and tank walls due to stray magnetic flux or other weak points in the mechanical frame, which could also develop due to improper handling of power transformer during transportation and erection.

iii) Conforming to standard service conditions

All the information about height above sea level annual rain fall, ambient temperature, category of seismic zone, fauna and flora, and the other information about the site where power transformer is to be installed is normally given in the bid documents to help in designing the power transformer. It is expected by the buyer/ electric utility that the manufacturers/ supplier should provide the power transformer suitable for safe and smooth operation for a long time [1] [2] & [9].

B. Reasonable Losses

In designing a power transformer there are three distinct circuits to be considered, the electric, magnetic and di-electric circuits [1] & [2]. In each of these, losses occur, which may be subdivided as follows:

1. Losses in the electric circuit

   a) IR loss due to load currents
   b) IR loss due to no load current
   c) IR loss due to current supplying the losses
   d) Eddy current loss in conductors due to leakage fields

2. Losses in magnetic circuit

   a) Hysteresis loss in core laminations
   b) Eddy current loss in core laminations
   c) Stray eddy current loss in core clamps, bolts

3. Loss in the di-electric circuit

a) This loss is small in magnitude and it is included in the no load losses.

In order that a power transformer may have a high efficiency all these losses must be reduced to a minimum. It is therefore of interest to consider, firstly, the features which determine their magnitude, the steps which should be taken to reduce them is important from manufacturer point of view whereas the test which could prove that the losses are really minimum is of interest for the buyers perspective.

According to SAUDI STANDARDS (T – 11) [12] the bidder is required to guarantee the declared losses of the power transformer, including the cooling fan and oil pump load as a copper loss. After the final tests the purchase price is adjusted in line with any losses in excess of those declared.

In SAUDI STANDARD (SASO T – 11) [12] nothing is mentioned about the procedure to calculate the compensation in cost nor any formula is

prescribed but in European countries following formula is usually adopted to calculate the amount which is added to bid price for evaluation and comparison.

Amount to be added to bid = 10438 LN + 4234 LL (in Dollars)
Where LN = No Load Losses in KW.
LL = Winding Losses at full rated output in KW.

C. Adequate Auxiliaries – (BUILT IN PROTECTION SYSTEM)

Transformer auxiliaries play a vital role in ensuring safe operation and long life. Some of the auxiliaries provide protection against abnormal performance and faulty conditions. Important auxiliaries are as under.

I. Bucholtz Relay

Any fault which develops inside the transformer results in generation of gases. Bucholtz relay operates under such faulty condition and gives audible alarms and isolate the transformer from the main supply.

II. Temperature Indications

These are precision instrument thermometers specially designed to protect the transformers against high winding or oil temperatures, and gives an audible alarm and switch off the transformer.

III. Cooling fans and oil circulating pumps provide

Additional cooling system for the oil which serves two purposes. One is to keep the large power transformer under normal temperature limits and the second is to increase the power output. In Power Transformers the oil serves dual purpose, as an insulating medium as well as a cooling medium. The heat generated in the power transformers is removed by the transformer oil surrounding the winding, core, and tap changer and is transmitted to atmosphere. Automatic switching for on and off arrangement is also provided to operate these fans and pumps according to the settings of temperature limits.

IV. Oil Level Indicators

Normally power transformers are provided with a conservator tank which takes care of expansion in the oil volume due to rise in temperature and conversely the reduction in oil volume when temperature drops. An oil level indicator on the main tank shows the level which can also be transmitted through magnetic switch to audible alarm or indication in the control panel.

V. Protection Against Spread Of Fire

Like any other electrical equipment a power transformer can become involved in a fire situation. Such a fire can be quite small or of enormous proportion, it may or may not evolve depending largely on the existence of detector, and automatically operating sprinklers, it may spread or remain confined. None of the standards committee has made any attempt to evaluate the behavior of the liquid cooled power transformer in a fire.

What is happening is that the transformer manufacturers, often aided by mineral oil producers, experts on fire safety and industrial insurers have taken some initiative and develop some techniques. Some of the European manufacturers have come up with a very good idea of draining the oil and introducing inert gas from the bottom of power transformers in case of fire so that oil does not take part in spreading the fire and the fire could easily be controlled.

D. Quality Assurance

Transformers are products, for whose individual components it is very difficult to obtain any definite results in pretesting. Thus compliance with strict quality standards during production is all the more important. These standards should be described in the Quality Manual which may be asked with the bids for reference purposes at any time.

E. Environmentally Friendly

Power transformer should be environmentally friendly. Increased awareness about the pollution and the adverse effects on the atmosphere and surrounding area has resulted in introducing some new standard and specifications and subsequently new tests have been introduced which needs revision in view of the new technological advances in the environmental sciences.

The pollution due to power transformers may be summarized as under; [12] [13] [14].

a) E.M.F. Fields. Normal limits 1.65 Tesla
b) Noise. Normal limits 55 dB to 100 dB
c) Vibrations. 40 – 150 Hz or 100 Microns

Special test need to be developed to measure these limits for the safety of the operating personnel and the people living in the vicinity of power transformers.

SAUDI NATIONAL STANDARD

Power Transformer is a special equipment which should be designed properly and manufactured carefully. Any slight change in the parameters requires re-design right from the basic level and a lot of work is required to cope with to the change in parameters, as such it is economical and time saving to both the manufacturer and buyer that some standard is adopted.

In Saudi Arabia there is an Electric Regulating Agency called Electricity Corporation (EC). This agency (EC) has established the standards of electrical equipment and the testing and commissioning procedures. The Government of Saudi Arabia has established a separate Department called SAUDI ARABIA STANDARDS ORGANIZATION and a lot of work has been done and standards and specifications of many electrical equipment have been made and issued for the guidance of electric utilities to follow.

Following details of test and their description is taken from E C standard book on Power Transformers T – 11.

S.# TYPE OF TEST IEC REF #	DESCRIPTION OF TEST
1. ROUTINE TEST	
1) M/O winding resistance	IEC – 76 Part 1 Clause 8.2
2) M/O of voltage ratio & vector	IEC – 76 Part 1 Clause 8.3
M/O of impedance voltage on principal tap short circuit impedance and load losses	IEC – 76 Part 1 Clause 8.4
3) M/O of no load loss & current	EC – 76 Part 1 Clause 8.5
4) M/O of Insulation resistance	IEC – 76 Part 1
5) Di electric test	IEC – 76 Part 3 IEC 60,270
6) Test on no load tap changer	IEC – 76 Part 1 Clause 8.8
2. TYPE TEST	
All the routine tests above plus	
1) Temp rise test	IEC – 76 Part 2 Clause A 3
Lighting impulse voltage withstand test	IEC – 76 Clause 12, 13

2) Partial discharge test IEC – 76 Part 3 Clause II IEC 270

3. SPECIAL TEST

1) Impulse Voltage Test IEC – 71
2) Di electric test IEC – 76 Part 3, IEC – 60, 270
3) M/O of zero sequence impedance EC – 76 Part 1 Clause 8.7
4) Short circuit test According to bid documents.
5) M/O of acoustic Noise level IEC – 551
6) M/O of harmonic of no load current IEC – 76 Part 1 Clause 8.6
M/O of the power taken by the fans and motors of power transformer. Within the declared limits.
7) M/O of Artificial Pollution IEC – 507 Clause 14.2

From buyers perspective the type test certificate is very important, sometimes it is demanded as part of bid documents. Type test are those test which are carried out to check the performance of the power transformer against standards. These test are performed in an independent testing laboratory of international repute which is acceptable to both parties.

Nowadays the Electric utilities are also pressing to witness the routine tests which are carried out in factory after the assembly is completed.

Special test are also witnessed by the buyers representative. After shipment and transportation of power transformer to site, all routine tests are again performed to guarantee that no damage has been done during transportation or erection.

The basic purpose of testing is to ensure that the power transformer has been manufactured according to the specification of the buyer and that the losses are under normal limits. There may be some power transformers cheap in price but may consume much power on its auxiliaries and have much transformation losses, thus becoming a big source of recurring losses on the power system. These test gives an idea of the overall performance of power transformers if carried out properly by some expert Engineer with the help of proper instruments and under proper conditions. Unfortunately no High Voltage Laboratory or testing facilities are available in GULF COUNTRIES as such we have to depend on the manufacturer facilities or sometimes we depend only on the Type Test Reports.

The establishment and maintenance of a high standard of both material

and workmanship can only be achieved by continuous inspection during the manufacturing stages and by subsequent testing of the components and finished product. To maintain uniform and trouble free operation and performance during the commercial operation, it is necessary to evolve a system of test at different stages and at different intervals. In order to obtain accurate results, it is essential that the testing instruments should be of low power factor, class AL and these testing instruments should be checked and calibrated at intervals not exceeding six months to ensure that the requisite accuracy in maintained.

GLOBAL STANDARD AND OPEN MARKET

In today GLOBAL MARKET, National standards are diminishing in importance to International Standards. Today, it is the global user community that is demanding freedom of choice in selecting new equipment. This freedom ensures multi-national industries, open markets and promotes global competition. With the strengthening of European Union and the big cartel coming into business it is very important to get latest technical know-how and knowledge about the test procedures and test equipment in use to verify the claims of manufacturers regarding performance of power transformers.

Actually standards are becoming market driven phenomena, gone are the old good days when one manufacturer or company could seize complete ownership of a new product or technology for itself. International standards level the playing field and assure fair competition because they require all suppliers to meet a common set of requirements. And by doing, so they reflect state of the art. Because of the complexity and cost of much of today testing equipment and testing facilities, the buyers of power transformers are right in demanding standards and testing procedures to assure long life and better performance of power transformers. This give rise to what we call the anticipatory nature of today new standards. In a distinct change from the past standards today often precede the market appearance of the products they describe.

In the recent ANSI Conference held in Washington DC on 3-4 March 1994 (as reported in I.E.E.E. Power Engineering Review Vol 14 Sept 1994) Mr. Willium J. Hudson said that, “Since most standards define requirements and not design specification, there is ample opportunity to differentiate the product through superior technology”.

According to Mr. Hudson, voluntary standards should not be seen as an end in themselves, but rather should be included in a company global market strategy and new product development effort. By working together, the Manufacturer, Buyers, the Government Regulating Agencies like Electricity Corporation of Saudi Arabia, and Institution like CIGRE, GCC, we can hope to improve the standards and specifications of Power Transformers and the testing procedures, for the benefit of Electric Industry in the GULF COUNTRIES.

CONCLUSION

Gulf Society is becoming an expense oriented society. In pursuit of higher standard of living we are using more and more Equipments which consumes Electricity. Even in a kitchen of a moderate house one can count more than a dozen items running on Electricity. The per capita consumption of electricity is among the highest in the world, to cope with the demand of electricity in Gulf Countries, new power stations of higher capacity and large network of transmission and distribution are being installed. Power transformers are usually the largest, heaviest and often costliest single piece of equipment in an Electric Utility as such it need proper consideration before purchasing, vigilance during manufacturing and special attention during Testing and commissioning.

In this article emphasis is given on a better understanding between the suppliers/Manufactures of power Transformers and the purchaser/ Electric Utilities, keeping in view the requirements of Electric utilities, the service conditions, the economic cost and the testing procedures that could prove that the power transformer is able to give a satisfactory service if put to commercial load.

The tests described as above and the preceding observation made it clear that IEC publications in force, do not consider endurance and life tests or equivalent tests. It is therefore suggested that Institute like CIGRE GULF should come forward and propose some revision in IEC Standards.

Some Manufacturer claim to have adopted detailed procedure to do these tests but still the tests criteria should be reviewed and rationalized to satisfy the buyers. The standard revision should be performed taking into account the particular characteristics of power transformer and all the Type tests performed on it. It is important that the slow pace of progress in the standards fields in electric industry in general and the field of transformers in particular has conditioned transformer manufacturer to follow fashion rather than to change them.

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A pose with delegation during the UnIG'96 Conference at Bogazici University, Istanbul, Turkey

GLOBAL TECHNOLOGY MANAGEMENT ISSUES, CRITICAL FACTORS AND VIABLE MECHANISM

Engr. Sarfaraz Ali Syed

Abstract - Managing technology plays an important role in the development of a country. Much of the discussion on this subject always centered around the National Policies and the behavior of International Market. Technology Transfer is a simple operation, if the donor and recipient are agree, it becomes easier and economical. But Managing Technology is not as simple. Cross cultural behavior, level of technology, financial incentives, trade regulation and price mechanism are the critical variables which plays important role in managing the technology across the international borders. This article focuses on these aspects. This article is divided into different chapters that describes the global techno economic scenario, issues and case studies, effecting the Management of Technology.

1. INTRODUCTION

Every product is based on an identifiable engineering skill or what might be called technology [1]. Most products are in fact composed of multiple technologies, some of which are created in the country while others are imported or purchased as components.

Technology is uniquely and exclusively a human attribute. Yet tragically it is not spreading fast enough or reaching to the services of a common man.

Technology Transfer is a simple operation, if the DONOR and RECIPIENT are agree it becomes easier and economical but managing technology is not as simple. The patent rights, protection from imitating, profit from initial investment, after sales service, political situation and geographical location of the recipient country on the globe, all these factors play important role in successful management of technology.

Managing Technology plays an important role in the economic development of a country. Much of the discussion on this subject always centered around the National Policies and the behavior of International Market.

Whereas Cross- cultural behavior,

Level of technology, Financial incentives, Trade regulations and Price mechanism are the critical variables which play important role in managing the technology across the international borders. As Professional Engineers it is our duty to study the problem and to suggest viable mechanism for successfull management of technology in the changing circumstances for further study and discussion for the benefit of developing countries.

2. GLOBAL TECHNO- ECONOMIC SCENARIO

Managing Technology means importing new technology and then merging it with local indigenous technology utilizing local raw material and local talents. This also includes providing necessary infra-structure for new industrial plants, training facilities for the local labor and encouraging overseas investment by formulating open market policies. Successful management of technology is very necessary for overall techno-economic development of the country. National Economic Policies and Political Stability of the country ensure better results in short time.

It is interesting to note that many under developing countries like Pakistan, India and Brazil have a good record of acquiring of new technology and merging it with indigenous technology and to some extent developing new technology but not in managing it. Whereas some Pacific Rim Countries like JAPAN, SOUTH KOREA, TAIWAN, HONG KONG, SINGAPORE AND MALAYSIA, present a fine example of not only economical transfer of technology but also of successful management of technology.

At the core of effective management of technology lies the critical need for devising viable mechanism for getting the product out of the laboratory successfully i.e. the effective management techniques through the different product development phases ending up with goods or services designed to meet the customer requirements.

The successful technology management is a combination of aggressiveness and working smart to build a distinctive competence and profitable business. Hoping to find a potent formula for successful management, governments and executives have invested heavily in new management tools and techniques in recent years. But there has been no objective evidence on whether increased tool usage is good or bad for big international companies and countries or which tools have produced what results over what period of time. However a strong

correlation exists between satisfaction with financial results and a country's ability to build distinctive capabilities that bring about overall technological and economical development.

Some basic issues need special attention like demand, source of technology and local resources available. The study of economical conditions, local resources, import policies and political environment should be studied before designing a strategy for managing the technology in today's fast developing world.

Two basic things attract attention. The first is that much of the imports and exports are transacted between companies and their foreign subsidiaries. Politically this is international trade but from economical and technical point of view, the flow of goods and services are internal transfer within the same enterprise. A second way of looking at the global market place is to consider that many components are imported to assemble or manufacture items.

Now a very interesting question arises; whether a TOYOTA car manufactures in USA is considered a JAPAN export? and if this car is sold to BRAZIL will it be considered a USA export? What makes the international economy so fascinating is the rapid rate of change. The forces of technology and economy are outpacing both the current management thinking and traditional politics. The standard geo- political map and the emerging techno-economic maps are out of synchronism.

In the past 60 years the technology has shifted dramatically from being almost exclusively domestic to international. This globalization of technology and setting up of manufacturing plants in other countries depends on the creation of a new CULTURE.

The term culture as it is used in this article means generally the pattern of behavior and thinking [2].

3. ISSUES & CRITICAL FACTORS

The problem with developing countries is inadequate planning and political instability. Each new regime brings its own philosophy. In most of the developing countries basic infra- structure necessary for installation of a new industrial plants is not available and luxury items are imported at the costs of cash crops and indigenous raw material. As there are very few manufacturing units in these countries the unemployment is high. The few learned and skilled personnel look for opportunities to go abroad. This brain drain is aggravating the situation.

Managing Technology is the application of principles of management on industrial and financial activities[3]. There are two fundamental aspects to this process. First the technology must be created or acquired and then it must be expeditiously transferred to the appropriate receptor. But to manage this process is proving to be at least as challenging and certainly more controversial than the first[4]. Probably the most difficult thing is to ascertain variables which effects managing the whole process of technology transfer and technology management as each developing country is unique, with its own priorities and idiosyncrasies, what works in one country may not work in another country.

Each country has to develop its own philosophy and techniques in view of its culture, education, political system and development plans.

The governments in Asian Pacific Countries orchestrated the acquisition and internal diffusion of foreign technology into its nascent high technology industries. At the same time they protected the domestic market from foreign competition.

High volume, low cost, self-support and low lending rate contributed towards their leap to progress.

Following six key factors emerges as specially critical in the management of technology in Pacific Rim Countries, which are summarized under each heading for information and further study, discussion, comments and guidance from engineering community, financial wizards and academia.

i. Communication
ii. Cross-Cultural Behavior
iii. Level of Technology
iv. Motivation
v. Price Mechanism
vi. Trade Regulations

i. Communication

Communications between the Donor and Receptor involves both active and passive links. Active links are direct person to person contact. The benefits of active links encourage personal contacts, helps in shrinking the mental gap, and ensures fast feedback. In passive links, use of technical books, journals, manufacturer's manuals, video films and high technical reports is carried out. Such media based linkages are considered to be the best for good management of technology.

ii. Cross-Cultural Behavior

This involves geographical distance as well as cultural gap between the donor and receptor. The geographical distance between the

two parties can slow the whole process, similarly the cultural gap between the two nations poses challenges in setting up a working network.

Each party brings its own mental values, working habits, attitudes and ways of handling the issues and problems. The wider the cultural gap between the donor and receptor, the more difficult it is to manage the technology transfer.

The lower the cultural gap that is the more the donor understand the values, attitudes and ways of doing the things the greater the chance of efficient and economical management of technology.

Once the persons from the developing country are exposed to the advanced technology and are given a chance to explain their point of view in respect of use of local resources and amendments in the design of finished product in view of their cultural demands the new technology can be introduced and markets can be captured.

Customer oriented design will surely give a domestic touch which will boost the sale and fast turnover with less risks.

iii. Level of Technology

The technology which is low in operation and maintenance techniques is fairly easy to understand [5]. It is easily adaptable and its low costs encourages easy marketing. A gradual and uniform rate of development brings satisfaction among the citizens and help in maintaining the political stability. Jump from cow cart to jetliner will not only destabilize the national economy but will increase the gap between the haves and havenots.

Recommendation to plan to transfer of low technology in the earlier stages are meant to make the technology more concrete, more understandable to the user, less ambiguous for the repair technicians and within the reach of common man. This will encourage local enterprise to invest in small industrial units on profit sharing basis utilizing new manufacturing techniques to keep the costs low.

iv. Motivation

The ease of operation, after sales service, economy in fuel consumption, reduction in man-hour are the points which attracts developing countries to aspire for new technologies. The developed countries or donor has to show it, prove it and motivate local entrepreneur to buy the new technology.

This can be done on government to government level or through co-operation among private companies under the supervision of the governments so that joint policies are adopted to encourage local investors to venture into new technologies.

The initial investment on the part of donor will be small fraction of future earnings and if shared by the recipient government it will repay in the shape of development of industry on modern lines and if manufacturing plant is established it will not only boost the internal revenue but will also help in solving the unemployment problems of the recipient country.

v. Price Mechanism

With the advancement of business techniques on scientific principles and better understanding between engineers and accountants, fixation of prices has become an ART in itself and when combined with project postmortem analysis and market feedback loops, the algorithms provide heuristic capabilities.

Following three important points needs special consideration before finalizing the costs and price[6].

(a) The quantity of product

(b) The mode of production

(c) The market conditions

In the first place the demand of the new product is determined after survey and study of market pattern so that manufacturing unit is designed and size of batch production is decided. After that the mode and pattern of manufacturing is designed in view of amount of investment and in accordance with the protocol signed. The cycle of production varies with the labor rate [7]. If the local labor is found to be cheaper, labor intensive methods are more economical and if labor is imported from other countries then more emphasize is given to automation and computer control so that production meets the minimum requirement for early break-even point. Once the quantity and batch size is decided then the proper marketing is taken care off. All these factor interacts and the proper ratio and expert blend of these facts results in the most economical determination of the prices.

vi. Trade Regulations

According to a study by OECD [8] many low developed countries will have measure of competitive in certain areas. But a lot depends on which country and which area. Every economist looks with interest and keen eye the balance of trade between USA and JAPAN, NORTH AMERICA and EUROPE and the behavior of newly opened EAST EUROPEAN MARKETS. Trade in services and merchandise is hot

topics since last UROGOY Talks. It is a common belief among Third World Countries that liberalizing the rules will benefit the developed countries at the expense of the developing countries, because competitiveness in services is not simply a matter of having cheap labor. Labor intensive services have other important aspects such as availability of raw material, finance and technical skill.

It is a universal fact that CAPITAL IS VERY SHY, it flies away even with a slight change in economic conditions so it is the prime duty of government to provide favorable conditions so that the local investor and foreign expert may work jointly for the ultimate economic development.

The Taxes, Duties and Tariff Regulations in certain developing countries results in artificial boost in government revenue but in long term either the plant goes in loss or adopts illegal means to evade taxes. In either case the process of technology management is hampered and such illegal activities results in blackmailing of management by labor union and thus the quality goes down, prices goes up and the sale of product is decreased.

These are the conditions in most of the developing countries and a new entrepreneur has to study the rules and regulations of the recipient country and formulate a suitable policy before entering in a new contract with foreign firms.

4. ENGINEERING THE FUTURE

The problem of the developing and under developing countries is that the industrial sector under public sector is usually run by non-technical persons and the financial matters are being dealt by accountants.

The problem of Industrial Sector and Engineering firms in these countries is the development of new technology and the adaptation of the Industrial concerns to technological change. Engineers must find ways to sharpen their ability to do technological forecasting and to translate these forecasts into strategies to gain from these technologies. This approach means that more attention must be paid to the problems of TECHNOLOGY MANAGEMENT rather than TECHNOLOGY TRANSFER.

Process development time should be reduced to compete in the present open market economy. In other words the time required for a product or services from laboratory to the consumer end should be reduced. This require close cooperation between

Universities, Industrial sector and Government. We can expect the trend toward Smart Managers rather than Hard Working Engineers in the future organizations.

Managerial holes in organization charts will be plugged by management oriented consultants rather than purely technical engineers that are now being produced by the universities. In the present market, Engineers need the skills and abilities to compete with the Business Managers and Financial Executives who are in much demand. A growing tendency is that now engineering graduates are doing courses in business administration or financial managements to get a good job or to rise to senior posts.

Professional obsolescence is a possibility. Responsibilities that once were important are no longer so. Others that were not so important have become critical. As responsibilities have shifted, so have the skills, abilities, knowledge, and attitudes that make for High Value Managers than High Tech Engineer. Let me call this new breed as Future Engineer.

What are the skills, abilities and attitudes most important to the success of the Future Engineer in the coming days in the world?

Are our Universities producing engineers who can take on the responsibilities and challenges of the new market strategies?

Back in the old days, a newly appointed engineer would typically have a honeymoon period of months or a year or several years to learn the peculiarities of the job. But no longer now. According to a survey conducted by Philadelphia -based Manchester Partners international, four out of 10 newly appointed engineers fail in their jobs and within the first 18 months, either resign their position or at minimum receive a poor performance review.

Their failure is due, in part to the fact that many crucial managerial tasks are not taught in Engineering institutions, but are left to be learned on the job, where few engineers ever master them because no one teaches them in the field. It also is due, in part, to the fact what takes place in the classroom often is miseducation that inhibits their ability to, learn from their experience. Commonly they learn theories and higher mathematics that are usually applied successfully in practice, a limitation many of the engineers discover only through the direct experience.

Business today have higher - than ever expectations for results. This

combination of higher expectations and lower organizational patience is presenting Engineers with a better - than - ever opportunity to achieve quick stardom or to suffer a swift career decline.

The most dramatic growth pattern we have seen in the last 40 years of engineering and technology management has been in educational programs. Educational institution throughout the world are offering an increasing number of degree-granting programs to prepare engineers and scientists to move toward management responsibilities while maintaining identity in their respective technical field.

These programs are offered under various titles such as, "Engineering Management", "Management of Technology", "Engineering and Management", "Technology Management", and several others.

A very interesting study was carried out in USA under Portland State University during 1994 according to which there were 159 degree granting programs. 130 of them were in United States, the remaining 56 were in 25 countries. These are the programs which provided detailed information about their curricula, research areas, organizational characteristics, and resource levels.

What I humbly suggest is that an independent study of all the educational institutions and the technical management programs they are offering should be carried out to assess the present situation and then a program may be devised in cooperation with the Industrial Sector and the Government.

"Creativity, invention, and innovation lie on a continuant" says Eng. Gerard. H. Gaynor (VP of Engineering Management Society) IEEE [9]. These three words define the engineering profession.

If we define innovation plus commercialization or implementation, then creativity and invention are the precursors to innovation. While these three activities define engineering, and ultimately determine organizational success, little effort is being paid on these activities by Industrial sector, Universities, Government and above all by Engineering Community.

Unfortunately engineering education system seldom focuses on this continuum that requires some level of engineering breadth.

Engineers for whom self-motivation is an absolute necessity, become comfortable in a paternalistic environment and ignore the implications of such an attitude on future growth opportunities.

What we need is a framework for well-established relationship with Government, virtual partnership with National Industries and mutual understanding with the Engineering Communities and Organisations like IEEE. CIGRE and IQA.

The following three steps are being suggested to improve the situation but each activity is to be taken up by different organisations for further study, comments and discussion in this International Conference.

1. Modification in the syllabus of Engineering Faculty
2. Change in Engineering Culture
3. Guidance in Career Management

5. CONCLUSION

Technology is uniquely and exclusively a human attribute, yet tragically enough it is not spreading fast or reaching to a common man.

Technology transfer is a simple operation, if the donor and recipient are agree it becomes easier and simple but managing technology is not as simple.

A lot depends on the cross cultural behavior, trade regulations, availability of raw material, basic infrastructure and last but not the least on the political stability of the recipient country. After the era of cold war, signing of START PACT between USA and RUSSIA and the emergence of a united Europe with its consortium, the economic scenario is changing rapidly. Pace of transfer of technology and managing it in new environment has become very tricky.

This is going to be an indirect affect of the policies and priorities of under developed and developing countries, and they will have to redesign their strategies and plans to acquire and manage new technologies.

Managing Technology plays an important role in the development of a country. Much of the discussion on this subject always centered around the national policies and the behavior of international market. Some basic issues needs special attention like demand, source of technology and local resources. The practice of Technology Management clearly does not take place in a vacuum. It takes place in design offices, research / testing laboratories and on plant floor, each of these represents organizational units of Larger Enterprises, Government Agencies, and Non - Profit Educational Institutions (Universities).

What we need is a framework for well-established relationship with

Government, virtual partnership with Industrial Sector and mutual understanding with Educational institutions and Engineering Communities like IEEE, CIGRE, and IQA.

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PROTECTION ELECTROMAGNETIC COMPATIBILITY PROBLEMS, SOLUTIONS AND PRECAUTIONS

Engr. Syed Sarfaraz Ali

ABSTRACT

Different types of Monitoring, controlling and recording relays are utilized in modern power system to detect the abnormal conditions and to initiate appropriate actions. These protection relays and their associated systems are compact units of analogue, discrete components and digital networks connected through a power system for the purpose of sensing problems. They are utilized in all parts of electric power system for detection of abnormal situation and intolerable conditions.

Electric power Protection is the science, skill and art of applying and setting relays or fuses to provide maximum sensitivity to faults, and intolerable systems conditions. In modern power system we are increasingly surrounded by different type of electromagnetic and static relays utilizing highly sophisticated means of sensing recording, computing and communicating these information for the safe and smooth operation of the system. Their power vary form milli – watts up to several watts at different frequencies. The consequence of this development is that modern circuits are potentially more susceptible to Electro- Magnetic Interference and are themselves sources of interference. All of these protective devices and equipment must be immune to all type of electrical or magnetic disturbance, otherwise they may result in CHAOS; unthinkable consequences.

A child playing outside a substation with a remote controlled car may interfere with the operation of switchgear or the tele - protection signal of a large network may interfere with the nearby industrial process or may disturb the landing of a Boeing 747 jet.

This undesirable interference or let me call modern problem of electro-magnetic pollution is termed as Electromagnetic interference, and all electrical equipment must be immune to such interference or Electro Magnetic Compatible.

In this article I have tried to summarize what is known and what is not known about Electro Magnetic Emission and Electro Magnetic Immunity.

PROTECTION
ELECTROMAGNETIC COMPATIBILITY
PROBLEMS, SOLUTIONS AND PRECAUTIONS

Engr. Syed Sarfaraz Ali

INTRODUCATION

Protection of Electric Power System is the science, skill and art of applying and setting relays and/ or fuses to provide maximum sensitivity to faults usually but always create changes in the system parameters, and intolerable system conditions in the system. System faults usually, but not always create changes in the system parameters, which can be used to distinguish between tolerable and intolerable limits of the system conditions. Relays and fuses are utilized to detect the abnormal conditions and it to initiate appropriate actions [1].

These protection relays and their associated systems are compact units of analogue, discrete components and digital networks connected through a power system for the purpose of sensing problems. They are utilized in all parts of electric power system for detection of abnormal situation and intolerable conditions.

In all type of protection relays inputs may be electrical, mechanical, thermal or other quantities, in order to take appropriate measures to avoid intolerable conditions to cause any damage to the consumer's equipment or power system as a whole [2].

These relays, devices and other protective equipment should be immune to all type of disturbance, like high ambient temperature, vibrations and other Environmental Pollution. The most important of them is Electromagnetic Disturbances. As it can prevent them from operating properly in a common electromagnetic environment.

Nowadays electronic relays are being extensively used because of their high performance and ease of operation. They need little space and are almost maintenance free. With solid state relays, protection system has become complex and more comprehensive [3].

Electronic relays offer the following advantages:

1) Low VA burden on CTs and PTs.
2) Absence of mechanical inertia and bouncing contacts.
3) Quick response, long life, shock proof.
4) Quick reset action.
5) No bearing friction or contact troubles.
6) No corrosion, wear and tear of components.
7) Ease of providing amplification improves sensitivity.
8) The basic building blocks of semi conductor circuitry permit a greater degree of sophistication in the shaping of operating characteristics, enabling the practical realization of relays with threshold characteristics more closely approaching the idea requirements.
9) Use of printed circuit avoid wiring errors and facilitate rationalization of bulk production.

But there are certain limitations and problems, which can be numerated as under:

1) Variation of characteristics with temperature and age.
2) Dependence of reliability on a large number of small components and their electrical connections.
3) Low short time overload capacity compared with electromagnetic relays.
4) Electronic Disturbances (Emission as well as Immunity).

It has now become possible to reduce to a certain extent all of these problems by improving the design and manufacturing techniques. New Standards and Specification are being formulated by IEC and ANSI and other international institutions to set the maximum and minimum levels of this Electronic disturbances created by electrical and electronic equipment's, and the required testing facilities and methods.

More recently European Union has also issued some directives specially to reduce the Electromagnetic disturbances. This article gives an overview of this problem and the latest standards on this aspects of static relays used in the protection of modern power system.

The extensive use of electronic circuits and certain limitations and problems in communication facilities on various frequencies demands immunity form ELECTRONIC DISTURBANCES from external and internal sources.

This ELECTRONIC DISTURBANCES (Undesirable interference) is problem of electro–magnetic pollution, also termed as Electromagnetic interference is not a new problem. About 60 years ago, the CISRP – (The special Committee For Radio – Electrical Interference) has formulated rules to protect against such radio interference [4].

PROBLEMS AND PRECAUTIONS

Unacceptably high-level electromagnetic disturbances can prevent electrical and electronic devices, apparatus, and systems from operating properly in a common electromagnetic environment. A device is considered to be electromagnetically compatible only if its effects are tolerated by all other devices operating in the same environment. To ensure that this compatibility exist, a relatively new engineering discipline, Electro Magnetic Compatibility (EMC), has evolved. EMC is the branch of electrical engineering that studies, analyzes, and solves electromagnetic interaction problems [5].

In modern power system we are increasingly surrounded by different type of electromagnetic and static relays utilizing highly sophisticated means of sensing, recording, computing and communicating these information for the safe and smooth operation of the power system. Their power vary from milli – watts up to several watts at the different frequencies.

The consequence of this development is that modern circuits including electrical and electronic equipment's are potentially more susceptible to EMI upsets and are themselves sources of interference. These EMI may be un-intentional or intentional.

Examples of un-intentional EMI

1) Clock rates used in digital circuits are of the order of tens of megahertz

with pulse rise time of a nanoseconds.

2) Modern power conditioning techniques uses thyristor and other switching elements involve currents at frequency interference.

Examples of intentional EMI

1) Tele-metering and other SCADA signals used in electric utilities and other industrial units.
2) All types of communication transmitters used for commercial and defense purposes.

These protective devices and equipment must be immune to all type of electrical and magnetic disturbances, otherwise they may result in CHAOS; unthinkable consequences.

A child playing outside a substation with a remote controlled car may interfere with the operation of switchgear or the tele – signal of a large network may interfere with the nearby industrial process or domestic gadgets. This undesirable interference or let me call modern problem of electro – magnetic pollution is termed as Electromagnetic interference.

SOURCES AND MODE OF PROPAGATION OF EM INTERFERENCE

The electromagnetic environment of an equipment comprises all the sources of disturbances and their coupling paths to it. Similarly, through these same coupling paths the electromagnetic quantities generated in the equipment act upon their environment. Attention must be paid to ensuring EMC at every phase of Electric Power System, from establishing the electromagnetic environment, defining and checking the measures to be taken, to the steps necessary when the installation is modified or extended. The procedure involved are listed as under.

THE MODE OF TRANSMISSION OF EM ENERGY

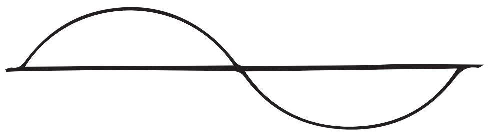
Basically EM is composed of two things,

- E is Electricity, an electric potential or Voltage
- M is Magnetic, a field created by Current
- But we can not overlook the third parameter that is always present

& that will change the way that these two effects are seen i.e. Time.

LOW FREQUENCY

(0<f < 10 kHz)



At these low frequencies voltage creates an electric field and current create a magnetic field. Both these fields are localized around the equipment. For example, if we consider a transformer working at a frequency of 60/ 50 Hz, the two fields (E & M) only extend to about one meter. Beyond a meter, we can virtually no longer detect them. The fields do not propagate, the energy is conveyed in the form of current and is called the conducted energy.

HIGH FREQUENCY

In the high frequency range, the two fields (E & M) no longer exist separately, an electromagnetic field is created. This electromagnetic field propagate through space, we can detect it from very far away. (Satellite transmission and Radio waves for example). The area of influence is very long say 1000 KM or more. The signal can be detected very far away, because an electromagnetic field propagates.

In this case, the energy is conveyed in the form of waves, and is called Radiated Energy.

According to the Laws Of Propagation, Waves attenuates itself, but a lot less quickly than at low Frequencies. High Frequency interference can be considerable and difficult to detect since without an electric link a Circuit Breaker operation can set a nearby Bank Alarm System to operate [6].

An electromagnetic interference can create undesirable disturbance in the electrical system as a whole. The collective term interference covers specific forms of interference caused by voltage, current, signals, energy, etc. Interference is caused by otherwise useful, man-made physical phenomena and also by the discharge of natural and man-made static electricity. The behavior of an interference depends on the nature of the event causing it, which can be recurrent (Periodic) or happening but once (switching). Periodic events include the AC voltage of power supply network, ripple control signal and also carrier signal. They may also be created due to harmonics caused by ignition processes, or by traction motors Switching events occur more or less abruptly on a changing of switching status in arc furnaces, in mechanical switches, and in the semi–conductors of power electronics and data handling system.

The discharge of static electricity such as lighting and discharges from the human body and also partial discharges in insulation systems (transformers, machines) due to transient over voltages can also be described as switching events.

For example, Take a simple case of an electronic relay protecting a Power Transformer. An EMI may cause a malfunction (upset) or even damage. If signals of sufficient magnitude are coupled onto electromagnetic devices as transformer from powerful interference sources insulation failure and permanent damage are possible.

The electronic circuit is usually the weak link, and therefore its susceptibility to EMI is a crucial factor in design.

The victims of EMI need not to be listed separately as they include practically all modern equipment, which increasingly rely on digital technology. What is however of crucial importance in EMC studies is the coupling mechanism between the source and the victim of EMI. Coupling of EMI into the system is achieved by a combination of undesired signals propagating in signal and power supply cables or radiated from equipment directly. The term radiated implies transport of energy through space in the form of electromagnetic waves.

EMI control measure attempt to limit signals to levels which will not cause a malfunction or, if this is not possible or economical, permanent damages should be avoided in any case. In a typical case there should be a MARGIN separating the two logical levels. At present standards are being formulated in order to set the EMI limits and the required testing procedures.

According to the European Union EMC has been defined as:

> "It is the ability of a device or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment".

(DIN VDE 0870)

Electromagnetic compatibility concerns all electrical and electronic equipment.

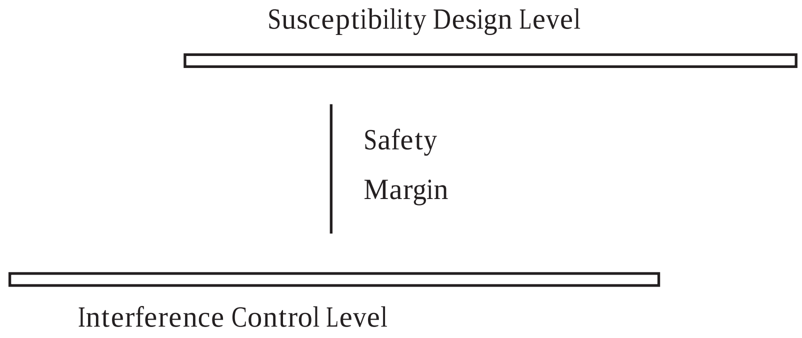
The European directive NO. 89/336 EEC, or the EMC, came into force on 15-09-92. DIRECTIVE OF EU [7].

It specifies that all equipment must be Electro – magnetically compatible i.e.,

1. Must not interfere with neighboring equipment
2. Must be able to withstand a certain level of electromagnetic interference produced by neighboring equipment

New approach in European countries specifies that all electrical and electronic equipment must be in conformity with the EMC levels. In many cases a temporary malfunction may have to be tolerated and may be subsequently corrected, provided that permanent damage does not occur.

The establishment of realistic damage levels can only be achieved by experimentation and it is a complicated task. In critical systems where a malfunction can not be tolerated, the maximum likely interference signal level must be determined. This level will depend on the sources of interference, the coupling paths and whatever countermeasures (shielding) have been incorporated in the design. Similarly the maximum signal level which will not cause malfunction of the equipment must be determined. This level will depend on the device characteristics and whatever countermeasures have been adopted in design (limiting devices). The system will operate satisfactorily if the susceptibility level exceed the interference level by a safety margin, clearly to ensure an acceptable performance, minimum standards must be set to cover both the emission and the susceptibility to EMI for all type of equipment. (See Figure)



According to this theory of EMI and the EMC Directives all electric and electronic equipment should be designed to a susceptibility level exceeding the control level by a safety margin [8].

These EMC levels are defined for the range of frequencies over 150 KHz. Below this level the standard bodies have not yet set a limit – discussions are in progress. The testing facilities and methods are not yet clearly defined. Today it is possible to test the EMC of an electric razor, but for a transformer the current laboratories, infrastructures are not suitable.

PRESENT STANDARDS AND CERTIFICATION PROCEDURES

Responsibility for the development of International Standard lies with the IEC, ANSI and other such International Institutions, and a lot of work is going on in this new engineering discipline. The European Standards Committee (CEN) has also issued an EMC Directive as described earlier. According to article 10 (1) Compliance with the Protection Requirements, the manufacturer should demonstrate compliance with the EMC directives.

In the absence of any uniform and internationally agreed standards, and issuance of IEC specifications, there are two ways for claiming compliance which is the present practice in European countries.

1) SELF CERTIFICATION
2) TECHNICAL CONSTRUCTION FILE

In either case the responsibility for compliance with the emission of and immunity from the Electro Magnetic Interference of the equipment lies with manufacturers, till the formulations of International Standards of EMC.

SELF CERTIFICATION

It is the simplest method and is achieved by satisfying "relevant standards" which are likely to be demonstrated either through in house testing, or contracting the tests to an independent laboratory. European Countries generally follow the recommendation of CISPR (International Special Committee on Radio Interference) as relevant standard.

It should be noted that the manufacturer is required to comply with the protection requirements of the EMC Directives and not with particular standards [9].

TECHNICAL FILE

The alternate method is to produce and hold a technical file to be available for inspection by the competent authority. This form of certification implies that the technical file should demonstrate conformity with the protection requirements of the EMC Directive.

The technical file or technical construction file should contain a description of the equipment and the EMC provision made, it must also include technical report or certificate form a competent body. The technical report may be based on a theoretical study and / or appropriate tests.[10]

The manufacturer is required to hold the technical construction file at the disposal of the enforcement authority for a period of 10 years. This route for claiming compliance will be obligatory after 1-1-1996, if there is no appropriate relevant standard.

Following procedure is being adopted by some reputable firms to satisfy the Utilities and other customers, which is given for information's, discussion and further study [11].

1) Identify EMC Sources

a) Identify interference sources
b) Determine interference quantities
c) Calculate / estimate / measure couplings
d) Determine interference immunity of interference sink

2) Measures For Achieving EMC

a) Measures the interference sources
b) Measures on coupling paths

c) Measures at interference sinks

3) Proof of EMC

a) Create the interference quantities with switching operations
b) Simulate the interference quantities in the laboratory

According to the requirements of EN 50082-2 AND IEC (801-2 3 & 4) at present the following test are recommended as minimum requirements to verify the EMC levels.

1) Immunity to Electrostatic Discharge Direct Panels

IEC – 801 – 2 1991
Contact Discharge : must Comply to level 1
Air Discharge : must Comply to level 1

2) Immunity to Radiated Fields

IEC – 801 – 3 1984
150 KHz to 1000 MHz : must comply to level 3

3) Immunity to Electric Fast Transient Bursts

IEC 801 – 4 1988
Power Lines : must comply to level 4
Signal Lines : must comply to level 4

According to the latest EMC Directive 89/336/ EEC the Severity levels for ESD (Electro Static Discharge) testing are given below.

LEVEL	TEST VOLTAGE (+/-10 %)
1	2 KV
2	4 KV
3	8 KV
4	15 KV

The following are the Special criteria for acceptance of test results:

1) No equipment damage
2) No erroneous equipment outputs, and any control output in progress is not prematurely terminated
3) No valid scan message containing incorrect information

4) No resets or restarts
5) No telecommunication errors allowed during testing
6) The equipment operates normally within specification after testing is completed

There are also some specification supplied by the companies and manufactures covering some aspects of EMC which may be studied before purchasing any new electrical and electronic equipment by the Engineers in the absence of IEC and other International Standards.

CONCLUSION

In this article I have tried to identify the problems and implications of the EMC for the Electric and Electronic engineers. The implications are not only technical but there are some legal and economical aspects also, which needs further study by professional engineers and research by academic scholars.

The scope of study of EMC and standards for compliance is very broad both in terms of the equipment affected and the electromagnetic phenomena encompassed.

