Management Engineering---An Emerging Discipline[*]
by Masood Hasan

From a one man concerns to giant companies and corporations is symbolic of the rapid advance made in science and technology making large scale production undreamt of half a century or so ago, possible. This has given rise to problems of co-ordination and control on account of decentralization of authority.

In the article below by Mr. Masood Hasan, Executive Director, United Consultants Ltd., read at the Seminar on "Development of Engineering Consultancy Services in Pakistan" held in Lahore on 29th June 1973, a case study has been made of Management Engineering as an Emerging Discipline.

"…The ideally perfect constitution of a public office is that in which the interest of the functionary is entirely coincident with his duty. No mere system will make is so, but still less can it be made so without a system, aptly devised for the purpose."---J.S. MILL.

I will be presenting one point of view in the development of engineering consultancy services in Pakistan. From the title of this talk it may appear there is a contradiction in putting the two words Management and Engineering together. However, it is not through accident that the Association of Consulting Management Engineers of the USA was set up by what are now the most respected management consultancy firms in that country, both in the USA and the UK their present-day large management engineering/ consultancy firms got launched during the early thirties---the years of the depression and were originally concerned with Work Measurement and Method Study ie Work Study. This is, of course, micro-oriented in character but served to introduce to organizations the type of assistance that outside consultants, with no axe to grind, could give.

Engineering is the art of compromise based on the conscious application of science to the problem of economic output. This is merely another way of stating that an economic solution to a technological problem is invariably a compromise. When we mention compromise it means there must be two or more alternatives. In order to evaluate them requires the collection of facts and assembling them in such a way so as to produce a coherent picture.

As long as organizations were small, one person could through personal co-operation ensure effective co-ordination or control. But when the size of the effort expands quickly the work methods of the one-man shows must change. If they do not then the organizational vehicle misfires and the more effort put in by the Number One the worse the total situation gets.

Historical: Development of Complexity

How has this position arisen? If we look back into history I believe we can develop new insights into our present day problems. Up-till about 1700 the philosopher was the respository of all scientific knowledge. However, around the end of the 18th century the

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sum total of scientific knowledge grew to such an extent that the philosopher gave way to the natural philosopher who as his successor became custodian in interest of all scientific knowledge. Around the mid of the 19th century history repeated itself and the natural philosopher unable to cope with the quickly expanding inventory of scientific knowledge threw in the towel and the natural scientist was born. Around this time the Universities split up into the arts and the sciences. This helped to bring a sharper focus to bear on smaller areas of knowledge, this was made possible quick progression in the various compartments called physics, chemistry, biology…. This was also tacit admission of the human beings incapacity to attack nature or knowledge as a whole. But it certainly did prove the superiority of the scientific method to the hilt. This fragmentation continues apace at a growing rate even right now. The problems that arise in communicating from one compartment to another have given rise to new multi-disciplines such as biopetro-chemical engineering or ortho molecular psychiatry etc., wherein several compartments have been brought together in an attempt to unravel the secrets of Nature. If this is what has happened on the pure side of knowledge acquisition let us pause to examine the commercial, industrial, administrative or technological side of human endevour.

The application of the results of pure research in the field made it possible for small one-man shows to grow and with growth a somewhat analogous proliferation of specializations came about. We are familiar with functions including costing, financial and management accounting, of maintenance, of procurement and inventory control, of personnel and training and so forth. The problem that now faces us is how to find a substitute for the one-man show-personal-cooperation that works so well in small organizations but of itself gums up the works in large organizations. This is but one aspect of complexity. There are others.

Time and space have in many contexts been annihilated. Not only can one move about at speeds unheard of a few years ago but also the audio-visual image can be instantaneously transferred across the world through satellites. Tofler in "Future Shock" deals with the implication of speed, rather the rate at which speed is increasing. Brzezinski in "Between Two Ages" talks of our being ushered into a "technetronic" area and there are others who have analyzed our present day frustrations.

In our day to day work we find Parkinsons First Law---that work expands to fill the time made available for its completion---helps in the final analysis to increase the paperwork increasingly shuffled around at geometrical progression rates.

