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IMPROVING THE EFFECTIVENESS AND UTILISATION OF THE INDUSTRIAL ENGINEERING FUNCTION

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ABSTRACT

Research work carried out by the University of Cape Town has examined the following questions:

- are industrial engineering techniques being used in industry?
- what are the reasons for not using the various techniques?
- what factors that can be addressed by industrial engineers, are inhibiting the improvement of manufacturing productivity?
- are industrial engineers being utilised in the most effective way?

Investigations in South African and overseas companies have indicated some barriers to acceptance that have to be overcome. This paper identifies key elements which, if implemented or adopted, will improve the effectiveness of both industrial engineers, and the introduction of industrial engineering techniques.

1. INTRODUCTION

Is productivity in South Africa bad? Is this a bad thing? If the answers to these two questions are both yes, then why is productivity bad and what can be done about it?

This paper starts from the hypothesis that the answer to the first two questions is yes to both. This does not mean that there aren't people who are working hard, there are. Some of them may even be working effectively. However there are many people who are either not working at all, or are working ineffectively, or are working for an ineffective system.
Also,the productivity concept also embraces not just the productivity of people, but that of machines, materials, finance and all factors of production. Many of these factors are either underutilised, working ineffectively or working inefficiently.

It is not the intention of this paper to justify these statements. Anyone who doubts them can be referred to numerous studies, including those of the National Productivity Institute. Figures 1 and 2 (N.P.I.[1]) are important broad indicators of the magnitude of productivity differences between countries and are shown here just to indicate that there may be a problem.

GROSS DOMESTIC PRODUCT PER CAPITA
1985 PRICES AND EXCHANGE RATES IN RAND

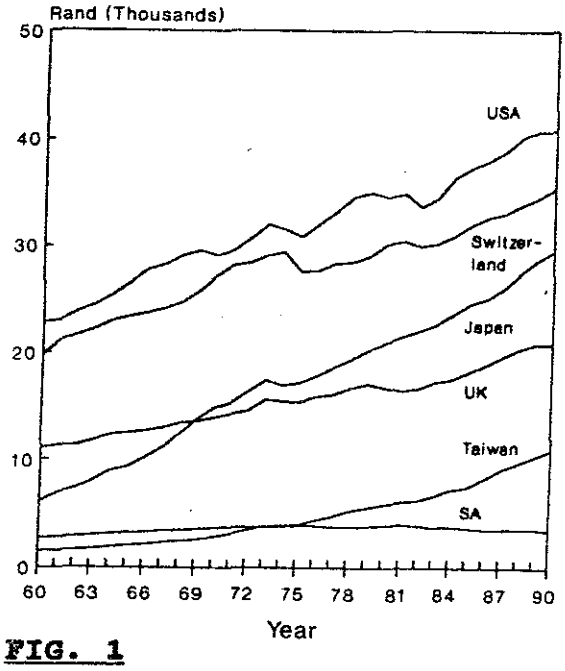

FIG. 1

POPULATION AND EMPLOYMENT
Average annual growth rate 1980-1989

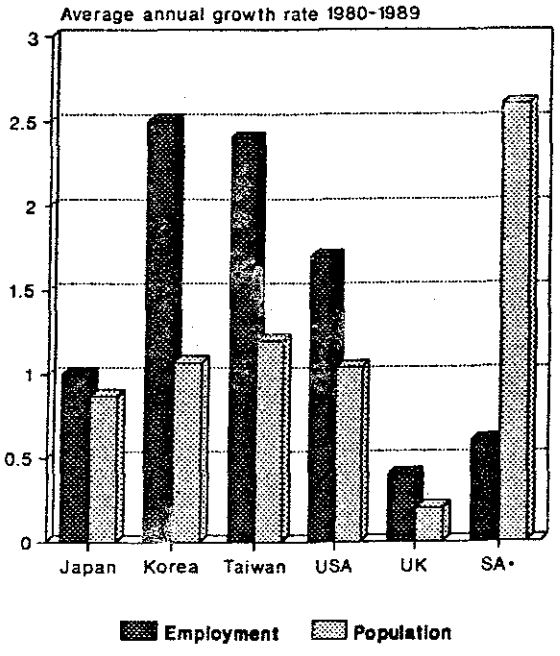

FIG. 2

This paper starts from the premise that productivity growth generates economic growth, and that this is a prerequisite for higher employment and a higher standard of living for all. It also assumes that the objective of industrial engineers and industrial engineering techniques is to improve productivity. It explores what can be done to make us more effective in achieving our objective.