In the absence of any uniform and internationally agreed standards, compliance with the objectives of the present European Standards and Directives may be achieved by generally following the recommendation of CISPR (International Special Committee on Radio Interference) as relevant standard. Responsibility for compliance with the objective of the directive lies with many manufacturers till the formulations of EMC Standards.

Till the finalization and issuance of IEC specifications, there are two routes for claiming compliance, one is Self-Certification and the other is Technical Construction File.

The most important thing is that the all electrical and electronic equipment should be constructed to comply with the essential protection requirements, that is the level of emissions should not interfere with the operation of other equipment and that the equipment should possess an inherent level of immunity to externally generated electromagnetic disturbances.

Engr. SYED SARFARAZ ALI

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QUALITY ENGINEERING
A NEW FRONTIER FOR INDUSTRIAL DEVELOPMENT

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Attending 4th Annual IEEE Technical Exchange Meeting at KFUPM, Dhahran 1997

A New Frontier For Industrial Development – Quality Engineering

Engr. Syed Sarfaraz Ali

Abstract:
Saudi products should meet the International Standards and Specifications to compete in the World Market. This is where new concepts of Product Quality, Product Reliability and Customer Satisfaction needs special attention by Saudi Industrial sector. The traditional role of Engineering in the era of open market and global competition is to obtain customer's requirements from marketing, translate them into a product with specified engineering characteristics, and manufacture such products so that they can confirm to International Standard and Specifications and keeping the prices low to compete industrial giants like USA, JAPAN and other EUROPEAN Countries. The article provides different definitions of Product Quality, shows how Quality Function Deployment can be used to ensure that Quality issues are dealt with at appropriate stage.

1. INTRODUCTION:

Saudi product should meet the international standards and specifications to compete in the world market, this is where new concepts of product quality, product reliability and customer satisfaction needs special attention by Saudi Industrial sector. Product Quality is the key competitive factor in industry today, and engineering plays a significant role in improving the product quality and overall success of any industry. The product quality incorporates identification of customer requirements, conceptual and detailed product design, process design, manufacture, distribution and use.

The traditional role of engineering in the new era of open market and global competition is to obtain customer requirements from marketing, translate them into a product with specified engineering characteristics, and manufacture such products so that they can conform to the international standards and specifications while keeping the prices low to compete industrial giants like Japan, USA and other Developed countries.

Saudi Industrial companies relying on traditional ways of designing new product and bringing them to market are being shocked into action by competition from world class companies.

This is where engineers can help Saudi Industries to compete successfully with the industrialized and Developed countries and prepare Saudi Arabia's Industrial sector to enter the 21st Century with dignity and honor [1].

1.1 SAUDI INDUSTRY - A PREVIEW

Low costs of basic raw materials to produce Hydrocarbons has enabled Saudi Arabia to build industries based on the export of petrochemical products. With the gradual fall of oil prices in the world market attention is being given to diversify the economy. Lower oil prices are not the only reason that Saudi Arabia is focusing on industrial development. There is the need to provide employment to Saudi Nationals by generating jobs in new industries [2].

A society can not move from having no technology, or a very low technology, to a high technology society without sound engineering skill and techno-economic knowledge. In Saudi Arabia at this stage there is little high technology, except for that based around the petrochemical industry. Most industry in Saudi Arabia is low technology and directed towards the consumer and retail trade and services. There is virtually no basic manufacturing industry. No one yet makes the machines that make the machines that make the goods.[3]

1.2 PROBLEMS OF DEVELOPING COUNTRIES

Prof. Ali A. Mazuri of the State University of New York has described very beautifully the problems of the developing countries as under:

"We borrowed the profit motive [of the west] but not the entrepreneurial spirit. We borrowed the acquisitive appetites of capitalism but not the creative risk-taking. We are at home with Western gadgets but are bewildered by Western workshops. We wear the wristwatch but refuse to watch it for the culture of punctuality. We have learnt to parade in display, but not to drill in discipline. The West's consumption patterns have arrived, but not necessarily the West's technique of production".

Actually what we need is to develop an engineering culture in Saudi Society as a whole. I am talking of Engineering here not as a profession, but in terms of the educational background. Saudi Universities are producing engineers according to the demand of the Saudi industry what is

required now is to give attention to the quality not the quantity of the engineers [4].

2. Stages Of Industrial Development

According to International Standards of Industrial Engineering and Development Economics there are four stages of the industrial development [5].

Various Saudi Industries are in different stages of development, each stage is described briefly as under.

(i) Stage 1 (Innocent Stage)

Also termed as Innocent Stage of any industrial company. In this stage the company's management and or its design group determines the market requirements without any input from the customers. They think they know the customers' needs better than the customers themselves! The results; 8 out of 10 new products and services fail in the marketplace.

(ii) Stage II (Awakened Stage)

In stage 2, market research is used to obtain customer inputs. But market research, as generally practiced, has several shortcomings. It deals more with the demographics of customers rather than with their desires - and it does not have the depth of technical knowledge to probe these desires.

(iii) Stage III (Progressive Stage)

In this stage a number of imaginative techniques are used to determine customer requirements. They include value research, the windows model, sensitivity analysis, multi attribute evaluation, and con-joint analysis. These techniques put the customer at center stage. However many companies are not aware of their utility.

(iv) Stage IV (World Class Stage)

In this stage Quality Function Deployment (QFD) is employed. QFD is explained in more details in the next section Definition and Dimensions. QFD technique was developed 25 years ago in Kobe (JAPAN) a shipyard and is now widely used in USA, EUROPE and other Industrialized Countries for producing Quality Products.

2.1 Role Of Engineers In Industrial Development

Engineers work in an industry not for the purpose of enhancing the engineering profession but to provide products and processes that meet customer needs/wants. That work can involve the many aspects of engineering from highly theoretical research, to the factory floor, and to customer support. The business of engineering is business performance and this requires a shift in mental attitude. Engineers are part of industry and cannot sit by the sidelines only concerned about engineering. [6] Engineering is a practitioner's discipline in industrial context and thus require an understanding of and involvement in the business world. In today's business world the engineer plays a much more integrated and diverse role in bringing QUALITY in industry.

3. Quality Engineering (DEFINITIONS & DIMENSIONS)

There are many different ways in which one can define the meaning of the word quality. Some famous definitions are summarized as under [7].

CROSBY defines quality as meeting requirements and says the only true measure of quality is through the cost of quality.

DEMING says that quality is a triangle involving the interaction of the product, the customer and the way he or she use the product, and the training of the customer. This definition incorporates functionality, conformance, and perception. The designer of the product must take into account how the product will be used even beyond its stated purposes (i.e., using a screw-driver handle as a hammer).

TAGUCHI states that quality is inversely related to the loss the product imparts to society; loss is related to functional variation and side effects; and functional variation is composed of manufacturing variation, product wear, and product use.

MIZUNO distinguishes between exciting and required quality. Required quality is the set of those characteristics that allow one to compete in the market, whereas exciting quality is the set of characteristics that differentiate the product from its competitors and thus form a market niche; they are also those qualities that are unexpected. A portable radio is expected to have a durable casing (expected), but the customer may be pleased to learn that a small light goes on when the battery power is low (exciting).

JURAN states that quality means fitness for use which is parameterized by the dimensions of quality and is measured by quality characteristics.

GARVIN outlines the eight dimensions of quality:

(i) PERFORMANCES
(ii) FEATURES
(iii) RELIABILITY

(iv) DURABILITY
(v) CONFORMANCE
(vi) SERVICEABILITY
(vii) AESTHETICS
(viii) PERCEIVED QUALITY

Other dimensions are also possible such as MAINTAINABILITY, SAFETY, and ENVIRONMENTAL IMPACTS.

4. Tools And Methodology

(FROM ZERO DEFECT TO ZERO DEFECTION) There are different methodology and tools by which Customer retention can be implemented in Industrial sector, the best and most efficient processes by which customer defection rate can be reduced is to apply the principles of Quality Engineering. In the 50 years long history of concept of quality the movement has lurched from fad to fad each claiming the way to the promised land of perfection.

In the 1950's ----It was Sampling Plan.

In the 1960's ----It was Zero Defect.

In the 1970's -----It was the Quality Circles.

In the 1980's---It was the Control and Flow Charts.

In the 1990's---- It is the Total Quality Management.

For Saudi Arabia which has sound economy and full Government support for industrial development a mix of different tools of Quality Engineering will be the best option, some of the required tools are described as under.

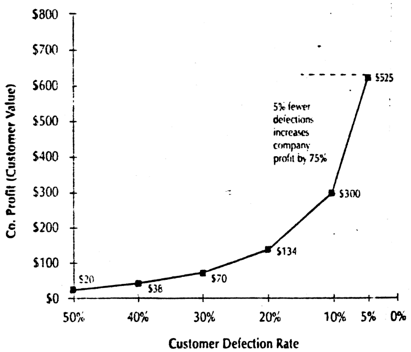
4.1 CUSTOMER SATISFACTION

The Quality movement has long stressed zero scrap and zero defects as essential ingredients of manufacturing, but companies should be even more concerned with scrap in its larger dimensions-CUSTOMER who do not come back (DEFECTION). Companies must move from zero defects to zero defection as the sine qua non of their existence. It is now becoming apparent that it is no longer customer satisfaction but customer loyalty that is dominant key to business success [8][4].

An interesting study by Reichheld and Sasser was carried out on defection rate of customers compared to company's profit (Customer Value). Company profit is the net present the profit streams a customer generates over the average customer life. At a 10% defection rate, for example the average customer life is 10 years (1 divided by 10% defection rate). As the defection rate is cut from 20% to 10% the average life span of the company's relationship with a customer doubles from 5 years to

10 years and the value of that customer or company profit nearly doubles from $ 300 to $ 525. See Figure -1

COMPANY PROFIT vs CUSTOMER DEFECTION

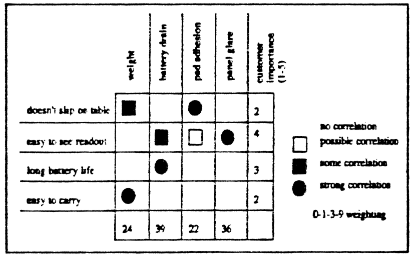


4.2 QUALITY FUNCTION DEPLOYMENT

It is a methodology and collection of tools by which customer needs can be back-propagated into design, manufacturing, and distribution requirements. First developed in JAPAN in the Kobe shipyard in 1970, QFD was introduced to the West in the mid-1980 [8][4].

The design of products and services should start with listening to the Voice of Customer not the Voice of Management. The premises is that by using the voice of the customer (VOC) Engineer can ensure quality through the alignment and integration of different organizational functions. By working on many issues simultaneously and up front, a better design will be generated, thus leading to overall reduction of development time.

Figure 2. Quality function deployment matrix for a calculator.



If done right, QFD can help a company design and manufacture products in half the time, with half the manpower, with half the defects, and with half the costs and - at the same time - best quantify and prioritize customer requirements. The key tool in QFD is the matrix diagram, which helps translate needs from one area to another.

An example is shown in Figure - 2 for calculator. Customer data (via surveys, focus groups, etc.) have shown that the feature easy to readout is the most important, rating a 4 on a 1 to scale, where 5 is the most important; three other quality issues have been mentioned.

Four engineering characteristics of the product design (e.g. weight) have also been identified. The design team then identifies the correlation between the customer qualify issues and the engineering design characteristics. For example, panel glare is strongly correlated with easy to readout, whereas panel adhesion is only weakly correlated with easy to see readout.

Each correlation is assigned a score (typically 0-1-3- 9 or 0-1-5-9 weights are used), and then that weight is multiplied by the customer importance rating and tallied down each row. Hence, battery drain is somewhat correlated with easy to see readout (3x4=12), and strongly correlated with long battery life (3x9=27), hence battery drain is allocated 39 points. From these data we see that battery drain and pane glare are the two engineering characteristics that need the most attention.

This attention may come in the form of tighter specifications, selection of higher-quality processing technique, selection of best quality vendor, etc. These ranking may also be used to select control characteristics for implementation of statistical process control.

4.3 STATISTICAL PROCESS CONTROL

The key tool in Quality Engineering that distinguish between systemic and special causes was developed by Walter Shewart while at Bell Labs in the 1930's and later refined by Deming in a well known paper, “On the Statistical Theory of Errors". SPC is required because variation is an inevitable fact of industrial life [9]. It is unlikely that two parts,

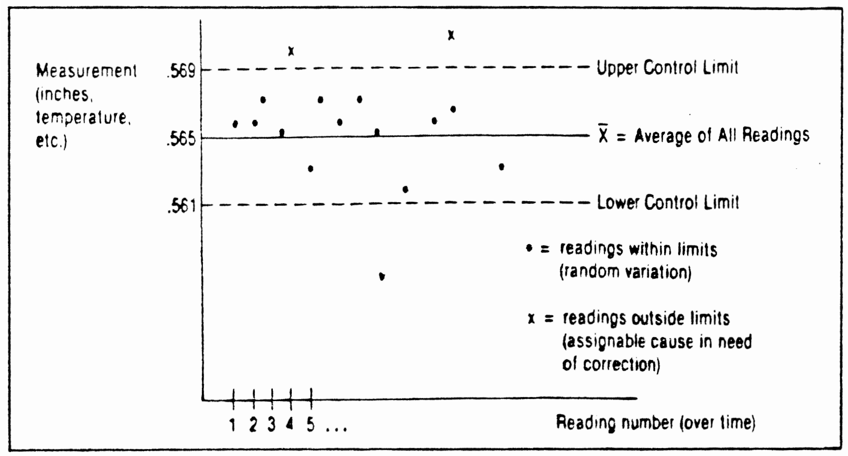


Figure 3. A typical control chart.

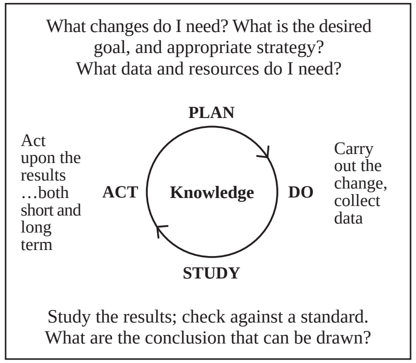
even when produced by the same operator at the same machine, would ever be identical. The issue is therefore, is distinguishing acceptable variation from variation that could indicate problems. The rules of statistical probability provided a method for making this distinction. Probability rules could determine whether variation was random or not, that is whether it was due to chance. Random variation occurred within statistically determined limits. If variation remained within those limits, the process was a stable one and in control. As long as nothing changed the process, future variation could be predicted easily, for it would remain indefinitely within the same statistical limits. See Figure - 3.

Data of this sort is normally collected and plotted on control charts. Such charts graphically plotted actual performance readings on graphs that also depicts the upper and lower control limits for that characteristic, which were statistically determined. Once a process is in control, readings that fell outside the limits indicated a special cause. When the cause of such non random variation is found and removed, the system returned to its stable state. To improve the system itself, even the common causes had to be removed. Simply because a system is in statistical control does not mean it is as good system as it could be.

Indeed, a process in control could produce a high proportion of defects. Control limits indicated what the process was, not what it should be or could be. To move the average (yield, sales, defects, return, etc.) up or down - and thus also move the control limits up or down typically required the concerted efforts of engineering.

4.4 PROCESS IMPROVEMENT (QUALITY CYCLE)

Process improvement will subsequently drive improvements in product quality, cost, and cycle time. The cyclical nature of process improvement makes it a learning cycle. Shewhart's Plan-Do-Study-Act cycle is a simple model of such a learning cycle also known as Quality Cycle. See Figure -4



Any process improvement or quality improvement cycle can be

broken into Quality parts; embedded in each part one can subsequently find smaller quality cycles.[I0] There are two ways in which quality cycle can be implemented: Innovation and Kaizen. Innovation is characterized by its outcomes: huge breakthroughs in performance due to the use of fundamentally different technologies from what have been used before. Kaizen is the Japanese term for "Continuous Improvement". Kaizen is characterized by small incremental improvements that occur on daily or weekly basis. While the magnitude of the increase is small, its accumulation over time can lead to profound improvement. Kaizen involves the expertise of the people involved with the process like operators, technicians, supervisors and engineers.

5. CONCLUSION

Low costs of basic raw materials to produce Hydrocarbons has enabled Saudi Arabia to build industries based on the export of petrochemical products. With the gradual fall of oil prices in the world market attention is being given to diversify the economy. Lower oil prices are not the only reason that Saudi Arabia is focusing on industrial development. There is the need to provide employment to Saudi Nationals by generating jobs in new industries. Saudi product should meet the international standards and specifications to compete in the world market, this is where new concepts of product quality, product reliability and customer satisfaction needs special attention by Saudi Industrial sector. Product Quality is the key competitive factor in industry today, and engineering plays a significant role in the success' or failure of any industry.

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MANAGING TECHNOLOGY DYNAMICS
INTEGRATING QUALITY INTO TECHNOLOGY TRANSFER

ENGR. SYED SARFARAZ ALI, TABOUK ELECTRICITY CO.

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Organized by
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&
The Electrical Engineering Department of King Fahd University of Petroleum and Minerals

In a happy mood with participants at the official dinner of 5th Annual IEEE Technical Exchange Meeting 1998 at KFUPM, Dhahran

5th ANNUAL IEEE TECHNICAL EXCHANGE MEETING
KFUPM SAUDI ARABIA

MANAGING TECHNOLOGY DYNAMICS INTEGRATING QUALITY INTO TECHNOLOGY TRANSFER

Engr. Syed Sarfaraz Ali

EXECUTIVE SUMMARY

This paper makes an attempt to illustrate the application of the principles of Quality Management Techniques in the transfer of technology in industrial production plants with special emphasis on the fast industrial growth and economy diversification activities in Saudi Arabia.

Since World War II, modern technology has emerged as one of the primary source of national power, prosperity and strategy. Nations that lack the autonomous capability to generate, develop and diffuse new inventions and innovations, must rely on the technology transfer process and eventual diffusion and assimilation of foreign technologies. Proper management of technology transfer is therefore, a critical success factor for the importing countries like Saudi Arabia.

Transfer of technology means transfer of knowledge or services from one place to another place or any geographical shift in this world on government to government level, government to private, private to private or vice versa. At first glance technology transfer seems a simple process depending on the market and profit but successful process involves a host of political, socio-cultural, and economical issues.

Introduction of quality means creating an environment where customer is the focal point and customer satisfaction is the driving force. Quality management is an integrated concept directed at continuous improvement in the quality of goods or services by involving all levels and functions of the industrial production plant. It involves everyone in the organization and extends to suppliers as well as the internal and external customers. The introduction of quality management techniques ensures proper

assimilation of the imported technology and continuous improvement of the process leading to satisfaction of the ultimate customers. Quality Management Philosophy has been applied successfully by many developing countries and multi-national organizations in many areas of business but as each country is unique with its own priorities, policies and philosophies, what works in one country may not work well in other country, so each country has to develop its own policies according to the political, cultural and economical conditions.

Saudi Arabia is acquiring and transferring new technologies at a very fast pace to diversify its oil based economy. University and Industry should work together for improvement in quality of industrial process and successful transfer of technology.

MANAGING TECHNOLOGY DYNAMICS INTEGRATING QUALITY INTO TECHNOLOGY TRANSFER

Engr. Syed Sarfaraz Ali

ABSTRACT

Nations that lack the autonomous capability to generate, develop and diffuse new inventions and innovations, must rely on the technology transfer process and eventual diffusion and assimilation of foreign technologies. Proper management of technology transfer is therefore, a critical success factor for the importing countries.

Saudi Arabia is acquiring and transferring new technologies at a very fast pace to diversify its oil based economy. University and Industry should work together for improvement in quality of industrial process and successful transfer of technology. This paper makes an attempt to illustrate the application of the principles of Quality Management Techniques in the transfer of technology in industrial production plants with special emphasis on the fast industrial growth and economy diversification activities in Saudi Arabia.

1. Introduction

Since World War II, modern technology has emerged as one of the primary sources of national power, prosperity and strategy. Nations that lack the autonomous capability to generate, develop and diffuse new inventions and innovations, must rely on the technology transfer process and eventual diffusion and assimilation of foreign technologies.

Proper management of technology transfer is therefore, a critical success factor for the importing counties like Saudi Arabia.

Transfer of technology means transfer of knowledge or services from one place to another place or any geographical shift in this world on government to government level, government to private, private to private or vice versa[1]. At first glance technology transfer seems a simple process depending on the market and profit but successful process involves a host of political, socio-cultural, and economical issues.

Over the last two decades, attitude in many developing countries have changed emphasis on the critical role of the private sector, increased liberalization, globalization trends, and the success of the Pacific Rim Countries such as South Korea, Singapore, Taiwan, Malaysia and

Hong Kong in effectively transferring technology and assimilating technology have led to the acceptance by many developing countries that their economic future will depend largely upon their ability to effectively technology transfer, adopt it internally and build up their own scientific and technological capabilities.

Transfer of inappropriate technology or inadequate assimilation and absorption of the imported technology may have serious consequences on the national economy[2]. International transfer of technology involves a host of political, social, and economical issues. In this paper it is attempted to demonstrate how Quality Management Philosophy can be applied successfully to the Technology Transfer process to ensure satisfactory performance of the imported production system.

2. Technology Transfer

According to a study by UNIDO[3] the developing countries account for only 6% of the global R&D. Thus for quite some time developing country firms will have no option but to depend on the firms from the technologically advanced countries for technology.

In this context technology transfer arrangement play a major role. However it does not mean that developed country firm will part with their technologies freely even if the transferees are willing to pay for it.

In addition several global developments can also influence the manner in which technology transfer will take place. In this context two development are of significance.

(a) Boomerang Considerations

In high technology sectors the technology owner do not want to create new competitors. The success of Korean and Taiwanese firms in assimilating and imitating transferred technologies and building up export capabilities is often quoted as justification for ensuring that the boomerang effect is avoided in the future.

(b) Reluctance to share R & D Results

Today, in some emerging technological areas such as Bio-technology, Micro-Electronics, and new material, current science is being used almost as soon as it emerges from the lab. Limitations are therefore being imposed in some cases on the participation of foreign researchers and students in high-level courses and scientific meetings.

It is against this wider scenario that formulation of technology transfer arrangement have to be viewed.

2.1 Transfer Components

The Industrial Production or Manufacturing Technology may be

defined as the manifestation of following four elementary and interacting components[4] which are described briefly as under.

(i) Techno-ware or Material transformation subsystem which perform the desired mechanical operations that the technoware has been designed to perform.

(ii) Human-ware consists of the skills needed to realize the potential of technoware and it include the operators and support facilities.

(iii) Orga-ware refers to the support net of principles, practices and arrangements that govern the effective use of technoware by the humanware.

(iv) Info-ware represents the accumulated knowledge needed to realize the full potential of the technoware, humanware and orgaware.

These four components are complementary to one another and are interrelated. They are required simultaneously in any industrial process or manufacturing unit and no transformation can take place in the complete absence of any of the above components.

A good understanding of these four components of manufacturing technology can help both the transferee and transferor to clearly spell out what components and their constituent elements need to be transferred and to what extent the existing components in the transferee firm need to be upgraded. The price to be paid by the transferee for the purchase of the technology would obviously depend on the scope and extent to which the component will be transferred. Thus a clear specification of the technology components to be transferred can provide valuable information for pricing and also for formulating implementation plans.

2.2 Transfer Activities

International technology transfer will be involved when the new production plant is located in one country and some of the technological and techno-managerial inputs to the investment process are imported from suppliers in another country.

Before a firm chooses a particular mechanism for transferring manufacturing technology it should examine to which the four components are likely to be transferred through the particular mechanism. The nature of component transfer through some important mechanism is outlined below briefly.

When a firm purchases plant and equipment, the main component transferred is technoware. The humanware is not developed unless the transferor agrees to provide training to the contract and support humanware. Of course it is possible that the transferee already has the necessary humanware. The transferee should also ensure that the basic elements of infoware are also obtained. Normally the basic elements of infoware and orgaware are never transferred during the purchase of plant and equipment. Thus when a firm purchases plant and equipment it should simultaneously embark upon programs to develop the missing components so that technology transfer is effective. Firms that develop these missing infoware and orgaware components will be more successful than those that have not, even though both may have similar technoware.

Bell and Hoffman[5] have identified group of activities that are not industry specific, they are:

(i) Pre – investment and Feasibility Study
(ii) Design and Engineering Study
(iii) Capital Goods Production
(iv) Installation and Testing

All of these steps of techno-managerial activities will usually be necessary in relation to each of the stages in the main stream of the technology transfer process. This stream of technology transfer process activities are critically important is in determining the nature of the transfer process and hence the nature of its ultimate consequences for the user of the final system and for the economy within which that system is located.

It is important to select appropriate mechanism for transferring the technology so that all the above specified components of technology would be transferred. This is where, the use of Quality management has proved successful in many countries. An industrial process plant incorporates a wide range of technical knowledge that is drawn into the investment process in different ways. The technological dimension of such a plant involves a process that incorporates an interconnected series of activities. Different kinds of technology in different forms are drawn in at different stages, and from different sources. Disegregated analysis of the technology transfer process is necessary to identify the appropriate steps for the application of Quality Management Techniques.

3. Quality Management

It is an integrative management concept directed at continuous improvement in the quality of goods and services by involving all levels and functions of the organization. Quality of products, and similarity of services, is now recognized as an important strategic variable in competitions in today's marketplace. Quality is no longer viewed as a luxury but a necessity. In such a competitive environment, Saudi products have to be made better, quicker and cheaper. Reducing the costs of "non-quality" such as defects, wastes and failures, is translated to increased productivity, profits and hence competitiveness. Moreover, rapid advances in technology, changing customer expectations, and reduced time of production means merely maintaining the status quo requiring a more proactive approach to production process.

3.1 Definitions

It is better to give a brief outline of the philosophies of three quality "gurus" of the western world before further discussion on the assimilation of quality into technology transfer process.

Crosby (1988) has four absolutes for quality management. First, he define quality as conformance to requirements, not goodness. Second the system of quality is that of prevention, not detection. Third the performance standard is zero defects. Fourth, the measure of quality is the cost of non-conformance, mainly the price of not doing the things right the first time. Central to his approach is his emphasis on developing a zero defect culture, an objective which his famous fourteen steps to quality management (Crosby 1984) is supposed to achieve.

Deming (1986) defines quality as a predictable degree of uniformity and dependability, at low cost, and suited to the market. He identifies two types of variations: special cause and common cause. Special Cause stems from isolated sources and can be attributed to man, machine and tools, while the Common Cause are due to deficiencies of the basic management system and is beyond the control of the workforce. He attributes the majority of causes for poor quality to poor management practices, which he highlights in his so called Seven Deadly Diseases. His entire philosophy can be summarized in just two words; reduce variation. This is the basis for his fourteen points for quality management, which stress management-led commitment, involving the entire organization, to continuous improvement in product, services and process using statistical quality control tools.

Juran (1988) defines quality as fitness for use. He focusses more on the firm's products and services, unlike Deming who emphasizes the management of the process. He was among the first if not the first to recognize that customer can be internal and external. He proposed a universal approach to managing for quality in his trilogy: Quality Planning, Quality Control, and Quality Improvement. Like Deming, Juran also identifies two types of Quality Problems: Sporadic and Chronic. The former is a sudden adverse change in status quo, while the latter is a long lasting adverse situation that can be corrected only by changing the status quo. Sporadic problems are detected and acted upon by the process of quality control, and chronic problems are dealt with by the process quality improvement. He advocates quality improvements on a project – by – project basis (i.e. identifying and solving particular chronic quality related problems) with commitment from top management. In addition his ten points Breakthrough Sequence, guided by the costs of quality considerations, is intended to help an organization achieve unprecedented levels of quality performance.

3.2 Customer Satisfaction

In the light of new development, catch-phrases such as "Zero Defects" (ZD), and "Do It Right First Time" (DIRFIT), which were once regarded as useful ideas and motivators, need to be reviewed. The "Do It Better Each Time" (DIBET) concept[6] provides a direction more congruent with that of continue improvement. The concept of Z.D. focuses more on the product than the process, while DIBET is more encompassing. It is process oriented and entails continuously looking out for and eliminating wastes and defects from product or services, and at the same time improving performance and exceeding customer's expectation. DIBET is a race with no finishing line.

Both these concepts of ZD and DIBET are considered in the concept of Total Quality Management (TQM)[7] relates to a culture advocating management led commitment to continuous quality improvement and innovation, involving the entire organization, through proper scientific tools and techniques. In a TQM environment customer is the focal point and customer satisfaction is the driving force.

4. Assimilation

In section 2.2 the TT activities have been identified. Now we will see how TQM can successfully be applied in each activity of technology transfer.

4.1 Management and Execution of Pre-Investment and Feasibility Study

This task is performed either by technology importer or by the consulting firms hired by them. The majority input required for the execution of this task is the clear understanding of the needs of the customers. This would allow the planners to identify the correct operation strategy, which in turn will allow them to choose the right process, technology, layout, and location of the proposed facility.

TQM is customer focused and it recommends various ways to listen the voice of customers. Quality Function Deployment (QFD) is one of the tools that is used to translate customer's requirements to appropriate technical specification. It helps in defining unit of measurement and provides a framework for evaluating tradeoffs among various combinations of design features.

This dimension of TT process is usually conducted by a group of individual having expertise in the related fields. TQM fits well into such situation as it also advocates group work. For example, Quality Control Circle is the most popular mode of group work in this activity.

4.2 Management and Execution of Design and Engineering Services

These services are usually performed by the technology supplier. Participation of the buyer's representative in the process is not uncommon. This stage of TT activity can best be performed jointly between the two groups as partners[8] ICI of UK followed this mode while building an Ammonia plant in Bangladesh in the late 1970 with excellent result. Saturn and Boeing 777 Projects are the two of many successful examples where teamwork was critical element of success.

4.3 Management and Execution of Capital Goods Production

Two of the three steps of TQM principles: Process management and total involvement of the employee are directly applicable to this phase. Here again, if the supplier and the purchaser work as partners, better outcome is expected as the purchaser has better knowledge of the total conditions including the needs and expectations of the ultimate customers.

Many developing countries depend solely on the supplier for this stage of the process as they do not have the technological and techno-managerial capacity to effectively participate, study shows that in many cases the post-transferred performance of the production system have been unsatisfactory because of the lack of proper participation and too much dependence on hired consultants.

4.4 Management and Execution of Installation and Commissioning

Leadership, effective communications, education and training and process control are the important elements in this stage of technology transformation process. These management activities are also the supporting elements of TQM philosophy.

4.5 Transfer Model

It is therefore evident that in all stages of technology transformation process TQM philosophy is appropriately applicable. Besides the transfer of technology, transforming and techno-managerial activities (as shown in fig. 1) international technology transfer projects may also incorporate transfer of skills, knowledge and experience

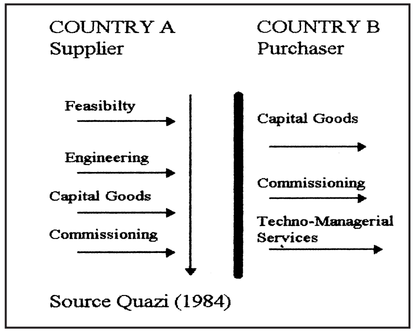

Figure 1

These add to the technological capacity of the importing nation. Fig. 2 illustrates the 'flows' of different types of technology that can be imported. Flow 'A' corresponds to the technology transformation and techno-managerial activities shown in Fig. 1. Flow 'B' includes skills/ knowledge required only to operate and maintain the production system being established by the technology transfer projects Flow 'C', on the other hand, includes the skills, knowledge and experience required to modify and change the production system.

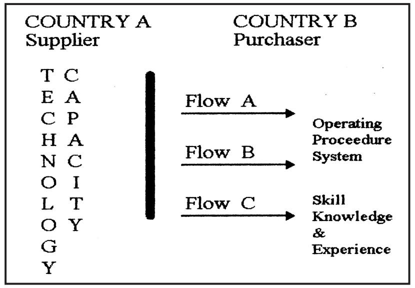

Figure 2

It includes at least three different levels or categories of skill and experience required to improve and modify existing production system. They are:

1. Skills and knowledge required to improve and modify existing plants.

2. Skills and knowledge required to manage the transfer of technology for new plants (including those required to monitor and supervise the design and construction of those plants).

3. Skill and knowledge required to supply the `core' technology intensive goods and services for investment in new plant.

Farrel [9] labeled Flow B as static technology. This is because operating skills simply to carry out routine procedures and practices are not enough to ensure continuous improvement of the process. He labeled Flow C as dynamic technology because it includes the necessary skills, knowledge and experience needed for continuous

productivity and quality improvement through technical change. He argues that Flow C provides the key to proper assimilation of the imported technology that help achieve continuous improvement of the production process. Many of the discussions on technical self-reliance have focused on the transfer of the kinds of technologies included in Flow C.

Many technology importing countries have experienced inadequate assimilation due to restricted transfer of skills and knowledge that are included in Flow C. However process improvement may be difficult to achieve without the proper technical skills and knowledge to deal with it. Therefore, the importance of managing the different types of technology flow becomes obvious when the issues of process improvement and ultimate customer satisfaction are discussed. Continuous improvement of the production system is necessary to improve the quality of the products and reducing the cost of production. This can be achieved by using the principles and supporting elements of TQM in technology transfer schemes as discussed earlier.

5. Conclusion

The term Technology Transfer implies the movement of technology from the technology owning country to another. This transfer can be successful if the receiving country understands the modern technology and use it effectively in the home environment. In technology transfer there is no donor and no recipient. There is only a buyer and a seller who may alternatively be called transferor and transferee and if adequate care is not taken in preparing for technology transfer the net result could be inappropriate technology flows, friction between both the transferor and transferee, and loss of business. Proper management of technology transfer process is therefore, a critical success factor for the importing countries. Transfer of inappropriate technology or inadequate assimilation and absorption of the imported technology may have serious consequences on that economy. Transfer of technology involves a host of political, social, and economical issues. This paper does not attempt to address those issues, this paper focuses on how Quality Management philosophy can be applied to the technology transfer process to ensure satisfactory performance of the imported production system.

Quality Management philosophy has been applied by many newly industrialized countries and the success of Korea, Singapore, Taiwan, and Hong Kong in effectively transferring technology and assimilating technology have led to the acceptance of this philosophy.

The production process that is created through technology transfer process provides products and services that are expected to meet the quality expectation of the ultimate customers. If the technology transfer process is not managed properly, the impact on the customer satisfaction and the profitability of the organization will be enormous. Proper understanding of the technology transfer process and quality management philosophy is critical is the success of the imported production system.

Saudi Arabia is acquiring and transferring new technologies at a very fast pace to diversify its oil based economy. University and Industry should work together for suggesting and guiding the new entrepreneurs to improve in quality of industrial process and successful transfer of technology.

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ELECTRIC INDUSTRY AND 21st CENTURY - ISSUES AND CHALLENGES

Engr. Syed Sarfaraz Ali

ABSTRACT

During the last few decades, demand for electricity has grown at faster rate than that of the global economy as well as demand for primary energy. Between 1970 and 1995 the world GDP increased by 100%, the world energy consumption only grew by 70%, while electricity consumption grew by 160%. In Gulf countries, the government regulates the working of Electricity department. Electric Utilities are run as public welfare departments, the prices are highly subsidized and the regulations are evolving as a substitute for direct competition to protect the consumers. We can call the system as Regulated economy.

As a result of economic diversification policy, fast industrial development is taking place in Saudi Arabia and much emphasis is being given nowadays to increase the QUANTITY and to improve the QUALITY of power supply. This is where the ENGINEER has to assume a role of MANAGER. He has to come out of the machine atmosphere and face the new challenges and issues to enter 21st century. He should listen to the complaints of consumers, suggestion of economic wizards and academic advises as attentively as he listens the hum of electric generator.

The main issues discussed and presented in this paper are, meeting fast growing demand of power, shortage of funds, difficulties in pricing, environmental and technical challenges, and institutional weaknesses in electric sector.

1. INTRODUCTION

Electricity has come of age in the last twentieth century. Innovation in technology now offer electric industry endless opportunities for both; to expand their enterprises and to differentiate themselves from their competitors. The electric industry is changing faster than ever before. Traditionally, the assumption was that if sufficient resources and talent were invested in new R&D activities the output stream of science and technology would meet the business objective - a paradigm that flourished in an economic environment in which the power of the suppliers exceed that of the customers.

During the last few decades, demand for electricity has grown at faster rate than that of the global economy as well as demand for primary energy. Between 1970 and 1995 the world GDP increased by 100%, the world energy consumption only grew by 70%, while electricity consumption grew by 160%[1]. Over the last few decades, growth in electricity matched that of real economic growth in many countries.

The Arab countries with ever increasing standard of living and population growth rate also have a very high demand of electricity. The per capita consumption of electricity in some of the Gulf countries is not less than any developed country of the world. The government regulates the working of Electricity department in all Gulf countries. Electricity department are run as public welfare department not as electricity utilities. The prices are highly subsidized and the regulations are evolving as a substitute for direct competition to protect the consumers. We can call the system as Regulated economy. Early in the development stage the Saudi Electric industry developed certain ways of thinking and doing the things and stuck to them until they became tradition. What factor determined the evolution of the present Saudi Power System? It is a fact that it was not designed from zero. The present system comprises what originally were different electric companies under municipalities, private public limited companies and/or owned by petro-chemical industries, operating independently in different cities of Saudi Arabia. All this was not only consolidated but a large network was built by investing billions and billions of Riyals in electrical projects running the electric sector as public welfare department. The present assembly of generating stations, substations, transmission lines and distribution networks has completed the basic infrastructure

necessary for the early development stage in the country. Now a time has come that this industry should stand on its own in line with the economic realities and changing world economic order.

2. GLOBAL PULSE

The mix of energy consumption has changed over the years, as well, with the role of oil giving way to other energy sources. In developing countries, nearly one-third of all commercial energy is devoted to electricity generation.

2.1 CONSUMPTION PATTERN

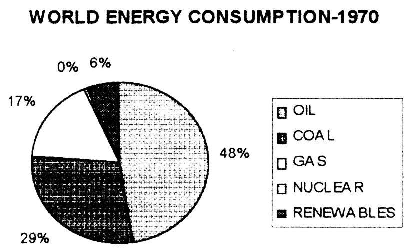
Following is comparison of world energy consumption by source for the years 1970, 1990 and projection for the year 2010, which reveals a diminishing role for oil based energy on the global stage.

World energy consumption - 1970 206.7 Quadrillion (10^{15}) BTUs

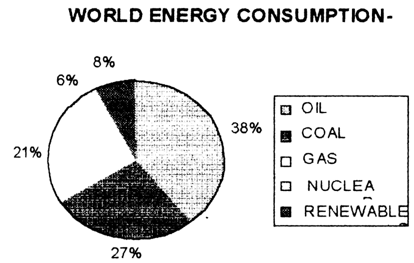
World energy consumption - 1990 345.6 Quadrillion

The structure of primary fuel use for electricity generation differs considerably among the various regions and countries of the world. In the industrialized countries with the exception of Japan and France, the projected trend is away from nuclear power and towards natural gas. Coal powered generation is projected to decrease in fuel share

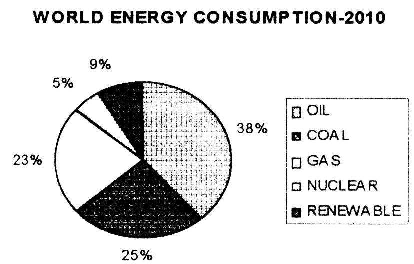
World energy consumption - 1970
206.7 Quadrillion (10^{15}) BTUs



World energy consumption - 1990
345.6 Quadrillion (10^{15}) BTUs



World Energy Consumption – 2010
471.1 Quadrillion (10^{15}) BTUs



percentage. Renewable power generation principally hydropower, is projected to increase in industrialized countries that still have unexploited resources.

Demand is expected to grow by 2.1 percent annually to 2015 [5], slowing from the 6.2 percent average annual growth experience so far in the 1990s. Conflicts in the region in the past decade have damaged electricity infrastructure in several of the countries in middle east. Saudi Arabia and Iran have the largest electricity markets, accounting for 51% of the total Middle East Consumption.

2.2 DEMAND PATERN

For the next few decades it is expected that the growth of world demand for electricity will slightly exceed that of growth of the world economy and primary energy consumption. It is expected that, in Industrialized countries, there will be nothing to stop all energy needs being met in the form of electricity, with the exception of transport. In the long term, after 2050, 70% of primary energy input in OECD countries will go into electricity production.2] Recently electricity production claimed slightly more than one-third of the world's primary energy demand, by the year 2020 more than half of the world's primary energy will be feedstock for electricity production. In 1997, production of electricity was estimated [3] at around 13800 TWh with an estimated capacity of 3170 GW, as detailed below;

3. NEW ELECTRICITY WORLD ORDER

Since the 1980s, a new international economic landscape has developed that fundamentally changes this traditional regulated economy, supply - driven model Forces shaping this new era include;

(i) An expanding & interconnecting global economy

(ii) The revolution in information technology; & the deregulation of historically controlled markets

Electricity remains at the heart of economic prosperity, environmental well-being, and quality of life, but now customer dominates suppliers, creating new levels of competition. Electric utilities that can not deliver returns greater than the cost of capital are at serious risk of acquisition, forced mergers, or elimination.

Many federal and state governments throughout the world are divesting themselves of their power generation and delivery businesses in a belief that privatization will contribute to the economic growth and prosperity of their countries. The sale of assets to private investors produces an immediate windfall of capital for the region's economy. This cash is often used to reduce national debt and support various social

programs. The number of divestitures in recent years has reached an all-time high. Countries in Europe, Central America, South America, Asia, and Middle East are aggressively privatizing. National and state entities typically pursue privatization to:

- Improve the existing electricity infrastructure & assure adequate investment in new facilities
- Pay off debts to commercial banks and lending agencies
- Hold down inflation rates
- Improve system reliability and assure future capacity levels are met
- Overcome poor business management practices
- Improve the quality of service

For a shift from the old to new paradigm Saudi Government has already taken steps by appointing consultants to suggest reforms in the electric industry. Some of the decisions have been announced and soon there will be a change in the overall policy in governing the electric utilities in Saudi Arabia in line with the international changes. As Professional engineers we should also be ready to face the coming challenges and prepare ourselves to face the new realities and issues. I have tried to give a general picture of the coming days and the issues and challenges for we should be ready to face with commitment by considering all alternative solutions to the future problems even though suggested by public and other pressure groups.

4. ISSUES & CHALLENGES

In the coming century, electricity will power our needs for precise, knowledge- intensive processes, industries, and services on which we all depend. Achieving these goals, however, will require scientific and technological advances in many fields and the integration of these new and advanced technologies. We have seen many changes in the last 10 years. Events in and around the country, our society in general and our consumers in particular will undoubtedly bring more changes that electric industry must be ready and willing to face. Electric Industry is being thrust into a market economy and it is very necessary for each employee of electric industry to act with vision and wisdom. The following issues are enumerated which are common in all developing countries. Although each country has different issues based on its resources, education, technical knowledge and political systems but they include but not restricted to the followings.

- Shortage of Electricity (quantitatively as well as qualitatively)
- Technical and Environmental issues
- Shortage of Capital and large investments
- Institutional weaknesses and Pricing difficulties

4.1 SHORTAGE OF ELECTRICITY

Shortfalls in power supply are common in almost all developing countries, because of low generating capacity and inadequacies in the transmission lines and distribution networks, particularly in the rural areas. Electricity shortages in any country affect in two ways: they handicap productive activities and delay social development. On the productivity side electricity shortages discourage investors by affecting production and necessitate more investment for on-site electricity production. This not only require more investment than that is needed for their main productivity activity, but also it would increase the cost of production since electricity from small generators is more expensive than national grid.