Some Present Day Institutions

We find that we have borrowed a number of institutions developed elsewhere and that they are not working as well as they are here as in their countries of origin. Witness our joint stock company system or our system of semi-autonomous/statutory bodies or our banking system… do we all not feel they leave much to be desired. Just hazard a look at our accounting system in the government which are basically M/s Foster and Whiffin's recommendations made in 1863. Whilst their procedures may be well suited to highly predictable accounting events taking place in one year such as for wages, salaries, TA

and DA, but where one year is no longer enough it creates chaos, it cannot take care of the pipeline problems.

"Until recently one year was enough for three reasons. Firstly, relatively few activities required thought or coordinated action which took more than a year to prepare for and these activities could be carried out, typically, on an ad hoc basis. Second, relatively few commitments of resources would last for more than one year, and third, when they did, they would not be drastically altered by changes taking place during their economic life. Today all three elements have changed". (Long Range Planning---WARREN).

If we look at our tax administration there are several indications of its malfunctioning. We are all aware that there has been a complete failure to redistribute wealth principally on account of tax evasion. The perpetuation of ancient thought patterns "bureaucratic inflexibility, combined with gradual rather dramatic change in the economic and social structure, is usually the cause of inadequate tax administration. The tax system shows the signs of strain: tax evasion increases, and administration, if not corrected, progressively deteriorates. This results in a sense of growing injustice felt by the tax-payers, which in turn leads to even greater increases in tax evasion (Tax Administration in Theory and Practice---NOWAK).

Some two years ago a measure of our tax administrations efficiency could well be gauged from the figures, that we collected less than 2% as Income and Corporation taxes in relation to our GNP. The average of undeveloped countries was 6 per cent and developed 17 per cent. The 4 per cent not collected represented nearly Rs 220 crores only.

In the private sector because of unreal exchange rates and protection of one kind or another the question of improving efficiencies by and large was never really an important question. The consequences of this wrong orientation towards output are quite apparent. Amongst other things it meant a neglect of utilization of those with professional backgrounds.

If we look at the law and the use of administrative discretion the position is also unsatisfactory. The two military dictatorships conferred on the bureaucracy (doubtless on a quid pro quo basis) almost unlimited and undefined discretion, creating virtually a jungle of administrative lawlessness ie usurpation and abuse of powers, corruption and inefficiency. Judicial review has fallen short at the interface of control over the legality and a full re-examination of administrative action taken. We should all look forward to the setting up of the relevant Administrative Courts as laid down in Article 212 of our Interim Constitution of 1972. It will create severe pressures to improve upon existing methods.

So far I have mentioned very briefly how complexity has arisen, how the environment will continue to induce added complexities and the resultant effects on some sectors of organized activity in the country.

Resolving Complexity

Nature is not concerned with limitations in the scope or depth of our abilities to come to grips with it. We cannot have our homework done by proxy and expect to know all about it. Let us not limit our appreciation of problems by limiting our method of approach. Let us also realize that attempts to build up the total picture by putting the small bits and pieces together---which we have created on account of our incapacity to understand Nature as a whole---will always give us the wrong picture. A systematic approach to understanding the problems of organized activities involving man and machines has its immediate origins in problems thrown up by the development of radar, Britain's then secret weapon, in the late thirties. A methodology was developed in World War II to a large extent by P.M.S. Blackett, himself a physicist of note, when he was put on to the evaluation of British weaponry with a view to increasing its operational efficiency. What may be surprising was the composition of his team. It consisted of two physiologists, one astrophysicist, one retired military officer, one ex-surveyor and two mathematical physicists. Later the team, known as Blackett's Circus, added another physiologist, a general physicist and two mathematicians. This method was given the name Operations or Operational Research (OR) or Operational Analysis. It exhibits 3 characteristics:

- the systems approach
- the multi-disciplinary attack and
- the use of the scientific method

In the USA such academicians as Phillip Morse and Bernard Koopman helped to further the above methodology.

I do believe, if we are to improve our administrative efficiencies the ways and means developed in OR can go a long way towards assisting is capturing the efficiencies that appear to be eluding us. This is what Management Engineering in Pakistan has so much to do with.