2. INDUSTRIAL ENGINEERING - WHAT IS IT?

If we are to examine " Industrial Engineering Techniques ", we had better understand what we mean by "Industrial Engineering". Figure 3 shows the heirarchical positioning of industrial engineering in progression from school level basic science and arts, to general management. At U.C.T., the philosophy is that industrial engineering knowledge is best built on the foundation of a basic discipline such as, for example, mechanical engineering. Figure 3 shows that industrial engineers have to incorporate a knowledge of the "arts' as well.

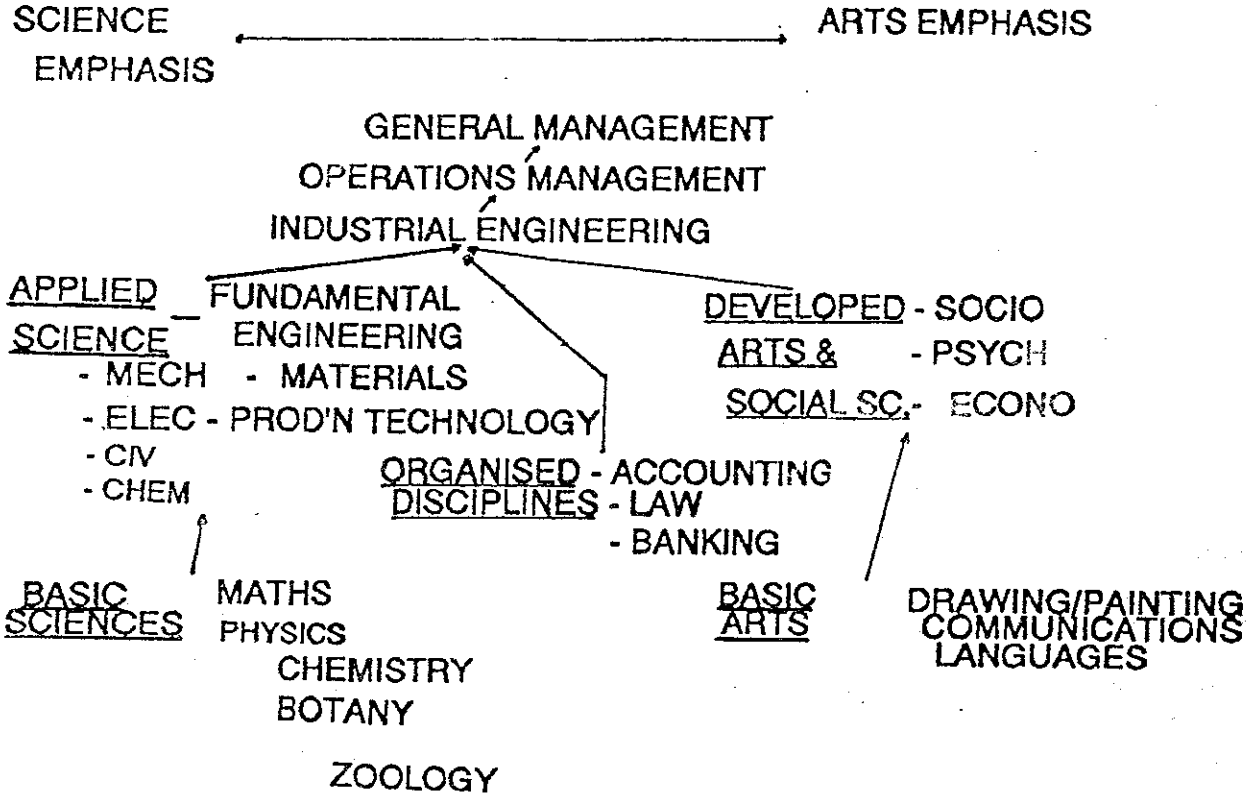

Fig.3

But what do Industrial Engineers do? The answer is as long as a piece of string. However, a guide can be found. An investigation into European industry by Prof. K. Holt in 1975 [2],and another investigation into industry in Hong Kong by W. A. Reynolds and M. K. Cheung[3]in 1984, used similar methods. Both investigations divided the industrial techniques into two groups namely Traditional (Classical) techniques and Modern techniques. This division is shown below in Table 1 (Holt[2]).