The quality of the power supply in many countries is unacceptable. Although it varies from one country to another in many countries the supply is characterised by low quality particularly in the low voltage distribution system. Quality in electricity is an issue that needs continual attention. In recent years, this issue has sharpened because of the increased number of loads sensitive to power quality and has become tougher as the loads themselves are becoming important causes of degradation of quality. Many electronic devices, such as computers, process control and communication equipment are sensitive to electricity disturbances. Short time dips are of concern in chemical process plants where processes are continuous and takes place under tightly controlled environment. Voltage dip of a few cycles can cause tripping of motor control devices. Voltage dips with duration of a few milliseconds can result in loss of computer data and computer errors. Bursts of voltage spikes can upset industrial counting system. Power quality excursions not only affect customers equipment but are also detrimental to the operation of the power system itself.

Electricity is essential for sustainable development yet little research has been done on the effect of the provision of electricity

on social development. More work has been done on costing unreliability of electricity supplies and its economic and social cost. It has been estimated [6] that unreliability losses could be as much as 4% of GDP in the short term. For India the cost of power shortage to the industrial sector has been estimated at 1.5% of GDP and in Pakistan 1.8%. This situation demands large investment on quality improvement in many countries. Power investment in many countries are required not only for expansion in generating capacity but also for standby plants.

4.2 TECHNICAL AND ENVIRONMENTAL ISSUES

New technologies for electric power sector take a long time to develop, but once proved they seem to start mushrooming every-where. Environmental considerations will, ultimately influence the choice of technology and fuels. But the effect of technology changes in the electricity generation system will be slow and quite limited in the case of developing countries, because these countries are more concerned about capital investment, transfer of technology and local resources rather than global environmental considerations. The new guidelines of World Bank on Environmental Protection will improve the environmental performance in the aid/loan receiving countries. Future technologies will aim at achieving the followings[7].

- High efficiency to limit fuel use and emissions
- Clean emissions to reduce environmental impact
- Low capital cost to limit investments
- Limited capacities with short lead times, to minimise uncertainties and risks

Owing to its high price, crude oil and its products will continue to diminish its share in electricity production. Natural gas is an ideal fuel for electricity generation and correspondingly it will increase its share in electricity production, but it is coal which will dominate the generation scene particularly in China, India and Pakistan. Coal's share in other developing countries is likely to double[8]. Therefore introducing coal technologies in developing countries is of vital importance.

4.3 SHORTAGE OF CAPITAL AND LARGE INVESTMENTS

The electric Industry is highly capital intensive, than any other industry particularly in the developing countries. Therefore, planning and proper financial arid economical evaluation of projects is important to rationalize investment and achieve economic efficiency. Recent studies [9] have indicated that there is a need to invest $ 2280 billions (in 1993 dollars) in the electric industry worldwide over the period 1995-2010, that is $ 152 billion on average per annum. Generation projects will account for 63% of these capital investments, transmission 8.8% and distribution 21.2%.The remaining 7% will be general expenditure mainly concerned with control, telecommunications and other services.

In 1993, the world's GNP was around $24000 billions. It is expected to increase to around $36000 billions in 2010. The investments in electric industry in the developing countries will average 8-9% of their total investments. This is a heavy burden on the economies of most countries in the world. In the past self-financing, as well as governments and developing agencies, used to provide the required funds for investment in electric power system, and this is still the case in Gulf countries. Due to privatization and restructuring, markets are being called on to provide most of the investments needed in developed countries and slowly but gradually in developing countries. Investment in developed countries do not exceed 1-3 % of their gross domestic investment, therefore there is no practical problem. But the developing countries need to invest heavily in electric sector. Due to subsidies and low electricity tariffs, internal fund generation is limited. Government capabilities to finance such infrastructure projects are becoming limited, due to the increasing demand of other more pressing social sectors like, education, and health. Therefore, the financing gap of electric sector is increasingly being filled by calling on foreign private capital flows through financial markets. Much activities in this respect are under way all over the world and new financial markets and opportunities have been developed with mixed results. There are some bad stories too like Dhabol projects in India and Hubco project in Pakistan. To make such private financing a success much reforms, privatization, restructuring and regulatory arrangements have to be made. The following three conditions are mandatory for achieving good results;

- Governments must be committed and guarantee a financially independent electric supply industry
- Electric utilities have to perform in financially and economically viable way
- Investors (foreign or local) must be convinced that they will obtain a good return on their investment, and will be able to repatriate these returns

It is becoming important that the financial and economical evaluation of power projects be carried out carefully with the evolution of the techniques for the calculation of return requirements.

4.4 INSTITUTIONAL WEAKNESSES AND PRICING DIFFICULTIES

In the electricity sector the role of the government is dominant. It is the owner, the regulator, the price fixer, and the operator. Electricity investment is very large and risky, it is only government that can afford it. The extent of share varies from country to country depending on the socio-political structure but until recently the governments in the developing countries had the major role in electricity sector not only as a regulator but also as majority owner and manager. Prices are fixed to reflect government social and industrial policies, and are usually subsidized. In a move to wean customers away from the artificially low and subsidized power rates that are a hallmark of Saudi Arabian power markets, the government is looking at privatization as a way to institute more realistic market rates. For privatization efforts to be successful in Gulf countries, prospective private operators of electric sector will make up the difference between the subsidized and theoretical market rates if the government mandates rates lower than true market levels.

As an indication of the Saudi government's desire to move in this direction, a plan has been outlined that calls for the full privatization of electric utilities in the medium to long term. As the financial markets has not been developed enough to take a sizeable ownership of the capital intensive energy market, therefore, the process of reforming the sector through restructuring and privatization and reducing direct government control, is going to take some time.

Such reduction of the government role which can be in the best interest of electricity sector and the national economy, may take many forms such as:

- Privatization, through the involvement of local and foreign investors. This requires mobilization of local capital through development of markets and enhancing the role of the private sector through fiscal measures, policies, and legislation

- Attracting foreign investment through independent power producers (IPP)
- Restructuring - through establishing government owned but autonomous companies and corporations to run the electric sector. An independent REGULATOR is a must to supervise the electric sector.

For these reforms to succeed they must be accompanied by phasing out of subsidies. Subsidies particularly in Gulf countries encourage overuse (wastage) and misallocation of resources. Electricity subsidies have to be gradually phased out in order to ensure that utilization of resources is optimised and waste is curbed. Such phasing of subsidies will reduce the present rampant growth of demand and reduce the government's requirements to invest in other social sectors. In short, there is an urgent need for improving the managerial as well as the technical performance of power systems in developing countries.

5. CONCLUSION

The competitive forces that have been unleashed in the worldwide electric industry have ushered in a new era of productivity and operating efficiency. Now more than ever before, improvements in electric utility operations are being propelled ahead in order to meet the competitive nature of tomorrow's electric utility landscape. Developing countries account for almost three -quarters of the world's population. All these countries have an electricity consumption per capita less than 1500 KWH per annum. In varying degrees, all these countries have almost similar features i.e., rapid growth of electricity demand, shortage of electricity, poor quality of supply, environmental strains, shortage of funds, weak institutional setup, political instability. They also suffer from a proliferation of subsidies.

For a shift from the old to new paradigm Saudi Government has already taken steps by appointing consultants to suggest reforms in the electric industry. Some of the decisions have been announced and soon there will be a change in the overall policy in governing the electric utilities in Saudi Arabia in line with the international changes. As Professional engineers we should also be ready to face the coming challenges and prepare ourselves to face the new realities and issues. I have tried to give a general picture of the coming days and the issues and challenges for we should be ready to face with commitment by considering all alternative solutions.

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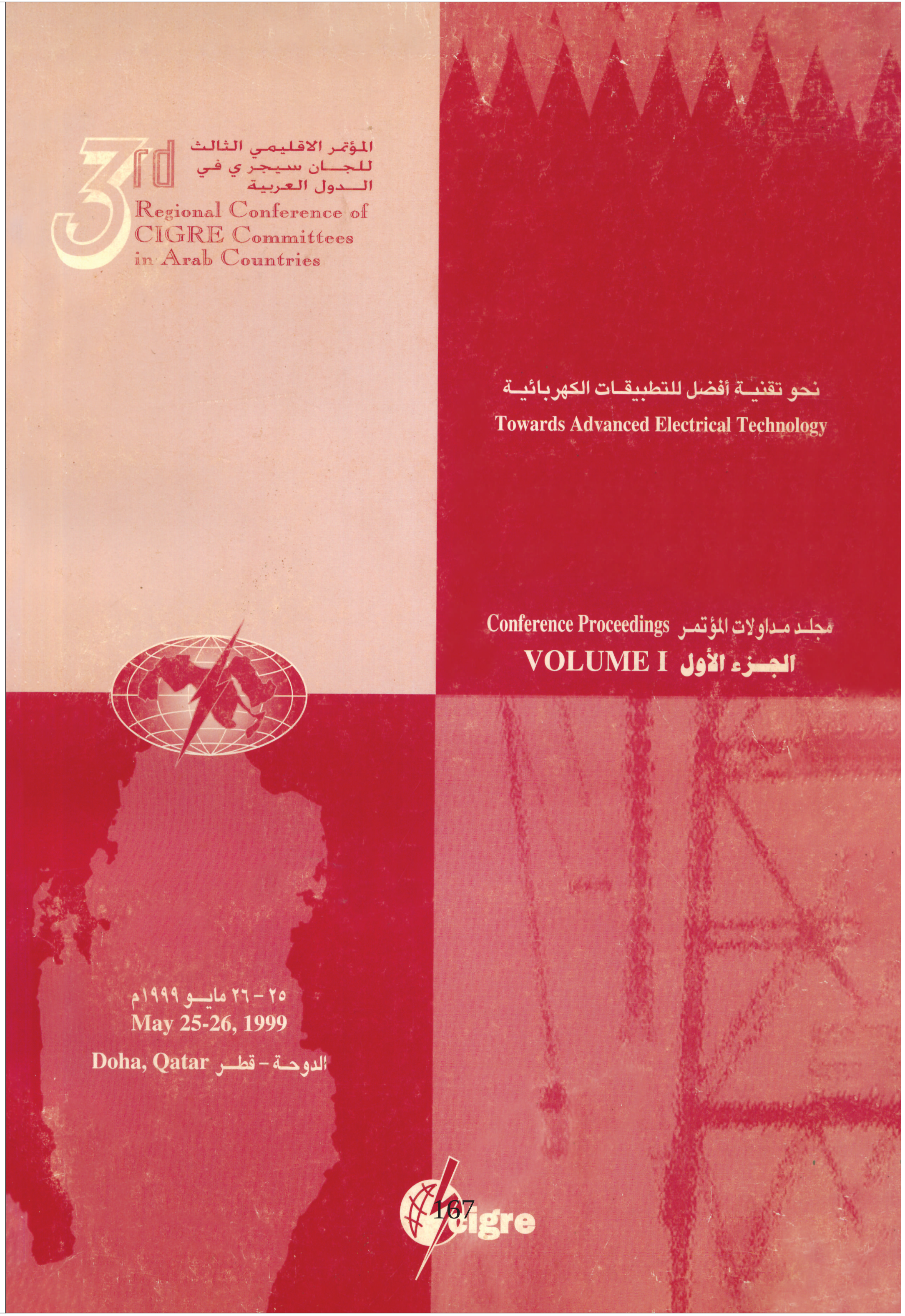
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COMPREHENSIVE POWER SYSTEM MAINTENANCE AN EXPERIMENT AT TABOUK

Engr. Sarfaraz Ali Syed

ABSTRACT: The changing economic scenario, the rapidly reducing oil reserves and the desire to move away from regulated regimes, the electric utilities are now looking towards a variety of approaches to minimize maintenance costs and maximize reliability. The drive for economy is leading electric utilities to examine their spare holdings. The need to reduce inventory has to be balanced with the risk of an unscheduled shutdown. This has given rise to new techniques in Maintenance Management Systems and now Electric Utilities of Saudi Arabia are looking towards more advanced techniques utilizing computer programs and quality management techniques for Power Station Maintenance.

1. INTRODUCTION

The electric utility business is going through tremendous changes, not just in Saudi Arabia, but all over the world. The route the electric industry is taking in Saudi Arabia and other Gulf Countries is quite clear. We talk more and more about reliability of power supply and less and less about technological and economical aspects. Care must be taken to keep a balance between the reliability, and economy. This means systems with a new approach. The big challenge is (MMI) Man –Machine – Interface. There is so much information available and needed, that it might be difficult for the engineers to get an overview. How, for example, an engineer act in case of a disturbance in the system, or fault on a machine is the key to success in the future competitive marketplace.

In every field of Electric Utility Business, whether it is generation, transmission or distribution, there has been clear progress and changes in the operation and maintenance philosophy. This means system with a new approach, development of local talents and introduction of Information Technology in electric utilities. Much attention is now being given to the reduction in inventory, quality of training and introduction of local talent.

The drive for economy is leading electric utilities to examine their spare holdings. The need to reduce inventory has to be balanced with the risk of an unscheduled shutdown. In the process, the more advanced users are re-examining the need for spares, the condition of the actual inventory, and the documentation system for maintenance. This has given rise to Comprehensive Preventive Maintenance Schemes and now Electric Utilities of Saudi Arabia are looking towards more advanced techniques like Reliability Centered Maintenance utilizing computer programs and quality management for Power System Maintenance.

According to Engr. Ben Stevens [1] a Senior Consultant (Price Water House Coopers, Canada) about 60% of computer based maintenance management programs fail to achieve their goals. The most important steps for engineering managers is to ensure to be part of the successful 40%, which could be obtained through careful and proper planning. Interest is growing to share the experience of users with different systems. At Hub Power Plant (IPPP in Pakistan) users went through the original implementation on a green field site and following two years of operation have completed review[2] of what they had against what their eventual operational requirements were. They have since upgraded the system against this review. Each Electric Utility has its own working environment and limitations based on the socio-economic system, so it is not necessary that one program or solution will be successful in every case. Each utility has to find out the best possible solution according to the requirements and limitations.

2. ELECTRICITY IN SAUDI ARABIA

The Electrical Power Sector in Saudi Arabia has reached great development and will continue to further develop with efforts to extend its services to all citizens.

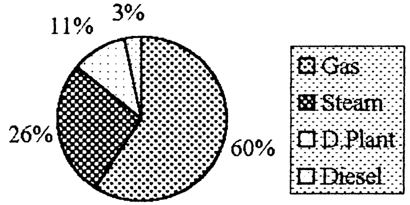
Peak load of Saudi Arabia during the year 1995-96 reached 17706 MW [3], which equals to approximately twenty one times of what it has been in the year 1975. Generating capacity witnessed huge development both in quality and quantity. The actual Generating Capacity for all Electric Utilities and projects reached to the level of 18780 MW by the end of year 1996.

2.1 GENERATION AND LOAD FORECAST

Following is the load forecast, annual growth, and generation pattern of Saudi Arabia which gives an idea of Electric Utility Market[4].

Load Forecast Annual Growth

Year	Peak Load MW	Annual Growth %
1993	16,078	-
1995	19,573	10.3
2000	27,933	7.4
2005	34,704	4.4
2010	42,643	4.2
2015	51,260	3.8
2020	59,267	3.0



3. MAINTENANCE OF POWER SYSTEM

Whether utility is a small isolated company comprising of a single diesel generator or a big interconnected network profitability can be markedly improved by optimizing maintenance schedules and spare parts inventories. The success of such maintenance depends on a systematic approach and requires a detailed analysis of the operating procedures, functions and failure modes of the whole power system.

The operation and maintenance of electric power system and minimizing the outages of machines, equipment or transmission lines in electric utility is a blend of many technical and managerial skills and each country is unique with its priorities and idiosyncrasies. As electric utility is a service industry and its philosophies are different from manufacturing industry, what works in one country may not work in another country. Each country has to evolve its own system and techniques in view of its cultures, education, political system and development plans.

3.1 SOME IMPORTANT DEFINITIONS

Before describing the modalities of different maintenance scheme and its influence on the life cycle profit, it is better to define some of the terms used in this article. Most of the terms used in this article are those as defined by the North American Electric Reliability Council (NERC) [5].

(1) MAINTENANCE is defined as measures required to maintain and reestablish a specified condition, as well as to assess the actual condition of the technical capabilities of a given system.

(2) AVAILABILITY FACTOR

$$AF = \frac{AH}{PH} X\ 100\%$$

in which

AH= SH = RSH = XH

AH: Total available hours in service or in reserve.

PH: Number of hours a unit has been in the active state.

(Usually it is taken as 8760 H for one year).

SH: Service Hours, number of operating hours i.e. hours the generator is connected to the grid.

RSH: Reserve service hours (equipment available, but shut down, either for economical reasons or because other equipment not available).

XH: Service hours during reactive power generation.

(3) RELIABILITY FACTOR

RF= 100 – FOF %

$$FOF = \frac{FOH}{PH} x\ 100\%$$

in which

FOF: Forced Outage Factor

FOH: Forced Outage Hours

(4) LIFE CYCLE PROFIT

It is the term used for the total earnings over a period of several years of operation of the original plant, after deduction of capital and operating costs, maintenance costs due to planed shutdowns and unplanned shutdowns and outages.

4. THE SCIENCE OF MAINTENANCE MANAGEMENT

The maintenance of power system has become a science in itself. Electric utilities go through different growth stages of development along with the countries they are situated in. In developing countries much attention is given to the construction activities whereas in developed countries utilities shift their focus to maintenance techniques of the running plants.

There are three approaches to the maintenance of any plant or interconnected system as described below.

4.1 BREAK DOWN MAINTENANCE:

Let it operate until it fails then repair it. This is not possible in any successful commercial operation and electric utility can not think of such schemes.

4.2 CORRECTIVE MAINTENANCE:

It is carried out to restore lost efficiency and hence to reduce the cost of production.

4.3 PREVENTIVE MAINTENANCE:

Conduct periodic inspection and take action to minimize failure. This

is the usual practice but with time and experience and advance techniques of management different versions and modules of preventive maintenance schemes are in use in power plants.

Preventive maintenance helps the plant operators (electric utility) not only to avoid some incidence from the very beginning but also to coordinate overhauls with repairs, upgrading or even up rating.

The main purpose of preventive maintenance are:

Ø To plan normally one year in advance, the schedule standard overhauls in order to reduce downtimes and share the work between the operational and maintenance staff.

Ø To remedy all possible defects affecting the availability of the plant or any kind of detrimental conditions, such as fouling or deviation from original performance.

Ø To provide access to the latest state of the art technology.

4.4 FEATURES OF MAINTENANCE SYSTEM

Electric utilities should select or developed a maintenance management program that is both easy to understand and to apply. The expert rules must accurately predict the condition of system components. Condition monitoring data must be accurately collected and recorded. Even if it is not intended to design an expert rules based maintenance management program, it is better to collect diagnostic data for critical system components.

Effective maintenance demands efficient responsive implementable maintenance program. Tabouk Electricity Company summed up followings as the requirement of System Maintenance.

1. Plant inventory and Technical/Specification and Grouping of Inventory
2. Plant specification
3. Scheduling the preventive maintenance
4. Project file, work order cards and work order cards status.
5. Daily plant statistics since commissioning
6. Job cards, Job history and History of the equipment/parts, history file for each scheduled and unscheduled maintenance
7. Local area network (LAN), Master location and Source of supply, Maintenance controller
8. Planning execution and control
9. Record keeping for store and

all maintenance

10. Contents of menu
11. Message communication in LAN
12. Type of protection of files and all other feeding (security and safety of maintenance program)
13. Store picture must be available in front of maintenance and operation engineers
14. All types of schedules should be prepared by having the knowledge of spare parts in store and the manpower and of course the budget availability

4.5 PRACTICAL EXAMPLES OF MAINTENANCE MANAGEMENT PROGRAM

Worldwide, electric utilities have a significant investment in their existing power network. It is critical that utilities economically maintain their power delivery system to ensure that safe, reliable power is available to their customers. Using a proper maintenance management system will assist utility personnel in making sound decisions when allocating their maintenance budgets.

(a) Reliability Centered Maintenance

RCM is a structured approach, which is used to determine the maintenance requirements of equipment and was develop by the aviation industry. The process is based on an analysis of the operating context of the plant, identifying its functions, types of functional failures, and likely failure, which are recorded on an "INFORMATION WORKSHEET". This information is then used to produce a "DECISION WORKSHEET", which details the tasks to be carried out, by whom and how often.

ESB (Electricity Supply Board of Ireland) has an installed capacity of around 4000 MW and demand in the country is growing at an annual rate in excess of 4% decided to apply RCM with the installation of a new combined cycle power near Dublin. A detailed RCM specifications were prepared and discussed with the companies that were bidding to supply the machines. Once the contract was signed, meetings were then scheduled with the successful bidder and ESB personnel to familiarize with the RCM concept and level of involvement required. A number of meetings were held to identify and finalize the areas of individual studies covering all the area of plant, completing the information worksheet and decision worksheet. ESB is predicting a large decrease in

unscheduled maintenance costs when compared a similar machines located elsewhere.

(b) Condition – Based Maintenance

CBM is an approach wherein utilities track the number and type of failures of equipment and materials to determine the loss of component life. Utilities also ask manufacturers to recommend service intervals for equipment. With improved diagnostic tools, results of periodic testing, and advanced computer softwares, engineers are increasingly moving towards condition based maintenance.

In the Netherlands, Dutch Electric utilities have requested an international research organization, KEMA, to develop a condition based maintenance program. KEMA with the help of CIGRE has developed a program and carried out a series of tasks which yielded the information necessary to build the maintenance management system. These tasks might provide guidance for other electric utilities to develop a similar maintenance program[8].

(c) Comprehensive Maintenance Program

CMP has been adopted by Tabouk Electricity Company (KSA) which is a three prong policy of arranging a proper coordination between MAN, MATERIAL, and MANAGEMENT (3M) Program. The complexity and/or importance of the power system requires a comprehensive maintenance approach for better and economical results.

5. HOW AND WHY CMP AT TABOUK

There are six Public Utilities and about eight Government Sponsored Power Projects in the Northern Province of Saudi Arabia, out of which Tabouk Electricity Company has installed capacity of 365 MW. TEC is trying to attain the highest standards of operation and maintenance (among the lot) by providing electricity to consumers reliably and efficiently, while keeping the expenses as low as possible.

TEC has two Power plants and Seven Sub-Stations with allied 132 kv Transmission Line network which is controlled by central SCADA center through Fiber Optic and Pilot wire cable communication networks.

Activities under each of the 3M is described briefly as under:

5.1 MAN

The most important resource in electric utility is the personnel involved. The behavior and performance of individual directly impacts the quality of services. In fact every employee whether working in generation, transmission, distribution, load dispatch, consumer services, or complaint section, contribute to some extent in the achievement of quality.

Since the early 1990's a number of companies have invested vast amount of money trying to become learning organizations. Hopefully they did a good job because to survive in the future, they have to learn one more big lesson: A learning organization is not enough. They need to become teaching organizations. In teaching organizations, Manager/Engineers see it as their responsibility to teach. They do that because they understand that it is the best. In a teaching organization, engineers /managers benefit just by preparing to teach others. Because such teachers are people with hands-on experience within the organization – rather than outside consultants – the people being taught learn relevant, immediately useful concept and skills.

Tabouk Electricity Company is following a policy of the development of human resources by adopting the following measures:

Ø It has developed a training department which is providing training, refresher courses, and special educational facilities to the staff.

Ø A special clause about training to the engineers/technicians is added in all new tenders and purchase orders so that company staff get conversant with the operation and maintenance techniques of the new equipment.

Ø A book on Operation and Maintenance Policies has been compiled by the Company which includes all the important technical data and details about equipment and its operating constraints. This book is issued to all new engineers/technicians for guidance and strict compliance.

Ø A book on safety procedures and rules in accordance with the National Safety Rules and OSAH Codes has also been compiled and a test is taken by Industrial Safety Department of all engineers/technicians before they are authorized to work on power system.

Ø Visits to the site of installation of new equipment and factories are being arranged for engineers and technicians.

Ø Company staff is deputed to work with the erectors to follow the erection procedures step by step.

5.2 MATERIAL

Procurement of spares and proper tools is being made for maintenance and overhauling, keeping the inventory as low as possible by using the latest computer software for inventory planning and control.

Details of items stocked by a particular station are contained in a warehouse which is itemized in code number sequence. In addition to being a quick guide to the maintenance engineers, on what is available from warehouse, it provides a useful control on the variety of items stocked and a common language between the user and stores staff. TEC has established a computer network between power plant maintenance department, warehouse and the purchase department via leased telephone lines based on AS400 software.

Overall control of stocks is maintained by a materials control of stocks is maintained by a materials control card for each item, which contain full information on receipt, issues, physical stock held, orders placed, bin location, recorder level, in addition to the code number and a detailed description of the item for reordering purposes. These records are regularly checked on a perpetual inventory basis against the physical stock and reconciled with the ledger account annually. They are also used in connection with items becoming obsolete or redundant.

Tools required for diagnostic and routine tests, and complete kit for repair and maintenance of machines and equipment have been provided and extensive training for their use and upkeep is given to the staff. Other special instruments like PC's (Desktop and Laptop) have also been arranged and engineers are using them as a routine for maintenance of the equipment and machines. Latest software (CAMMS – Computer Aided Maintenance Management System) has been purchased for computer aided maintenance of the plants and introduced in the maintenance which has several advantages.

Advantages of CAMMS

1. Plan / Manage, Execute and Control on maintenance jobs
2. Improve equipment reliability and increase plant availability by means of properly maintained equipment.
3. Minimize down time and reduce cost.

4. Optimize use of unexpected maintenance opportunities during unforeseen or forced shut down of the unit.

5. Keep accurate and accessible maintenance records.

6. Get rid of manual paper work. All the trouble reports are directly fed in the computer terminal and maintenance personnel can check directly in their computer terminal about the defects of the plant. This is an extra advantage as for communication among operation and maintenance engineers the computer is always there.

5.3. MANAGEMENT

Electric Utility is a service industry and quality in a service organization requires a clear and defined policy from the Top Management. TEC motto is "We are not selling a commodity, we are providing a service to our customers".

The purpose of managing quality in electric utility is to ensure that Quality Services are being rendered to the customer/ consumers. The concept, principles and quality system elements as described in ISO 9004-2: 191(E) are being implemented. Tabouk Electricity Company has adopted Quality Management Techniques in all departments to minimize the disturbance in generation, transmission and distribution of Electricity according to the ISO, IQA and OSAH Codes.

Quality is work which has many meanings depending on the context in which it is used. Managing quality in a service business like electric utility is inherently challenging. First the utility services do not produce a "THING" whose quality can be measured, weighted, and tested. Quality is determined in individual transaction between server and customer, occurring thousands of times each day in an electric utility. Because service quality is intangible, therefore there is strong tendency to manage service business on various other easily measureable factors such as:

Ø Number of consumers served.

Ø Costs of providing the service.

Ø Time to attend the faults (after sales / service).

Ø Revenue generated, etc.

Quality cannot be added to a system or services at the last stage. It has to be incorporated from the start. Managing quality is the dynamic process designed to determine to extent of compliance with predetermined standards, but quality can not be assured unless

there is a control, to control something there should be some set standards, checks and balances on each activity. The basic adopted by TEC is to set standards of procedure, performance, supervision and control for each activity in each unit / department.

6. RESULT OF CMP AT TABOUK

Although the full maintenance system is not in operation but the results so far obtained are very encouraging as seen from the Annual Reports of Tabouk Electricity.

Ø The system losses have reduced from 11.83% in 1993 to 11.71% in 1998.

Ø Plant availability factor reached 98.94 for Diesel generator and 97.12 for Gas Turbine.

Ø The average productivity of generated energy per employee increased to 3.7%

Ø 95 employee were provided with special training during 1998.

Ø The percentage of Saudi employees has reached 63.4%.

Ø Gradual decrease in the spare holding and proper control over inventory.

7. CONCLUSION

Worldwide, electric utilities have a significant investment in their existing power network. It is critical that utilities economically maintain their power delivery system to ensure that safe, reliable power is available to their customers. Using a maintenance management system will assist utility personnel in making sound decisions when allocating their maintenance budgets.

Since the early 1990s, a number of companies have invested vast amount of money trying to become efficient organizations. Hopefully they did a good job because to survive in the future, they have to learn one more big lesson. They need to become teaching organizations. In teaching organizations, Manager/ Engineers see it as their responsibility to teach. Because the teachers are people with hands-on experience within the organization – rather than outside consultants – the people being taught learn relevant, immediately useful concept and skills.

Electric utilities should select or develop a maintenance management program that is both easy to understand and to apply. The expert rules must accurately predict the condition of system components. Condition monitoring data must be accurately collected and recorded.

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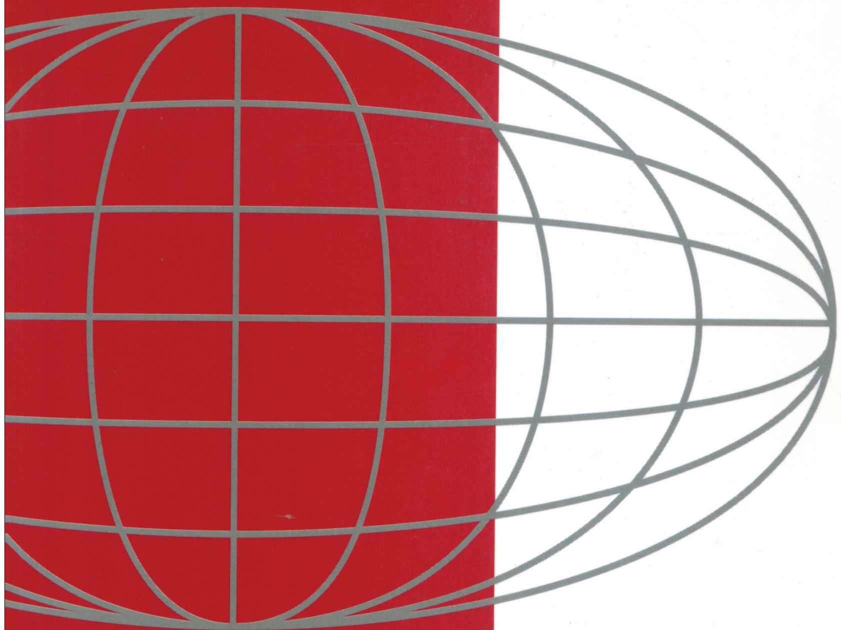

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MANAGING PRODUCT IMPROVEMENT WITH QUALITY TOOLS AND FACTORS

Engr. Syed Sarfaraz Ali

1. INTRODUCATION

The design of a product begins with an idea and continues through a variety of planning, design, manufacturing and testing phases until actual production begins and the product is made available to the customer.

Attaining the highest quality at the lowest cost is emerging as a major manufacturing challenge. To meet these tough and contradictory goals, requires continuous improvement at all levels of product development i.e., from idea to market.

To run the industry on the principles of project management a formal product development framework not only help in the successful transfer of technology but also guarantee the success of the industrial unit as a whole. There are two problems in the product development process. First, the management of creativity and second the project management problem. The creative process may be facilitated by a systematic framework. A structured framework facilitates the retention of organizational learning. Efficiency in development is enhanced by systematic review of efforts at defined milestone. This framework must be geared towards a vision to acquire development capability to further the purpose of the organizations.

2. FRAMEWORK FOR PRODUCT IMPROVEMENT

New products and processes go to market through the process of development which transform ideas and concepts into physical realization.

An outstanding development required asynchronies process that is well understood, highly capable and in control. Clark and Wheel Right[1] set out a six elements framework for improvement in the product development which involve different issues but has individual significance and importance in interaction. Each activity is to be dealt as a project activity and is described in brief as under:

2.1 Project definition

This determines how the firm establishes its boundaries, the business purpose and the objectives of the project. There must be a consistent process that allows senior management to authorize the completion of each phase of a project after reviewing its associated goals, objectives and resource commitments.

2.2 Project organizations and staffing

This element defines the selection of a project team members and the way it will be organized. Organization includes the relationship as well as the physical structure. Support group and its relationship to the project team should be defined.

2.3 Project management and leadership

This element has two aspects. The first includes the nature and the role of the project leader or manager and the way in which project tasks are sequenced and managed. The other aspect includes the way in which tasks are divided and grouped into phases, how the work in these phases is monitored and managed and how check points or milestones are used to signal the completion of each phase.

2.4 Problem solving, testing, and Prototyping

The focus here is on individual work steps, the way in which they are conducted, and the means by which the knowledge required to solve problems is developed. Central to this element is the nature of problem solving and the way in which testing and prototyping are used to validate progress to date, to confirm the appropriateness of choices already made and focus the project on the remaining tasks. This element, in combination with the preceding ones determines the rate at which the project converges to the final manufacturing solution for market introduction.

2.5 Senior Management Review and Control

This element deals with senior management participation in the project. The behavior of senior management with respect to the project signals to those working on the project, the degree to which responsibility has been delegated to them, and creates powerful incentives and motivation during the course of the project. Seemingly routine pattern such as the timing, frequency and format of review, can have a significant impact on the overall effectiveness of the project.

2.6 Real-Time/Midcourse Correction

This element deals with issues such as ongoing measurement and evaluation of the project status, re-scheduling, re – sequencing and re-defining the remaining tasks resolving differences between problem solving in the laboratory or on the costumer side and determining when the organization is ready for production scale-up.

An important part of this element is the balance between early conflict resolution and subsequent adaptability, the relationship between unexpected early challenges and subsequent potential delay, and choices between deferring re – scheduling to maintain motivation verses re – scheduling early to maintain project credibility. The project team must be organize to handle these issues.

3. ROBUST DESIGN

A design that allows for component and other possible sources of variation, is known as Robust Design. To ensure robust design is completed in the shortest possible time, new ways of working are required. In today's borderless economy, global market, and tough competitive market, new products need to be developed at a very fast rate. Apart from meeting the customer's functional requirements, these products have to be manufactureable, that is produces a high production yield, and yet still be reliable. The design function has a significant influence on product development. Failure of design to flow smoothly though the manufacturing process has substantial financial penalties. It is generally accepted[2] that for every stage of a manufacturing process which a product passes through, the cost of failure increases by a factor of ten. This is illustrated graphically in following figure 1.

Therefore a robust design can provide substantial savings by reducing failure costs. A further benefit of well design and robust product is that it runs more smoothly through the factory.

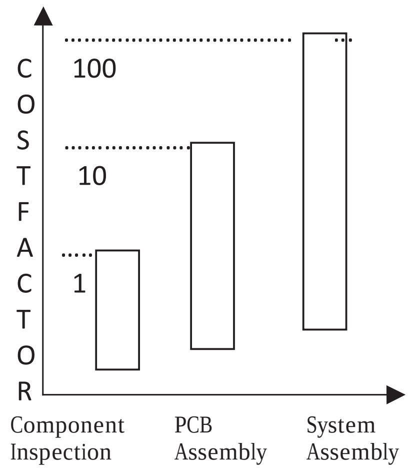


Figure. 1

In addition every major failure causes a delay in the product-to-market time with the resultant loss of opportunity cost. A reliable product has to be able to work within specification, in verity of different operating environments. It must be able to withstand variations in temperature, pressure, humidity, and customer abuse to a certain degree, just to name a few examples. Unless there is systematic procedure for design evaluation, these problems will only be discovered late in the manufacturing stage or even late in the testing stage. The late the problem is discovered, the costlier it is to solve it.

The most costly penalty to an industrial unit is if the product is late to the market. Carter and Baker [3] suggest the formula shown in equation 1 to calculate the loss to an organization for late market entry. The financial penalty for not getting design right the first time can be illustrated by equation 1 below.

$$r = \frac{d(3w - d)}{2w^2} \cdot 100\ \%$$

where

r= Percentage revenue loss

d= Delay in time to market

w= Market window (i.e. half product life cycle)

From equation 1 it can be estimated that if a product is say 5 month late to the market, and the market window is 12 months, the loss revenue amount to 54%.

4. QUALITY & IMPROVEMENT

Quality is the totality of the features and characteristics of a product that bear on its ability to satisfy stated or implied needs. The aim is to achieve only those quality characteristics that are necessary, not those that are possible.

Traditionally, producers tended to equate quality with conformance to specification at the time of final product test. This form of definition of quality gave inadequate attention to a number of quality factors such as safety, reliability, usability, etc., which influenced quality as defined by users. To be competitive or simply put to remain in business, continuous improvement in all activities are required, for example, to improve the response to customers, to improve the production, to target specific market segments, and in an advanced form, to deliver mass customized products. It involves the entire workforce in improvement – oriented planning, execution, and control. The central idea is to concentrate on people and process rather than products and organization. Kaizen [4] evaluates and rewards everyone from the bottom to the top of the company, not merely on the basis of their output, but also in terms of their ability to improve what they are doing and to help other to improve.

4.1 Quality Factors

There are many Quality Factors that influence the product development cycle. Some of the gurus of the Quality Management have identified the following factors.

Andersen [5] has described seven systems necessary to solve the product development task.

a. Organizational Structure

b. Decision Structure

c. Groups and Individuals

d. Methods and Tools

e. Knowledge Structure

f. Measurement Systems of the experience effect

g. Physical Facilities

Another European Quality Guru Hubka[6]

[defines nine factors that influence the product development cycle].

a. Customer product requirement

b. Full description of the product technical system to meet the given product requirements

c. The design process

d. The engineering designer

e. The tools available to the designer

f. The existing technical knowledge

g. The management of the design process

h. The active environment

i. The procedure and technique employed by the designer

Louis, William and Canestus of Australia identified the following six quality factors.

i) Usability

ii) Reliability

iii) Technology

iv) Safety

v) Environment

vi) Cost

4.2 Quality Tools

To achieve the highest quality at the lowest cost quality guru "Deming" (1986) defines quality as a predictable degree of uniformity and dependability, at low costs and suited to the market. His entire philosophy can be summarized in just two words: reduce variation.

[Yeo, Goh & Xie] This is basis for his fourteen points for managements, which stress management led commitment, involving the entire organization, to continuous improvement in product, service and process using quality tools.

There are many tools that are available to improve the product and process. Each one of them is defined under its heading as under;

4.3 Statistical Process Control

It was developed by Walter Shewart in 1930, and later on refined by Deming on the principles of variation theory. It is unlikely that two items, even when prepared by the same operator, on the same machine, would ever be identical. The issue is therefore to distinguish acceptable variation from variation that could indicate problems. The rules of statistical probability provide a method for making this distinction. Random variation occurred within statistically determined limits. Data is collected and plotted on control charts. If variation remained within limits, the process remains stable.

4.4 Quality Function Deployment

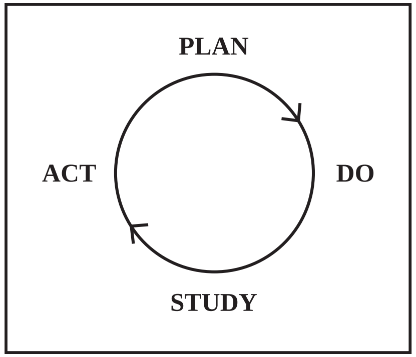
It was developed in Japan in Kobe Shipyard in 1970 [7]. It is methodology by which customer needs can be back propagated into design, manufacturing and marketing. The premises is that by using the feedback from the customer, engineers can ensure quality through the alignment and integration of different organization functions. By working on many issue simultaneously and up front, a better design will be generated, thus leading to overall improvement in the product. If done right, QFD can help a company, design and manufacture products in half the time, with half the manpower, with half the defects, and with half the costs.

4.5 Failure Modes and Effect Analysis

It is used to assess the probability of occurrence of a failure as well as the effect of a failure first formal application of FMEA was developed in the Aerospace industry in mid-1960. It is a team-oriented effort which identifies potential process failure modes, assess the potential customer effect of failures, identifies the potential manufacturing or assembly process causes. It also signals significant process variables to focus controls for occurrence reduction or detection of the failure conditions and also establishes corrective actions [8]. If potential modes are identified, improvement actions could be initiated by eliminating the causes of failures.

4.6 Quality Cycle

The basic steps involved in product improvement are planning the improvement, problem identification, documentation, evaluation, measurement and understanding of variation problem, development, implementation of solution, study of implementation and, if the study indicates that the implemented improvements were not successful, a repetition of the whole exercise is necessary. The cyclical nature of process improvement makes it a learning cycle. Shewart's[9] Plan-Do-Study-Act cycle is a simple model of such a learning cycle also known as Quality Cycle. See Fig below.



5. CONCLUSION

Quality of product, and similarly of services, is now recognized as an important strategic variable in competitions in today's marketplace. Quality is no longer viewed as a luxury but a necessity. In today's competitive environment, products have to be made better, quicker, cheaper and to the satisfaction of the customer. In the light of global competition and new market developments, catchphrases such as (ZD) Zero Defect, (DIRFIT) Do It Right First Time, and (DIBET) Do It Better Each Time, which were once regarded as useful ideas and motivators, need to be reviewed. The understanding of quality factors and use of quality tools as described in this paper provides a direction more congruent with that of continuous improvement. This paper discusses these ideas from the perspective of established quality philosophies advanced by Crosby, Deming, and Juran, and examines how they relate to current views on managing product improvement.

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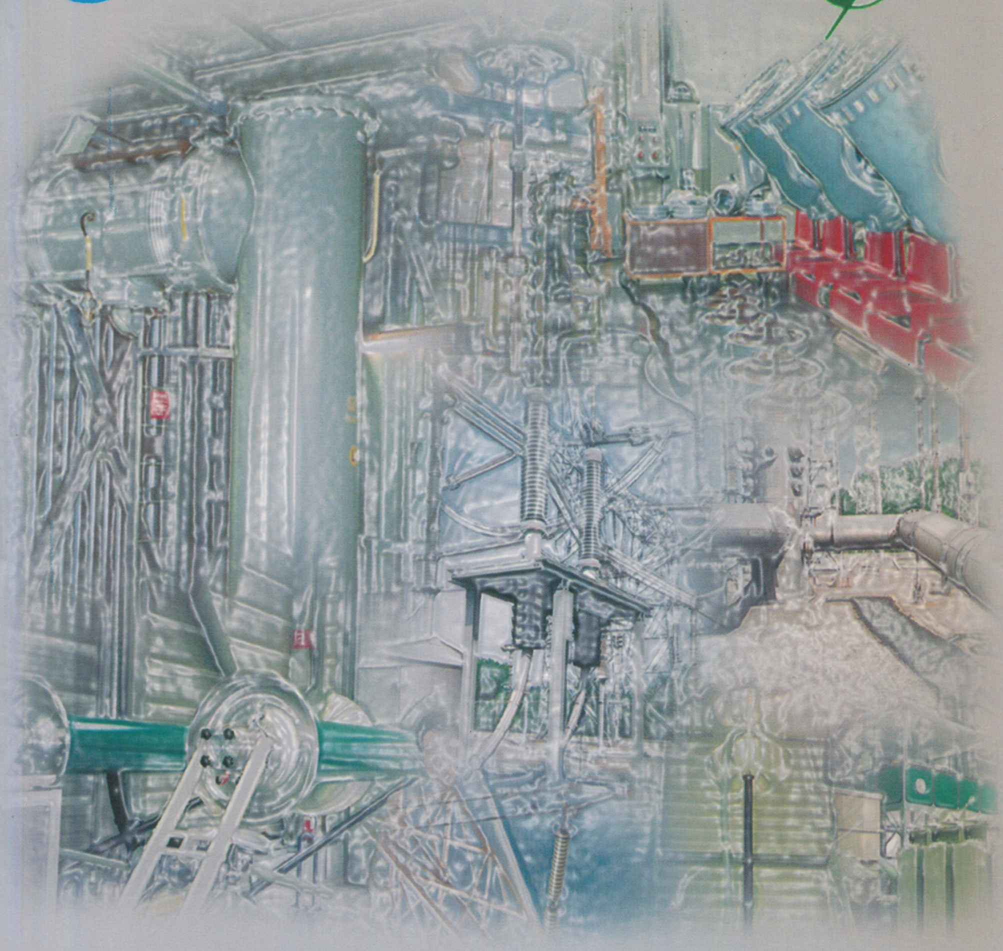

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FERROUS AND NON-FERROUS METALS USED IN TRANSFORMERS APPLICATION, STANDARDS AND COMPATIBILITY

Engr. Syed Sarfaraz Ali & Engr. Haroun Osman Sam

SUMMARY

Gulf countries are facing a huge potential increase in electricity demand that is likely to double in the next 10 years. Uptill now the electric industry in Gulf countries has done pretty well as public financial sector (regulated economy), but to face the world economic realities, changing oil prices, global competition, and fast developing technology, Gulf countries are opening the electric sector gradually to private financing.