This should not be foreign to our genius for if we look back 13 centuries ago we will find that the liberating influence of Islam spread the word of the inductive method or that of empirical science around in no uncertain terms. The Greeks were the masters of the deductive method, which as we are aware consists of starting with assumptions and there from logically developing a thesis. But the validity of our conclusions can only be as good as the validity of the original assumptions. This attitude of pure mental gymnastics led the learned Aristotle to aver that women and fewer teeth than man. Although twice married, it never occurred to him to put his assumption to test by subjecting his wifes mouths to his observation. The inductive or empirical way of doing things forces us to doing a lot of home work. To make observations where the ground level transactions or procedures are actually taking place. To attempt to determine patterns. To then formulate hypotheses. To validate them and so to enunciate theories and possibly later, laws.

Free Flow of Information a Must

The Manager of today has saddled on his shoulders an administrative heritage that requires to be shrugged off. Managers or administrators are doing two and only two things ie, handling information and making decisions (which is but a moment in the process).

"The business of government consists of processing information and taking decisions. The information which has to be processed is very extensive and the decisions which have to be taken are very complex. It is unreasonable to expect Ministers and senior civil servants to manage the business efficiently unless they are supported, on a massive scale by the techniques of moderns information technology" (The Design of Information Processing Systems for Government, - Robertson).

When the Management Engineer/Consultant can Assist

What then is the answer to some of the problems that have arisen on account of and in spite of us? Recognition of complexity is the first prerequisite, the second is that of accepting the scientific method with all its unfamiliar inconveniences. And it is here that the management engineer or the management consultant can assist. He is a logical adjunct to professional management and an assist when:

- a one-time problem must be solved
- specialized skills are needed part-time
- an 'outside viewpoint' is desirable
- executive manpower is overloaded
- a new company or project is being organized
- an objective appraisal is needed
- an organization becomes "too ingrown"
- a long-range view is called for

Should an organization set up their own arrangement for the above, it is possible, but it will have to continue to justify the retention of such individuals up till their retirement. This obviously is tied up with evaluation and with the definition of yardsticks, otherwise there can be no such thing as accountability.

There is of course the view point that the management engineer is an outsider so why should he be let in. This is a hang-over of the days when the administration wished to function according to the dictates of imperialism. With the tendency to move towards the dispensation of social unity these attitudes will have to dissolve in the solvent of accountability. We must move from a "control" view point to a "production" or output oriented society. Nontheless it has been said that the use of outside consultants leads to:

- decrease in departmental work loads
- undermining the integrity of employees
- creation of an impression of departmental incompetence

- placing a premium on experience as consulting houses have hardly any experience in Pakistan
- paying more for work which can be done internally

the above view point arises, in my opinion, on account of a sense of false pride that "I as a manager or administrator have so many years of experience have little or nothing to learn from someone who has never been in my organization". This attitude unfortunate because it does shut the door.

Form and Content of Problem

There are two aspects to problems ie the "form" and the "content". Consider sighting submarines in the sea. You can take a fast aeroplane and sweep a large area but observational errors will be higher than in one take a slow aeroplane and sweep a smaller area. A fast auditor can flip through several vouchers but will make more observational errors than an auditor who spends more time on each voucher. Naturally, the slower auditor will go through fewer vouchers.

The "form" of both problems is the same, they are search procedures subject to similar "sampling" and "observational" errors. But the content of both activities are poles part: The management engineer, who has had the opportunity to look into several organizations is much better equipped to isolate the "form" of a problem. The "content" is given by those involved in their activities for 5, 10 or 20 years. And it is by bringing both together that new insights are made manifest for purposes of problem solving. With the increasingly less time one has to proact to change it is humanly impossible for the line manager or administrator to not only be concerned with the content of his work but also to start identifying the form. This is where outside assistance can be of considerable value. Management techniques have become more and more dissociated from the content of activities.

Because of our in-built traditional way of thinking we fail to recognize that the needs of the market, that the needs of the people are ever so much more important than the convenience of the various functions ie the output is more important that the antediluvian procedures, which we consider sacred because of their old age. The management engineer is an agent of change and his function is to help organizations respond better to change thrust upon it from without, over which it might have little or no control by helping it to build up internal resilience and strength.