The challenge of financing electrical industry is not only that of mobilizing adequate funds but also that of making the right choice of material, equipment and technology to ensure supply of reliable and economical electricity to the satisfaction of the utilities and consumers.

This has necessitated Electric Utilities in Gulf countries to consider the ways to reduce the operating costs, technical losses and adopting new technologies to keep the prices of electricity in reasonable limits. As transformers are one of the largest, heaviest and often costliest single piece of equipment in an electrical power system, care must be taken in choosing the loss-optimized transformer rather than the low cost transformer.

As transformer always operate continuously and most frequently in loaded condition, it is very important that the iron and copper losses may be studied carefully because the added cost of these continuous losses will nullify the initially low cost of the transformer.

The design of the magnetic circuit or transformer core is based on the rating, operating conditions and transportation limitation as it has significant effect on the overall economy of the transformer. Profound improvements have been made in the windings and core materials due to advancement in the metallurgy and manufacturing techniques. Low loss transformers use better materials and advanced manufacturing techniques and thus the high initial cost. The high cost of low loss transformers can easily be recovered in the shape of savings in energy use in less than three years.

This paper gives details about the ferrous and non-ferrous metals generally used in the manufacturing of transformers, their application, usage, standards and their role in reducing the transformer losses and minimizing the environmental impacts of transformers. Detailed loss evaluation methods for transformers have also been discussed taking into consideration the project – specific evaluation factors.

1. INTRODUCTION

The ever-increasing cost of electrical energy has made it necessary for electric utilities all over the world to carefully evaluate the inherent losses of electrical equipment and machinery. As transformers are one of the largest, heaviest and often costliest single piece of equipment in an electrical power system, care must be taken in choosing the material especially the core and winding metals to ensure low losses and low environmental effects.

A transformer consists essentially of a magnetic core built up of insulated silicon steel laminations, upon which are wound two distinct sets of coils suitably located with respect to each other, and termed the primary and secondary windings respectively. If an alternating e.m.f is applied to the terminals of the primary winding of a transformer with the secondary open circuit, a very small current will flow in the primary circuit only, which serves to magnetize the core and to supply the iron loss of the transformer. Thus an alternating magnetic flux is established in the core which induces an e.m.f in both primary and secondary windings.

The design of the magnetic circuit or transformer core is based on the rating, operating conditions and transportation limitation as it has significant effect on the overall economy of the transformer. Profound improvements have been made in the windings and core materials and design due to advancement in the metallurgy and manufacturing techniques of ferrous and non-ferrous metals.

As transformer always operate continuously and most frequently in loaded condition, it is very important that the iron and copper losses may be studied carefully because the added cost of these continuous losses will nullify the initially low cost of the transformer. Low loss transformers use better materials for their construction and thus the high initial cost by stipulating loss evaluation figures in the transformer inquiry, the electric utilities convey a message to the manufacturer of transformers to provide a loss optimized transformer rather than the low

cost model.

This paper gives details about the ferrous and non-ferrous metals generally used in the manufacturing of transformers, their application, usage, standards and their role in reducing the transformer losses minimizing the environmental impacts of transformers. Detailed loss evaluation methods for transformers has been described taking the project – specific evaluation factors of a given customer into account, which are discussed in details in this paper.

2. STANDARDS

In today's Global Market, National Standards are diminishing in importance to International Standards. Actually standards are becoming market driven phenomenon, gone are the old days when one manufacturer could seize complete market itself. Competition on level playing field is assuring state of the art technology in design, choice of material, minimum losses and less environmental effects.

2.1 Design

Basically Transformer comprises of two electrical circuits (windings) coupled by a magnetic field. The main elements of a transformer are Iron core, Copper winding, Insulation, Tank and Bushings. Ordinary Steel sheets were used in the early days of transformer manufacture and magnetic aging caused a great deal of trouble at that time. Transformers made of inferior grades of laminated steel have higher core losses and shows pronounced aging effects, further aggravating the hysteresis components of iron losses. Resulting from the aging effect, the hysteresis component of the iron loss in a transformer magnetic circuit was found to have trebled in value during the very early life of a transformer. It was subsequently found that very small quantities of silicon alloyed with low-carbon-content steel produced a material with low hysteresis losses and high permeability.

Windings are made of copper conductors which are covered with multi-layer paper. As the transformer is to withstand power frequency, impulse and switching surges during testing and operations, it is necessary that the copper strip is perfectly smooth. The surface should be free from various defects like mills, ceacks, slivers, scratches, pits, black spots and copper oust. Micro projection on the copper strips may puncture the paper insulation layer. Such defects will produce partial discharges due to nonconformity of field, which may ultimately brake the insulation [1&3].

2.2 Ferrous Metals

- Cold rolled grain oriented silicon steel (CRGO), type BS : 601/ASTM, A 665/DIN 46400, for making transformer core
- Cold rolled carbon steel sheet, grade D of IS : 513 ASTM A 620, BS : 1449-part 1, for making radiator
- High tensile strength structural steel plate, Gr, Fe 540w-HT of IS : 961, for core clamp plate, anchoring and clamping core to bottom tank
- 1.5% nickel-chromium-molybdenum steel bar and sections hardened and tempered, grade 40Ni6, Cr 4M03 type D of IS : 5517, for lifting pin and roller shaft
- Austenitic chromium nickel steel titanium stabilized plate (stainless steel), type Gr, 07Cr 18 Ni 10 Ti 20 to IS : 6911, Turret opening, non-magnetic insert,.. etc. to neutralize the effect of eddy current.
- Stainless steel sections (austenitic), Gr 07Cr 18Ni 9 of IS : 6603, for non-magnetic bar for high current applications
- Structural steel-stranded quality (plate, section, flat, bar, channel, angle,..etc., type Gr, Fe 410 S of IS : 226, for tank, end frame, clamp plate, 'A' frame for radiator, conservator, turret, cable box and for other structural purposes.
- Bright steel bar and sections-cold drawn, type Gr, St 42 of IS : 7270

2.3 Non Ferrous Metals

- High conductivity copper: sheet, strip, foil-hard and soft type IS : 1897, rod type IS : 613, tube type Gr, C103 of BS : 1977, casting & forging type Gr, HCC1 & CC1-TF of BS : 1400, tinned foil, type IS : 3331, flexible cable, type IS : 8130 class 5, and flat flexible braid, all for various current carrying applications.
- Copper alloys: Free machining brass rod, square and hexagon, type IS : 319 for tie rod and for making different components, Phosphor bronze rod type IS : 7811 for tap changer components. Nickel silver strip type Gr, NS 18 of IS : 2283 for making winding sheet.
- Aluminum: Aluminum alloy plate, type alloy 54300M, (NP 8-M) of IS : 736 for flange in bushing, cable box, other non-magnetic applications. Aluminum plate (99.0 %), type alloy PIC of IS : 736 for shielding of reactor tank. Aluminum foil for condenser layer in bushings [3].

2.4 Other Materials

- Insulated power conductor and cable
- Paper covered rectangular copper conductor, type IS : 7404 (pt. 11) to SI : 6160 for making different types of windings
- Paper covered continuously transported copper conductor, type PVA enameled strips to IS : 3855 (part 111) for making different types of windings
- Paper covered stranded copper cable, type IS : 8572, conductor to IS : 8130 for making lead and terminal
- Crepe paper covered flexible copper cable, type conductor to class 5 of IS : 8130 for making lead and terminal required to be bent to a small radius
- PVC insulated copper cable-single and multi-core type IS : 1554, for control wiring in marshalling box

3. CHARACTERSTICS OF FERROUS AND NON FERROUS METALS

There are three main metals used in the construction of power transformers. The properties and metallurgy of these metals has a direct effect on the efficiency, losses, life and environmental effects of the transformers. Thus extreme care should be taken in selection of material for the construction of core, core windings and cooling methods. These metals are described under each heading giving details of properties, specifications and standards as applicable in transformer manufacturing industry.

3.1 Copper

In its commercially pure form, copper is the most effective conductor of electricity and heat and has no competition in the windings of efficient machines such as generators, motors, transformers, and other electrical components. Pure copper has a resistivity at 20°C of 1.679 Ω-m x lower than that of any known material except silver.

3.1.1 General

The largest market for copper is for the high-conductivity grade. Refining techniques have improved significantly during the past two decades, as have the methods of manufacture of rod and wire. The result has been that the electrical industry now uses a product which is purer, easier to anneal and is more consistent in properties and tolerances. At the same time, there have been demands for grades of high-conductivity copper that have higher strength at ambient temperature and also at the higher temperatures at which many machines run.

For applications such as heavy-duty transformers and motor windings needing high conductivity copper but with a good creep strength at moderately elevated temperatures being more important than proof stresses, the copper used in frequently Cu-ETP with addition of silver specified at one of several possible preferred values between 0.01 and 0.14 %. The copper retains a conductivity of 100% IACS (International Annealed Copper Standard).

Alloys are now in commercial production to suit the needs of modern industry offering a variety of combinations of properties. The alloying additions made are many and varied, including silver, cobalt, chromium, iron, magnesium, nickel, phosphorus, silicon, tin, titanium, zinc and alumnia.

Founders and fabricators of copper have been shown to be keeping well up with the requirements of modern industry for materials that can meet very demanding performance requirements. Existing production methods are being improved and new ones developed to meet the needs of advances in well-established and new alloys.

3.1.2 Copper used in Transformer Windings

Insulated Copper Conductors are used for transformer windings. The following types of conductors are used for making spiral, helical, continuous disc, layer and interleaved disc windings of transformers:

1. Paper covered rectangular copper conductor
2. Twin paper covered rectangular copper conductor bunched together
3. Paper covered continuously transposed copper conductor (CTC)
4. Twin transposed copper conductor bunched together

Twin paper covered rectangular and twin transposed copper conductors are used to improve the winding space factor. Individual conductor is covered with only three or four layers of paper to electrically separate them instead of giving full insulation. The bare strips are made from electrolytic tough pitch (ETP) grade copper wire bars to IS:191 with high conductivity (99.14% IACS or 57.5 Sm/mm^2) and annealed complying with requirements of IS:6160. The manufacturing operations involved

are hot rolling, pickling, shaving, drawing, flattening, annealing and finally covering with requisite number of kraft paper layers. Since transformer windings are to withstand power frequency, impulse and switching surge voltages during factory tests and operation, it is required that a strip is perfectly smooth [3].

3.2 Steel

Over the past 30 years, the engineering steel industry has been subjected to increasing demands from users for components that are more economic, efficient and capable of improved performance, withstanding more arduous environments and service conditions.

The objectives posed by the customer represent a considerable metallurgical challenge to the steelmaker, with the need to maintain and improve toughness, machinability, formability and weldability at an increased strength level and at a minimum through cost. The steelmaker’s interpretation of needs for steel can be summarized as: reduced manufacturing cost; improved fuel economy; improved performance; reduced emission; reduced noise; vibration and barsbness; improved safety and improved durability. In response to these changes, the use of high strength steel strips has grown over the last 10 years. The use of aluminum and new materials, such as plastics, has contributed to the reduction in steel intensity in manufacturing [3].

Steel is used in transformer industry for two purposes, one is for making tank which is defined under Structural steel and second for making cores which is defined as core steel.

3.2.1 Structural Steel

Structural steel mainly in sheet and plate form is used in the fabrication of transformer tank, radiator, conservator, clamp plate, end frame, marshalling box, cable box, roller, turret and inspection cover, etc. Normally, standard quality mild steel is conventionally used for core clamp plates. However, it is economical to use high tensile strength (HTS) steel plate, since by reducing the thickness of clamp plates, magnetic core area can be increased, resulting in improvement in utilization factor. HTS bar (1.5% nickel-chromium-molybdenum) having a very high tensile strength in the range of 900 to 1050 Mpa are used for lifting pins. Stainless steel (austenitic chromium nickel) plates are used as cover for turrets of high current bushings to neutralize the effect of eddy current. These plates are titanium stabilized for weldability with standard quality magnetic steels.

3.2.2 Core Steel

In the early 1930s, it was discovered that cold rolling improved the magnetic properties of strip in the rolling direction. The improvement in magnetic properties is a consequence of the particularly easy magnetization of certain direction in the crystals of silicon steel and the alignment of these crystals by certain cold-rolling and heat-treatment processes. The improved properties that were available in the rolling direction only (e.g. along the length of the strip) may be characterized by the iron loss which, at a maximum flux density of 1.5 teslas, approximated to 1.0 watts/kilogram for sheets having a thickness of 0.33 mm which are commercially available.

3.2.3 Cold Rolled Grain-Oriented Electrical Steel Sheet (CRGOS)

CRGO electrical steel with approximate silicon content of 3% is used for magnetic circuits of a transformer. The following features influence selection of the type of steel sheet:

1. Maximum magnetic induction to obtain a high induction amplitude in an alternating field
2. Minimum specific core-loss for low no-load loss
3. Low apparent power input for low no-load loss
4. Low magnetostriction for low noise level
5. High grade service insulation
6. Good mechanical processing properties

CRGO made from a ferrous base present maximum magnetizability, i.e. permits a high induction. Iron crystallizes into a body-centered cubic lattice, with the cube edges of the lattice pointing in the direction easiest magnetizability and lowest core loss. Grain oriented electrical sheet consists of silicon-iron alloy, with the crystallites predominantly oriented by means of a specific manufacturing process, in such a way as to have 4 cube edges pointing in the rolling direction and diagonal plate being parallel to the sheet surface. In this way the rolling direction becomes the direction of maximum magnetic properties and approaching the ideal properties of the individual crystallite.

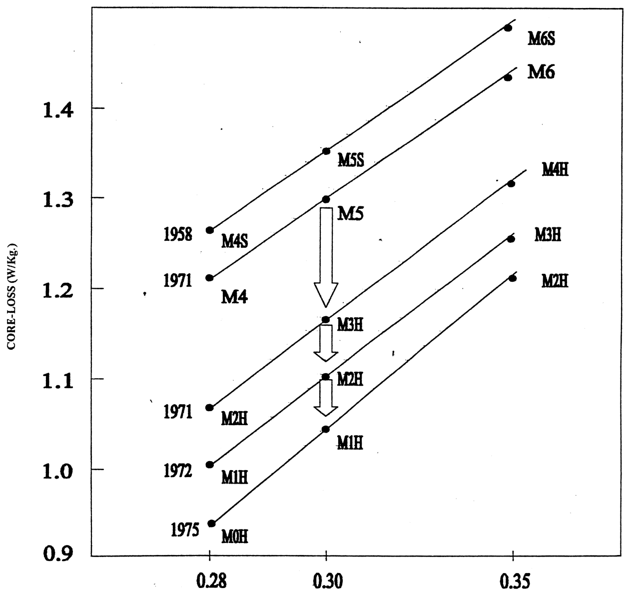
Conventional grain-oriented (CGO) steels are made in various grades: M4 to M7, while low loss HI-B steels are available in grades (M - OH to M - 4H). The table below shows characteristics of some typical grades uses commonly in transformers.

Specific core-loss is made up of hysteresis and eddy current losses. Hysteresis loss is usually reduced by making an improvement in grain orientation. In terms of hysteresis loss, HI-B is two grades superior than conventional material. Eddy current loss depends to a large extent on the sheet thickness, the frequency of the alternating field and to a minor degree on the electrical conductivity. Eddy current loss is usually improved by applying a surface coating which generally consists of a glass film and a phosphate coating.

Characteristic	M4	M-2H	RG	RGH	RGHPJ
3 Physical					
• Thickness	0.27	0.30	0.27	0.23	0.23
• Density g/cm^3	7.65	7.65	7.65	7.65	7.65
• Specific electric resistance, Ωμ cm	48.00	45.00	48.0	45.00	45.00
• Thermal conductivity at 25°C, j/m Sk	26.00	28.00			
4 Magnetic					
• Specific core-loss, W/kg (max.)					
(i) At 1.5 T	0.89	0.83	0.78	0.66	0.61
(ii) At 1.7 T	1.4	1.17	1.20	0.95	0.84
• Magnetic induction at magnetizing force of 800 A/m (Bg), T(min)	1.75	1.85	1.85	1.87	1.87
• Specific apparent power at induction of 1.5T, VA/kg (max.)					
• Saturation induction, T	1.25	1.00			
• Aging test (increase in core-loss	2.03	2.03			
after aging at 150°C for 14 days), % (max.)	3.0	3.0			
5 Electric 1. Resistance of surface coating,Ω (min)	2 for 80% of the readings 5 for 50% of the readings				
6 Mechanical					
- Tensile strength, Mpa					
(i) Longitudinal	350	330	324	314	314
(ii) Transverse	420	390	373	363	363
- Yield point, Mpa					
(i) Longitudinal	330	315	314	294	294
(ii) Transverse	360	325	314	304	304
- Elongation %					
(ii) Longitudinal	0	8	15	15	15
(iii)Transverse	24	30	44	44	46
- Hardness, HV (load 50)	175	170	195	200	200

Table: Characteristics of CRGO Magnetic Steel: [3 & 4]

The figure below shows the improvements in core-loss of HI-B steel over CGO when the induction is over 1.5 T



THICKNESS (m.m.)

IMPROVEMENT IN CORE-LOSS

Therefore, HI-B permits the manufacture of transformers with the same no-load loss as before, but a higher induction amplitude with the resulting economic advantages such as smaller size, less weight and reduced amount of material. Alternatively, transformers can be manufactured with 5% to 20% reduction in no-load loss depending upon the grade and induction amplitude using HI-B grade.

Core-loss in Cross-grain Direction:

If magnetization is applied in directions other than the rolling direction, the core-loss increases substantially. Core-loss is more than three-folds at 90° to the rolling direction, and more than four-folds at 60°. This aspect is taken care of when designing the magnetic circuit of transformers. Core-loss of HI-B steel in 90° direction is inferior to those of conventional steel. Due to lower specific apparent power of HI-B steel, 10 to 50%

reduction in transformer exciting volt-amperage is obtained. [3]

3.2.4 Plasma Core RGHPJ, RGH and RG Core Grain Oriented Magnetic Steel Strips

Plasma core is a core material developed by the use of new technology in plasma flame irradiation offers ultra-low iron loss. Radiating a plasma flame to the surface of RGH and finely subdividing the magnetic domain has made it possible to further reduce core loss. RGH and RG cores have low iron loss and high magnetic density when magnetized in the direction of rolling, low magnetostriction because of their low strain susceptibility, high interlaminar resistance because core materials come with D coating and high lamination factor because of the smooth surface of the materials [5].

3.2.5 Amorphous Metal Transformers:

Amorphous steel, also referred as metallic glass, is a non-crystalline solid created by rapid quenching of metal-metalloid alloys. Amorphous steels of thickness 25 to 50 •m and width up to 175 mm are now commercially available and it is expected that wider strips will follow [7].

2.3 Aluminum

Aluminum and its alloys are widely used in the electrical industry because of their good thermal and electrical conductivity, excellent mechanical properties and corrosion resistance, ease of fabrication, low density and non-magnetic properties. Pure aluminum has a resistivity of 2.64 Ω-m $x10^{-8}$ at 20°C with a mean temperature coefficient of resistivity over the range 0-100 °C of 4.2 $x10^{-3}$ °C. Thus it has about 64% of the conductivity of pure copper or 66% of that of the International Annealed Copper Standard (IACS) at 20 °C. On an equal weight basis the conductivity of aluminum at this temperature is 211 is that of copper and exceeds that of all known materials except the alkali metals.

Aluminum and steel-cored aluminum conductors made of alloys containing 0.3-1.0% silicon, 0.4-0.7% magnesium with small amounts of iron, copper, nickel and manganese are being used increasingly for electrical applications. Aluminum strip and wire are also used for transformer windings, and casting alloys have been used in place of steel for large transformer casings with advantages in reducing the associated magnetic losses.

Aluminum's excellent combination of properties (good thermal and electrical conductivity, good corrosion resistance, lightness and exceptional strength/weight ratio when alloyed) has given its use a faster growth rate than other metals. It has already replaced copper in many electrical applications and is now second only to steel in overall annual usage. New types of alloys and new applications are constantly being developed.

Because of increase in the cost of copper, more attention is being paid to the use of aluminum for transformer windings especially in distribution transformers. Aluminum is a less effective conductor compared to copper, but despite this intrinsic disadvantage (which results in a larger transformer for a given efficiency) there is a net saving in overall cost. Aluminum strip can be used to wind any of the types of transformer coils because aluminum can be rolled to a thinner and more flexible foil than copper [2].

4- ENVIRONMENTAL ASPECTS

Power Transformers should be environmentally friendly. Increased awareness about the pollution and the adverse effects on the surrounding area has resulted in introducing some new standards and specification. The pollution due to power transformers and the International Limits are as under.

EMF	Normal Limits	1.6 •Tesla
Noise	Normal Limits	55 db to 100 db
Vibration	Normal Limits	40-50 Hz or 100 Micron

For environmental protection, the noise level produced by the transformers has recently been a significant factor to the user. Such transformer noise is generated by the iron core of the transformer, as well as from that made by the fans. In an ideal core, the laminations of which are pressed together in such as to prevent any fluttering or shifting the noise is generated by the magnetostriction of the laminations in the alternating field, causing the core to vibrate and thus act as an acoustic source. If the above mechanical conditions of the core manufacture are not observed other causes (such as magnetic vibrations) may also be the reason of the noise. Careful design and manufacture is necessary to ensure that the noise emitted is within the level normally accepted as reasonable for a given size of transformer. Magnetostriction, i.e. the change in configuration of a magnetizable body in a magnetic field, leads to periodic changes in the length of the body in an alternating magnetic field. The frequency

of this megnetostriction is twice as large as that of the alternating magnetic field, i.e. when magnetizing an electrical sheet with 50 Hz the fundamental frequency of magnetostriction is 100 Hz. The process of change in length as a function of induction is not strictly a linear one, so that the magnetostriction of an alternating field gives both a fundamental and harmonic frequencies. The fundamental frequency is predominant in an alternating magnetic field up to an induction of 1.7 T, while as result of the sophisticated process of alternating contractions and expansions, the harmonic frequency prevails for induction above 1.7 T. Magnetostriction is minimum in the rolling direction whilst in the 90°-direction it is maximum. Except for the 90°-direction, all other directions that present major deviations from the rolling direction have a high percentage of harmonic frequencies in the spectrum, which are particularly undesirable because they generate harsh noise in frequency ranges, where the human ear is especially sensitive. Therefore, for sheets used in transformers, all transverse and oblique effects are kept to a minimum and very high induction amplitudes are prevented in the rolling direction [3].

Magnetostriction of HI-B is lower than that of CGO, and consequently 2 to 7 dB reduction in the noise level of transformer is achieved. RGH and RG steel cores have lower magnetostriction than HI-B and CGO [3&5].

5. LOSS EVALUATION AND COST FACTOR

As transformer always operate continuously and most frequently in loaded condition, it is very important that the iron and copper losses may be studied carefully because the added cost of these continuous losses will nullify the initially low cost of the transformer. The high cost of low loss transformers can easily be recovered in the shape of savings in energy use in less than three years.

Low loss transformers use better materials for their construction and thus the high initial cost, by stipulating loss evaluation figures in the transformer inquiry, the electric utilities convey a message to the manufacturer of transformers to provide a loss-optimized transformer rather than the low cost model.

Detailed loss evaluation methods for transformers have been developed and described accurately in various research papers taking the project-specific evaluation factors of a given customer into account, which are discussed in details in this paper.

The following simplified methods for transformers have been developed and are described accurately in the literature, taking the project-specific evaluation factors of a given customer into account, making the following as assumptions [6]:

1. The transformers are operated continuously
2. The transformers operate at partial load, but this partial load is constant
3. Additional cost and inflation factors are not considered
4. Demand charges are based on 100% load

The total cost of owning and operating a transformer for one year is thus defined as follows:

5.1 Capital cost Cc

Capital cost can be calculated by the following formula taking into account the purchase price, the interest rate, the depreciation period:

$Cc = \frac{Cp.r}{100}$ [amount/year] where:

Cp = purchase price

$r = \frac{p.q^n}{q^{n-1}}$ = depreciation factor

$q = \frac{p}{100} + 1$ = interest factor

p =interest rate in% p.a
n =depreciation period in years

5.2 Cost of no-load loss Cpo

Cost of no load-loss can be calculated based on no-load loss, and energy cost using the following formula:

Cpo = Ce . 8760 h/year. Po [amount/year]

Where:
Ce =energy charges [amount/year]
Po =no-load loss [kW]

5.3 Cost of load loss Cpk

Can be calculated based on the copper loss, the equivalent annual load factor, and energy cost using the following formula:

Cpk = Ce . 8760 h/year .a^2. Pk [amount/year]

a = constant operation load/rated load

Pk = copper loss [kW]

5.4 Demand charges

Can be calculated based in the amount set by the utility, and the total kW of connected load using the formula:

Cd = Cd(Po + Pk)

Cd = demand charges [amount/kW, year]

Taking an example of 1600 kVA distribution transformer to demonstrate such calculations for a standard (low cost transformer, 13900 $), and an efficient (loss-optimized transformer, 15556 $), assuming the following:

-Depreciation period n = 20 years
-Interest rate p = 12 % p.a
-Energy charge Ce=0.14$/kWh
-Demand charge Cd=194.4 $/kW.year
-Equivalent annual load factor a=0.8

From which we get:

The total cost of owning and operating a standard low-cost transformer = 24991 US$

The total cost of owning and operating the loss-optimizing transformer = 21024 US$

Therefore, the energy saving of the loss-optimized transformer of US$ 3967 per year pays for the increased purchase price in less than one year.

6. EFFICIENT TRANSFORMERS

Since new low-loss transformer technologies such as Cold Rolled Grain-Oriented Steel Sheet and Strip, Amorphous Metal Core, Cryogenics, and

Laser-etched Silicon Steel became commercially available, many electric utilities encouraged their use. According to Barry W. Kennedy 1999, electric utilities widely buy energy efficient distribution and substation transformers, which contribute significantly to utility's system losses. The following are examples of international move taken in some countries toward research and development of Efficient Transformers: [7]

Europe: To help the governments in the European Union to understand the present and future potential benefits of using energy efficient transformers, and also help electric utilities to identify and specify energy efficient transformers based on a clear understanding of the commercial availability of the products and their cost effectiveness, the European Commission recently awarded a contract to a team led by the European Copper Institute to assess the potential energy saving from the use of energy efficient transformers. This team will study what effect energy-efficient transformers could have on energy conservation efforts and global warming. It will identify the technical, engineering, and financial challenges to their application and develop a strategy, if appropriate, for their introduction in the European Union.

U.S.A: When purchasing substation transformers, engineers at Seattle City Light, Seattle, Wash, evaluate no-load losses - $4950/kW, and load losses are evaluated at 1700/kW.

China: In 1997, the Chinese government adopted the energy conservation law to promote energy efficiency (and energy-efficient transformers) and environmental protection. In 1998, China's State Development Planning Commission (SDPC) developed policies to encourage the use of Amorphous Metal Transformers (AMT's), which reduce no-load losses by 80%. SDPC adopted these policies as part of electric distribution system improvement program that includes 39 major Chinese cities. China is now producing amorphous metal transformers.

Victor Zhou, International Copper Association China Project Manager, estimated the potential for annual electric energy saving 25 billion kWh in China over the next 20 years from the use of energy-efficient distribution transformers. He estimated the saving could result in the annual reduction of 28 million tons of CO_2 emissions.

India: At the Energy Efficient Transformers and Motor Workshop in Bombay, India in May 1999, M. A Narsimhan, International Copper

Association India, Deputy Director emphasized the great opportunity for improvement in India's electrical distribution system by the use of energy-efficient transformers.

Narismhan estimated that India consumed 360 billion kWh in 1998. He projected that India has the potential to save 22 billion kWh/year over the next 20 years if it uses energy-efficient distribution transformers. Narismhan encouraged the use of total owning cost method for selecting distribution transformers to achieve the saving cost effectively[7].

7. CONCLUSIONS

As transformer always operate continuously and most frequently in loaded condition, it is very important that the iron and copper losses be studied carefully because the added cost of these continuous losses will nullify the initially low cost of the transformer.

There are two types of losses in power transformers; No-Load Losses and Load Losses. No load losses occur due to flow of main flux in the core. It depends upon the grade of steel, frequency, flux density, type and weight of core, and manufacturing technique of core construction.

Load losses are due to the ohmic resistance of winding and stray losses. The load losses of transformer is a function of temperature and generally expressed at a reference temperature of 75°C. Subdivision of conductor radially reduces the eddy current losses due to axially leakage field, similarly subdivision of conductor axially reduces the eddy current losses due to radial component of leakage field.

Low loss transformers use better materials for their construction and thus the high initial cost that can easily be recovered in the shape of savings in energy use in less than three years in addition to their less environmental impacts. By stipulating loss evaluation figures in the transformer inquiry, the electric utilities convey a message to the manufacturer of transformers to provide a loss-optimized transformer rather than the low cost model.

To increase the short-circuit strength of the windings, annealed copper conductor is already being replaced by controlled proof stress copper. Copper-silver alloy will replace high conductivity copper, specially in higher rating transformers. Under short-circuit conditions in the windings, copper-silver alloy conductor is less susceptible to annealing and is thus easily able to retain its strengths. Mechanical strength of transposed conductor is further increased by bonding together all the conductors in a stack, by use of epoxy bonding enamel over PVA enameled strips. These changes are likely to take place faster, to cover almost all transformers.

However, copper is expected to be used unless it is replaced by a new generation development of superconducting material, since anodized aluminum strip conductors have their limitations HV windings.

Possible substitute for grain-oriented electrical steel magnetic core transformers is amorphous steel lower-loss transformer technologies. Also cryogenics and laser-etched silicon steel low-loss transformers are now commercially available.

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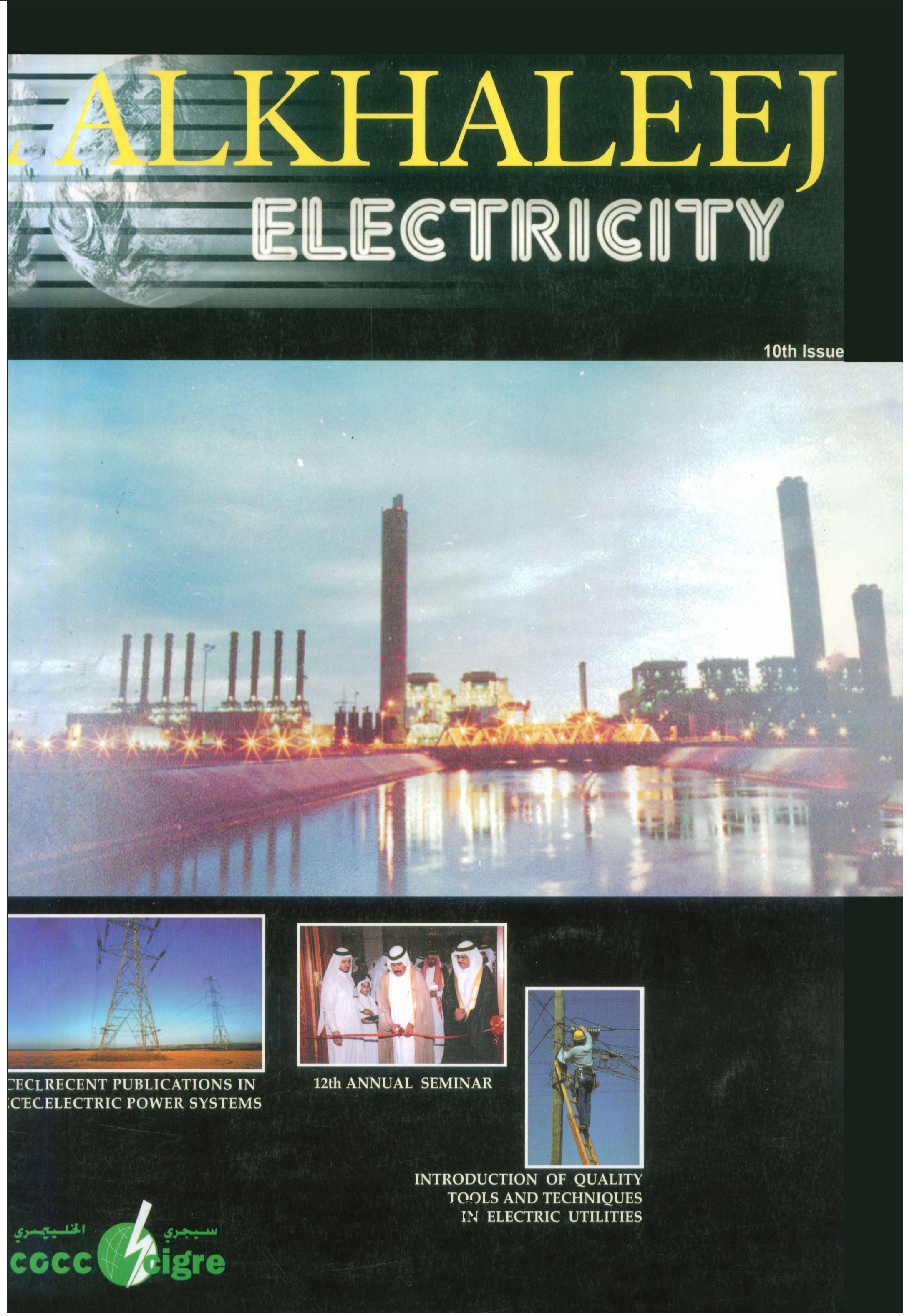


Delivering a technical talk

INTRODUCATION OF QUALITY TOOLS AND TECHNIQUES IN ELECTRIC UTILITIES

Engr. Syed Sarfaraz Ali

1. Introduction

Electricity has become the most important commodity of the modern world. It is highly capital intensive business Billions and Billions of Dollars have been invested to build the infrastructure but still it needs improvements in the services. In spite of all the developments and the comforts that electricity has brought to the mankind, today the electric industry is facing tremendous challenges not only in Gulf countries but all over the world, in some countries it is the galloping load growth, in some countries it is re–structuring, de–regulation, and opening the market to competition, while in some countries it is the question of real pricing. The electric power system may range from small isolated system to very large interconnected network covering vast geographical areas, but nowadays the most important problem for electric utilities, is to maintain quality with economy.

Engineers working in Electric Utilities are looking towards new ways to solve these quality problems to remain competitive in this fast changing business environment. New analytical tools, special equipment, and management techniques are being evolved to improve the quality in the services to the consumers without given any consideration to the size and type of load.

2. Solutions

These can be divided into two types of solutions:

(i) Technical Solution

(Monitoring and Remedial Techniques)

(ii) Managerial Solution

(Implementation of Quality Management Techniques)

The main objective of this article is to introduce the concept of Quality Tools and Management Techniques to engineers working in Electric Utilities and the ways in which these can be utilized in the services sector to improve the performance and for continuous improvement in the power system, however a brief overview of technical solution in use and under study in some countries are also given for the sake of information and continuity of the subject.

2.1 Technical Solutions

Electric Power Research Institute of America is developing an advanced technology for use by utilities to improve overall distribution system reliability and to keep power quality problems of the distribution networks from reaching customers end. This technology, the basis for a concept, EPRI calls "CUSTOMPOWER" involves a combination of power electronic controllers, distribution automation equipment and an integrated communication protocol which together will enable electric utilities to meet the power quality needs of sensitive loads. Georgia Power (USA) is using a new software "DINIS"(E) an integrated data capture and electrical network analysis workstation package developed by ICL of U.K. and it is working satisfactorily.

University of Canterbury of New Zealand developed a power system monitoring tool known as "CHART" for continuous harmonic analysis in real time, and is being utilized for power quality improvement by Trans Power Ltd of New Zealand and Electra de Viesgo of Spain.

2.2 Managerial Solutions

Quality Management Techniques

Before going into the details of Quality Management it is proper to explain, what is Quality and how it could be measured and applied in electric utilities. It requires some historical background about the concept and definition of Quality and its introduction in the services sector like an electric utility. Some of the most respected people in the Quality Profession have advanced their own definition of Quality.

(1) Joseph Juran describes Quality as "Fitness for use"

(2) Philip Crosby describes Quality as "Conforming to requirement"

(3) Deming divides the Quality in two and says

(i) Quality of conformance means good specifications

(ii) Quality of performance means good services

Actually Quality as a word has many meaning depending on the context in which it is used. The British Standard definition of quality according to BS 4778 is "The totality of features and characters of a product or services that bear on its ability to satisfy stated or implied

needs".

The same definition has been adopted by ISO 9000 and by EU.

3. Managing Quality

Managing for quality in a service sector like electric utility is inherently challenging.

Firstly the electricity must be produced simultaneously with its use. This requires a system capacity and capability to meet load demand at whatever moment it occurs.

Secondly, the electric utility does not produce a "thing" it produces electricity which is intangible so how can we measure the quality of an intangible thing.

In electricity service sector it can be determined individual transaction between server and customer occurring thousand times a day. Because quality of electricity services is intangible therefore there is a strong tendency to manage service business on various other easily measurable factors such as;

(i) Number of consumers served

(ii) Number of complaints

(iii) Type of faults

(iv) Frequency of faults

(v) Duration of faults

(vi) Loss to consumers

(vii) Loss to utility

But focusing on what's easily measured leads to "Looking good without being good" and that is actually what is happening in electric utilities nowadays. Engr Meno de Vries of KEMA describes this situation as "In the past, quality was always linked to the product, nowadays it is linked to the people. It is the perception of what people think about the quality".

The purpose of introduction of quality management in electric service sector is to ensure that customer is satisfied with services provided and that costs of such services do not bear negative impact of the revenue earnings of the utility. International Standard Organization have described the concepts, principles and quality system elements under Clause ISO 9004-2: 1991 (E) and the same have been adopted by European Union under the nomenclature as EN ISO 9000.

4. Implementation of Quality

Quality can not be added to a system or services at the last stage. It has to be incorporated from the start. Implementation of the Quality is a dynamic process design to determine the extent of compliance with determined standards. But how can you assure quality unless you have some controls. To control something you should have some check and balances, or set standards. Many versions of quality tools, techniques, steps, and procedures have been developed and designed for successful implementation of quality improvement in service sectors like electricity utilities.

4.1 The basic step

The basic steps involved are to set standards of; procedure, performance supervision and control over each activity in each unit / department.

An understanding of the electric power system and commitment of Top Management, is essential for the successful implementation of Quality Management System.

4.2 Quality Circles

Organize quality circles in each unit/ department like generation, networks, consumer services, load dispatcher, etc.

All such quality circles should be made responsible for writing their own plans and procedures to provide best services to the customers according to the set standards. These quality circles should also be made responsible to watch and control the deficiencies which are effecting the overall quality of the services. Obviously, outside customers are not the only customers, there are a number of internal customers (Sister departments) who play a vital role in maintaining the overall quality of services. Each department should write;

Their own Plan (what they are doing) Their own Procedure (how they will do) Their own system of Measurement (what they did) and finally suggest Improvement. (how to do it again).

Regardless of the size or system of electric utility, these four activities can be brought under the control of quality circles.

4.2.1 Planning

The activities / duties to be performed should be planned before they happen.

Responsibilities must be set so that accountability and ownership of resulting performance is established. The identity and needs of the customer should be defined clearly. Requirement should be specified in written documents. All this become the requirement for which detailed procedure should be prescribed.

4.2.2 Performance

The actions should proceed as planned. Special short orientation programs and refresher courses may be arranged for the staff to

work according to the set standards and safety rules. The performance of the staff should not only be checked and supervised by the in-charge of the quality circle but on the spot guidance should also be given to follow the procedure according to the set standards.

4.2.3 Measurement

All the work and activities should be recorded, and success or failure of an activity needs to be measured according to the set standards. Following are the main tool used in the measurement of the performance.

(i) Inspection

(ii) Surveillance

(iii) Audit

(iv) Appraisal

(v) Review

(vi) Feed Back

All persons involved in the activity should be made aware of the results as measured.

4.2.4 Improvement

By comparing the results with the set standards, measures to improve the performance can be taken. Problems must be corrected and process improved Engineers and subordinate staff can share concepts for improvement but the ultimate responsibility for such improvement rests with the Top Management as they should encourage and appreciate the improvements. Changes should also be communicated to the customers.

The most appropriate improvement plan is a direct response to an identified problem within the quality circle meetings, because once the problem is diagnosed the right remedy can be found and applied.

5. Quality Cycle

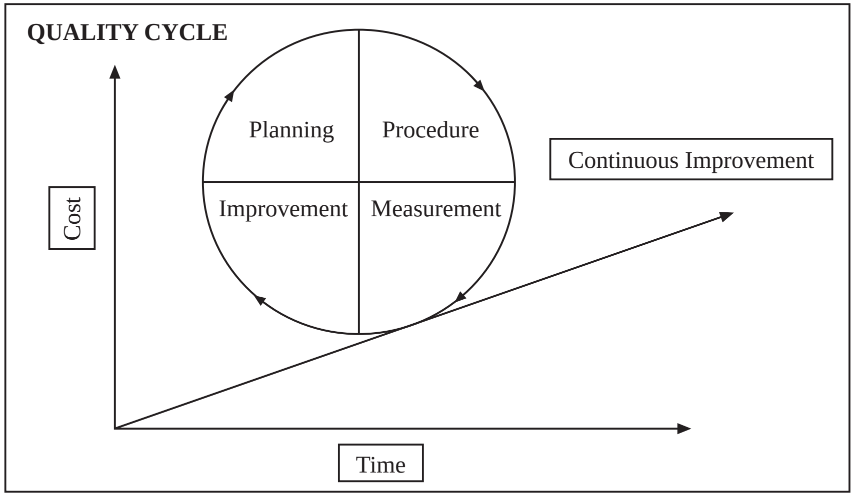
The above four activities are represented in the following model as quality cycle.

See Fig (1) below if the study indicates that the suggested improvement were not successful, a repetition of the whole cycle is necessary. It is now recognized that quality and productivity cannot be inspected in, they must be managed in. Management should ensure that the employees are properly trained, equipped, motivated and supervised to achieve the desired quality.

6 Common Problems in Implementation of Quality Management.

The most common problems that are being faced in the electric utilities are categorized and

Figure No. 1



described as under;

(i) "Don't know"

(Lack of knowledge)

(ii) "Won't do"

(Lack of discipline)

(iii) "Can't do"

(Lack of system)

If the problem is a knowledge deficit, then education, training or further coaching is needed. If the problem is one of compliance then counseling or discipline are the remedies, if the problem is a system barrier, then take it at a higher level.

Management should provide sufficient and appropriate resources to implement the recommendations of quality circles. The most resource in an electric utility is the personnel involved. Because the behavior and performance of individuals directly impacts the quality of power supply. In fact every employee whether working in Generation, Networks, Load Dispatch, Meter Section, Design and Planning or Emergency Compliant Attendant, contributes to some degree to the achievement of quality. If the duties and job description are properly compiled, maintained and brought under the control of quality circles, they can provide management with a good control of quality circles. They can provide management with a good means of clear and un–ambiguous communication with personnel at

all levels.

Finding creative solutions to these problems arising in the fast changing economic situation needs continuous improvement in the present electric utilities.

7 Conclusion

Electric Utilities in GULF Countries are under a transition stage gone are the good old days when consumers were content with the quality, degree and adequacy of electricity and its charges. Today we are facing not consumers but customers who is educated and agitated. Who take for granted the electricity. Public now questions the future planning on economic grounds, challenges the sitting and location of electric installations for fear of adverse pollution effects and protest against mode of generation.

This paper is being submitted in the hope that the concept of quality management which has brought success in western and other far eastern countries will be studied and brought in operation in electric utilities in GULF countries for staying competitive in the fast changing economic environment.

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AVAILALBILITY, RELIABLITY AND ADEQUACY OF POWER SYSTEM NEW PARADIGM OF PLANNING UNDER DE–REGULATED ECONOMY

Engr. Syed Sarfaraz Ali

Abstract: The Electric Industry in Gulf countries is being thrust to Market Economy. Now we are forced to face, de-regulation, privatization, competition and globalization. Changing energy demands, the drive for fast economic growth and the ever increasing standard of living calls for more emphasis on power system planning and control. The demands on professional engineers are also changing. If the 20th century was spent building the infrastructure, the challenges of 21st century lie in delivering quality services to the consumers. The task of planning engineer in the electric utility is to design an electric power system with a compromise between the requirements and available resources. He has to balance the quality of supply and the economics of the power system in terms of operating and capital costs. In this paper some important definitions are discussed under new market economy and a new paradigm of planning is suggested to attain a high degree of availability and reliability of a power system in de-regulated economy. In recent years the de- regulation has exploded in the electric utility industry affecting every area of operations. Some ideas about the new paradigm of planning under market economy are being submitted for further discussion and guidance from those who are closely involved in utility business.

1. INTRODUCTION

Electricity has been a natural monopoly during most of its century long history as it involved a very large capital investment on generating plants, transmission lines and distribution networks. In Gulf countries, electricity is still a highly subsidized sector whereas the per capita consumption of electricity is not less than the developed countries of the world. In this era of de-regulation, free market and global competition, politics has pushed the electricity sector towards competition and consumer choice. At the same time, new technologies have been developed which call for more efficient planning to cope with the rising demand of quality and economy.

The focus in the electric utility business is gradually shifting from supply of electrical demand to delivering a competitive Kilowatt-Hour. In fact the Electric Industry in Gulf countries is being thrust to Market Economy. Now we are forced to face, de-regulation, privatization, competition and globalization. Changing energy demands, the drive for fast economic growth and the ever increasing standard of living calls for more emphasis on power system planning and control. The demands on professional engineers are also changing. If the 20th century was spent building the infrastructure, the challenges of 21st century lie in delivering quality services to the consumers. Gone are the good old days when consumers were content with the quality and quantity of power supplied, but today's consumer do not want to wait or put on hold. Today’s hurried, time starved consumer wants quality and quantity in real time, which is to say availability without losing time and quality at competitive price.

Availability and reliability are two very important factors in achieving the desired quality of power supply. Is it not an irony that the benefits of higher level of availability and reliability are realized by the consumer but the costs are to be borne by the utility?

The task of planning engineer in the electric utility is to design an electric power system with a compromise between the requirements and available resources. He has to balance the quality of supply and the economics of the power system in terms of operating and capital costs.

Another important task of planning engineer is to design a power system to minimize the possibility of a large scale system failure by adopting suitable techniques to reduce the frequency and duration of service interruptions caused by the occurrence of faults in the system.

In today's power industry, newly minted words we can call "Planning Engineer" as "Asset Engineer" who understand both the financial fundamentals to keep turning the profits, and the engineering essentials to keep turning the shafts.

In this paper, a two stage philosophy of planning is described to attain a high degree of availability and reliability of a power system. In the first stage, any new facility is designed keeping in view

the load and considering probable interruptions and faulty conditions including scheduled outages for maintenance of the equipment and networks. In the second stage, control equipment and protection devices and sometimes new additions and augmentations in the system are proposed in view of the load growth, so that reliability of the power supply is assured against severe contingencies.

2. OLD TERMS NEW CONCEPTS

The increasing distance between power plant and load center, the possibility of saving fuel cost by exchanging power between inter connected systems and the constraints in building new transmission lines is now demanding optimum utilization of existing capacity of the system. In the market economy, electric utilities may no longer have to report directly to government officials or board of directors but to shareholders and consumers directly. A power system running at 50% of its capacity and frequent interruptions is not acceptable by any standard of the business.

Before going into the details of the challenges of 21st century and the effects of privatization, it is better to discuss and define some of the basic terms which have attained new concepts in the de-regulated economy.

2.1 Availability

The definition of availability may be described as the percent of time that a unit/system is available to supply power whether needed by the system or not. It is a measure of overall adequacy. It should not be confused with capacity factor.

There are many practical aspects of running a large power system below their rated capacity. The two principle reasons for keeping capacity factor lower than availability, are reliability and load variations. It is also necessary to have in operation at all times at least enough generating capacity to allow the load to be supplied in the event that the largest unit should trip out un-expectedly. This reserve, which is usually termed as spinning reserve is distributed over all the generators to make the reserve power quickly available when required.

Similarly the hour-to-hour load on an electric power system varies over a wide range. Typically the load in Daytime is more than the Nighttime load. The seasonal variations cause the peak load to increase and shift its duration and timing. It is not advisable to bring large generating units in and out of service every day or every week.

Therefore the power system operation is planned in such a way to have enough capacity on line all week long to carry the load of the peak hours of the week. At other times it is necessary to reduce the output of some of the older, smaller and less efficient units. For technical reasons it is not practical to reduce the output of steam turbine units below 40% of the rated capacity, therefore it becomes necessary to reduce the output from the larger and efficient units also.

2.2 Capacity Factor

Capacity Factor is a measure of energy actually produced / transmitted compared with the energy that could have been produced / transmitted if the system were operated at its rated capacity continuously. Capacity factor will always be lower than availability because generating units are generally operated below their rated capacity.

2.3 Reliability

The reliability of a power system can be defined as the ability of the system to cope with incident / faults without suffering uncontrolled loss of load. A network is never perfectly secure; in fact there will always be incidents or events bringing about faults and failures. On the other hand, the availability of a power system with regard to specific faults can be assured. That means either the consumers will not be affected by these failures or if they are affected it will be for a short time and situation will be under control of the operator / load dispatcher. In the first case the availability is not affected while in the second case the reliability is not affected.

A power system can be taken as reliable if it is able to withstand a sudden accident, with reasonable likelihood of occurrence, without experiencing large scale outage. Large scale failure occurs if an incident induces the power service interruption exceeding a certain percentage of a total demand. This value differs from utility to utility and basically depends on the total installed capacity and interconnection with other power system. If proper reliability is not considered at planning stage then minor incidents could develop into serious conditions through the successively spreading faults in the system which can be summarized as under:

- Loss of generator synchronization
- Abnormal system frequency
- Successive line overloading
- System voltage collapse

The primary sudden interruption can be reduced by different operational measures and by installing suitable control and protection equipment, whereas back-up protection, automatic re-closing and frequency controlled load shedding can prevent subsequent cascading system failures.

2.4 Adequacy

The adequacy of a power system is its capability to meet the energy demand, within component ratings and voltage limits. Inadequacy exists if, for one reason or another e.g. a particular combination of planned and forced outages, the operator is required to perform load shedding. It should be noted that the operator faced with the serious risk of incidents / faults, may very well decide to take preventive measures or to initiate load shedding or both; in other words sacrifice economy or part of the adequacy of his system to avoid subsequent and more serious and uncontrolled loss of consumers.

2.5 Steady State Operation

The normal operation of a power system involves transmission of power from the generators to various loads, as the load requirements changes, power output will increase or decrease. The system will adjust to a new operating cycle as the system adjust to gradual changes within tolerable limits.

2.6 Transient Operation

Transient stability defines the ability of the power system to adjust to large and sudden changes. System faults, line switching, and the loss or application of big load can result in sudden changes in the electrical characteristics while the mechanical inputs and outputs remains relatively constant. It is important that the power system readjust to these changes in order to continue operation and service, within permissible limits.

3. UNDERSTANDING MARKET DYNAMICS AND PLANNING VARIABLES

Driven by ever increasing energy demands, environmental constraints, deregulation and privatization of electric power sector, existing generation capacity and transmission systems are often subjected to the limits of performance capability of their original design. To ensure that under new Market Economy, the economical, reliable and secure operation of the power system is maintained, new concept has been employed by many electric utilities around the world.

Load sharing, loss elimination, regulating power flow through transmission corridor, transient stability, enhancement and rapid power flow management to prevent overloads as well as controlling power flow pattern are of concern and needs careful planning and design of the system to keep the system available and reliable economically. Electric utilities have the common energy generation, transmission and distribution problems, yet have different technical, economical, environmental and political requirements. The success lies in the availability of power supply with good reliability factor and economical costs.

This can also be achieved by using a set philosophy, fixed approach, and proper planning in stages, which has been discussed hereunder:

3.1 Philosophy

The (n-1) philosophy is the most common rule in electric utilities when determining adequacy of the system. This means that any outage of a single line or transformer must not result in disconnection of consumers or operation out of voltage range and current limits. The outage of a busbar or of both circuits of an overhead line on single tower is not generally regarded. In these cases extended voltage and current limits which vary from utility to utility are accepted. Sometimes local disconnection of consumers is allowed. The condition of power stations differs. Some utilities explicitly consider power stations together with outages of other components in their deterministic network planning conditions.

3.2 Approaches

There are two kinds of approaches, deterministic and probabilistic. Deterministic approaches give an answer to the questions;

“What happens to the system, if one of a selected series of credible outages or incidents occur".

Probabilistic approaches attempt to evaluate;

“How often and for what time a system is in a non-desired state because of outages”.

Going from deterministic to probabilistic means going from analysis of a small set of critical cases to the analysis of a very large set of system states; therefore, in this case one cannot speak of anticipated outages or incidents for the deterministic approach.

Basically two computation methods are available to handle the complexity involved in the

probabilistic approach when studying the composite (generation & transmission) system, namely the "Montecarlo" sampling technique and the contingency ranking and selection method.

Because of the amount of computing resources required by this kind of calculations the probabilistic approach is at present used mainly for adequacy analysis at the planning stage.

Adequacy is mostly checked by deterministic approaches, regarding quasi-stationary states of the networks. In several countries probabilistic approach for composite system evaluation is used a supplementary tool or is under development. It is mostly used for long term planning, or to choose between variants which are considered of equal value by a deterministic approach. Much more wide spread, but not considered here, is the use of probabilistic approach for evaluating busbar-systems generation adequacy and therefore the generation reserve margin.

As regard protection planning, the transient and dynamic phenomena of the transition between the normal operation state and the outage state of the network are considered mostly by use of deterministic approach. In some cases, operational constraints deriving from this security-checks (e.g. limitation of power transmission on a line) to avoid the risk of cascade tripping in case of a fault on this line) are introduced into the programs for adequacy evaluation.

3.3 Stages: There are two stages of planning to attain a high degree of availability and reliability of a power system.

(i) Selection of Equipment

In the first stage any new facility is designed keeping in view the load and considering probable interruptions and faulty conditions including scheduled outages for maintenance of the equipment and networks.

(ii) Design of System

In the second stage control equipment and protection devices and sometimes new additions and augmentations in the system are proposed in view of the load growth, so that reliability of the power supply is assured against severe contingencies.

3.4 Protection Scheme

Protection design and planning is the science, skill and art of selecting, installing and setting different type of relays and fuses to provide maximum sensitivity to faults and undesirable conditions. It is important to recognize that the "time window" of decision in modern power system operation is very narrow, and when faults have occurred, a recheck for verification or a decision making procedure that involves additional time is not desirable.

(i) Minor Faults

The primary sudden interruption can be reduced by different operational measures and by installing suitable control and protection equipment, whereas back-up protection, automatic re-closing and frequency controlled load shedding can prevent subsequent cascading system failures.

(ii) Major Faults

A power system can be taken as reliable if it is able to withstand a sudden accident, with reasonable likelihood of occurrence, without experiencing large scale outage. Large scale failure occurs if an incident induces the power service interruption exceeding a certain percentage of a total demand. This value differ from utility to utility and basically depends on the total installed capacity and interconnection with other power system. If proper reliability is not considered at planning stage then minor incidents could develop into serious conditions through the successively spreading faults in the system as described in section 2.3 above.

(iii) Transient Operation and Stability

System faults, line switching, and the loss or application of big load can result in sudden changes in the electrical characteristics while the mechanical inputs and outputs remains relatively constant. It is important that the power system readjust to these changes in order to continue operation and service. If the changes are too severe instability results and the various parts of the system no longer operate together in synchronism. The resulting loss of synchronism or out-of-step operation requires that the parts be separated, stabilized, and resynchronized in order to continue supply of power. Transient stability defines the ability of the power system to adjust to Large and Sudden Changes.

(iv) Counter Measures / Protection Scheme

It is impossible as well as impractical to avoid the consequences of system faults, natural events, physical accidents, equipment failure, or wrong operation, which provide Large and

Sudden Changes, resulting in intolerable conditions. These changing quantities include over current, over-or-under voltage, power, power factor, or phase angle, power or current direction, impedance, frequency, temperature, physical movements, pressure, and contamination of the insulating media. Different type of sensors, fuses, and relays are installed at various points in a power system for the detection of these changes. The type and location of the disturbances is very important in designing a protection and control scheme for a power system.

In general terms a two-step procedure is adopted in planning protection and control scheme.

(i) Standard protection relays are installed mainly so that the power system can become adequate for relatively probable incident conditions including scheduled outages of system components.

(ii) After assessing the adequacy of the power system by means of the first step (as above) control equipment or protection devices and sometimes new equipment are installed so that security of the power system is assured against more severe contingencies. Stability and dynamic analysis against various sudden disturbances are performed in the second step.

Countermeasures against minor and major breakdowns can be classified into three classes. The brief description of each is given as under:

(a) Prevention of Minor Faults:

In networks with long distance transmission lines this happens by optimal dimensioning and coordination of reactive power compensation equipment. For this purpose, traditional series and shunt compensation as well as Synchronous Compensator and Voltage Stabilizers are used.

In all networks it is attempted to reduce the frequency of faults by adopting a proper and scheduled maintenance program, checking and cleaning of insulation or others. In addition to this, the use of different manufacturers and constructors can be helpful to avoid dependencies. Lightning strike are frequently avoided by surge arrestors and automatic rapid re-closing.

(b) Prevention of Subsequent Cascading

It includes providing preventive re-dispatching or load shedding during critical system states. Primary back up or duplicated protection systems as well as automatic re-closing devices (single phase) are installed. Duplicated protection means that there are two sets of protection equipment for one component, if fault is not cleared by the first protective devices, the second back up protection equipment of the neighbor components works.

Automatic or manual load shedding triggered by low frequency, low voltage or thermal sensor is provided to avoid cascading.

Online monitoring is also recommended in some countries. Remotely blocking the voltage regulators of HM/MV transformers also provide safeguard against cascading and subsequent system collapse.

(c) Reducing the duration of interruption

These measures include improving the methods to locate faults and remove the defects, black start capability of power station, and emergency plans for network reconstruction.

These plans are developed by analyzing possibilities of isolated operation of separated networks.

Good training and education of operation and maintenance staff.

Simulation of various network situations by SCADA staff and analyzing the results may suggest improvement in the operation and maintenance schedules and practices.

4. SUCCESS IN DEREGULATING MARKET

It is the global transition from highly regulated economies with government sponsored monopolies to market based economies with private ownership and less regulation. This fast change is tearing down the walls between departments of electric companies. Accounting and customer services used to have little contact with Engineering and Load Dispatching, but now they are being tied together to reduce the expenditures and other overhead charges to sell electricity at reduced prices. Within electric utility, the boundaries between formerly separate applications are blurring. All of these areas have changed dramatically and more changes are on the horizon. Change is also represented by our Gulf Countries, rapidly increasing demand for energy, which is expected to triple by the year 2050. Strategic analysis and precise timing is required in order to excel in today market economy, we must anticipate change, recognize opportunities, and be able to plan to design a modern power system.

Following are five important factors

which are closely related to the new paradigm of planning under market economy. Each one is described briefly as under for careful study and application during planning under new market economy:

4.1 Economy Factor

It is fundamental to obtain maximum benefit at minimum cost, as such economy is a major factor in designing a power system. The initially lowest - priced power system may not be adequate and it surely going to Involve greater difficulties in installation and operation as well as higher maintenance costs. Cost of protection and control system is considered as very high and unreasonable when considered alone, but they should be evaluated as compared to the cost of equipment.

The loss of revenue in the case of prolonged outages or the total loss of equipment in the case of damage to the equipment or operating personnel due to improper protection or inadequate planning of the overall power system.

Designing and planning does not produce revenue and the results are intangible as such it is not given proper attention. Everybody in electric utility hopes that the system will run itself and the standard protection and control provided by manufacturer is enough to run the system, but when frequent and prolonged faults occurs everybody blames planning and design engineer for inadequate system.

A single fault where the equipment is isolated from the troubled zone, thereby minimizing the duration of interruption and saving the costly equipment from total damage, can more than pay for the amount spent on proper planning.

4.2 The Personality Factor

How and when a fault will occur with what intensity in the power system is unpredictable. A network is never perfectly secure; in fact there will always be incidents or events bringing about faults and failures. Thus the power system should be designed for the most probable events based on past experience, anticipated possibilities, recommendation of equipment manufacturer, coordinating and interfacing with the existing protection and control system, with good practical judgment. This tends to make planning an art in the technical world. Since much depends on the personal judgment and Planning engineer helps the operator/ load dispatcher by designing a protection system which could initiate load shedding, preventive dispatch measures or both, sacrificing economy or part of the availability of the system to avoid uncontrolled loss of load. To attain an adequate power supply system considering availability and reliability factors requires a detailed and proper study of the load pattern, sensitivity of the load, location of load center and sources of power supply, at planning stage. The job of planning engineer is to design a power system that is acceptable from a consumer's point of view and economical from operation point of view.

Although there is much common technology, but operation and management of power system is still far from standardized, as such each system planned and designed by planning engineer has its own characteristics and reflects the personality of the engineer who planned and designed it.

4.3 Location Factor

The location of protection relays and control equipment depends on the location of the main equipment. Because the current, voltage, frequency and other parameters for measurements and comparison are taken from these points through current transformers, voltage transformers, sensors and transducers. This data provides basis for monitoring, and isolation if required as per set limits.

4.4 Measurement Factor

The proper operation of power system requires some controls and checks to be carried out at regular intervals. To control or monitoring, the quantities should be measured against some standard or set limits. To monitor or control, there must be some standard equipment to check the signal or change in the quantities which will operate the relay for operation. If significant difference does not exist between the normal and abnormal limit, there should be no operation through relay.

The key to the planning and design of a modern power system is first to determine acceptable limits between tolerable and un-tolerable conditions. From this information the type and mode of protection relays, control equipment and operating policy is decided and the whole planning of the power system is carried out which gives the best availability and reliability factors within reasonable costs.

4.5 Accounting Factor (Company Policy)

Planning is a decision making process whose purpose is to configure economically the future composite (generation and

transmission) power system in which suitable availability and reliability are assured.

To drive down costs, it is necessary to remove institutional barriers and accepts the change in letter and spirit. But in electric industry, which was running under government as public welfare department for the last one century, it is not an easy thing to understand. It is not easy to find out the expenses for an individual generating unit. Many expenses, such as corporate overhead are not identified and the depreciation accounts are not booked at all. So proper accounting system is necessary to be incorporated at the planning stage and an activity based accounting system should be adopted right from the planning.

While fuel is the major operating costs in power industry, there are other excess O&M expenses, because of business inefficiencies allowed during regulated economy period. But to be really competitive in this new era it is not enough to reduce the O&M cost; a utility has to consistently reduce the cost year after year, and do so at a faster rate than its competitors.

5. CONCLUSION

Electricity is still a highly subsidized sector whereas the per capita consumption of electricity is very high is Gulf Countries. In this era of de-regulation, free market and global competition, politics has pushed the electricity sector towards competition and consumer choice. At the same time, new technologies have been developed which call for more efficient planning to cope with the rising demand of quality and economy.

In fact, the Electric Industry in Gulf countries is being thrust to Market Economy. Now we are forced to face, de-regulation, privatization, competition and globalization. Existing generation capacity and transmission systems are often subjected to the maximum limits of performance capability in accordance with their original design. Add to this the cultural shift from cooperation and coordination to competition and confidentiality between the new power players in the market. To ensure that under these conditions the economical, reliable and secure operation of the power system is maintained, power flow management concept has been employed by many electric utilities around the world.

Availability and reliability are two very important factors in achieving the desired quality of power supply.

The task of planning engineer in the electric utility is to design a power system to minimize the possibility of a large scale system failure by adopting suitable techniques to reduce the frequency and duration of service interruptions caused by the occurrence of faults in the system.

To design an adequate power supply system considering availability and reliability factors requires a detailed and proper study of the load pattern, sensitivity of the load, location of load center and sources of power supply, at planning stage.

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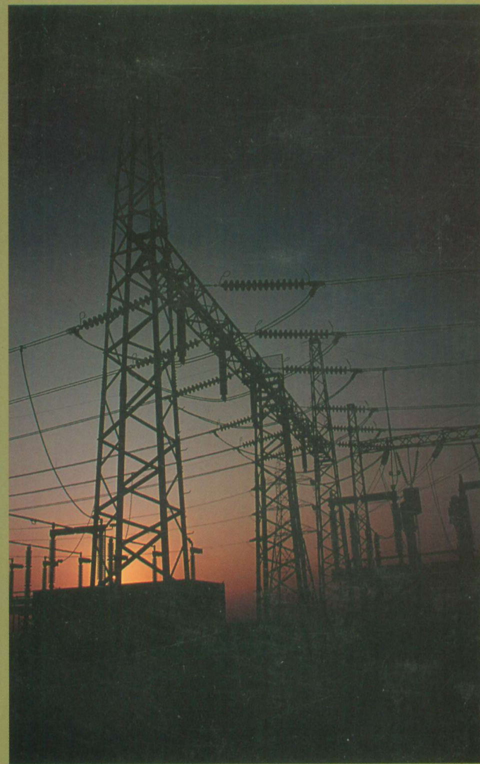

الندوة الثالثة عشر
التصميم والتشغيل والتحكم في المحطات الكهربائية
مسقط - سلطنة عُمان - ٢٣ - ٢٤ / ١٠ / ٢٠٠٢م الموافق ١٦ - ١٧ / ٨ / ١٤٢٣هـ

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Substation Design Operation & Control
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Informal discussion during GCC CIGRE's 13th Annual Seminar

AUTOMATION SYSTEM FOR NEW SUB – STATION # 8 TABOUK SELECTION CRITERIA FOR INNOVATIVE SOLUTION

Engr. Syed Sarfaraz Ali

ABSTRACT

The Electric Industry all over the Gulf counties is moving towards de-regulation. New Laws and Policies are being made in the electricity sector, which is leading towards competition and consumer choice. These changes calls for more efficient control of electric power system to cope with the rising demand of quality and economy.

For the SCADA Control and Operation System of a new 132/13.8KV Sub station in Tabouk Region of Saudi Electricity Company, a numerical integrated solution has been chosen for better performance and efficiency. The decision was made after a very detailed study and evaluation of different types and makes of Sub–Station Automation Systems offered by different manufactures and suppliers. This paper describes the selection criteria of the new Sub – Station Automation System.

1. Introduction

We can say that the 20th century was spent building the infrastructure, now the challenges of the 21st century ask for improvement in the quality of services to the consumers. The increasing distances between power plant and load center, the possibility of saving fuel cost by exchanging power between inter-connected systems and the constraints in building new transmission lines is now demanding optimum utilization of existing equipment, installations and concentrating on providing electricity in a more efficient way by using latest computer controlled devices and introduction of programmable logic in sub-stations control. This will not only reduce the duration and frequency of outages, but it will also results in less maintenance costs and ultimate increase the life of the substation equipment. With privatization has come the fall of hard working engineer and the rise of smart manager. Similarly the consumers are becoming costumers asking for uninterrupted power supply with lower costs. In the market economy, electric utilities may no longer have to report directly to government officials or board of directors but to shareholders and consumers directly. A power system running at 50% of its capacity and frequent interruption is not acceptable by any standard of the business.

The most important feature of the Restructuring of Electricity Sector in Saudi Arabia is to reduce O&M costs while maintaining the reliability of power supply. Utility Managers are looking for innovative ways to maintain quality with economy, which demands more emphasis on the planning and control of power system. The focus in the electric utility business is gradually shifting from supply of electrical demand to delivering a competitive Kilowatt–Hour. In fact the Electric Industry not only in Saudi Arabia but all over the Gulf countries is being pushed to Market Economy. New Laws and Policies are being made in the electricity sector, which is leading towards competition and consumer choice. All these changes calls for more efficient control of electric power system to cope with the rising demand of quality and economy.

2. Design Philosophy

2.1 Design of Power System

The primary objective of designing a power system is to maintain a very high level of continuity of service, and when intolerable conditions occur, to minimize the outage time. The purpose of designing and control system for a network is to operate high and medium voltage switchgear economically and reliably with the aid of data processing and information technology. The principle aim under normal conditions is to minimize overheads and capital costs by optimizing utilization of the equipment, and under fault conditions to secure the supply of power at all points of the network and restore the situation to normal with interruption times kept to a minimum.

In order to achieve this, the status of the network as regards topology, voltage, and load must be known at all times, abnormal values must be instantly detected and signaled, and countermeasures taken. As power supply systems become even more complex, this is done at control centers which are fed by way of tele–control links which may be Pilot Cables, Power Line Carrier, Fiber Optic Links or Radio Signals with all the information from the equipment necessary for appraising the network’s status and controlling it.

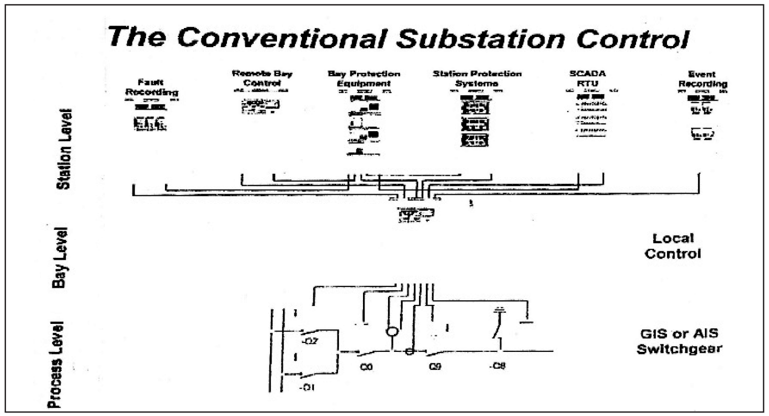
It is important to recognize that the “time window” of decision in case of faults on power system is very narrow and when faults have occurred a recheck for verification or a decision making procedure that

involves additional time is not desirable. It is very important that a correct decision be made by the load dispatcher, as to whether the trouble is intolerable or whether it is tolerable or transient situation that the system can absorb, both cases demands quick action. The primary sudden interruption can be reduced by different operational measures and by installing suitable control and protection equipment, whereas back-up protection, automatic re-closing and frequency controlled load shedding can prevent subsequent cascading system failures.

2.2 Design of Substation Control

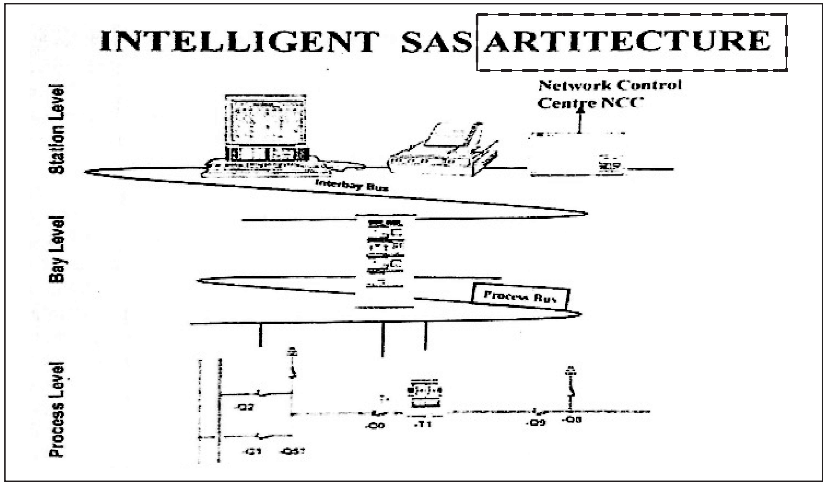
The Substation are the nodes of the power system. For the effective protection, supervision and control of these substations, it is essential to have fast response time at the process level, high overall system reliability and a dependable acquisition and processing of the primary system data in the harsh environment close to the switchyard. System faults usually, but not always, provide significant changes in the system quantities, which can be used to distinguish between tolerable and intolerable system conditions.

The purpose of a control device in substations is to change a defined actual condition into a specified condition. The operating sequences of controlling, interlocking, and signaling can be performed either by simple contact type electro-mechanical and electromagnetic devices such as discrepancy switches, auxiliary contacts and auxiliary relays or by contact–less electronic components, operations and programmed switching. Both methods allow single switching sequences up to fully automated switching routines. (Fig. No.1 below)



3. New Trends in Design of Protection and Control System

Under the changing business environment electric utilities are looking for optimum management of the power system network at all levels. This requires that all equipment for protection, control, monitoring, metering, communication which is termed as secondary equipment be linked together with serial communication buses to communicate with each other. This system, which performs all these functions is called Substation Automation. (Fig. No.2 below)



This increasing demands for more information and data for quick and correct decision making in cases of faults are possible by using advanced technology, like numerical devices in the secondary process and sensor technology in the primary process. The correct interpretation and management of data from these process controls opens up new possibilities in power system operation and control. The Substation Automation System provides all functions required for the safe and reliable operations.

Because of its high immunity to Electromagnetic Interference (EMI) it is well suited both for indoor and outdoor installations. The bay units are mounted in separate cubicles close to the process or directly into the switchgear panel. The use of fiber optic links for serial communication guarantees noise free communication resulting in high dependability.

The main objective in choosing a

Substation Automation System, are reliability and economy. The integration of control, protection and monitoring in one common system (Horizontal integration) means remarkable advantages which are summarized as under.

i. Man machine interface

ii. Adoptive relaying based in the synergy of control and protection

iii. Use of similar or identical hardware

iv. Multiple use of measurements and status information

v. Tailored supervision and control functions according to the need

vi. Serial communication saves cabling volumes.

vii. Self-supervision of the system avoids failures

viii. The station level Ethernet (TCP / LAN) supports the integration of any equipment.

3 Sub–Station Automation System:

3.1 Computerized Control System:

With the growing trend towards centralized control of power system and the accompanying large volume of incoming information, operating staff were subjected to an ever heavier work and load until eventually they were unable to cope even under normal conditions owing to the limits on their ability to assimilate data within a given time span. In the interest of clarity and security, the information therefore has to be conditioned and condensed. The operators must be relieved of routine duties so as to be free for important tasks of decision making.

Following are many of the demands that can be met only by using programmable process computer.

(a) Display and Supervision

i. Alphanumeric display

ii. Graphic display

iii. Additional information

iv. Color display

v. Mimic panel

(b) Controls

i. Command input

ii. Step commands

c) Load Management

i. Measurement

ii. Load management

iii. Calculations

iv. Automatic commands

(d) Load Shedding

i. Determination of load to be

disconnected.

ii. High speed detection of fault criteria and measurements.

iii. Shedding of load

(e) Documentation, Event Recording and Storage of Data

i. Print outs

ii. Text summaries

iii. Production of reports

iv. Analysis and forecasting

v. Selection of storage media

vi. Memory – Storage of Data

(f) Data Acquisition and Processing

i. Tele-control Functions

ii. Indications of faults

iii. Collection of faults signals

iv. Processing of measurement and meter readings

v. Commands

vi. Verification of interlocks

vii. Execution of commands

viii. Simplified reports

(g) Other tasks for process computer

i. Networks Operations.

ii. Networks Planning

iii. Load Dispatching

iv. Maintenance Planning

v. Statistics

4.2 Why Sub – Station Automation System for New S/S # 8?

For the SCADA Control and Operation System of a new 132/13.8 kv Sub-station in Tabouk Region of Saudi Electricity Company, with a capacity of (4 x 20/ 26.6/33.4MVA) comprising of all the protection, control, measuring as well as the connection to the SCADA Control Center, Tabouk, a numerical integrated solution has been chosen. The decision was made after a very detailed study and evaluation of different types and makes of Protection and Control Systems offered by the bidders in their offers.

The S/S # 8 is designed to supply power to sensitive areas including defense area, as such a very efficient, fast and reliable control system was required. The basic decision was made keeping in view the following two important aspects, which are summarized as under.

(a) Technical Aspects

i. Data Acquisition

ii. Fast Operation

iii. Reliability

iv. Recording

v. Fast clearance of faults

vi. Sequential switching

vii. Coordinated control

viii. Self-diagnostic system

ix. Flexibility & Expansion

(b) Economical Aspects Cost reduction in

i. Operation

ii. Maintenance

iii. Installation

iv. Addition and Expansion

In existing substations with conventional SCADA based on RTU technology, a lot of hardware (cubicles with a number of relays, contacts, alarms, indications, lamps and wirings) are used for different functions which require more space, more trenches and much cable and wirings. All these cubicles and cabling will be reduced by installing one programmable multifunctional unit. The flexibility of the numerical technology enables cost savings and technically effective solutions, with partial or total retrofit in the existing system opens the possibility of realizing a fully numerical protection and control system. This Substation # 8 is designed to supply power to important defense oriented projects in Tabouk, therefore it was decided to get maximum energy flow coupled with the highest possible availability, highly intelligent protection system, minimum losses, more data acquisition and correct interpretation of the information, and the local process automation.

DETAILS OF BIDS

KEEPING ANONYMITY OF BIDS AND VENDORS

Bidders	Existing System	SSA Type 'X'	SSA Type 'Y'	New RTU
A	√	√		
B	√		√	
C	√	√		√
D		√		
E	√			

For selection of the most cost effective solution in the absence of any international standard like IEC, CIGRE or IUTU, a committee was formed comprising of engineers form SCADA, Networks, and System Study Department to study and submit the recommendations. This committee carried out an extensive study of all the bids and after technical discussions suggested to get additional guarantees, additional warrantees, and special training options for the O & M staff from the manufacturer through the Main Contractor.

5. Limitations and Guarantees:

It is a fact that the new technology Substation Automation System eliminates the conventional wiring between the bay units and the control room, and between the control room and the network control center but there are certain limitation specially with the Communication protocols, which are numerated as under;

5.1 Limitations

a) Monopoly of Vender

b) Problem of Protocol Converter

c) Change in the Protocol

d) New versions

By introduction of the process bus, the wiring between the primary process and the bay equipment could also be eliminated. This process bus contains the binary and analogue information. But to reach to this step, a lot of standardization will be necessary, because the utilities require the "openness" of the system. It should be possible to install equipment from other manufacturers in production and control system and the system should give access to a third party. Consequently a lot of work is going on in international organizations like IEEE, CIGRE, IEC and ITUT, but still the standards and specifications have not been finalized. It may take another year or two to finalize the International Standards and Specifications.

Nowadays there are a large number of communication protocols in the market, and each manufacturer is using its own specific protocol. As a result devices from different manufacturer and even devices from different versions of the same manufacturer cannot communicate with each other. These require protocol converters at different levels, which complicates the circuits and increases the cost.

These are the major problems, in the application of Substation Automation System, and require careful study and additional guarantees from the manufacturers and suppliers to avoid future problems, which may arise due to protocol converter or due to the change in the protocol by the manufacturer in his own devices.

5.2 Guarantees

Following additional guarantees were asked from the manufacturers/ suppliers of the two new SSA System.

i. The manufacturer should certify and verify that the protocol converter can provide 100% communication between the new and existing system.

ii. The manufacturer / supplier

will be responsible for the interfacing between different types and make of GIS, relays and other equipment installed in the new S/S # 8 and the existing system.

iii. Five (5) years extended warrantee should be given for the new SA System.

iv. Provision of free training to (8) Nos. Engineers/ Technicians on new SA System.

v. New SA System shall cover all the required SCADA, Security, Fire Alarm, Tele–communication and other auxiliary services.

Bidder "A" and Supplier "X" agreed to the above conditions and hence the new System was chosen for S/S # 8.

This paper gives an account of the advantages, disadvantages and some limitations of the Substation Automation System which were noted and discussed in details with the manufacturers and venders during the technical study carried out during this process of selecting the Substation Automation System for new substation # 8 in Tabouk. All this is being submitted for the general guidance of utility engineers and to discuss further the technicalities and philosophies of this new technology (S.A) with academia and industrial engineers for further improvement in the S.A. system, which can be utilized for the betterment of the Electrical Power System in the Gulf Countries.

6. Conclusion

In existing substations with conventional SCADA based on RTU technology, a lot of hardware (cubicles with a lot of relays, contacts, alarms, indication lamps and wirings) are used for different functions which require more space, more trenches and much cable and wirings. All these cubicles and cabling will be reduced by installing one programmable multifunctional unit. The flexibility of the numerical technology enables cost saving and technically effective solutions, with partial or total retrofit in the existing system opens the possibility of realizing a fully numerical protection and control.

Under the changing business environment electric utilities are looking for optimum management of the power system network at all levels. This requires that all equipment for protection, controls, monitoring, metering, communication which is termed as secondary equipment, be linked together with serial communications buses to communicate with each other. This system, which performs all these functions is called Substation

Automation.

Ideally, the controls and equipment should go hand-in-hand, but sadly enough, there are a large number of communication protocols in the market, and each manufacturer is using its own specific protocol. As a result, devices from different manufacturers and even devices from different versions of the same manufacturer cannot communicate with each other. These require protocol converters at different levels, which complicates the circuits and increases the cost. This match making, or finding the right controls for the right equipment often causes the utilities much concern and worries. This requires careful study and additional guarantees from the manufacturer and supplier to avoid future problems which may arise due to protocol converter or due the change in the protocol by the manufacturer in his own devices.

Additional guarantees were taken from the manufacturer and supplier of this Automation System for this S/S # 8 project besides specialized training at site and close association of operating and maintenance engineers during the design stage to familiarize with the new equipment and system.

A simulator is also being arranged by the manufacturer of this S.A System for the actual verification of the functions and efficacy of the protocol converter being designed for interfacing of this new system with the existing SCADA system.

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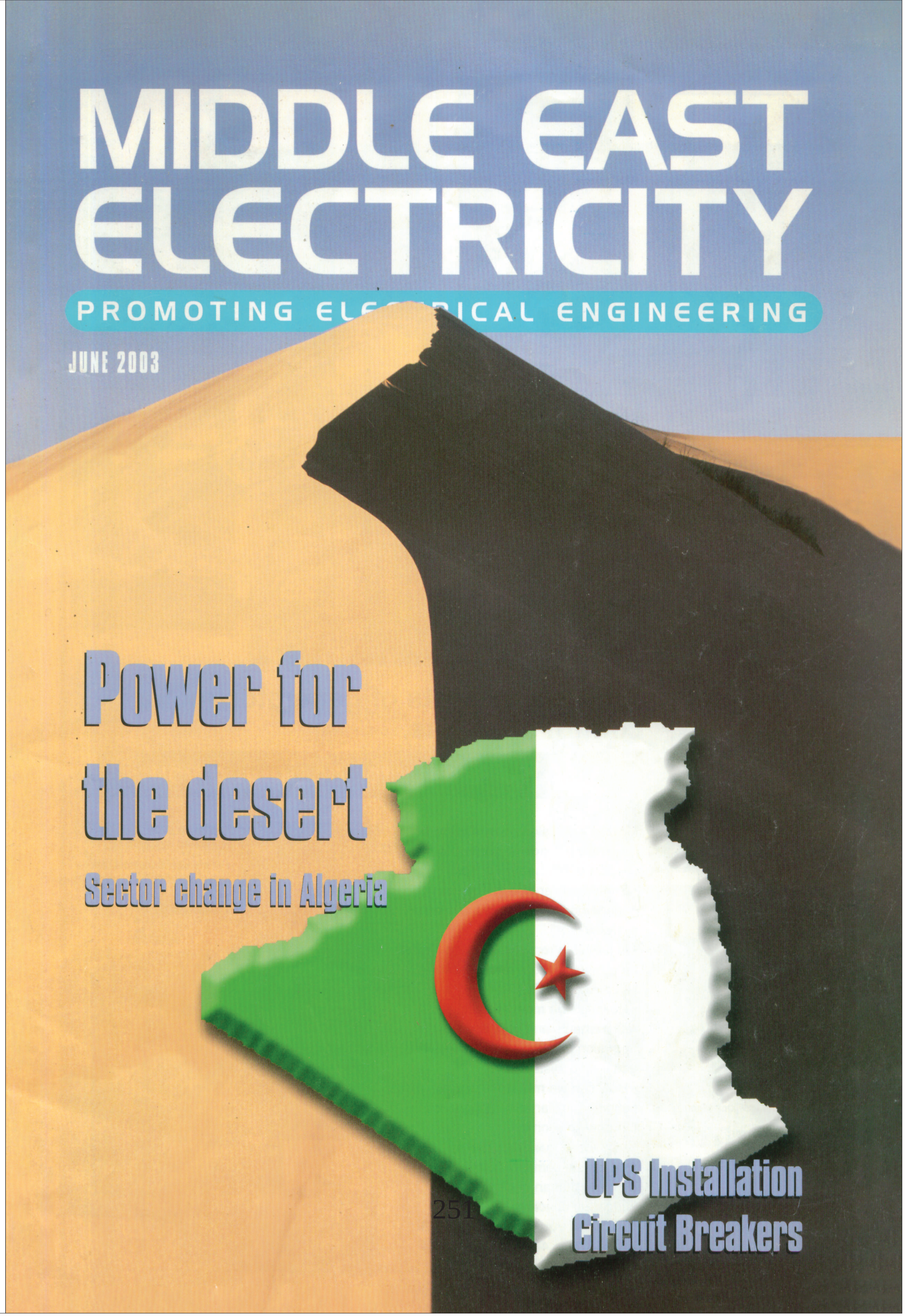

Supply of electricity to every area is my mission – Syed Sarfaraz Ali

Monitor and Supply the Remotest Areas People living in the remote areas of the Gulf states will not be deprived of an electricity supply

Engr. Syed Sarfaraz Ali

Under a broad-brush approach rural electrification schemes generally cover small habitats (areas) away from the main cities and lacking other civic amenities such as water, communications, education and health facilities.

Whatever the size of the population, the ratio of labour to capital in production is high and income is low compared to the cities.

Although rural electrification schemes, water supply or rural health schemes, are not necessarily meant to be viable commercially either to the government or to the electricity utilities, they must always be affordable and reliable.

New Order

Electricity in the Gulf Countries has always been a government monopoly and is still subsidised. However due to the increasing power demand and desire to enter into the World Trade Organisation (WTO), the regional governments are deregulating the electric sector and turning to private investment sources. It has been realised that to cope with the increasing demand for electricity, the private sector has to play an important role in the future. To attract private investment a series of legislative and administrative reforms have been taken by regional governments.

The current demand for electricity in the Gulf countries is 350,000GWh and this demand is expected to double by the end of the decade. The average growth rate of electricity consumption in the Gulf States stands at an impressive 10 per cent in UAE, seven per cent in Saudi Arab and Kuwait, and ranges between four-six per cent in Qatar, Oman and Bahrain. Such big demands call for big investments for both power stations and transmission and distribution networks.

It is forecast that about US$200billion in investment would he required to cope with this rising demand. To attract this huge sum of money the regional governments have decided to open the electricity supply sector to private investors.

The Gulf countries are now deregulating the sector and introducing, in one form or another, privatisation and liberalisation.

For example:

- Oman had a power project on a Build Operate and Transfer (BOT) basis as long ago as 1994
- The UAE has entered into joint ventures that have attracted about $4billion
- Saudi Arab has its first IPP under construction by a local investor with technical support from CMS Energy

Alternate energy

The fuel in the Gulf is oil. But now some states seek to convert their future generation capacity to gas-fired plant and are even considering renewable energy sources such as solar, wind, geo thermal and tidal power.