Reorganization

One of the classical reactions to organizational inefficiencies in Pakistan is to "reorganize" and having reorganized we expect everything to fall into place. We must understand that the structure of an organization is merely an "enabling" mechanism, it merely permits work to be done properly provided it is done properly. What is important is to put the Systems (the smallest unit of a system is a procedure), on a proper footing. If this is not done, whether the reorganization means "decentralization" (or a "centralized"

organization) or "centralization" (of a "decentralized" organization), policies will not be converted into the ground level transactions or procedures so as to be in consonance with proper policy implementation. It is far easier to alter policies rather than procedures which is most unfortunate.

It is true that when a change is being made the individuals in authority are more important than the system itself. But if the changes made have to stand the test of time the system have to be put on an even keel. It is on this score that we talk of an institution being the lengthened shadow of a man. It is also on this score that we find that systems work is painstaking and laborious for it involves detailed observations which have to be recorded, analyzed and developed. Then only can recommendations be made. More importantly it is vitally important to carry all concerned in the organization otherwise recommendations end up beautifully bound volumes gathering dust. Fortunately there are ways and means which have been developed to bring about involvement of the individuals right from the time an inquiry starts off. But this enters the realm of techniques and this is not the proper forum for them. Suffice it to say developments in management science in the past 12-13 years have advanced by leaps and bounds. It is for us to capture such knowledge. It is the lost property of anyone who finds it, as is where is.

Training

Training forms the basis of the management/engineers-consultants methods for introducing new techniques. New techniques which are required as an answer OUR problems. Basically we can divide training into two categories:

- Pre-entry (prior to assuming responsibility)
- Post-entry

Pre-entry training can be sub-divided into functional and general, both away-from-the-job.

Post-entry can be sub-divided into functional and general, both away-from-the-job and on-the-job. The management engineer is also concerned with general training on-the-job, of which we have precious little. It is only in this fashion that the administrative tone can be improved. This also in keeping with the empirical approach which is really meaningful in the context of the organizational ills we suffer from currently.

It is as well to remember that the major objective of almost all organizations small or large, national or supernational is "continuity" and that the links in the chain of continuity are the men behind the technique, procedure, transaction or gun. The better trained in implementation he is, the stronger the organizations internal strength. The external posture is in the final analysis but a reflection of what goes on within.

It is not the total inventory of knowledge that a society has that is meaningful. It is the turnover involved which converts the potential energy into kinetic. It is a fact that

management engineers/consultants have been involved in the development of almost all successful management techniques. In their own small way they add to the storehouse of knowledge, help turn it over, increase productivity through employing highly qualified and experienced professionals. In so doing rigidity: "the hobgoblin of small minds" is rejected and this leads to creative change Jean-Francois Revel in "Without Marx or Jesus" says (even though belonging to the French left), that the USA has given birth to a second revolution ie of a sweeping social transformation. He says that 5 revolutions must take place simultaneously or not at all ie:

- a political revolution
- a social revolution
- a technological and scientific revolution
- a revolution in culture, values and standards
- a revolution in international and interracial relations

Even though the parallel in Pakistan is not similar, we can conclude that agents of change should be encouraged if their objectives are all for the good. This brings me to an aspect of management engineering and that is: what is it that a client is purchasing?

Professional Services Purchasing

Purchasing a service is not the same thing as purchasing a physical product. God forbid that any of us contract appendicitis, but if so, if so, would one gather a number of surgeons together and have an auction match? I am sure neither the surgeon with a hatchet in his hand nor the smooth talker would be given the professional responsibility. Other considerations must of needs come into the picture. There are three key concepts which are involved in management engineering services:

- Minimizing uncertainty
- Understanding problems
- Buying the professional

As W.T. Wittreich has observed that :

".... It should be recognized that the ultimate goal of considering what a professional service organization has to offer is to bring about a degree of increased certainty for the client where uncertainty is felt... (and) when management is considering the purchase of professional service, it should insist that the representative of any professional service firm be able to address himself directly to a substantive problem... (and) management should insist on dealing directly with individuals of true professional competence. The professional salesman may be fine and dandy for tangible goods, but he has little or no place in the selling of professional services, he can only function as a middleman".

We have yet to develop the proper attitudes in purchasing such services.

How much does a Consultant Cost?

It appears that we have rather warped ideas on the score of costs. It is presumed consultants have no overheads: I have had occasion, in connection with various assignments, from time to time, to be told management engineers/consultants are outrageously expensive. This led me on to an investigation as to how much does a government servant cost the exchequer in real terms. If one works out the total overall cost of a government servant drawing Rs 2,500.00 p.m. or Rs. 30,000.00 pa as salary and if he is provided transport, at a conservative reckoning his total annual cost under 30 different cost heads amounts to Rs 108,000---112,000 pa. or Rs 9000-9,330 pm! Hence merely looking at the Rs. 2,500.00 figure means turning a blind eye to reality. Can a competent management engineer/consultant cost less, in fact he must cost more! Fortunately devaluation of our currency over a year ago has helped in being able to value expatriate management engineers/consultants realistically. About the minimum for a passable expatriate in this field would be £ 60.00 pd plus subsistence charge of £ 10.00 pd (excluding transportation from country of origin and back also, within Pakistan). This amounts to about £ 2100.00 pm or Rs 53,000 pm. You will all agree that this is an extremely healthy minimum. If we can adequately service similar jobs at 20 per cent of the cost of expatriates it is reasonable enough.

Let us also remember that it is only through creation of surpluses that it is possible for management engineers to go abroad and develop work which we are fully competent to do. These surpluses can only be generated out of our income here. In developed countries governments go out of their way to encourage their nationals to get consulting assignments abroad, because it is common knowledge that they give preference to suppliers from their own country, thus assisting in creating more job opportunities right down the line for their own. Our attitudes require complete revision on this score for we are not producing productive jobs fast enough for our educated unemployed.

It would appear a good idea for all organizations to set aside ½ -1 per cent of their budget for improving/developing their managers. Marine insurance to look after shipments costs as little if not more.

A Minimum of ½ to 1 per cent of Profits by Developing Managerial Skills

The Industrial Reconstruction Institute (IRI), was originally set up in 1933 by Mussolini in Italy as an instrument, at that time, for the recovery of their banking system. Now it is involved in very very much more. It includes 130 companies in the industrial and service sectors, with a payroll in excess of 320,000 with an annual turnover of 3000 billion liras and an investment capacity of 1000 billion liras pa. Under Articles 18 and 24 of its by-laws, 15 per cent of the annual net profits of the various companies must be transferred to a special fund to be used for training persons to be employed as industrial executives, as well as for professional and technical training and social welfare."

The suggestion of ½ -1 per cent is, therefore, not out of this world. But it appears the more pressing a problem, the less money an organization can devote to its solution! This

attitude to a large extent stems from a lack of appreciation that technology "manipulates the elements of one environment, namely the physical, as a means for creating utility in a second environment namely the economics, which has to do with the desires of people and is therefore, a segment of the social environment" (Thuesen).

Our colonial tradition of "control" has tended to ignore the human problems. Michel Crozier, a leading French sociologist, makes a good point when he says that human problems have been subordinated to economic considerations. And that only as soon as management principles are divorced from traditional bureaucratic practices will it be possible to move away from the tyranny of ad hoc small decision making of which we are prisoners. Such a situation has come to pass, in part at least, in a Third World country ie Chile which has stolen a march over the rest of the world by using computers to get an up to the minute picture of its economy.

"Information from companies and industrial centers throughout the 3000 miles length of Chile is fed daily via a communication system of telex and microwave links into a computer centre in the capital, Santiago. At the level of the firms, management monitors performance according to a cybernetic model and generates summary data and alarm signals for feeding into another similar model for a whole industrial sector. The result--- the government has an accurate picture of what was happening in the economy yesterday" (Data Systems).

Naturally, management engineers made this possible. The basic system was developed in about 14 months! We are aware governments usually have to wait 6 months to a year before they can get the economic information they want. If Chile can do it, is it impossible for us? Not if we accept the scientific method.

Computers

Talking about computers it is of interest to note that in their early days it required about 75 per cent of the investment on the hardware and 25 per cent to be invested on the effort to effect their efficient mobilization (software). Now in developed countries it is not unusual for 25 per cent to be invested on the hardware and 75 per cent on the software! This means the two or three dozen computers that we have say, worth Rs. 10 crores should have had Rs. 30 crores spent on mobilizing them! The fact that we have spent but a fraction of that sum is a direct reflection of the efficiency with which our organizations are run. John Diebold, a leading US management engineer/consultant says that we need to give much more formal attention to the design of decision systems and information flows. A good decision maker is not necessarily the best designer of an information system (and vice versa). A good wrestler is not expected to design a good crane!