Although renewable energy has not been given proper attention in the Gulf, high growth in electricity demand, environmental concerns and economic factors have led the governments to investigate technologies such as wind turbines and solar panels. Renewable generation also has a localised dimension with the emphasis on meeting the needs of local communities and creating employment for local people.

Some current examples are:

- The UAE is developing a renewable energy project in collaboration with a group of German firms
- Solar powered signals, and phone booths on highways are a common feature in some Gulf countries
- A windfarm is being installed in Fujariah and a new department is being set up in the UAE to investigate the potential of solar power

Future expansion

Demand for energy in the Gulf has not reached its full potential. Half the consumption of electricity is by residential users rather than the industrial sector. Per capita consumption of electricity differs widely, Kuwait has the highest followed by the UAE and Saudi Arab.

Deregulation

The Gulf States have major capacity upgrades in their plans. About $80bn has been invested in the last decade, and the projected costs of the expansion programme in the electricity supply sector is about $100bn for the next decade.

Such a big demand for energy requires a corresponding rise in the present generation capacity and extension to the transmission and distribution network to supply not only the cities, but the remote area.

Most infrastructure upgrade projects in the Gulf have been awarded to local firms and even some projects are coming up on BOT and BOO (Build Own and Operate) basis. Licenses have also been issued for IPPs in the region. A cross-border network connecting all the six member states is under active study.

There are more than 15 economically available options for electrifying the remote communities.

In view of the socio-economic conditions of the Gulf and the earnest desire of the regional governments to provide all the rural areas with electricity, the following seven options are suggested. Subsequent study and discussion may produce more suitable solutions that accommodate local conditions.

To connect a village to the National Grid is general practice. A distribution line at 20kV or 13.8kV is usually built from the nearest substation, or an existing feeder is extended up to the village.

This involves the cost of the extension in the substation, cost of the distribution feeder, which can sometimes be more than 20 kilometres, cost of distribution transformer and its protection, the costs of low voltage lines and services up to the consumer premises.

Advantages:

(i) Reliability

(ii) Safe, quite and public acceptance

(iii) Easy expansion in case of an increase in load

(iv) Ease of maintenance

(v) Slight over loading possible

Disadvantages:

(i) High installation costs

(ii) Additional load on Grid

(iii) Inaccessible to some areas

(iv) Further extension not possible

> ”Although rural electrification schemes, water supply or rural health schemes, are not necessarily meant to be viable commercially either to the government or to the electricity utilities, they must always be affordable and reliable”.

Isolated power plant

One medium size or two small size diesel generating sets with load control and a minimum protection scheme may be installed in a central location far from the National Grid network. This could provide electric power for up to five or six remote villages accessible to this isolated power station.

Advantages:

(i) Low installation cost

(ii) Suitable for reactive loads

(iii) Climatic conditions no problem

(iv) Availability of local resources

(v) Use of local talents

Disadvantages:

(i) Lack of proper supervision results in disturbed supply

(ii) Generator will usually run on low power factor

(iii) Poor efficiency

(iv) Complicated logistic

(v) High cost transporting fuel

(vi) Environmental problem

(vii) Limited flexibility

Local diesel generator

Small diesel generators of say 500kW each supplying power to a group of houses and general community services such as water supply, mosque and basic health unit can be a possibility.

Advantages:

(i) Low capital cost

(ii) Simple technology

(iii) Effects of faults limited to village

(iv) No expenditure on complicated protection and distribution schemes

(v) Local people involved in scheme

Disadvantages:

(i) High operating cost

(ii) Noise and environmental effects

(iii) Very low power factor

(iv) Low efficiency

(v) Short life of the plant

(vi) Frequent maintenance

(vii) Complicated logistics

(viii) No flexibility

Big solar energy plant

The Gulf countries enjoy sunshine almost the whole year round, as such solar plant of 120/220V with suitable arrangements of microprocessor based controllers can be an ideal solution for rural electrification.

Environmental concerns and a shortage of electricity in some areas are driving regional governments to investigate solar technology to

provide power to remote areas. Solar powered signals and phone booths are commonplace in some Gulf countries. At the moment, solar energy is being tried on an experimental basis but it has a great potential in view of the availability year round sunshine, plus the reduction in the cost of photovoltaic technology.

Advantages:

(i) Low maintenance

(ii) Fully automatic

(iii) Simple control

(iv) No long distribution networks

(v) Quiet, solid state and environmentally friendly

(vi) No fuel logistics

(vii) Low rate of failure

(viii) Modular easily expandable

Disadvantages:

(i) High capital costs

(ii) Limited over load capacity

(iii) Dependence on solar radiation

(iv) Large land area required

(v) Expansion requires more batteries and PV panels.

Solar systems

Small solar systems, sufficient to supply the average house with lighting and water heating can be installed on the roof top. 48 volts DC with batteries, battery charger and control system is ideal for such domestic requirements.

Advantages:

(i) Low maintenance

(ii) Fully automatic

(iii) Simple control

(iv) No distribution networks

(v) Quiet, solid state and environmentally friendly

(vi) No fuel logistics

(vii) Rate of failure low

(viii) Modular and easily expandable

Disadvantages:

(i) Full access to sun not available at some homes, requiring solar panels to be installed some distance away from house, which creates unnecessary problems

(ii) Due to weight of solar panels and high wind loading the roof has to designed accordingly

(iii) Very high capital cost

(iv) No over loading possible

(v) Dependant on climatic conditions

(vi) Each house needs separate plant

(vii) Require high technical skill to maintain and operate

(viii) The power generated and not used or stored in battery bank is lost

Wind energy

The windpower generators used in the region have horizontal shaft, high speed propellers.

The baseline model includes a battery, battery charger and an inverter. The wind generators can be installed in the area where the wind blows at high or moderate velocity.

There should be an average wind speed of 5m/s per year for an efficient wind turbine. In most of the coastal areas of the Gulf wind blows round the year with a sufficient speed to run these turbines.

Turbines may be installed for pumping water for irrigation and community services in individual farms or medium size villages. Groups of wind turbines (windfarms) can be erected.

Advantages:

(i) If wind speed is constant such plant will provide low cost energy

(ii) Produces a large electricity supply if installed as windfarms

(iii) Non- polluting

(iv) No thermal or chemical process involved

(v) Minimum operating and maintenance costs

(vi) No fuel cost or logistic

(vii) Good reliability

(viii) Possibility of developing the wind turbines locally

Disadvantages:

(i) Depends on wind velocity

(ii) Performance is unpredictable

(iii) Land requirement is very high

(iv) Noise level high.

Hybrid systems

A modular solar-diesel hybrid power plant with optional wind generator can be a good solution for all types of terrain and loading conditions.

Such a system may include a diesel generator with wind and solar panels with suitable battery and inverter, battery charger and control system.

The station battery is charged by the combined output of wind turbine and solar panel and normally feeds the load. The diesel generator takes over, supplies the load and recharges the batteries when these are not available.

Advantages:

(i) Hybrid system offers the most reliable power system for the remote areas

(ii) Lowest life cycle cost of all the renewable energy sources

(iii) Independent of site conditions

(iv) Independent of climate

(v) Highly energy efficiency

(vi) Low maintenance

(vii) Low technology easy to operate and maintain

(viii) Simple protection system

(ix) Reserve capacity and capability

(x) Overloading and overrated energy output possible

(xi) Flexible

(xii) Offers the best upgrade path for system improvements

Disadvantages:

(i) Capital cost higher than diesel system

(ii) Higher level of design

(iii) Required detailed survey and technical study before design and installation

Demand

The expected increase in demand for electricity requires a corresponding rise in generation capacity and extensions in the transmission and distribution network. It is not only the cities but also the remote rural areas that will be considered.

Up until now, attempts have not been made to justify financially or evaluate technically rural electrification schemes. The priority has been the government drive to connect up all the remote areas.

The deregulation of electric utilities and inviting private and foreign investment in this field has meant re-thinking the problem in terms of economics.

Rural electrification schemes require a great deal of capital investment per consumer. The smallness of revenue returns reduces the possibilities of economic viability of rural electricity schemes.

These considerations plus the difficulty in maintenance of the system, meter reading and collection of revenue requires a detailed study by the emerging electric utilities working under a deregulated economy.

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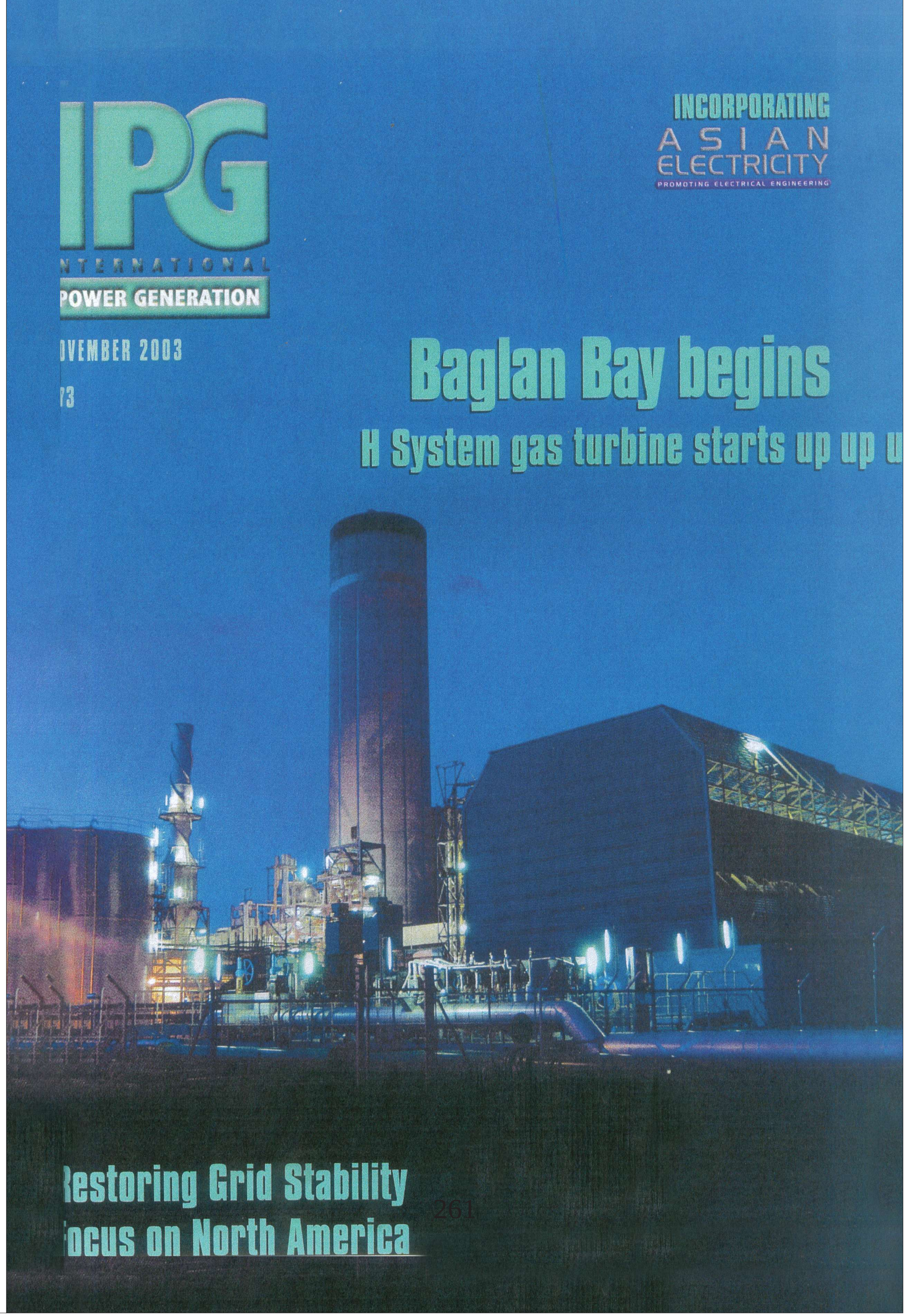
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Participants are fully involved during the session

Grid Management

A reliable management system can reduce the impact of disruptions, surges and blackouts.

Engr. Syed Sarfaraz Ali

Professional engineers have to think of ways to improve performance and to create programmes to tackle incidence when the power supply is disrupted either due to technical faults, human error or natural disasters.

For the purpose of this article a critical incident is defined as one of sufficient size or magnitude so as to disrupt supply or halt operation question of the generator, which may ultimately lead to total blackout.

The Philosophy

The aim of any maintenance wing of a department such as generation or transmission and distribution should be to provide an efficient service in order to achieve as high availability as possible at the minimum expenditure. The definition as stated in BS3811:1964 is "Work undertaken in order to keep or restore every facility, i.e. every part of a site, building and contents, to an acceptable standard".

The maintenance wing varies slightly from one department to another, but in all instances it is directed at ensuring that the plant/ facility is available for supplying power for the maximum time possible considering the efficiency, safety and maintenance costs.

There are two main aspects of safety in electric utilities which should be achieved to avoid a big loss in terms of human life or costly equipment.

- Safe design
- Training of personnel

Both aspects are the responsibility of management but, as individual conduct is the least predictable aspect, management should provide additional safeguards in the form of safety rules, codes of practice, and operation manuals which must be complied with under strict supervision.

TYPES OF MAINTENANCE

Maintenance can be divided into three types:

- Preventive maintenance – to

ensure that the plant / installation is in safe and reliable condition to meet the load demand. This can be usually be done without shut down or after arranging alternate arrangement for the power supply. This is also called Scheduled Maintenance.

- Corrective maintenance – to replace some parts or spares during the running of the system, which may cause some major breakdown if not attended to immediately. It is arranged in emergency after shutting down some portion of the system or some plant / equipment with intimation to the consumers for the duration of the outages. This is to avoid a major break down or big loss to equipment.

- Break down maintenance – when any machine equipment or auxiliary hardware is broken due to a problem caused in normal operations, accident or human error a situation arises which is called a fault in the system. The power supply is disturbed for a long period of time until the fault is located and attended and the system is brought back to normality.

This situation may also arise if the maintenance crew does not follow standard operational practices and wait till the break down occurred, or they become careless in following the safety rules and operating procedures.

TROUBLE SHOOTING

To achieve high levels of availability for the power plant, substations, transmission and distribution networks and other auxiliary equipment, a proper maintenance schedule should be comprehensively prepared and stringently followed.

For a major breakdown or normal calamity, a programme for attending the breakdown should also be kept ready at an easily accessible location. The duties of the staff who will attend to such incidents should be clearly assigned and proper communication be maintained to reduce the outage time.

South African electricity company Eskom carried out a study during July 1995 to June 1996, which provided a breakdown of interruptions (as shown in fig. 1).

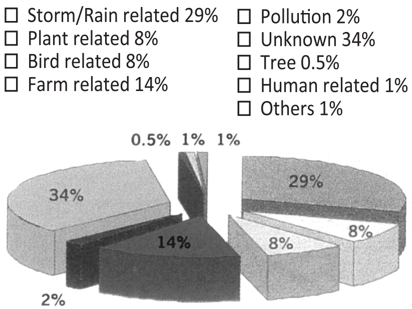


Figure 1: Results of an Eskom study into the causes of interruptions

Similarly, a study was carried out in the US for the loss due to outages in production at the consumer's end. The cost of such interruption was found to be substantial. One glass plant for instance estimates that a five cycle interruption, and outage of less than a tenth of a second, can cost about US$200,000. And a major computer centre reports that a two seconds outage can amounts to $600,000.

CRISIS MANAGEMENT

When an incident occurs in the system (wherever it occurs or whatever the reason) it should be dealt with and controlled properly by the management.

So how an incident should be managed to reduce the overall impact technically as well as financially?

The basic objective of crisis management is to restore the system back to normal operation and to reduce the impact as much as possible.

There are five major objectives of crisis management:

- Locate and investigate the fault
- Restore normal operation
- Hold detailed enquiry
- Restore the confidence
- Reduce the political impact

Many of these objectives overlap. The work necessary to satisfy them will also overlap. Much of the work effort will proceed in parallel tracks i.e. work will be done in different fields by different departments simultaneously. It is important to know how to deal with them jointly as a team and the integrated effort required by all, from top management to the lowest rank under separate heading.

Preliminary investigation and location of fault involves three basic questions:

* What has happened?
* Where has it happened?
* How has it happened?

Protection systems, which started with fuses then moved to electromagnetic relays then to digital relays, have now entered into the age of automation with combined protection control and monitoring.

Protective relaying has become a vital part of any electric power system quite unnecessary during normal operation, but very important during trouble faults, abnormal disturbances.

Once the failure mode is determined then matters relating to prevention, mistakes, responsibility, and re–occurrence can be addressed. Another tasks during the preliminary investigation is to do damage assessment. This might be done better by the management then the investigation team.

If a fatality or near fatality occurred critical incident debriefing may be required for the staff and public.

For minor faults the system can be brought back to normal operation by resetting some relays and by a physical inspection and removing/ replacing the damaged part or hardware after arranging proper shut down.

But if it involves substantial equipment, a system start up may be required, much as if the plant or equipment was new. This can include resting of equipment, inspection of procedure and facilities, and interviews with operating personnel.

An in-depth start up will take a significant amount of time and a lot of work. The testing should also be well documented, as it will help in further litigation if required, as a result of final investigation report.

The best practice, which is followed by many electric utilities around the world is to prioritize the activities:

- Safety of operator
- Safety of equipment
- Continuity of supply

Sometimes it is in the utility's best interest to mandate a procedural change even if such a change would not have prevented the accident. The intent here is to try to establish a proactive, as opposed to reactive, reputation. This may be a helpful strategy with employee, the government, and the public.

Try to settle early with injured parties and provide medical facilities before starting detailed enquiries. The activities may be taken on at the same time. Choosing how and when to provide information is also a critical issue. For this reason, it is imperative that a public relation expert be used.

Detailed enquiry

A team must be created to conduct the investigation. The first attempt should be to determine if the failure was equipment or procedure related. Some equipment or evidence may have to be preserved. This may include records, interviews, statements, documentations, photos and medical reports for future litigations.

This will not only help in formulating the future policies regarding the mode of operation in such emergencies but also to

suggest remedial measures to avoid or at least to reduce the time taken in the restoration of supply.

In the case of a fatality it may not be in the interest of the utility to suggest that this operator / person did something wrong, especially if he was killed on the company premises.

A fatality affects everyone and it is imperative that the company's remorse is communicated to the public.

A system start up goes a long way towards restoring confidence in both the staff and the public. This is particularly true if it is made clear that a significant amount of time and money was committed to this effort.

Reducing the political impact

Every government and regulatory agency at all levels will be sensitive to long outages of power. Police departments, health inspector, labour unions, fire department and the press (local and national) are among those affected.

The preliminary investigation handling of the situation, the early restoration of supply, and the detailed enquiry report by the company will have a large bearing on how the various regulation agencies feel about the incident/ accident and the management of the utility.

It is suggested a critical incident manager or a team for the crisis management that consists of experts on technical, legal, public relations, accounting and cost control and a corporate representative may be made to attend to all such incidents. While the occurrence of faults may be beyond the control of the company, the management of crisis should be well within the control of the company.

Confusion, uncertainty and turmoil are common in all fatal/non-fatal accidents and major/minor breakdowns. It needs a cool mind and expert analysis and the ability to make quick decisions to handle such a situation.

Procedures must be clearly written the job description and responsibilities defined, communication to be constant and of high quality but even with all these in place uncertainty can still occur. The situation needs a responsible supervisor to take control of the situation and to start restoration operations after prioritizing the activities.

The following are the four major problems:

- Confusion – the common denominator of all site of faults whether major or minor, fatal or non-fatal. The situation can be very uncertain, especially in the early few hours. Time is required to gain control of the situation. An experienced, calm and resourceful person in required to manage the situation.

- Conflict – conflict between operating and maintenance staff is a result of different priorities of each department. The load dispatcher or distribution department may have trouble understanding that the normal operations cannot be resumed until the situation is under control and some decisions have to be made as regard to the extent of damage and the risk involved in early restoration of supply.

- Time – one of my senior engineers in the early days used to say that, "When you estimate the time that is will take to restore the supply double it and you will be closer to the actual time" and it still holds good. Even with hard work, things go slower than expected. Everybody is under stress. Sometimes the public will become critical, an event which can increase the stress.

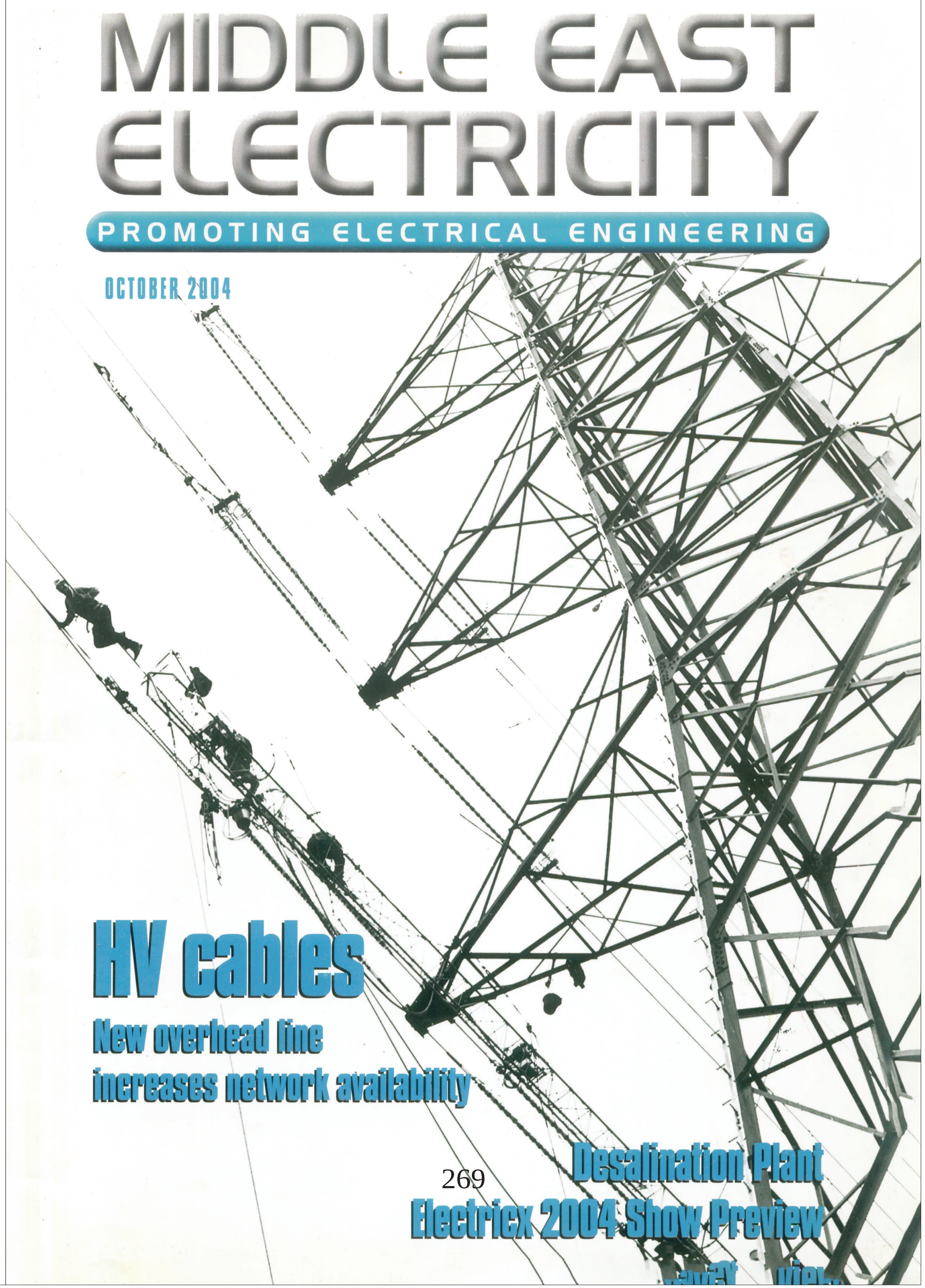
A word of encouragement and appreciation from management reduce the tension and can improve the working of the maintenance people on the job.

- Other impacts – expect the repercussions of the moral, physical, technical and financial impacts of the incidents to take a long time to go away.

If you have a good crisis team in place early on it becomes far easier to tackle all these negative impacts one by one, and or at least reduce the time taken to overcome these problems. The occurrence of a crisis is a matter of bad luck for any utility.

Getting some idea of the strategies, tactics and building a crisis team to manage the critical situation, cost control issues and public relation matters before the incident occurs, can take a lot of the confusion out the management of an incident.

> "Sometimes it is in the utility's best interest to mandate a procedural change even if it would not have prevented the accident. The intent is to establish a pro-active not reactive reputation".



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From Engineer to smart manager

Organizational changes in the electric utilities in the Gulf counties mean that top management must help engineers learn to take on new responsibilities says Engr Syed Sarfaraz Ali, project engineer at Al – Jazirah Engineers and Consultants in Saudi Arab

As the electric prices in the Gulf countries are fixed to reflect government social policies, the new management, are looking towards re-engineering of business processes.

International consultants are hired to assist in the restructuring of the monopoly players, legislative reforms and training of engineers to take on the new responsibilities as managers under the changing business environment.

The way to achieve change is to get engineers to change their behavior and the best way to do that is to ensure they are involved. Change in the corporate policies cuts across functional boundaries and traditional hierarchies, which is one reason why the change is so hard to achieve.

Traditional structures

Engineers working in Gulf countries are typically tied to the vertical and traditional structures of the last three decades under the old companies system. Rank and position often become more important than lateral, cross-functional quality processes.

All engineers need to see the relevance of their work and understand how it influences the utility business. The new management need to show these hard working engineers the new strategies to take on the responsibilities as smart managers.

In what context is this change in the electricity industry taking place in our region?

Electricity in the Gulf Countries has been under government monopoly and is still very highly subsidized. However due to the increasing power demand which registered an exceptional 12 percent annual rise in the last decade, regional governments are turning to private investment sources. It has been realised that to cope with the increasing demand of electricity, private sector has to play an important role in the future.

Current production capacity in the Arab world is estimated at 500TWh. Projected to rise annually by 5 percent to 760TWh in 2010, generation capacity in the Middle

East is growing at more than double the world average. Over the coming decades, it is forecasted that some US$200 billion in investment would be required to satisfy demand for electricity in the region.

To attract private investment in the electricity sector a series of legislative and administrative reforms have been taken by regional governments.

In 1994, Oman built a 90MW power plant in Al–Manah, which is the first BOT power project in the Middle East. The Abu Dhabi Water and Electricity Authority entered into joint ventures with French – Belgium consortium to attract nearly $4 billion so far.

In 1999, Saudi Arab merged several private electricity companies to form Saudi Electricity Company as a step towards privatization. At present the foreign participation in the power sector is limited due to the geo-political situation, but significant investment opportunities are open in Saudi Arabia's fast expanding private power market, particularly in power generation projects.

US firm CMS Energy is co-operating with a local company Al–Zamil on a 240MW power plant (the first IPP in the kingdom) in the Jubail Industrial zone. France's Alstom Power is working on an upgrading of Shuaiba Plant, which will add 2x350MW units in the second phase. The new guidelines also approve the co-generation and desalination plant.

Changing business

Executive development efforts, in the old companies were focused on the engineers as an individual.

The intention was for a phased programme through which successful engineers advance. Promotion were usually based on age and experience.

Today, due to changes in the rules and policies under new business environment these policies need revision as well. An effective executive development programme for engineers requires a shift in thinking – a movement away from mid–career development for a few high potential engineers towards on–going talent planning and management for a broad range of engineers at all levels of the utility.

This new skill development programme for engineers call for a blend of coordinated work experience and various forms of education and training in an effort to build management depth and competitiveness across all engineers. It should have full financial and administrative support from the top management and should be adopted as strategic objectives.

If the new electric utilities under de-regulation want to remain viable entities in the open market then they have to face these challenges and

prepare there hardworking engineers to take on the responsibilities of high potential managers, which I call a smart manager.

This career development plan if is adopted for engineers at all levels, will play a key role as a communication vehicle to inform engineers about the strategic directions, adopted by the new company.

The new utilities must appraise and compare performance and potential to identify hard working engineers and provide them with bottom line responsibilities, experiences, in dealing with other international companies, and opportunities for increasing scope and responsibility that lead to higher managerial position.

Issue and challenges

Following are the right major challenges that executive faces in the changing business environment in the electricity sector:

- Open market – after enjoying a long spell of regulated economy the electric utilities are being thrust to open market economy. Executives must create new ways of thinking about the quantity and quality of supply of electricity while keeping the price as low as possible.

- Customers focus – gone are the days when the consumers were contact with the quality of service offered by the electric utilities, now we are facing customers who are educated and agitated. This is a new concept in utility business – a shift to a customer focus.

- Growth in profit – traditionally utilities have managed profits by reducing the cost of people, processes, and other business expenses. But cutting and controlling costs is only half of the equation. Electric utilities must push themselves to find new ways to increase revenue and reduce costs.

"All engineers need to see the relevance of their work and understand how it influences the utility business"

This two prong policy elicits two questions:

(i) How can a commitment can be created for rapid growth while controlling cost?

(ii) How can an organizational structure be created that provides autonomy and discipline among engineers?

- New organization – organizational capabilities are the building blocks of competitiveness in open market economy. There can be grouped into two categories: hard and soft.

Hard includes technology development, financial acumen and flexibility, whereas soft includes competition in the market place and ability to retain and attract critically needed human resources.

- Process v/s purpose – the purpose of this change in business rules is to attract foreign investment and to run the electricity utilities as business entities so do not confuse process with purpose. New management should help employees to learn to change faster and comfortably. First, an organizational change model must be disseminated and applied throughout the new company and then shown by personal examples. Many executives can give lecturers on the necessity and importance of change but the same executive fail to change themselves. This presents a problem because employees pay much more attention to what they see than to what they hear.

New technology

- New technology – physical boundaries have given way as new technology enables virtual teams whose members may be located thousand miles away. This calls for providing the necessary equipment and intensive training of engineers to make information technology as viable and productive part of the new working strategy.

- Local talent - attracting, recruiting and training the local talent in the electric utilities is the most important task in this changing business environment.

The electric utility is moving from product orientation to service orientation and this needs local talent to bring the cultural change in true sense in the business dealing at all levels. To create value and deliver results, the human resource professional must work with line managers / engineers to induct and train the local talents to give a sense of partnership.

Mutual trust is the lubrication that makes it possible for organization to work smoothly and this occur when ideas are both, generated and generalized within the company. We must trust and give responsibilities to local talents and challenge them professionally to be able to work in small teams, to let them feel they have an impact on the decision making and running of the company.

- Evolution not revolution – Gulf countries are transitioning markets in comparison to mature markets of Europe or USA, as such the market models are still evolving towards privatization and competition.

Executives should not try revolutionary measures but try to evolve a system that creates changes in the corporate policies and provide adequate equipment, necessary tools, proper training and promotion

policy to respond to the new challenges.

From engineering to managing

Electric utilities in the changing economic activities demand a change from traditional engineering companies. When I talk about traditional engineer I refer to those hard working engineers who share responsibility through delegation but generally still oversee the work done by their technician and sub-ordinates.

Such practice is no longer possible when we talk earning profits and reducing costs. After merger of several small companies the engineers who survived the rightsizing or adjustment of the new big company have longer lists of responsibilities and duties than ever before. Many have greater spans of control and jurisdiction spread over a wide area geographically and physically kilometers apart.

Engineers do not have the time they once had to look over the shoulders of their subordinates. Delegation is no longer sufficient to allow today’s engineer to work and supervise. They need to truly empower to manage the work.

In order to discharge the duties and new responsibilities successfully the engineers must develop several core competencies like skills, abilities and attitudes to become a smart manager.

Following five core competencies as described below are the minimum requirement for an engineer to become a smart manager.

- Understand new operations – on assuming new responsibilities engineers should try to understand the job description and the skill required not only to do the job himself but how to get it done by the subordinate staff under his control. Without time spent getting to know the skill of the subordinate staff engineers may be reacting on the social skill rather than professional skill. Engineers need and should take some time to understand about the operation or whom to delegate the powers, to become a successful manager.

- Listen actively – this involves listening both to what is said and what is not said. May be even more important, it means listening to the sub-ordinates opinions and concerns with a willingness to change the old system.

- Operate on purpose – engineers should develop a relationship between each work that he and his sub-ordinate do with clear objectives and goals as a separate department and its role as a part of the larger organization. Unless engineers have the understanding of how their work will effect individual department and the company as a whole, they could not make effective and timely decision, which is very important for a manager.

- Growth and opportunities – engineers should send clear message through words and actions that they respect professionalism. This creates a positive feeling in the department that reinforces their willingness to play a more active role in the changed working conditions. They need to know the financial implications of their work and they should also feel the importance of reducing the operation and maintenance costs while working efficiently with dedication to serve the internal and external customers. When engineers will start viewing of problems as opportunities to show their skill and device new economical methods of doing the things they are on road to take on the role of managers.

- Think critically – there are quite a number of engineers who are perfectly happy with the status quo and have little interest in getting more involved. But to become a managers, an engineer should think critically, about how to improve the performance and bring about change in the system to reduce losses and improve working.

Engineers should demonstrate that they care for the improvements in the work and conduct and explore opportunities to improve efficiency and quality with confidence.

In small companies engineers were reluctant to suggest for any change in the system or rules but in the new environment engineers should get a chance to suggest and devise ways to improve the organization.

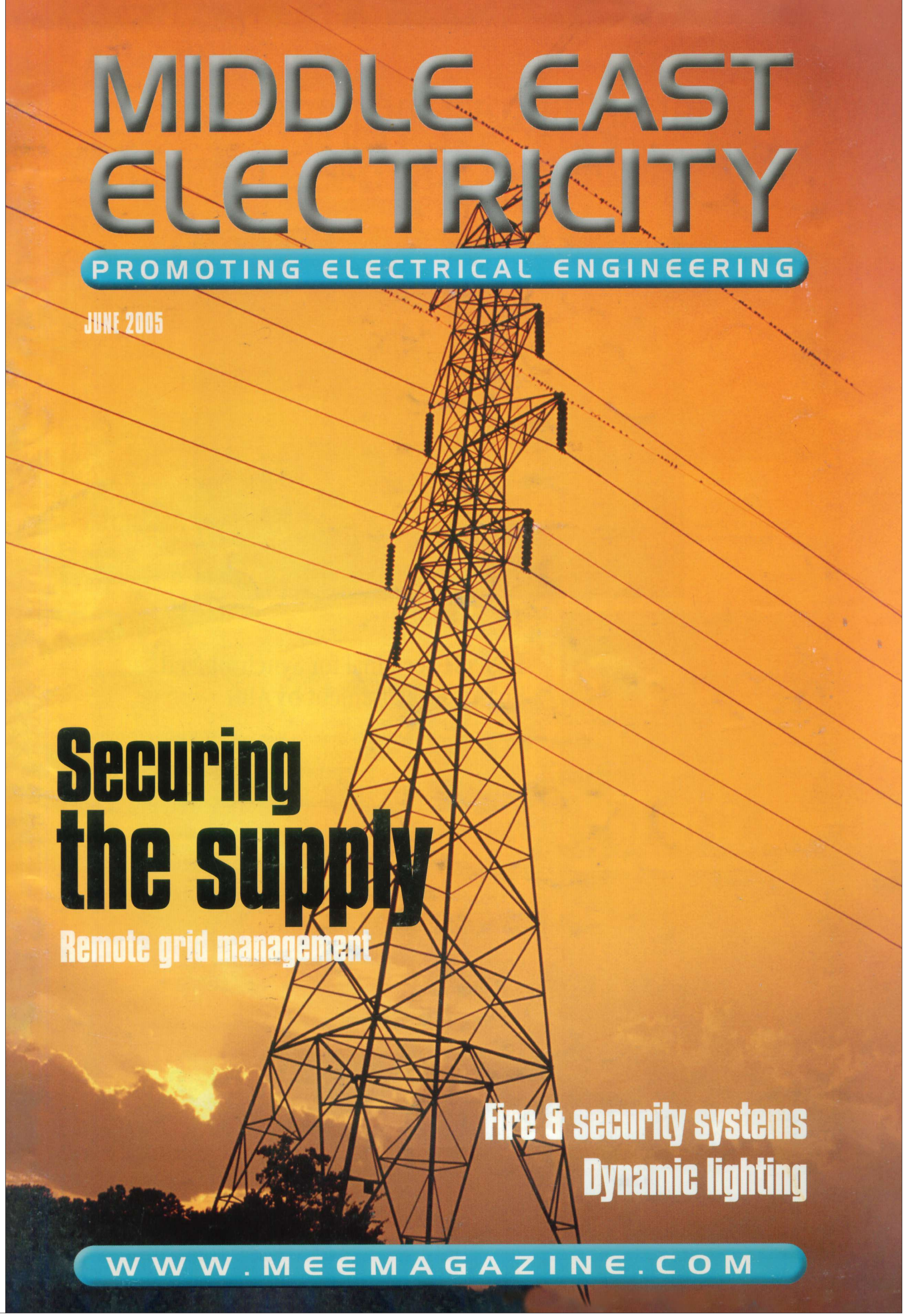
Models of competition

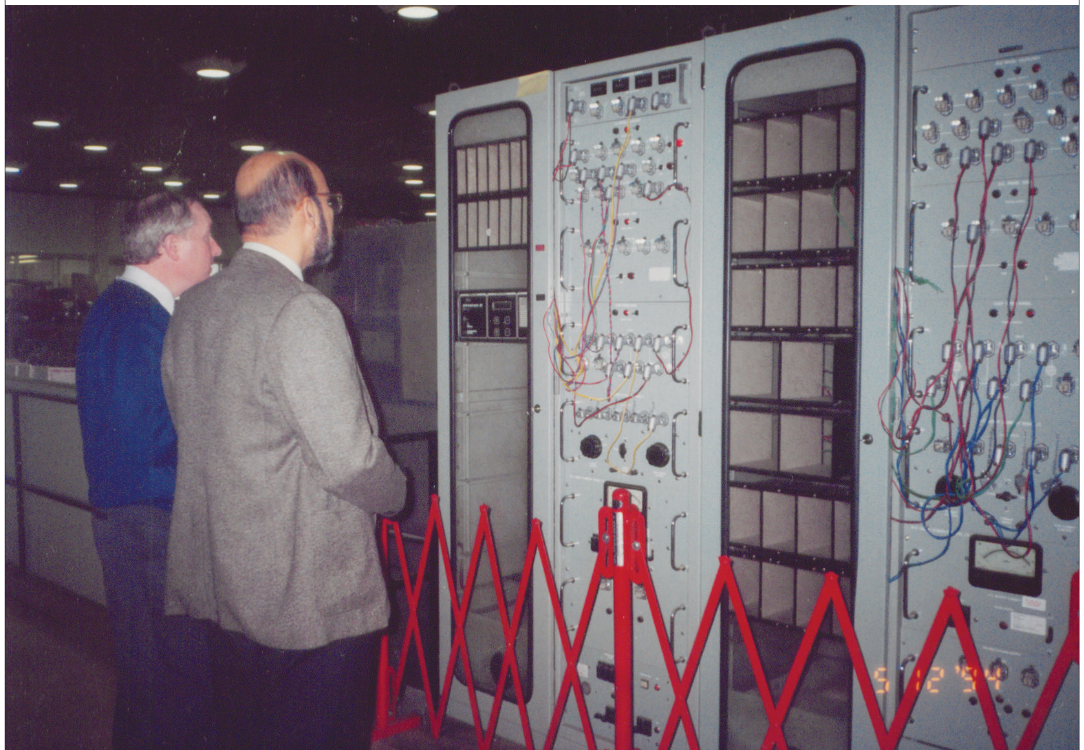
The issues and challenges faced by the new management executives responsible to bring about these changes are not only technical and financial but a mix of so many administrative, cultural and social-political. The competitive landscape is changing, new models of competitiveness are needed to deal with these challenges.

> "To attract private investment in the electricity sector a series of legislative and administrative reforms have been taken by governments"

In the changed circumstance the new management has to prepare employee to develop their skills to face the new challenges. The new policies call for a shift to customer focus rather than product focus.

This new way of thinking about service and quality should be created among hard working engineers who are up till now concentrating only on the hum of machines and prepare them to become smart managers to run the electric utility like any other commercial company earning profit for shareholders.





Provision of quality electricity in smart and modern way is part of our duty

Knowing of the need

Engr. Sarfaraz Ali Syed

The Saudi Electricity Company is considering the installation of programmable power controllers in 110 /13.8kV substations within the Madinah City. It is believed that the move will help improve the city's power supply situation in view of the fast growing load and concentration of reactive loads of newly emerging high-rise residential buildings.

At present the city's summer peak is about 1,100MW, supplied by two 380kV transmission rings at two power plants. It is distributed by a ring of 16Nos 110/13.8kV substations of different capacities throughout the city. However, there are further moves to improve the quality and reliability of supply.

Improvements of this kind are no longer uncommon in the Middle East as electricity utilities have stopped selling a product, in favour of providing a service to their customers. They are now looking, with the help of their engineers, to not only improve the quality of supply within the region but also increase the cost efficiency of their tools — a comprehensive approach to reducing cost whilst increasing the levels of service offered.

Utility providers across the region have had to adopt new business techniques as the market begins to flourish and competition increases. Such techniques include total quality management (TQM), and business processing re-engineering (BPR). Part of these strategies is to ensure that there is sufficient funding for research and development (R&D). The reason behind this turn towards investment is, aside from the need to improve supply, to reduce losses and create a more competitive utility — one that can provide value for money to its customers.

Engineering profits

In response to this change of direction from the utilities, engineers have had to learn about a new market. This altering business environment now requires those working in it to be more profit conscious. Engineers are looking at each strand of their work and calculating the benefit to them and the company. They now have to weigh up the concerns of their customers with those of their bottom line.

Part of that equation is the need to provide customers with a service that they will want to pay for. In years gone by variation in supply from time to time were excusable. Today that is not the case.

Even the smallest variation could spell disaster for customers. In a world that is now so reliant on technology, the smallest variation could bring the whole factory or office complex to a standstill, and result in the accumulated loss of millions for both the consumer and utility. One glass plant, for instance, estimates that a five cycle interruption, or outage of less than a tenth of a second, could cost as much as it US$200,000.

Measuring power quality

Electricity can be measured in quantity as well as in quality. The quantity is measured by machine only (meters) whereas quality can be measured by both man and machine. In technical terms the shape of voltage time curve, its smoothness or wave shape, is a measure of the quality of supply.

Power problems can be grouped into two categories. The first includes wave form distortion. This usually arises on the customer's premises and can best be resolved there. The other group includes power interruptions and voltage sags that originate on the distribution system.

Monitoring tools and remedial equipment on the system may help resolve these issues and keep such problems from effecting the customer.

Assessing market needs

It is important to assess the needs of customers to ensure that the service and supply being delivered is meeting requirements. Part of this is to consider the type of customer being served; they're individual or business-related needs. This might include giving consideration to their property. As part of a technical survey, utilities could look at the type of load, process, equipment and special requirement of load at the site/ premises.

These types of technical surveys should be performed on a regular basis to keep track of the development of the future load and special requirements, if any, of customers. Additionally, reliability of supply requirements also needs to be discussed with the local administration and local developing authorities concerned. This will enable utility providers to assess

the requirements for future extension schemes and the type of load development already taking place in and around the area to help improve overall reliability.

Problems with supply

Power quality can be measured by using a number of parameters, including voltage fluctuations (notches, voltage dips, under voltage, spikes, surges and over voltages), frequency variation, voltage unbalance, harmonic distortion and voltage flicker.

There is a difference between voltage dips and voltage flickers from the perspective of quality control, its origin, duration and effects on the system.

A voltage flicker is a fluctuation in utility supply voltage. It is caused by fluctuating currents drawn by flicker generating loads such as arc furnaces which give rise to a fluctuating voltage as a result of series impedance of the utility network. In industrialised countries, standards have been adopted for permissible flicker. For MV and LV networks the compatibility level for short-term flicker severity is 1.0, with a long-term flicker severity being 0.8.