These decision making or information systems represent major investments in manpower and money and require multi-disciplinary inputs. But because we cannot see the brick and mortar of this highly intellectual activity we baulk at investing in the software. These attitudes will have to be modified because such Management Information Systems (MIS)

form the coordinating concrete over the wide mosaic of differing activities, and it is coordination that we miss. Committees can take you so far but no further.

To be remembered is that if we improve our hi-level decision-making capacities without improving our implementation capacities we will face the serious hazard of "executing inefficiently" the right policies, and this is where we come back to putting our systems right first. Understandably managers/administrators are wary of the new, this is a normal reaction. However, in the world of today this gap just has to be narrowed otherwise policy-makers will not have enough time for:

- developing objectives and goals
- projecting economic conditions that affect their organizations
- formulating alternate courses of action
- analyzing the consequences of each course so formulated
- deciding which programmes are more feasible
- devising methods for measuring progress towards the objective and goals which are usually subject to modification.

We just do not have time to wait for good administrative theory to help us. In any case history does teach us that good theory comes late in the development of any field and usually after several false starts. It is necessary, therefore, for us to make use of whatever management aids or tools that are available and that too not in series, but in parallel. One such aid is the management engineer.

Programme Implementation/Dichotomies and Complexity

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Who is there in charge of programme who does not feel that for one reason or another that things could work much better only if this or that information were available now: A little cogitation could throw up the following:

- Authority flows vertically while
- Work flows horizontally

and that therefore there is a dichotomy between the two, that

- History produces the structure for enforcing authority and
- the structure determines the function.

but the function does not determine work flow. And work flow is what we are looking for, also

- when an organization or system expands rapidly personal cooperation merely becomes a hygiene factor ie an aid for creating a mechanism for formal coordination. The nature of the problem changes if only on account of size and size alone,

this means we have to find some substitute for personal cooperation. The means to do so have been developed by the Management Services/Sciences generally since World War II, in particular since 1960, The successful use of the Management Services/Sciences has arisen principally by their being able to look at problems so as to isolate to their form from the content ie to conceptualize the problems.

Since this paper has been concerned with complexity. with the objective of indicating how management engineers/consultants can help out as agents of change, I will make a reference to the development of complexity that has arisen in a field that engineers should be familiar with but have a tendency to keep away from. These developments took place as an answer to certain requirements which ultimately concerned the public. I refer to world developments in the accounting function.

The first stage was around 1850 lay in putting emphasis on the formation and liquidation of companies because of the necessity to define asset ownership.

The second stage, around 1890/1910, put emphasis on audit, as a means for prevention and detection of fraud.

The third stage, between the two World Wars, was concerned with taxation and the ways and means to avoid the same so as to minimize its incidence.

The fourth stage, since World War II has moved towards measurement and control. It is concerned with input costs and output values ie management accounting. And this is what engineers have been concerned with all along, for as I mentioned earlier they operate in two environments---the physical and the economic.

Qualities required of a Management Engineer

I will come to close after indicating the capacity and attributes required of management engineers/consultants. In this I have borrowed freely from various publications of the Association of Consulting Management Engineers (USA). The management engineer must have a

- capacity to learn
- capacity for feeling and a
- capacity to produce energy and be able to
- understand people (human relations)
- maintain integrity
- exhibit courage in disagreements or difficulties
- be objective

- have ambition ie the desire and motivation to earn and obtain recognition as a professional
- apply himself successfully to problem-solving
- through ability and reasoning power to arrive at wise decision, a course of action or conclusion
- communicate effectively
- through his actions to exhibit psychological maturity so as to live with frustrations, adversities and inequities.

May all of us look forward to an even more active policy by those concerned in furthering this emerging disciplines of Management Engineering.

"…. In a world increasingly rushed to death, the long range waits on the immediate. What is urgent take priority over what is merely important, so what is important will be attended to only when it becomes urgent, which may be too late" --- (L.J. Halle)

/Management Engineering