Voltage dips are largely caused by power system faults such as insulation flashovers (utility initiated voltage dips) and the connection and operation of large loads such as motors (customer initiated voltage dips). They are characterised by a number of parameters such as:

- Frequency of occurrences
- Duration
- Magnitude of depression
- Phase shift
- Propagation

Dips due to power systems cannot be eliminated completely but can he reduced by adopting additional remedial measures on the distribution system. Those beyond the meter, due to consumers' equipment, can be reduced by providing additional filtering and controlling devises at the consumer premises, however, it benefits only that consumer.

Faults on cables and lines are often the cause of line disturbances. Single phase to ground faults cover more than 80 per cent of all interruptions in power supply. The speed of operation of the protection relays and the opening time of the breakers at both ends can determine the speed at which the fault will clear, as does the choice of relay technology.

Today, digital relays based on neural

network technologies are available. These monitor the line voltages during open pole condition. Through a signature analysis the 're-closer' can determine when it is safe to re-close and thereby minimise the number of voltage dips.

A Group photo of AJEC Engineers on World Quality Day-2010

A Touch of Green

Syed Sarfaraz Ali

Suggests ways towards greener quality management

As quality professionals, we continue to evolve systems to meet the needs of a changing world. Today, environmental thinking has moved past merely how to eliminate or reduce the emission from products and processes. In recent years, numerous papers, books and conferences have focused on the subject in terms of lessening the negative human impacts and the ability to sustain life. Specific goals have often emerged from these discussions, such as minimizing waste, increasing recycling or approaching sustainability.

The quality movement has long stressed zero scrap and zero defects as essential ingredients of manufacturing, but now quality professionals should be even more concerned with the scrapping of its larger dimension. This article provides a framework for quality professionals to engage in when designing new materials, products, processes and systems that do not disturb human health and the environment, while maintaining and following quality principles.

The essence of green quality management must be to provide for the fundamental needs of mankind without disturbing the natural system of life on earth. Although it is certainly true that all human processes and actions will have some impact on the environment, minimizing those actions that irreversibly alter the sustainable supply of a resource can lead to the design of more sustainable products, processes, and systems. Quality professionals must be able to use not only their basic technical discipline, but should acquire knowledge of environmental, ecological, social and cultural concepts to be able to move away from traditional technical solutions towards environmentally friendly solutions.

Managing green projects

There are 12 main stages for quality professionals to consider when working on green projects. These results form part of a primary study based on different project completion reports, some personal experiences, and articles by a panel of well-qualified experts in environmental health, toxicology, land reclamation, ecological restoration, hydrogeology, integrative biology, economics, and engineering.

Stage 1: Designers need to strive to ensure that all material and energy inputs and outputs are as inherently non-hazardous as possible

Although the negative consequences of inherently hazardous substances may be minimized, this is accomplished only through a significant investment of time, capital, material, and energy resources. Generally, this is not an economically or environmentally sustainable approach. As a first step toward a sustainable product, process, or system, designers should evaluate the inherent nature of the selected material and energy inputs to ensure that they are as benign as possible.

Stage 2: It is better to prevent waste than to treat or clean up waste after it is formed

Proposals for manufacturing processes or service systems that are 'zero-waste' are often criticised as ignoring the laws of thermodynamic and enthalpic (a measure of the total energy of a thermodynamic system) considerations. An important point, often overlooked, is that the concept of waste is human. In other words, there is nothing inherent about energy or a substance that makes it a waste, rather it results from a lack of use that has yet to be imagined or implemented. As such, waste is assigned to material or energy that current processes or systems are unable to effectively exploit for beneficial use. Regardless of its nature, the generation and handling of waste consumes time, effort, and money. Hazardous waste demands even greater additional investments for monitoring.

Stage 3: Separation and purification operations should be designed to minimize the energy consumption used by materials

Product separation and purification consume the most energy and material in many manufacturing processes. Many traditional methods for separations require large amounts of hazardous solvents, whereas others consume large quantities of energy as heat or pressure. Appropriate upfront designs permit the self-separation of products using intrinsic physical or chemical properties, such as solubility and volatility rather than induced conditions, decreasing waste and reducing processing times.

Additionally, design decisions at the earliest stage can impact the ease of product separation and purification for later reuse and recycling of components. Economic and technical limitations in separating materials and components are among the greatest obstacles to recovery, recycle and reuse.

Stage 4: Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency

It is important to maximize mass, energy, space, and time efficiency because processes and systems often use more time, space, energy, and material than required. The results could be categorised as 'inefficiencies', but the consequences are often broadly distributed throughout the product and process life cycles. If a system is designed, used, or applied at less than maximum efficiency, resources are being wasted throughout the life cycle. The same design tools traditionally used by engineers to increase efficiency can be even more broadly applied to increase intensity. Space and time issues can be considered along with the material and energy flow to eliminate waste. Furthermore, in optimized systems there is a need for real-time monitoring to ensure that the system continues to operate at the intended design conditions.

Stage 5: Products, processes, and systems should be 'output pulled' rather than 'input pushed', through the use of energy and materials

Le Chateller's principle states that when a stress is applied to a system at equilibrium, the system readjusts to relieve or offset the applied stress. Approaching design through Le Chateller's principle minimises the amount of resources consumed to transform inputs into the desired outputs. This same technique can be applied across design scales. For example, just-in time manufacturing requires that equipment, resources, and labour are only available in the amount required and at the time required to do the job. Planning manufacturing systems for final output eliminates the wastes associated with overproduction, waiting time, processing, inventory, and resource inputs.

Stage 6: Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition

The amount of complexity that is built into a product, whether at the macro, micro, or molecular scale, is usually a function of expenditures of materials, energy, and time. For highly complex, high-entropy substances, it could be counterproductive and sacrifice value to recycle the material. High complexity should correspond to reuse, whereas substances of minimal complexity are favoured for value-conserving recycling, where possible, or beneficial disposition, when necessary.

Natural systems should also be recognized as having complexity benefits that should not be needlessly sacrificed in manufacturing transformation or processing. End-of-life design decisions for recycle, reuse, or beneficial disposal should be based on the invested material and energy and subsequent complexity across all design scales.

Stage 7: Targeted durability, not immortality, should be a design goal

Products that will last well beyond their useful commercial life often result in environmental problems, ranging from solid waste disposal to persistence and bioaccumulation. However, this strategy must be balanced with to design of products that are durable enough to withstand anticipated operating conditions for the expected lifetime to avoid premature failure and subsequent disposal.

Effective and efficient maintenance and repair must also be considered so that intended lifetime can be achieved with minimal introduction of additional material and energy throughout the life cycle. By targeting durability and not immortality as a design goal, the risk to human and environmental health at the end of life is also significantly reduced.

Stage 8: Design for unnecessary capacity or capability solutions should be considered a design flaw

Anticipating the necessary process agility and product flexibility at the design stage is important. However, the material and energy costs for overdesign and unusable capacity or capability can be high. There is also a tendency to design for worst-case scenarios or optimize performance for extreme or unrealistic conditions, which allow the same product or process to be used regardless of local spatial, time, or physical conditions. This requires incorporating and subsequently disposing of and treating components, the function of which will not be realized under most operating conditions. The tendency to design an eternal, global solution, such as chlorofluorocarbons, should be minimised to reduce unnecessary resource expenditures.

Stage 9: Material diversity in multi-component products should be minimized to promote disassembly and value retention

Products as diverse as cars and food packaging all have multiple components. Within individual plastics there are various chemical additives, including thermal stabilisers, dyes, and flame-retardants. This

diversity becomes an issue when considering end-of-useful-life decisions, which determines the ease of disassembly for reuse and recycle. Options for final disposition are increased through upfront designs that minimise material diversity yet accomplish the needed functions. At the process level, this is being done by integrating desired functionality into polymer backbones and thereby avoiding additives at a later stage in the manufacturing process.

Stage 10: Design of products, processes and systems must include integration and interconnectivity with available energy and material flows

Products, processes, and systems should be designed to use the existing framework of energy and material flows within a unit operation, production line, manufacturing facility, industrial park, or locality. By taking advantage of existing energy and material flows, the need to generate energy or acquire and process raw materials is minimized. At the process scale, this strategy can be used to take the heat generated by exothermic reactions to drive other reactions with high activation energies. Byproducts formed during chemical reactions or through purification steps can become feedstocks in subsequent reactions. In this manner 'waste' material and energy can be captured throughout the production line, facility, or industrial park and incorporated into system processes and final products.

Stage 11: Products, processes, and systems should be designed for performance in a commercial afterlife’

In many instances, commercial end of life occurs as a result of technological or stylistic obsolescence, rather than a fundamental performance or quality failure. To reduce waste, components that remain functional and valuable can be recovered for reuse or reconfiguration. This strategy encourages upfront modular design, which reduces the need for acquiring and processing raw materials by allowing the next-generation designs of products, processes, or systems to be based on recovered components with known properties.

By incorporating commercial 'afterlife' into the initial design strategy rather than as an afterthought at end of life, the value added to molecules, processes, products and systems could be recovered and reused at their highest value as functional components.

Stage 12: Material and energy inputs should be renewable rather than depleting

The nature of the origin of the materials and energy inputs can be a major influence on the sustainability of products, processes, and systems. Whether a substance or energy source is renewable or depleting can have far-reaching effects. Every unit of finite substance used in a consumptive manner incrementally moves the supply of that substance toward depletion. Certainly, this is not sustainable. In addition, because virgin substances require repetitive extractive processes, using depleting resources causes ongoing environmental damage. Renewable resources, however, can be used in cycles in which the damaging processes are not necessary or at least not require as often. Biological materials are often cited as renewable. However, if a waste product from a process can be recovered and used as an alternative feedstock or recyclable input that retains its value, this would certainly be considered.

Useful reading

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Addressing on the occasion of Annual Meeting Dinner at IEP-SAC Journal

Maintenance Planning and Inventory Control

Engr. Syed Sarfaraz Ali

Maintenance is defined as measures required to maintain and re-establish a specified condition, as well as to assess the actual condition of the technical capabilities of a given system. Maintenance requirements of an engineering plant vary according to the size, design, process type, location, business environment and the available technical and material resources. Plants and equipment that provide a service 24 hours a day, seven days a week have different maintenance requirements than, for example, plants and equipment that operate eight hours a day, six days a week. Industries and utilities should select or develop a maintenance management program that accurately predicts the condition of system components. Condition monitoring data should be accurately collected and recorded.

Therefore, maintaining the items of equipment on whose continuous operation the facility depends, is a high priority program. The drive for economy is forcing machinery users to examine their spares holding. This often neglected job is on the top of machinery users agenda nowadays. The need to reduce inventory has to be balanced against the risk of an un-scheduled shutdown. In the process, more advanced users are re-examining the need for improvement in the condition of the actual inventory, and the documentation system for the procurement of spares. In all these areas, the Original Equipment Manufacturer (OEM) has a key role to play. Much attention is given to plan an effective maintenance program for the plant keeping in view the manufacturer's recommendations and the important spares to meet any emergency, at least on yearly basis, so that minimum stock of essential spares is available. This requires a regular and vigilant watch on the present stock, the procurement, storing and the re-ordering process. This is generally described under the heading of Inventory Control.

Benefits of Good Maintenance

Efficient and economical operation of plant and equipment and the profitable utilization of resources while maintaining safe working and environmental conditions are essential in today's business. Excessive operating costs, due to poor maintenance can lead to the followings losses:

- High electricity consumption due to excessive friction in bearings and belts
- High electric consumption due to non alignments of moving parts
- Extra fuel consumption due to low heat transfer surfaces.
- Extra fuel consumption due to lack of cleaning of filters and tubes
- Loss of steam, compressed air, fuel gas, cooling water etc., through leaks in valves and flanges
- Loss of heat due to damage or defective insulation on pipes.

The list seems endless, yet experience shows that many engineers/managers try to increase profits by cutting maintenance costs which may lead to the total breakdown of the plant which ultimately can cause substantial losses.

In fact, a well-managed and planned maintenance program has the potential for major savings in the cost of spare parts. By knowing the typical life of equipment and extending this through a good maintenance process can substantially cut its inventory of spares with corresponding reduction in the capital tied up with the spare parts holdings.

Basic Elements of a Maintenance Program

Some systems of documentation is needed for the maintenance program. A simple system will satisfy the essential requirements by providing answers to the following four questions.

- What is to be maintained?
- How is it to be maintained?
- When is it to be maintained?
- Is the maintenance effective?

Taking these questions in order leads to an effective maintenance program:

a. Compilation of the inventory of the whole plant and equipment with identification codes.

b. Developing the procedures for required maintenance for each item listed in the inventory.

c. Drawing up a program to establish when each item is to be maintained.

d. Complete documentation for each maintenance work carried out with the details of trouble report, job order, spares used, duration

and dates.

e. Feedback on the work conducted and the results achieved in order to continually evaluate and improve the maintenance program.

Types of Maintenance

There are three approaches to the maintenance of any plant or interconnected system. However, the experience has shown that the Preventive Maintenance is the best approach that can be adopted to obtain better efficiency and improve profitability.

Breakdown Maintenance

Let the system operate until it fails and then repair it. This approach is not possible in any successful commercial operation and modern industrial concerns cannot even think of adopting such a scheme.

Corrective Maintenance

It is carried out to restore lost efficiency and hence to reduce production cost.

Preventive Maintenance

Conduct periodic inspection and take appropriate maintenance action to minimize failure.

Preventive maintenance helps not only to avoid some incidents from the very beginning, but also to coordinate overhauls with repairs, upgrading or even up-rating. The main purposes of preventive maintenance are:

- To plan normally one year in advance, the scheduled standard overhauls in order to reduce downtimes and share the work between operational and maintenance staff
- To remedy all possible defects affecting the availability of the plant or any kind of detrimental conditions such as fouling or deviation from the original performance
- To provide access to the latest state-of-the-art technology

Advanced Techniques of Preventive Maintenance

Different versions and modules of preventive maintenance schemes which are in use in industrialized countries are briefly described as follows:

Reliability Centered Maintenance (RCM)

Reliability Centered Maintenance is a step-by-step instructional tool for how to analyze a system's all failure modes and define how to prevent or find those failures early. RCM is a structured approach, which is used to determine the maintenance requirements of complex systems. It was originally developed by aviation industry.

Condition Based Maintenance (CBM)

CBM is an approach wherein industries track the number and type failures of equipment and materials to determine the loss of component life. Industrial units also ask manufacturers to recommend service intervals for equipment. With improved diagnostic tools, the results of periodic testing and advanced computer software, the engineers are increasingly moving towards condition based maintenance approaches.

Comprehensive Maintenance Program (CMP)

CMP is a three prong policy of arranging a proper coordination between the Man, Material, and Management (3M) Program. The complexity and/or importance of the basic system e.g. an electric power system require a comprehensive maintenance approach for better and economical results. There are very good management information systems (MIS) available that optimize, streamline, and automate.

Inventory Control

Procurement of spare and proper tools is required for maintenance and overhauling. Details of items stocked by a particular plant are contained in a warehouse which is itemized in code number sequence. In addition to being a quick guide to the maintenance engineer on what is available from warehouse, it provides a useful control on the variety of spares stocked and a common understanding between the maintenance staff and the stores staff during any emergency. Automated inventory management systems are software suites that optimize many processes in the management and control of inventory hence increase efficiency and reduce downtime and costs.

Types of Spares

Maintenance store generally contains the following two types of spares.

1. General engineering spares, like nuts and bolts, screws, tools, metals/piping, jointing and packaging materials, electric light fittings and protective equipment, clothing, etc.

2. Capital spares are an initial replacement or assembly of a high value essentially associated with a particular unit or type of plant which is anticipated will not be used for normal repairs and maintenance, except by way of interchange and will only be required in case of a breakdown.

Stock Levels

Stock levels for spares with a predictable rate of use are determined on a basis which takes into account the expected consumption, overall delivery time, cost of the item and the administrative costs of ordering the stock. The aim is to keep stocks at a minimum economical level consistent with the needs of the repair and the maintenance work. Modern inventory management information systems provide the optimum re-order levels and re-order quantities are provided for the use of stores staff. They take into account historical consumption over a short period which may arise at the time of a major plant overhaul. Excess stocks are prevented by the preparation of lists of items required for a scheduled overhaul. This enables the stores supervisor to have such material available for the scheduled date without over-stocking for the remainder of the year.

Insurance

Where major items of plant are transported to a workshop or a manufacturer's works, insurance has to be arranged against normal contingencies at the time of dispatch from the store. The store supervisor issues an advice note on the dispatch of the goods and notifies the Regional headquarter, which arranges the necessary insurance cover.

Conclusions

The old system of purchasing of spare parts in bulk quantity, storing them, blocking a large capital in dead stock, and then waiting till a breakdown occurs so as to use the dead stock is no longer feasible. Modern Maintenance Management System requires experience and good judgment. An efficient and well maintained maintenance program offers the potential for major savings in the cost of spare parts. By knowing the typical life of equipment (and extending this through good maintenance) a company may substantially cut its inventory of spares, thus reducing the capital tied up in stores.

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TECHNOLOGY TRANSFER

by

Engr. Syed Sarfaraz Ali

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TECHNOLOGY TRANSFER

Engr. Syed Sarfaraz Ali

This is the age of science. Present society is based on knowledge and facts Dr. Dixy Lee Ray, former president of the Atomic Energy Commission, U.S.A. said in his address to 1990 CIGRE Session held in Paris:-

> "Our society today is technically advanced. It is based on facts, verifiable, determinable, repeatable facts, developed through the intuitiveness of science and the pragmatism of technology. It is not a perfect society, it is only the best that the world has ever known".

(Electra-Issue Oct'90 p.11)

We can improve the condition of our society by proper use of science and technology. Of the world's roughly five billion people, some four billion lives in the developing countries. About 70% of the latter still live in slums without proper food, sanitation, water, electricity and educational facilities. Devastation of millions of people in Bangladesh due to cyclone and flood is a recent story.

The man has landed on moon, but still millions are starving due to shortage of food. It is a big challenge for the scientists to use the technology in the service of mankind.

The technologically advanced countries are fighting over the import quotas and trade regulations but the people of poor, under-developed countries are still fighting to get a loaf of bread. Why this difference? It is only the ways and means, knowledge and methodology which can improve the living conditions.

This knowledge and methodology which improves the working conditions and habitat is called technology. We can say that the greatest inventions which makes the life on this earth easier was the invention of WHEEL. But the force which drives the wheel was converted from muscle power to electrical power only 100 years ago.

This is an example of development of technology. Technology is uniquely and exclusively a human attribute. Yet tragically enough it is not spreading fast enough or reaching to service of every man despite the claims of human rights and universal brotherhood. What do we mean by technology transfer. It can be defined as sharing of knowledge, it involves any geographical shift of technology (ideas as well as physical products) person to person, group to group, or Government to Government (K. Weick – 88 & R. Segman – 89).

At first glance technology transfer seems a very simple operation. If the Donor and recipients are agreed it should be easy. But it is not as simple. The patent rights, protections from imitating, profit from initial investment, after sales service, political situation and geographical positions of the recipient country on the globe all these factors play important role in transfer of technology.

A true transfer of technology is more than simply holding a technical lecture by some sales executives or big advertisement in Media. It starts from choosing the appropriate technology, moving it in matter and letter from the developed country to the developing country and creating a favorable environment in the recipient country to absorb it, adopt it, and making reasonable profits on the projects to fulfill the economic requirements. This last one is the most important of all, because a common man is not interested weather you install a large chemical plant or a small match factory. He is interested in the prices. If he can not get cheaper product from his own national factories, he will not be satisfied. After the price, comes the quality of product. In many third world countries when cars were being imported from abroad they were cheaper but now when these automobiles are being assembled in these countries the prices have triplicated and quality gone down. Well there are reasons like international price hike inflation, political instability but the blunders made by the planners and bureaucratic archipelago are the main reasons which resulted in such down the hill performance.

There are four conditions necessary for a successful transfer of technology. These conditions should be fulfilled before venturing into any project:-

1. Identifications
2. Evaluation
3. Environment
4. Partnership

1. INDENTIFICATIONS

The developing country or the recipient party must clearly identify party

the need and carry out marketing survey of the product or services required. Nowadays, the developed countries or advanced nations are inventing new products and creating technology faster than the power and ability of developing countries to absorb it. Today you hear a machine able to perform 5 functions at touch of your finger, the other day you will know that an advance version with 25 functions and self-programming unit has been marketed by some other country or some international group and by the time you finish your formalities and arrange all the clearances from Government controlling agencies you hear that now fuzzy logic has been introduced by a third country and the machine or equipment that you had planned to purchase and installed in your country has now become obsolete and no more in production. We will discuss the red tape of bureaucracy in detail at a later stage but the choice of appropriate technology keeping in view the immediate demand of market is the first and foremost requirement.

The setting up of car manufacturing plant without support services and T.V factory without knowing chips technology is not logical. The problem with developing countries is the lack of national spirit and education. As the literacy rate is low in developing countries, the number of qualified persons to decide on the choice and value of technology is even less and the situation becomes all the more tragic when decisions are taken by bureaucracy without any scientific background and technical understandings. The decisions are taken on whims and personal interests. Millions of dollars are spent on feasibility studies and foreign visits but the result are large sick units which needs regular transfusion of funds.

2. EVALUATIONS

The financial implications in taking up a project of new technology must be studied and arrangement for funding should be settled before execution. It has been observed that big projects like Fighter Planes Assembly of Missile Production are taken up without proper guaranties from financial agencies and study of marketing potentials. Any delay on the part of funding agent may create time delays, payment problems and sacrifices on many national policies by the third world countries. The recipient must have enough funds to bear the expenses till proper marketing of product. Another financial risk which is not considered in the early stages of project evaluation is the risk of financial failure by any of the sub-contractors employed on the projects. In third world countries there are a number conditions and restrictions regarding the use of funds and flow of currencies inside and outside the country. This require adequate arrangement of keeping a certain amount of foreign currency as imprest with project authorities so that emergency payment are made without going through the whole exercise again and again. Sometime a barter deal is made between the parties and usually the goods offered by third world countries is in the shape of agriculture produce like rice, and cotton, in such conditions the fate of the new product hangs in the middle as one can not guarantee bumper crop each year and Donor makes deliberate delay in supplying the required man and machine which ultimately results in overall delay in marketing the products. There are chances that some other competitor may bring his product in market and take away the initial charm.

There is also a possibility of some new inventions. Second generations of the machine may capture the market while the recipient and donors are still busy in settling the financial problems with bureaucracy. So, it is better to study the total value of the project including such incidental escalation in the initial estimates so that the final product when offer for sale is at reasonable cost and competitive price.

3. ENVIRONMENT

Transferring a technology from a developed country to a developing country and setting up a center, plant or a large industrial complex is like implementing a sapling in your lawn. You have to provide favorable environment, supply all essentials, keep regular maintenance and protect from any damage or harm till the small sapling is a tree and is able to face the gust of winds, suck the food and water on its own and can heal itself the small scars inflicted by children playing in the lawn. Similarly before planning to set up a plant or factory, a study of the essential needs is made and then the site should be finalized. You have to provide basic services like road, water, electricity and accommodations. It is unfortunate that for these services there is no single authority or agency in developing countries. The financier or investor has to go from door to door for each of these services. Sometimes the source of water or electricity is hundreds of Kilo Meters away from the site and a large amount is required to arrange for these services. Although much drum beating is done regarding “One window operation” by the governments of developing countries but the story is completely divorce of the facts. Arrangement of local labor and induction of local expertise in the manufacturing and assembly line is very important to keep the prices low and to acquire the technology. This can be done on government level. A chain of training centers for un-skilled

labor and technical institutes for semi-skilled labor should be established so that young generations may get the basic educations and technical know how? and are ready to learn the new technologies from foreign experts in different fields. The setting up of industrial complexes by local or foreign investor will also provide employment opportunities for the locals. Well, this is a matter of MACRO ECONOMICS. The financier will earn when the finished product is sold but the government earns in the shape of reductions of un-employment. So it is also in the interest of third world countries and developing countries to invite foreign investors to install their plants and even if they take away big chunk of the profit, the gain in the shape of employment and training of local labor will surely improve the economic conditions of developing countries. As mentioned earlier the favorable environment is very necessary for successful transfer of technology this also include the trade union activities and labor laws.

Unfortunately trade union activities are not developed on healthy lines in some third world countries and some times, vested interest takes control of the labor unions activities. The smooth and safe operations necessary for a budding units are not available which results in extra demands, strikes and lockouts. The management of new plant can not be absolved of their responsibilities of failure in handling the situations in certain cases but government should provide some protections against such activities upto a certain period or declare some technologies as essential and put ban on union activities for a certain period.

We should remember capital is very shy. It flies away even with a slight change in economic conditions, so it is the prime duty of government to provide favorable conditions, so that local investors and foreign experts may work jointly for the transfer of technology and ultimately economics development.

The taxes, duties and tariff regulations in certain developed countries results in artificial boost in government revenues but in long term either the new plant goes in loss or adopts illegal means to evade taxes. In either case the process of technology transfer is hampered and such illegal activities results in blackmailing of management by labor unions and thus the quality goes down, prices goes up and the sale of products is decreased.

These are the conditions in most of the developing and third world countries and a new entrepreneur has to study the environment of recipient country, and formulate a suitable policy before entering into contract with foreign firms for acquiring new technologies.

4. PARTNERSHIP

There has to be a true partnership in which the Donor, and the Recipient commit themselves to seeing the process of technology transfer through to success. This partnership can be on government to government or government to private investors or vice versa but the terms of references, scope of work and level of technology must be defined clearly. For sophisticated technology or large industrial complexes a third party such as consultant may be associated to supervise the fine details of technical process till commissioning of the plant or upto the warranty period.

For large industrial units public sector should play major role in this program and after successful completion and satisfactory running for 3-5 years, the plant may be sold to private sector. If the private sector is involved from the very start then public sector should take the responsibilities of identification and environment and private sector may be left to deal with the financial and administrative matters. In some third world countries industrial development boards have been setup and they have obtained very good results. But in those countries where public sector has assumed full powers or in other words where industries are under estate control or nationalized, as a result of political process the inherent red tape and lethargic attitude of bureaucracy has destroyed the whole process. When the affairs are in the hand of an industrialist, he manages the system on efficiency and economy. He is worried about the annual profit and loss account, balance sheet and dividends to be distributed to shareholders. He links wages with quality and quantity. He is worried about the refund of loans and accumulated interest. But bureaucrat or manger of public sector has no such worries. He is worried only when there is news of change of government. He is not concerned with the quality or quantity of product or the labor and management relations. Because the wages are increased by the government without considering the output of the plant. This is true in all cases of state run enterprises, weather it is Russia or Asia. But the problem is that poor countries of third world can not have this development of technology 100% in the hands of private sector. Some check has to be made in the interest of country and National policies. So a proper balance is required in partnership in the development schemes for transfer of technology so that the essential technology is obtained at competitive rates and without jeopardizing the national policies.

ECONOMIC ASPECTS OF TECHNOLOGY TRANSFER

by

Engr. Syed Sarfaraz Ali

PREFACE

Transfers of technology has gone profound changes since it became a major focus of international cooperation.

In the period of reconstruction and colonization following Word War-II technological development was largely to capture markets. No attention was paid towards social, economic and political factors.

But today emphasis is given on all Socio-economic conditions and political situation. With the advancement of communications and better understanding of human behavior the responsibility of Engineers has increased particularly in developing countries. What is being overlooked in technical assistance to developing country by the aid giving developed countries is the impact of techno-economic development upon old systems and traditions and the reasons of very slow improvement in the living standard of masses.

Large part of international development program (Technology transfer) depends directly or indirectly upon Engineering, both theoretical and applied.

As an Engineer engaged in the development projects for the last 20 years I feel it my duty to submit my observations and experiences in writing for future guidance, further study and critical analysis

The subject of this Master thesis is

"ECONOMICAL ASPECT OF TECHNOLOGY TRANSFER".

This is being submitted for the approval of Pacific Western University.

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ANALYTICAL EXPOSITION

1. INTRODUCTION

This is the age of science. Present society is based on knowledge and facts. Dr. Dixy Lee Ray, former president of the Atomic Energy Commission U.S.A. said in his address to 1990 CIGRE Session held in Paris:-

> "Our society today is technically advanced. It is based on facts, verifiable, determinable, repeatable facts, and developed through the intuitiveness of science and the pragmatism of technology. It is not a perfect society. It is only the best that the world has even known".
>
> (Electra-Issue Oct '90 P.11)

We can improve the condition of our society by proper use of science and technology. Of the world's roughly 5 billion people, some 4 billion lives in the developing countries. About 70% of the latter slums live in slums without proper food, sanitation, water, electricity and educational facilities. Devastation of millions of people in Bangladesh due to cyclone and flood is a recent story.

The man has landed on moon, but still millions are starving due to shortage of food. It is a big challenge for the scientist to use the technology in the service of mankind. To-day world has been divided into haves and haves not. This gap is increasing day by day.

The technologically advanced countries are fighting over the import quotas and trade regulations but the people of poor under-developed countries are still fighting to get a loaf of bread. Why this difference? Is the land different? Water is different? Or Air is different? No, God has created this world and has given abundant resources. It is only the ways and means, knowledge and methodology which improves the living conditions.

This knowledge and methodology which improves the working conditions and habitat is called technology. We can say that the greatest inventions which makes the life on this earth easier was the inventions of WHEEL. But the force which drives the wheel was converted from muscle power to electrical power only 100 years ago.

This is an example of development of technology. Technology is uniquely and exclusively a human attribute. Yet tragically enough it is not spreading fast enough or reaching to the service of every man despite the claims of human rights and universal brother hood. It is up to the reformers and political leaders at the helm of affairs to remove the barriers and allow free flow of knowledge but as a student of Economics and engaged in the development of Electrical technology for the last 20 years I came across many different situations which were difficult to tackle and interesting to remember. In the following pages, I will try to summarize my experiences and views for the benefit of all those people who are in favor of fast flow of knowledge, so that the lot of poor people is improved.

We are living in the age of science and technology. Every new day brings a new invention to the service of mankind. With the advancement of communication and international understanding, the world has shrunk.

Today research results belong to no single person, company or country. It is shared by all, knowledge is spreading almost instantaneously. That leaves no room for ethnocentrism in technology. A global market place is establishing.

Two basic things attracts attention. The first is that much of the imports and exports are transacted between companies and their foreign subsidiaries. Politically this is international trade, but from economical and technological view point, the flow of goods and services are internal transfers within the same enterprise.

A second way of looking at the global market place is to consider that many components are imported to assemble or manufacture one item. Now the question arises whether a Toyota car manufactured in USA is considered a Japan export and if this car is sold to Brazil will it be considered a US export? What makes the international economy so fascinating, is the rapid rate of change. The forces of technology and economics are out pacing both current management thinking and traditional politics. The standard Geo political map and the emerging techno-economic map are out of synchronism.

This article will focus on the economical aspects of transfer of technology with special emphasize on the development of third world countries. This article is divided into three portions that treats the definitions, conditions, and factors for the most economical transfer of technology.

2. SCOPE OF THE STUDY

What do we mean by technology transfer? It can be defined as sharing of knowledge, it involves any geographical shift of technology (ideas as well as physical products) person to person, group to group, or Government to Government. (K.Weick-88 & R.Segman-89)

At first glance technology transfer seems a very simple operations. If the Donor and recipients are agree it should be easy. But it is not as simple. The patent rights, protections from imitating, profit from initial investment, after sales service, political situation and geographical positions of the recipient country on the globe all these factors play important role in transfer of technology.

During the last century our world has changed beyond recognition. With the advancement of knowledge, technology is improving, business are becoming global, political arrangement are becoming more co-operative but the condition of poor countries (Third world) is not improving. Millions die due to shortage of food or medicine, potable water is still a major problem and infant mortality rate is still very high. There is big gap between developed countries and under developed countries. Unfortunately this gap is increasing day by day.

Why the fruits of scientific research are beyond the reach of millions. The process of sharing of knowledge and transfer of technology cannot take place unless the principle of economics and traditional trade are not studied.

This study covers the need and identification of technology and its socio-economic effects of under developed countries. The lack of knowledge on the part of planners and the greed to earn maximum profit in minimum time by the investors sometime results in total collapse.

The conditions conducive for new technology, product strategy and corporate success are discussed in this article based on study of some feasibility reports, project completion reports, interviews with senior colleagues and personal experience.

3. DESCRIPTION

Every product made is based on an identifiable engineering skill or what might be called technology. Most products are in fact composed of multiple technologies, some of which are created in the country while

others are imported or purchased as components. Some basic issues need special attention like demand, source of technology and local resources available. The study of economic conditions and favorable environment are carried out to design a strategy.

The successful technology transfer is a combination of aggressiveness and working smart to build a distinctive competence and profitable business. Conditions necessary for a successful technology transfer is the comprehensive way in which man, machine and material interacts in the presence of a catalytic agent. That catalytic agent is the rules and trade regulations.

Competition is driving companies to move from design to market faster than ever. Meanwhile, products keep growing more and more complex as manufacturers strive to make them even more capable and attractive. Those two forces - faster pace and greater complexity - are creating new phenomenon: the requirement that engineers become more involved with the entire product - development cycle and hence with overall management. Thus contrary to what might be excepted technological complexity is pushing "Engineers" to place a higher value on human relation skills because engineers have to deal with more people in the course of their work.

Complexity is growing because technology enables engineers to do more things in a better way. The levels of efficiency and reliability acceptable some fifty or so years ago are no longer holds good. Virgin markets where no one had embedded technology have disappeared. Today networked computers sell to those peoples who are already working on single unit personal computers (PC), and digital audio tapes are being introduced to these people who know about compact discs. A new product has to be compatible with that already exist. It also has to beat what is out there already and differentiate itself from those of competitor, generally by offering more features.

Being first to market gives the company a huge advantage. In the beginning, when energy one still experimenting with the product a lot of process may not be perfected but a year or two later the same product is usually being turned out at discounted rates. The farther one gets down the learning curve, the cheaper the product becomes. Because of this premium on timeliness, all the steps in developing the product and getting it to market - research, development, manufacturing, documentation and marketing- have to be done in a well-organized manner. A technology by itself is rarely so inherently powerful that a product can be a winner if the delivery mechanism fails.

Those delivery steps must occur in parallel. Today, technology is transferred fast and most efficiently when engineers and others involved in the organization be it a government or private enterprise work concurrently as one team. Right from the beginning, everyone involved with technology transfer program has to think about the entire development process from research and development to the end user.

Engineering has become a group activity involving teamwork and a search for consensus before the technology is selected and decision is made. It may be not the best decision, but if the team has experts from the finance and marketing, it may be better than many aristocratic decisions.

The successes story vary from country to country and situation to situation. But the factors that effects the transfer process has been described as a frame work. This framework is not the only path to success but it is surely one of the shortest.

4. SUMMARY

A true transfer of technology is more than simply holding a technical lecture by some sales executives or big advertisement in Media. It starts from choosing the appropriate technology, moving it in matter and letter from the developed country to the developing country and creating a favorable environment in the recipient country to absorb it, adopt it, and making reasonable profits on the projects to fulfill the economic requirements. This last one is most important of all. Because a common man is not interested weather you install a large chemical plant or a small match factory. He is interested in the prices. If he cannot get cheaper product from his own national factories he will not be satisfied. After the price, comes the quality of product. In many third world countries when cars were being imported from abroad they were cheaper but now when these automobiles are being assembled in these countries the prices have triplicated and quality gone down. Well there are reasons like international price hike, inflation, political instability but the blunders made by the planners and bureaucratic archipelago are the main reasons which resulted in such down the hill performance.

Transfer of technology mean transfer of knowledge or services from one

place to another place or any geographical shift in this world on government to government level, government to private, private to private or vice versa. In this article the problems and some possible solutions have been given in the prospective of economy and trade.

At first glance technology transfer seems a simple process depending on the market and profit but successful process depends on proper identification, correct evaluation, true partnership and Corporate strategy.

Even when these conditions are satisfied technology transfer can founder for several reasons. Impediments are always present one degree or another but they should be taken as challenges that can be faced and control provided there is a will.

Six important factors that effects the transfer process and economy are communication, level, gap, motivation, price mechanism and trade regulations. Each of these factors have been described with probable solutions using basic scientific and economic terminology so that the personal experience and knowledge gained through review of the technical journals on the subject can be submitted for objective evaluations and future guidance.

The under-developed and developing countries should re-examine their traditional approaches and techniques of technology development and transfer, and look for lessons to be learned from abroad.

The following guidelines are given as a summary:

1. Technology transfer is essential for economic development
2. Direct person to person contact is the most effective means of transferring technology
3. Government should supports and formulate the corporate technology strategies and their accompanying transfer actions with inputs from industry
4. Indigenous technology should be improved and merged with the imported techniques
5. Training of local talents in all aspects of the business, technology, management sciences and human behavior should be arranged
6. Japanese and European culture does not punish individuals for failure,

with the result that failures can be lessons. In other countries, on the other hand, failure is punished SO that mistakes get hidden, thereby adding to production cost and slow progress

7. A sense of participation should be created in the personnel by giving them incentives and bonuses tied to corporate financial performance
8. Rather than providing detailed directions management should see that the resources are available
9. Private enterprise should be encouraged to develop links with the foreign firms and government should act as guardian not as a profiteer. Experienced business executives can be utilized to act as internal consultants and auditors to watch the progress of state enterprises
10. Strict quality control should be exercised and efforts should be made towards continuous improvement in process development

CRITICAL CONTEXT

1. PRESENT SITUATION

The technological gap between the developing and more developed countries is increasing day by day. The poor and under developed countries popularly known as THIRD WORD needs new technology to help them fight against shortage of food, scarcity of drinking water, health hazard, population explosion, education, communication and environmental problems. But unfortunately this process of technology transfer is being hampered not only due to some international restrictions imposed by monopoly of big powers but by the defective policies and immature actions of their leaders.

The developed countries are creating new technologies faster than the developing countries can observed. Many developing countries are not even aware that a potentially useful technology exist. Computer assisted management technologies offers a good example. These provide guidance in all fields of industries finance and resource development. Often conveniently organized into computer programs they help decision makers work cost effectively. Even more crucially they help keep politics out of decision making.

The problem with developing countries is planning and political instability. Each new regime brings its own philosophy. Due to low literacy rate and

non-democratic type of system, the bureaucracy has taken full control of planning. Basic infrastructure necessary for development of industry is not available and luxury items are imported at the cost of cash crops and indigenous raw material. As there are very few manufacturing in the country, the Unemployment is high. The few learned and skilled personals look for opportunity to go abroad for better pay. This brain drain is aggravating the situation.

“Your development gets rotten if you take too long to market it”.

(Hoggishly A Like, JVC Had, Tokyo)

The mode of transfer of technology by developing countries can be Acquiring, Merging or Joint Venture (JV) with developed countries which possesses the technology according to J.C.Freir (Mergers and Acquisition vol. 10 No 2 PP 670-672) are three general search, there approaches, an opportunistic approach, a research approach and a combination of both. Once these objectives are defined by the recipient country, time should be the prime consideration as emphasized by Mr. Hoggishly A Like, a Senior Executive of M/S JVC, a Japanese firms.

With the increase in competition on National and international levels, the rising cost of advanced research, the need to motivate local talent and the desire to share the risk as mentioned earlier under the basic conditions, there is a growing conscious on the formations of consortium so that best economical result are obtained in minimum possible time.

Technology transfer is the applications of knowledge (Mr. K. Weick, Mr. R. Segman). There are two fundamental aspect to the transfer process. First the technology must be created or discovered. Second it must be expeditiously transferred to the appropriate receptor. This second aspect is proving to be at least as challenging as and certainly more controversial than the first. (Mr. B. R. Inman Mr. J. T. Pinkston). Probably the most difficult thing is to ascertain variables which effects technology transfer, as each developing country is unique, with its own priorities and idiosyncrasies what works in one may not work in another. Each country have to develop its own philosophy and technique in view of their culture, education, political system and development plan. Based on experience of participating in various engineering projects involving technology transfer preparing project completion reports, studies of different feasibility study reports and interviews with senior colleagues, six key variables emerge as especially critical in the transfer of technology economically.

1. Communications
2. Distance/Gap
3. Level of Technology
4. Motivation
5. Price Mechanism
6. Trade Regulations

1. COMMUNICATIONS

Communications between the Donor and receptor involves both active and passive links. Active links are direct person to person contact. They may range from visits by experts, onsite demonstrations, training of receptor engineers/technicians in manufacturing facilities of Donor country and seminars. The benefits of active links encourages personal contacts, helps in shrinking the mental gap and ensures fast feedback. Such face to face communications is however more costly in terms of time commitments and thus it needs government help or financial support from international development programs like United States International Development Agency, Canadian International Development Agency, United Nation International Children Educational Fund or World Bank. In passive links use of technical journals, manufacturer's manuals, video films, and highly technical study reports is carried out for transfer of technology, such media based linkages are considered to be best for fast transfer of knowledge to a number of receptor parties in different locations at one time and a relatively low cost. In this case the receptor stay at his place and save the cost of visit to abroad but the Donor is often unaware of whether the receptor understands the technics and how the technique has been utilized. The effective communications is a blend of active and passive links for economical transfer of technology. The recipient country/party should authorized a group of persons to receive, monitor and appropriately utilize the technology, whereas the Donor should set up a technology transfer center to monitor, issue instructions and follow up the progress reports and feedback.

In this way target can be marked for a certain period and achievement can be analyzed with reference to quality time and expenditure. This

interaction on personal level will develop personal networks within the two parties and frequency of instructions and time schedules can be accelerated keeping the expenditure under limits.

2. DISTANCE/GAP

This involves geographical distance as well as cultural gap between the Donor and Recipient. The geographical distance between the two parties can slow the transfer process. Similarly the cultural gap between the two nations poses challenges in setting up a working units. Each party brings his own moral values, working habits, attitudes and ways of handling the labor. The wider the cultural gap between the Donor and Receptor the more difficult it is to transfer the technology. The lower the cultural gap that is the more the Donor understand the values, attitudes and ways of doing the things the greater the chance of efficient and economical transfer of technology.

To overcome this problem Donor or developing countries should employ people from developing countries and train them at their factory premises under a phased program so that understanding between the people of different cultures is increased.

This will not only solve the Unemployment problems of developing country but the developed country can get cheap labor. Grants for research and studies in the developed countries for the students of under developed countries can also be a good solution in this respect.

Frequent seminars, lectures, workshops and visits to technical sites should be arranged so that persons from developing countries may have a chance to visit the technically advanced nations and see with their own eyes the wonders achieved. This will boost the interest, improve vision, and take the shy away. Once the persons from the developing country are exposed to the advanced technology and are given a chance to explain their point of view in respect of use of local resources and amendments in the design of finished product in view of their cultural demands, the new technology can be introduced and markets can be captured. Customer oriented design will surely give a domestic touch, it will boost the sale and fast turn over can be obtained with limited capital and less risks. The arrangements of joint sessions of design and sales executives, open house discussions and sharing of knowledge with respect to cost structure and price break up among the two parties will bring best results in record time.

3. LEVEL OF TECHNOLOGY

The technology which is low in operation maintenance technics is fairly easy to understand. It is easily adoptable and its low cost encourages easy marketing. Both developed countries and developing countries should consider this point in view of the living standard, Literacy rate, Gross national product and Inflations. It is the question of priority. A gradual and uniform rate of development brings satisfaction aiming the citizen and political stability in the country. Jump from cow cart to jet liner will not only destabilize the national economy but will increase the gap between the rich and poor. It will establish an upper class of few privileged and many poor. The Middle class will start shrinking and the frustration among poor will give rise to opportunist to take advantage of the volatile situations. Results will be demonstrations, Strike, Lockout, and Disturbance and then as the fate of most of the third world countries political turmoil's will results in coup.

Change of government means change of policy and shift of political affiliations. This may be a gloomy picture for some prospective entrepreneur but this is the way of life. The tale of nuclear development and construction of large dams in some third world countries are fresh in the press where not only millions of dollars were dumped on false pretext without any fruitful results in near future. Recommendations plan to transfer of low technology in the earlier stages are meant to make the technology more concrete, more understandable to the user, less ambiguous for the repair technicians and within the reach of common man.

Donors may arrange trade shows, industrial expositions where able possible to make general public aware of developing technologies, develop education and training programs on sales and marketing and encourage local enterpriser to invest in small industrial units on profit sharing basis. Individual researchers should be encouraged to come up with their ideas and to associate them in the manufacturing of goods utilizing new technologies to keep the cost low.

4. MOTIVATION

Incentives for adopting new technology can boost business but before that the recipient must be enlighten of the future success and assured of financial benefits that will come after adopting new methods.

The ease of operation, after sale service, economy in fuel consumption, reductions in man-hour are the points which attracts developing countries to aspire for new technology. The developed countries or Donor has to show it, prove it and motivate local entrepreneur to buy the new technology. This can be done on government to government level or through cooperation through Chambers of Industries and Commerce of both countries so that join policies are adopted to encourage local investors to venture into new technologies.

The initial investment on the part of Donors will be a small fractions of future earnings and if shared by the recipient's government it will repay in the shape of development of industry on modern lines and if manufacturing plant is established, it will not only boost, the internal revenue but will help in solving Un-employment problem.

In some cases subsidiary can also be given on the production of some important items like pesticides and fertilizer. The recipient government does not lose anything in economical perspective because the cheap pesticide and fertilizer will increase the agricultural; output and thus the overall economy will improve. Incentives and rewards like visit abroad, opportunity to work in Donor country's manufacturing plant, personal contacts with highly technical personals even inviting as visiting lecturer may motivate the local personnel engaged on the new projects. Financial rewards in the shape of bonuses, pay raise, honoraria and family excursion trips can be offered for best Performance.

Performance appraisal through new letters, certificate of commendations or promotions are a better way of motivation for senior persons or managers.

Any of the above or combination of them as award according to the position of personnel in the organizations and his cultural background brings excellent results in the long run.

5. PRICE MECHANISM

According to Professor Samuelson a great economist these factors plays important role in the fixations of price.

(I) The quantity of product

(ii) The mode of productions

(iii) The market conditions

“Principles of Economics"

(by Prof. Nasir Ahmed Salami),1971Cambridge Printers, Lahore, Pakistan.

In the first place the demand of the new product is determined after survey and study of market pattern so that manufacturing unit is designed and size of batch of productions is decided. After that the mode and pattern of manufacturing is designed in view of the amount of investment and in accordance with the protocol signed. The cycle of productions also varies according to the labor rate. If the local labor is found to be cheap, labor intensive methods are more economical and if labor is imported from other countries then more emphasize is given on automation and computer control so that productions meets the minimum requirement for early breakeven point. Once the quantity and batch size is decided than the proper marketing is taken care of. All these three factors interacts and the proper ratio and expert blend of these factor results in most economical determinations of prices. But what about profit of investor? What about the interest on loans? And what about duties and taxes? So now it becomes a complex equations of many quadrants. Experts of cost and management accounts and production technology are employed to carry out this long exercise and then a price is fixed so that neither it is beyond the reach of Common man nor discouraging to the investor.

The most important point is the competitive price. Otherwise if the product after importing new technology is costlier than the already available in market through export, or smuggling as the case may be will not bring desired results. Of course some big companies have monopoly on certain products and certain technologies but then they adopt price discriminations to remain in market.

With the advancement in scientific principles of business and better technique understanding between engineer and accountants, it has become an art in itself and when combined with project postmortem analysis and market feedback loops, the algorithms provide heuristic capabilities.

6. TRADE REGULATIONS

According to organization for a recent study by the economic co-operation

and development, trade in services and developing countries (OECD, Paris, Oct'89 129 PP]

"Many low developed Countries will have a measure of competitive in certain areas."

But a lot depends on what country and what area. All eyes are focused on the current round of international trade negotiations. Trade in services as well as merchandise is on the table this time and it is thought by many that liberalizing the rules will benefit the developed countries at the expense of the developing countries. Because competitiveness in services is not simply a matter of having cheap labor. Labor intensive services have other important aspects as, finance and technical skill. While some developed countries are able to sustain development expenditure to train their labor, the developing countries will find that new technology is causing Unemployment for local labor, whereas relative cheap labor is being sought by industrial countries. This mobility of skilled and semi-skilled labor across international borders also raises question about the exploitations of expatriate workers and the possible drain on domestically available labor. This is a complex issue and needs careful study for future technology transfer projects.

After 1992 there will be united Europe with its consortium against American Cartels and Japanese Keiretsu, all fighting for bigger share in the new era of border-less economies. Pace of transfer of technology is bound to effect. After the era of cold war and signing of START Pact between Russia and United States of America, the economic scenario is going to change. We may hope confidently that ban on transfer of technology will be lifted and now the technology will be used for peaceful purposes in the service of mankind. This is going to be an indirect effect on the policies and priorities of under-developed and developing countries and they will have to re-design their strategies and programs to obtain new technologies without any strings attached to the deal or under tied loan from developed countries which up major cause of price till now has been a spiral international debate and this is going to accelerate the process of technology transfer but the internal policies and regulations on trade and finance by developing countries also play major role in this process. It is high time that the developing countries and under-developed countries should also amend their internal regulations for attracting investors to finance on new projects bringing new technologies in their countries. The present rules and regulations for setting up a new industry in most of the third world countries are not market oriented and the development plans are made on ad-hoc basis. This ad-hocism should now be replaced with objective and long term planning on the principles of modern business tactics with open mind and sharp eyes.

Now a few point regarding Defense Technology. The laws prohibiting export of military technology, its information, its design and potential use to other countries in general and enemy countries in particular have been in the books for a number of years.

Enforcement of these laws create different set of problems in different times, In a recent book 'Technology And Tyranny of Export Control"; Whisper Who Dares Written by STURAT MACDONALD a detailed analysis of the problem has been carried out.

The rational for controlling the export of military technology to potential enemy cannot be denied. But serious attention was paid during the cold War era the activities of "CoCom" (Coordinating Committee) of West including Japan for Export Control of Military Technology were also increased. The activities of CoCom are also shrouded in secrecy which create problems for under-developed and poor developing countries. Each country has its own export control rules which allows it to impose unilaterally control over defense technology.

The implication of the structure of controls for social, political and economic environment needs study on individual basis. USA has used export control as a primary tool for its foreign policy, while Russia and China used it for expansion of Communism Ideology in poor countries, whereas countries like Pakistan use it for economic and security purposes.

The internal domestic policy plays significant role in this matter. Leak of information, espionage and trade relations of friendly allied countries with the enemy block are main factors. But with each new strict rule to control these factors we pay a high price in slowed innovation. The assessment of the economic impact of export control is very difficult, but it include the following costs.

(I) Indirect administrative costs

(ii) Lost sales of non- Manufactured goods

(iii) Reduced effectiveness of R

(IV) Complexities in the licensing system discourage small firms from exporting

(v) Warehousing and other costs increased while product awaits an export license

2. COMPARATIVE STUDY

The study of development of some countries who emerged as industrial giants belonging to Asia reveals that they took diverse approaches to competing successfully in the field of technology. Government usually played a strong role in guiding development, establishing the appropriate business environment, providing education and training for the work force. No single formula exist for success.

The area's five most dynamic nations are JAPAN, SOUTH KOREA, TAIWAN, HONG KONG, and SINGAPORE. Their ascent to this position is due to their high technology. That ascent has been spectacular. According the WORLD BANK reports these five nations have increased their gross national product (GNP) at double to triple the rates of most industrialized nations. The Fortune magazine has projected, the entire Asian Pacific Rim, despite including some of the worst poorest nations, will have a share of world gross economic product exceeding that of the European community and equal to North Americas By 2020, it may have double the EC wealth.

It has been speculated that soon Japan may surpass the United States economically and technologically. Historically, technology has been an Asian forte. Chinese invented Gunpowder and Paper centuries ago. History tells us that The Great Kublai Khan requested the famous traveler Marco Polo for 100 Europeans learned in science and arts. That quest for knowledge still persists. Combined with the Confucian ethic of toil, respect authority, and preference for cooperation over confrontation, it has inspired achievement far out of proportion to the populations and resources.

Japan's climb from the devastation of world war-II to one of the top technological power is the wonder of globe. Critical to that success was a national strategy for economic growth that the Government and private enterprise hammered out together. The key to success was trade with the world. The government orchestrated the acquisition and internal diffusion of foreign technology into its nascent high technology industries.

At the same time it protected the domestic market from foreign competition. High volume, low cost, self-support and low lending rate contributed towards their leap to progress.

Taiwan Aerospace Corporation acquisition of about 40% of McDonnell Douglas jetliner business in 1991 stunned the world's aircraft industry. That coup was the most visible of many moves by Taiwan in recent years to consolidate its position in the lucrative global aerospace market. Once sweatshop economy that sucked in capital to fuel the growth of its low-tech export industries, TAIWAN has come of age. Now its workforce is among the best paid in the region, and the country's coffers – private or public – are bulging with cash.

Government is encouraging Taiwanese firms upgrade their products by investing into new technologies at home or buying them through mergers and acquisitions abroad. Even before the McDonnell Douglas deal, leading - edge Taiwanese firms were moving within eye towards obtaining new technologies and marketing and distribution networks, in the past four years, for example, the Mitac Group, Taiwan's second largest computer manufacturer, has invested quietly in electronic firms in the US and Britain.

3. TYPICAL EXAMPLE

We should study the system and the development schemes of such nations who have wrought their economical and technological miracle. Following is a brief description of the technical development and the economical progress of some of ASEAN countries

Japan

In 1947 the production of Japan was barely 1/3 of its pre-war level. By 1975 Japan has succeeded so well in modern technology and manufacturing techniques that it trailed only the USA and USSR in GNP. This success was mainly due to combination of free market and Government guidance popularly known as KIERTSU.

Japan's development in the following fields modern age an example of use of high technology and its gain in the economic field.

(I) Consumer Electronics

Japan has become un-challenged king worldwide in consumer electronics.

It has most of the world leading companies in the field, achieving that top rank mainly by continuously introducing new products. In 1990, several Japanese companies unveiled high definition television (HDTV) products, even though there is only one hour of satellite broadcasting of HDTV programming per day.

Among other advanced consumer electronics products that Japanese firms have introduced domestically in recent years are those incorporating fuzzy logic and neural networks. (Fuzzy logic is a branch logic that uses degrees of membership in sets rather than a strict either- or membership. A neural network consists of many densely interlinked processing elements that keep adjusting their outputs until the net result represents the inputs).

Another Japanese innovation is satellite network of 18 digital pay-to-listen F.M. Radio Stations that offers relaxing music, mostly from the United States and natural sound recordings like bird songs, and an ocean waves. This service has more than 3 Million subscribers.

(ii) Computers and IC's

The personnel computer (PC) may have been born in the United States but most of the Laptop and Notebook Computers are coming from Japan. According to a US Department of Commerce Report "The Competitive Status of the US Electronics Sector" (APRIL, 90).

"Their large scale Mainframes and Supercomputers match the best that the United States has to offer in single processor performance."

The Japanese are serious challenger in this field. NEC for example claimed that its SX-3 Supercomputer is the fastest in the world. Japanese companies have also been embarking on Joint Ventures, setting up plants abroad, and buying up companies in the hope of overcoming threats of protectionism in overseas markets and combatting the appreciation of Yen. Japan's manufacturers are also making their mark in computer peripherals, including liquid crystal displays, laser printers, high capacity floppy drives, and large capacity storage system such as optical disc drives. Canon supplies its laser printer "Engine" to a worldwide array of companies and is said to own some 80% of this market.

(iii) Automotive

Most electronics in Japanese vehicles are produced by automakers subsidiaries, affiliates or associated companies. Japan is producing a full range of automotive electronic products, from sensors to engine and transmission controls, anti-lock braking system, navigation system and four-wheel steering. Fuzzy logic is also on the agenda for Japanese cars. Toyota officials estimates that such systems as speed and brake control using fuzzy logic could be ready for commercial sale in five years.

(iv) Robotics

Labor shortages and global competition has forced Japan to introduce automation in production (Robotics) more intensively and extensively. Of the industrial robots employed in 16 leading industrialized countries in1989 about two-third were employed in Japan. Professor Fumio Hiroshima of Tokyo University's Institute of Industrial Sciences told IEEE, "SPECTRUM" in an interview, "If you, calculate that one robot can do four times the work of a person, then the number is actually equivalent to about 2 million workers".

Factoring in other factory automation tools, such as computer numerically controlled (CNC) machines and transportation, as well as storing machines, such as un-manned forklifts the Japans tireless workforce becomes even more significant.

According to one report, automatic control of blast furnaces is saving the NIPPON KOSHUKA STEEL CO, about US$ 700,000, annually. The ferocity of the fight in Japan to accelerate production process while minimizing mistakes is winning converts to computer- integrated -manufacturing (CIM), where manufacturing from design to marketing are coordinated by a computer and communication.

This also reduces the time of production cycle. Japanese firms are trying their best to reduce the cost and improve the quality through the use of high technology in every field from car to VCR.

(v) Telecommunication

Japan National Telecommunication (NTT) changed from government run monopoly into a private company in 1985. The aim was to encourage competition among private companies and drive down prices and improve services. Now Japan has hundreds of competing carriers and value added network suppliers and the cost of domestic and international calls has plunged.

(vi) Aerospace and Military

In 1990 Japan sent its first space craft around the moon- the first lunar probe by any country in 14 years, and the first that was neither American nor Russian. On military side, Japan has had a domestic aircraft industry since the 1920. One that rose to world class in World War II. Since than it has worked closely with US aircraft industry.

The post-war Japanese aerospace industry re-started with maintenance contracts on primarily military aircraft and then commercial transports far away from regular repair depots.

Today 80% of the Japanese aerospace spending is from defense- related contracts for the country's self-defense forces (Japan constitution prohibits conventional all-purpose forces)

(vii) Medical electronics

Japan concentration has been on technologies like X-ray and ultra- sound, and is flooding the United States and European markets with low cost quality equipment. From 1980 to 1990, Japan's portion of medical product imports to Unites States, the world's largest consumer, rose from 18% to 24%.

Japanese companies keeps cost down by developing application specific units, rather than the general purpose instruments. The ultra- sound (CT OF MRI) equipment developed by Japan have more channels and better memory than Western products for the same price.

(viii) Power and Energy

M/s Hitachi, Toshiba, Mitsubishi and Fuji Electric of Japan have annual revenues ranging from about US $ 5 Billion (Fuji) to US $ 50 Billion (Hitachi). Heavy Electric Equipment- Turbines, Steam supply system, Transformers, Switchgears, and complete power plants (Turn Key Basis) are being supplied by these Japanese firms throughout the world.

Key research thrusts in Japan include advanced battery storage system, fuel cells, heat pumps, ceramics gas turbines and application of super conductivity. The Ministry Of International Trade and Industry (MITI) sets the main research directions with the assistance of leading electric Companies.

(ix) Transportation

Japan has led in rail technology ever since 1964, when Japan's Bullet Train introduced high-speed rail transit to the world. Japan is also improving the linear induction motors use on railways. Japan's Railways has run Prototype at about 500Km/h.

Japan has the largest airline complex. Four international carriers and four domestic airlines offers scheduled services which is also a clear proof that Japan is one of the largest economy in the world.

South Korea

After world war-II South Korea adopted vertically integrated conglomerate called CHAEBOLS; rigid import barrier and the exploitation of an open USA market for export. South Korea moved up to steel, ship building and auto production and then to simple electronic products. More recently through joint venture and indigenous R&D, it has ventured into more advanced technology like aerospace and (VLSI) very large seek integration and industrial robots.

Korea's development field is an example in the following of use of high technology in the development of the national economy.

(I) Consumer electronics

Korea's principle consumer's electronic products are Television sets, Video cassette recorders, Radios, stereos, amplifiers, recorders, microwave ovens, telephones, refrigerator and electronic watches Korea produces about 15% of the world's market for TV sets and VCs and about 25% of the world's market for the Microwave ovens. In microwave ovens Samsung, Gold Star, Daewoo controlled the global market from 1985 1989.

In the long run, Korean electronics firms are expected to remain as important players in the world markets despite current problems marked by price competitiveness. But technology development will remain a challenge and collaboration with foreign partners under the Government supervision Korea will be in the forefront.

(ii) Computers and ICs

South Korea has amazed the world by growing from a minor supplier of discrete semiconductor devices and IC packages to a Major producer of ICs. Today South Korea furnishes about 3% of the total world market for

ICs and 15% of the world market for DRAM

Samsung Electric Co produces both 1M-4M bit DRAM's and is independently developing a 16 M bit version. M/s Samsung has joined M/s Hewlett Packard in research on RISC chips.

This year M/s Samsung plans to spend 12% of its US $1.4 Billion semiconductor sales revenue on R & D and other important IC producers includes both M/s Gold Star and Hyundai producing 1M- bit DRAMS.

(iii) Automotive

Most the South Koreas car manufacturer have their own electronic subsidiaries. Hyundai Motors and Daewoo Motors producing their own sophisticated electronic controls for engine control. There are about 100 car radio and compact disc player makers in South Korea and depends mostly on foreign markets. Collaboration of Hyundai with Mitsubishi and Daewoo with General Motors is an important factor In the development of national economy.

(IV) Robotics

The domestic production of Computer numerically Controlled (CNC) machines started 1980. Since 1987, the sales passed the 2000 unit mark.

About 20 known firms are producing industrial robots. By late 1989, about 1200 industrial robots were employed at Korean factory sites, mainly for arc welding, spot welding and assembly. Most are used in auto industry.

The use of automation in production technics has resulted in the reduction of work week from 55 hours in 1987 to 48 hours in 1993.

(V) Aerospace and Military

In March 1991 South Korea signed a Learn-by-Doing contract with General Dynamics for 120 F-16 Jets, at US $ 5.2 Billions

South Korea wants to be able to supply its Air Forces with AFX fighters designed and produced domestically. The first 12 fighters (F16) will arrive complete and ready to fly from USA. The next 36 will assembled in Seoul. The remaining 72 will be manufactured under license by Samsung with Korean made components and sub-assemblies.

A similar Learn-by-Doing program for space technology has been started in Collaboration with Telesat of Canada and Satil Conseil of France. South Korea first communication satellite MUGUNGWAH will begin service in Oct, 1995 at a cost of about US $ 40 Million. The country's domestic participation in this program is limited, but the technical knowhow gained during this program will lay a foundation for future satellite production.

(VI) Power and Energy

The generation and distribution of electricity is in private sector. Two Nuclear power plants are under construction at Yonggwang and negotiations are going on for third Nuclear power plant in collaboration with M/s BBB of Sweden.

South Korea's main heavy electrical equipment makers are M/s Leeching, Gold star, Hyosung and Hyundai. All of them makes transformers, switchgears, medium sized generators and capacitors. National progress for electrical power R&D is fairly large. Major research of thrusts include investigation ceramics, metals, and other high tech materials.

Taiwan

Taiwan has achieved another spectacular success. Privatization of state industry plus corporate planning paved the way to industrial development. Cheap labor and financial incentives attracted sufficient foreign investment for economic take off.

National savings rate has rose up to 30%, one of the highest in the world. Taiwan foreign exchange reserves stand at more than $75 billion, up from $46 billion only five years ago. In 1991 Taipei announced a $ 303 billion infrastructure modernization plan that will undoubtedly bring more industrial units.

(1) Consumers Electronics

Electronics has been the No. 1 Industry in Taiwan since 1984, when it surpassed Textiles. But most of the Consumers electronics part of that industry was built on low-end products- TV sets, VCR, Telephone, Calculators, Cameras, and Electronic watches.

Facing problems like inflation, rising labor and land costs, and an unfavorable foreign exchange rates, big electronic manufacturing firms like, National, Tatung and Sampo are making R&D commitments as they

shift their focus to high value added products. To cope with high labor costs, Taiwan is also shifting the manufacturing units in other neighboring countries, like Hong Kong, China and Malaysia. Some companies are manufacturing world renowned Car Radio and Audio Speakers in other countries but R&D and quality control activities are still based in Taiwan.

Taiwan is also planning to begin a 5 years R&D program to develop a working HDTV at a projected cost of US$ 192 Million.

(ii) Computers and ICs

The consumer electronics industry received a setback in 1988 due to global shortage of chips. Since then Taiwan is developing its own indigenous IC industry. At present, the IC industry exports more than 40% of its production and account for about 1% of world production. The ACER group is collaborating with Texas Instruments Inc. and is building a manufacturing plant in Taiwan. The production will start in 1992 and will meet the demand of domestic market.

(iii) Aerospace and Military

Taiwan industrial base is about the same size as that of South Korea. It already has a prototype of its indigenous defense fighter (IDF), and is in the service of Taiwanese Air Forces. Popularly known as "Chin- Ku" Fighter this is a fast climbing, light weight, defense interceptor. It can also carry anti-ship missiles.

Taiwan Industrial Development Board (TIDB) is responsible for Design, Manufacturing, Quality control and Certification of Aero-Space Industry and prediction are that the Aero-space business could be worth as much as US $ 600 Million by the end of year 2000.

(iv) Other Fields

Taiwan's largest equipment maker Shinshu Electric and Engineering Corporation produces circuit breakers, capacitors, transformers and other allied electrical equipment in joint venture with M/s Mitsubishi.

Taiwan National Electric Utility Co., has stepped up its internal research activities and now spends 1% of its gross sales on R&D.

Taiwan also plans a Bullet Train at a speed of 300 Km/h linking Taipi with Kaohsiung (353 Km) by the end of 1998.

SINGAPORE

With only 2.7 million people become fully independent in 1965 and parlayed strategic port, ship building and oil refining facilities into a diverse economy with per capita income second in Asia only to Japan.

Plowing back revenues into education and physical infrastructure, it methodically progressed. SINGAPORE depends heavily on foreign Multi-National Corporations to set up operations to transfer technology and provide jobs and a share in the profits from the international trade.

(I) Consumer Electronics

The principal consumer products made in this small City- State are Hi Fi Equipment's, color TV sets and Audio Cassette Recorders.

M/s Robertson Audio produces state-of-the-art Audio Amplifiers selling for US $5000 to 6000.

France's Thomson has set up a plant in joint venture with Toshiba to design and manufacture VCR' S in Singapore. The capacity of this plant is 4 Million units annually.

Sony Corp produces precision head cylinders for VCRs in Singapore.

Aiwa Co has set up a plant at a cost of US $ 40 Million manufacturing Audio equipment.

Singapore encouraging other Multinational Corporations to manufacture precision components and consumers electronics products.

(ii) Automotive

SINGAPORE automotive components industry hit the US $1 Billion mark in 1990. The country has come a long way since the 1960 when production by a handful of companies centered on simply original equipment manufacturer and replacement components only for domestic market. Now Singapore is a major manufacturing base particularly for the production of higher-value-added engineering systems.

The engineering development content of major manufacturers has been growing with greater autonomy of product design, purchasing and material control functions. But the country's continuing focus is on niche products or activities such as vehicle controls and car navigation systems and on firms that can utilize advances in technologies to design and produce

new generation of components.

Today a broad range of components are being produced, including subsystems like ignition control modules and pressure sensors. GM Singapore, a wholly owned subsidiary of GMs

Delco Electronics Division, for example has a workforce of 2500 employees. They manufacture engine control modules, audio systems, pressure sensors, voltage regulators and other products for worldwide markets

(iii) Mixed Economy

Mixing free enterprise with government guidance and grants, Singapore has attracted Multinational companies that have the technology, cash and capacity for growth. The multinational companies set up factories and provided employments and provide international trade facility through their already established networks in the world. This policy brings the technology transferable to indigenous engineers and would be entrepreneurs. Singapore government also introduced a series of measures to attract the foreign investors. These measures included lengthening the work week, reducing the number of holidays, restricting payment of retirement bonuses, paid leave, overtime and bonus in general and exempting promotions, transfers, firing and work assignment from collective bargaining.

These policies succeed. SINGAPORE became known as a place for low-cost assembly for export. By 1979, the output of electronics topped $ 3.7 billions, having grown 30% in that year alone.

In short order, the industry developed from labor intensive assembly to product Engineering and automated assembly.

INTEGRATION

1. CONCLUSIONS

The success of economical transfer of technology depends on certain conditions:

These conditions are not directly related to technology. They do however promote a desire for new technology and atmosphere in which it can grow. These conditions for a successful transfer either existed or were created by the newly developed countries like Taiwan, SINGAPORE and Malaysia. A proper blend of the strategies in accordance with the culture and tradition can bring very good result but what work well in a developed country may not be suitable for a developing country. In some cases primitive technics may be the best and the cheapest solution.

Probably one of the most difficult thing in this study is that each developing country is unique with its own priorities and idiosyncrasies. There are five conditions necessary for a successful transfer of technology. These conditions should be fulfilled before venturing into any project :-

1. Identifications
2. Evaluations
3. Environment
4. Partnership
5. Commercialization

1. IDENTIFICATIONS

The developing country or recipient party must clearly identify the need and carry out marketing survey of the product or services required. Nowadays, the developed countries or advanced nations are inventing new products and creating technology faster than the power and ability of developing countries to absorb it. Today you hear a machine able to perform 5 functions at the touch of your finger the other day you know that an advance version with 25 functions and self-programming unit has been marketed by some other country or some international group and by the time you finish your formalities and arrange all the clearances from Government controlling agencies you hear that now fuzzy logic has been introduced by a third country and the machine or equipment that you had planned to purchase and installed in your country has now become obsolete and no more in production. We will discuss the red tape of bureaucracy in detail at a later stage but the choice of appropriate technology keeping in view the immediate demand of market is the first and Foremost requirement.

The setting up of car manufacturing plant without support services and T.V factory without knowing chips technology is not logical. The problem with developing countries is the lack of national spirit and education. As the literacy rate is low in developing countries the number of qualified persons to decide on the choice and value of technology is even less and

the situation becomes all the more tragic when decisions are taken by bureaucracy without any scientific back ground and technical understandings. The decision are taken on whims and personal interests. Millions of dollars are spent on feasibility studies and foreign visits but the result are large sick units which needs regular transfusion of funds.

2. EVALUATIONS

The financial implications in taking up a project of new technology must be studied and arrangement for funding should be settled before execution. It has been observed that big projects like Fighter Planes Assembly or Missile Production are taken up without proper guaranties from financial agencies and study of marketing potentials. Any delay on the part of funding agent may create time delays, payment problems and sacrifices on many national policies by the third world countries. The recipient must have enough funds to bear the expenses till proper marketing of product. Another financial risk which is not considered in the early stages of project evaluation is the risk of financial failure by any of the sub-contractors employed on the projects. In third world countries there are a number of conditions and restrictions regarding the use of funds and flow of currencies inside and outside the country. This require adequate arrangement of keeping a certain amount of foreign currency as impress with project authorities so that emergency payment are made without going through the whole exercise again and again. Sometime a barter deal is made between the parties and usually the goods offered by third world countries is in the shape of agriculture produce like Rice, and Cotton, in such conditions the fate of the new product hangs in the middle as one cannot guarantee bumper crop each year and Donor makes deliberate delay in supplying the required man and machine which ultimately results in overall delay in marketing the products. There are chances that some other competitor may bring his product in market and take away the initial charm.

There is also a possibility of some new inventions. Second generations of the machine may capture the market while the recipient and donors are still busy in settling the financial problems with bureaucracy. So it is better to study the Total value of the project including such incidental escalation in the initial estimates so that the final product when offered for sale is at reasonable cost and competitive price.

3. ENVIRONMENT

Transferring a technology from a developed country to a developing country and setting up a center, plant or a large industrial complex is like implanting a sapling in your lawn. You have to provide favorable environment, supply all essentials, keep regular maintenance and protect from any damage or harm till the small sapling is a tree and is able to face the gust of winds, suck the food and water on its own and can heal itself the small scars inflicted by children playing in the lawn. Similarly before planning to set up a plant or factory a study of the essential needs is made and then the site should be finalized. You have to provide basic services like road, water, electricity and accommodations. It is unfortunate that for these services there is no single authority or agency in developing countries. The financier or investor has to go from door to door for each of these services. Sometimes the source of water or electricity is hundreds of Kilo Meters away from the site and a large amount is required to arrange for these services. Although much drum beating is done regarding "One window operation" by the governments of developing countries but the story is completely divorce of the facts. Arrangement of local labor and induction of local expertise in the manufacturing and assembly line is very important to keep the prices low and to acquire the technology. This can be done on government level. A chain of training centers for un-skilled labor and technical institutes for semi-skilled labor and skilled labor should be established so that young generations may get the basic educations and technical knowhow and are ready to learn the new technologies from foreign experts in different fields. The setting up of industrial complexes by local or foreign investor will also provide employment opportunities for the locals. Well this is a matter of MACRO ECONOMICS. The financier will earn when the finished product is sold but the government earns in the shape of reductions of unemployment. So it is also in the interest of third world countries and developing countries to invite foreign investors to install their plants and even if they take away big chunk of the profit the gain in the shape of employment and training of local labor will surely improve the economic conditions of developing countries. As mentioned earlier, the favorable environment is very necessary for successful transfer of technology, this also include the trade union activities and labor laws.

Unfortunately trade union activities are not developed on healthy lines in some third world countries and sometimes, vested interest takes

control of the labor unions activities. The smooth and safe operations necessary for a budding units are not available which results in extra demands, strikes and lockouts. The management of new plant cannot be absolved of their responsibilities of failure in handling the situations in certain cases but government should provide some protections against such activities up to a certain period or declare some technologies as essential and put ban on union activities for a certain period. We should remember capital is very shy. It flies away even with a slight change in economic conditions so it is the prime duty of government to provide favorable conditions, so that local investor and foreign experts may work jointly for the transfer of technology and ultimately economics development.

The taxes, duties and tariff regulations in certain development countries results in artificial boost in government revenues but in long term either the new plant goes in loss or adopts illegal means to evade taxes. In either case the process of technology transfer is hampered and such illegal activities results in blackmailing of management by labor unions and thus the quality goes down, prices goes up and the sale of products is decreased.

These are the conditions in most developing and third world countries and a new entrepreneur has to study the environment of recipient country and formulate a suitable policy before entering into contract with foreign firms for acquiring new technologies.

4. PARTNERSHIP

There has to be a true partnership in which the Donor and the Recipient commit themselves to seeing the process of technology transfer through to success.

There has to be a true partnership in which the Donor and the Recipient commit themselves to seeing the process of technology transfer through to success.

This partnership can be on government to government or government to private investors or vice versa but the terms of references, scope of work and level of technology must be defined clearly. For sophisticated may be associated to supervise the fine details of technical process till commissioning of the plant or up to the warranty period. For large technology or large industrial complexes a third party such as consultant industrial units public sector should play major role in this program and after successful completion and satisfactory running for 3-5 years the plant may be sold to private sector. If the private sector is involved from the very start then public sector should take the responsibilities of identification and environment and private sector may be left to deal with the financial administration matters. in some third world countries industrial development boards have been setup and they have obtained very good results. But in those countries where public sector has assumed full powers or in other words where industries are under estate control or nationalized as a result of political process the inherent red tape and lethargic attitude of bureaucracy has destroyed the whole process. When the affairs are in the hand of an industrialist, he manages the system on efficiency and economy. He is worried about the annual profit and loss account, balance sheet and dividends to be distributed to shareholders. He links wages with quality and quantity. He is worried about the refund of loans and accumulated interest. But a bureaucrat or manager of public sector has no such worries. He is worried only when there is news of change of government. He is not concerned with the quality or quantity of product or the labor and management relations. Because the wages are increased by the government without considering the output of the plant. This is true in all cases of state run enterprises, weather it is Russia or Asia. But the problem is that poor countries of third world cannot have this development of technology 100% in the hands of private sector. Some checks has to be made in the interest of country and National policies. So a proper balance is required in partnership in the development schemes for transfer of technology so that the essential technology is obtained at competitive rates and without jeopardizing the national policies.

5. COMMERCIALIZATION

Technology transfer and its role in economic development has been discussed in the above pages. Much of discussion was based on international and national organizations. On the international level research on technology transfer focuses on movement or transfer of technology from developed to developing countries. On national level the emphasis has been on transferring technology from government, academic institutions and research organizations to private industry. It is interesting to know that many under- developing countries like Pakistan, India and Brazil have a good record of acquiring of high technology and

merging it with indigenous technology and to some extent developing to new technology but not in managing it. Effective management critical need for getting the laboratory successfully. At the core of the effective management of technology lies the critical needs for devising viable mechanism for getting the product out of the laboratory successfully that is, the effective transfer of technology through the different product development phases ending up with goods and services designed to meet the customer needs.

In the present world of intensified competition, splintered mass markets, shortened product life cycles and advanced technology and automation, the developing countries should examine their philosophy and approaches to corporate technological innovation and technology transfer. They must look at the Pacific Rim countries especially Japan and SINGAPORE with an eye towards learning from these countries approaches and methods for economical transfer of technology. By its nature new technology requires a major investment which may not provide any return for several years but they should sacrifice for the future generation and they should tighten their belts and avoid spending on imports of luxuries. They should develop an in-depth knowledge of the requirements and the market trend and should make full use of their available resources. A thorough knowledge of the market place can also lead to discover new uses for indigenous technology. Countries that understand the value of technology have their sight set on new invention and their use for the benefit of their country. Even after acquiring a technology they should take steps update the manufacturing process to improve quality, reduction in wastage, reduction in energy consumption, and ultimately reduction in cost. One of the most important characteristics of the countries successful at the commercialization is their tendency to plan for the long term. How do Pacific Rim countries develop new product faster than other countries do? They identify emerging technology and nurture it to commercialization. They see innovative technology in its infancy stages and dare to dream what it can become. Countries that ignore this long-term planning and wait for technology to come to them will have to spend out of their hard earnings. Technology today is a global commodity. It is being refined, bought, sold, and traded around the world at unprecedented speeds. Countries willing to Improve their economy should acquire new technology, adopt it as their own and selling it back to other countries at competitive prices.

The most important growing trend in these efforts today is cooperation. Many countries are joining forces to stay competitive. This cooperation is growing in the automotive, telecommunication, aerospace industries and semi-conductor technologies. Governments can be more supportive of cooperative efforts. A great deal of Research conducted in the universities and government laboratories primarily sponsored with government funds is being developed with little thought given to its value in the commercial marketplace. Technical impediments must be eliminated so that product or services based on these researches can be marketed. Governments can be more supportive in identifying these technologies to the private sector that will create market in the future. The joint action taken by both government and industry might spur commercial development in the country. To a great extent, the key to success of the Pacific Rim countries was successful commercialization. That was demonstrated in the consumer electronics and computer industries. In the next decade global competition will be more formidable but Not invincible. Our challenges will be great, but our opportunities will be even greater.

2. RECOMMENDATIONS

Technology transfer takes time and money. A transfer generally implies a change in procedure, product, material or system. People normally resist change and technological change is no exception. Economical technology transfer cannot be rushed, although impending changes of government, impatience on the part of investor or changing priorities often preclude allowing the time needed. With many reasons why technology transfer may not be as successful as we like our job is to overcome the difficulties. In the past 60 years the technology has shifted dramatically from being almost exclusively domestic to International. This globalization of technology and setting up of manufacturing plants in other countries depends on the creation of a new "CULTURE".

The term culture as it is used here means generally "pattern of behavior and thinking" in the same way as Newman/Summer said;

> “Men live and work together. Their relationship soon results in pattern of behavior and belief, social scientist call all such pattern CULTURE. Every enterprise develops within the broader national framework its own culture that is the belief and pattern of conduct that are associated with living and working together in that company.”

(The Process Of Management, Are Prentice Hall 1961, p 138)

In the successful cases where the local talent was employed in production engineering after proper training and their loyalty was gained by solving their day to day problems; improvement in production quickly stabilizes plant operations, and to the degree that local employees participated to the improvement of the product. The Successful technology transfer depends on the successful operations of its plant in new country, under new environment and creating new culture which is nowadays is known as CORPORATE CULTURE.

The policy needs to be made on economic principle rather than wishful thinking. Right man for the right job and hunt of talent without any quota or reservation will bring excellent results. The present system of red tape, lethargic attitude and supremacy of bureaucracy over professionals should be amended.

What is needed to search for relevant, valuable and protectable technology that gives a competitive edge through superior products, improved production and greater a share of international market. In addition to their own indigenous technology, under-developed countries should scan the globe to buy new technology from other developed countries and merge it with their own produce marketable products.

In pursuit of short and sure path from technology development to commercialization the under-developed countries should follow the examples of countries like South Korea, Taiwan, and Singapore, who in spite of being smaller in size and without any natural resources like Oil and Minerals have developed strong economy through technology transfer.

The progress of Japan, Taiwan, and Singapore can be taken as glaring example of hard work dedication and successful policies. They have managed to stabilize population. It is the ripple effect of regional cross investment that accelerate the development of economy and technology.

The policy of right man for the right job and hunt of talent without any reservations will bring intelligent people with revolutionary ideas and up-to-date knowledge. The present system of red tape, lethargic attitude and supremacy of bureaucracy over professionals in the Third world countries results in slow progress and sometimes the whole investment goes in vain. But the problem is as the saying goes "They do not know that they do not know."

3. PRACTICAL EXPERIENCES

Following are some examples of the experiments carried out in Pakistan during the last 20 years with brief description.

NATIONALIZATION

In 1971 Pakistan made radical changes in the economic and industrial sector. All the private industries, Banks, Educational institutions and even export of rice and cotton were taken under state control.

This resulted in total collapse of the economy. The units which were running in profit and were distributing dividend to the shareholders started their downhill journey. Prices in share market dropped. Production reduced in quantity and quality. The high qualified and experienced management and skilled labor were replaced by the bureaucracy. Overhead charges of industrial units increased as new management started lavish spending on office furniture and luxury cars. No efforts to sale the product in local market were made. All the export orders were cancelled due to low quality.

To quote an example the case of M/S. Batala Engineering Company (BECO) which was manufacturing lath machines, motors, pumps, medium size equipment and tools and was earning handsome foreign exchange became a sick unit within two years. Many senior managers and workers were laid off and the new labor engaged had no idea of working in such complex unit. Similarly the services of banks became very poor, interest rate on deposits goes down, deposits reduced as people started withdrawing their deposits. Even for drawing a simple cheque in three digits from saving account use to take three to four hours. How can you expect public to come to a nationalized bank and faces humiliation. Now after twenty years all these nationalized units are being de-nationalized. Pakistan wasted twenty years as a result of this experiment.

WAGE AWARDS

During the same period the wages were raised twice by the federal government, this rise of wages was universal having no rational with the inflation or true economy. This results in collapse of small industrial units. Management had no control over the production or quality as previously they used to raise the pay according to the ability and efficiency of the worker but now all were equal. This action was very disheartening for

efficient workers. The investor also suffered as they lost market due to poor quality production. This system brought very adverse effect on the economy of the country.

These two examples has been quoted to give an idea of environment and regulation which place an important role in the development of a country.

PROJECT IDENTIFICATION (Steel Mill)

Pakistan entered into an agreement with USSR for setting up a steel mill near Karachi. Unfortunately the bureaucracy succeeded in rejecting the recommendation of Engineers. A plant was purchased which cannot utilized the local iron ore. Now Pakistan is importing ore, coal, and fuel for this steel mill and it is more than twenty years that the steel mill has not reached the breakeven point.

The size of the plant is also very big and Pakistan has to make arrangement for a new port facility and a big railway network. Instead of such a large unit and depending on raw material from foreign countries, if Pakistan have gone for erection of 3 to 4 mini steel mills near the ore deposit and production technology based on indigenous raw material the scheme could have been successful and economical.

PRIVATE GENERATION OF ELECTRICITY

Pakistan is now asking private sector to invest in power plants. In Pakistan the sole responsibility of generation, transmission, distribution and sale of electricity is under state control. It took thirty years for the non-technical bureaucratic authority to agree that it is not possible to overcome the shortage of electricity. Now they have liberalize their policies of government control and allowing private sector to help government in setting up power plant to cover a shortage of about 2000 Mega Watt.

TASK FORCE

While working as Project Director "Grid System Constructions" in Pakistan, I avail the opportunity to use the concept of "Task Force" in completions of projects where foreign equipment was being purchased and installed. In Task force the key Ingredient is team work. People from many department or different fields of expertise. Collaborate over a "job"/Assignment from planning to completion. Initial surveying, planning, Designing, cost evaluation, budgeting, material acquisitions, tendering, supervision and monitoring works together from the outset to anticipate problems including political bottlenecks and to eliminate them early on. In doing so, I was successful in avoiding delays in completion of projects and costly failures in service. Accountant and Financial people were given due attention and sometime taking into confidence at the early stages results in minimum objection and less audit remarks.

This system is also known as parallel engineering or simultaneous engineering. Indeed Japanese consumer electronics manufacturers have practiced it for years without giving it a special name, they consider it simply good business and engineering sense. My motto was "Work smarter not harder". Integrating all resources and services the concept of task force strikes to achieve the targets in minimum possible time, most importantly, task force. Reduces the overall completion time because the activities as seen on C.P.M. are handled in parallel instead of in serials.

If the same technique is adopted in technology transfer, it can shorten the overall product development process because the steps can be taken in parallel instead of in series.

The time to market is also improved because in this system the number of product iterations is reduced. First prototype not only meet specifications but also are compatible with the company's manufacturing capabilities. In forming an inter functional or inter disciplinary team the best tactic is to set specific goal as early as possible. These should be aggressive not evolutionary and should be based on experience with the current practice.

Task force is a co-operative enterprise within an enterprise in which persons or group of persons, other expert’s field supervisors and trade union leaders work on different facets of the job under the directions of a project leader. The members of task force or this newly created interdisciplinary group roves across traditional department boundaries. Unconstrained by arbitrary barriers, this special group communicate their insights, make recommendations, and negotiate conflicts. They bring problems to light. Once the problems are highlighted the solutions are sought or joint policy is formulated to overcome these problems.

In the initial stages it was very difficult to convince the Engineers and Administrative Officers to sit together with the field supervisors and labor leaders. It was also very difficult to win confidence of the field staff as

they were taking it as a NOVEL idea only, not feasible practically. My colleague working in the department also warned me not to mix freely with the Labors and junior officers. But with the support of some of my senior officers and firm belief in the principles of right man for the right job I started to form these special groups regardless of their rank, position or educational background. The difficulties and their solutions were discussed freely with the lowest rank in the presence of supervisors and officers. Experts from one Sub-Division or Division were deputed to visit sister Sub-Division and Division and the mutual interaction opened field for joint efforts. A sense of mutual understanding and working for a common interest was created slowly and progress started to improve. It was found that some persons are expert in collecting and transporting heavy equipment and material so they were deputed to collect the material for the Whole Directorate and person’s instruction experts in construction and installations were given the task for short intervals. After every phase the progress was reviewed and in some cases the working gangs and supervisors were switched over to other jobs according to their expertise and interest. This free flow of expert labor and supervisors on mutual basis promoted a sense of co-operation. The ultimate goal was to develop a system in which the people working on a project can instantly communicate with each other and access, share and store up-to-date information in a transparent way, unhindered by geographic separations, departmental structure, transport facilities and incompatible tools. I am proud of my achievements in completions of transmissions lines and Grid Stations in record time and expenditure in desert of Pakistan working on this principle

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Syed Sarfaraz Ali, MSc

You have fulfilled all requirements for the earned Master's degree as of March 15, 1992; and to confirm your achievement, the University issues this official

STATEMENT OF COMPLETION

Further, upon recommendation of the Faculty of the

Commercial and Industrial Economy

and by virtue of the authority vested in the University by the California Superintendent of Public Instruction, we have conferred upon you the degree of

Master of Science

with a major in Business Administration, with all the Rights, Privileges, and Honors appertaining thereto.

Working with you toward this goal has indeed been a pleasure.

Congratulations,

R. Frank Sutter, PhD
Vice President

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