TABLE 1 - DIVISION OF INDUSTRIAL ENGINEERING TECHNIQUES

a) Traditional Techniques

Work measurement	i)	Manufacturing	ii)	Clerical	
Method Study	i)	Manufacturing	ii)	Clerical	
Wage determination	i)	Job evaluation	ii)	Incentives	
	iii)	Measured day work etc.			
Plant Engineering	i)	Layout	ii)	Material Handling	
	iii)	Maintenance	iv)	Cost Estimating	
Production Engineering	i)	Process planning			
	ii)	Tooling			
	iii)	Product development			
	iv)	Production control			
	v)	Quality control			
	vi)	Product Costing			

b) Modern Techniques

Electronic data processing	i)	In House computer
	ii)	Bureau computer
Systems analysis		
Network analysis	i)	In projects
	ii)	In production control
Operations research	i)	Linear/dynamic programming
	ii)	Forecasting
Value analysis	i)	Existing products
	ii)	Value engineering on new products
	iii)	Variety reduction

One of the findings of these studies was that traditional techniques tended to be located in industrial engineering departments, but newer techniques tended to be used by individual managers. This emphasises that industrial engineering is a function of operations management, and not a separate discipline. Thus we are examining here not only how Industrial Engineers can be made more effective, but also all operations managers.

Today, we have many more modern techniques to add to Table 1. These would include computer simulation, systems engineering, logistics technologies, expert systems, etc. A list of primary industrial engineering activities issued by the American Institute of Industrial Engineers is given in Appendix C.

The basic objectives of industrial engineering are usually:-

(1) to establish methods for monitoring and controlling operational costs, and

(2) to develop programmes for reducing these costs.

Methods and programmes to do this are carried out by line management.

3.ARE INDUSTRIAL ENGINEERING TECHNIQUES BEING USED ?

Limited research work (Clancy[4]) has given the answer "yes but only to a limited extent." Companies seem to stick to the older, simpler techniques. For example, an analysis of forecasting techniques used in companies, fairly bristling with computer equipment, showed that only 20% used anything more than simple or weighted moving average methods. Similarly, an examination of the use of scheduling methods showed that only 40% of the companies used any form of formal scheduling rule, and this was only a simple priority rule method. On the other hand, work study (certainly work measurement if not methods improvement) was used by all companies. Again, only the simpler techniques such as flow diagrams and outline process charts were used.

In smaller companies, it was found that even simple work study work was not a regular practice. It was noticeable that the only American owned company in the survey employed considerably more industrial engineering techniques than the others, especially in relation to its size.Significantly, in another survey (Sparg[5]), it was found that only 18% of the companies had productivity statistics.

Similar survey work has been carried out in Great Britain by Oakland and Sohal [6 & 10]. These surveys found a very low level of usage of operational research and statistical techniques and a disappointingly low level of usage of usage of the 'traditional' techniques. Usage of highly mathematical techniques, for example Branch and Bound and Game Utility Theory was non existant. The most commonly used techniques were those for controlling finance,investment and inventory.

4.ARE THESE TECHNIQUES BENEFICIAL IF USED ?

No evidence has emerged to suggest the contrary. If anything, the evidence collected so far confirms that the application of industrial engineering techniques is beneficial. For example,in the companies surveyed, the application of Just In Time techniques was claimed to have improved efficiency from 49% to 82% and a comparison of companies with and without incentive schemes, showed that labour turnover was reduced on average from 6,6% to 5,44% with the introduction of incentives.

5.WHAT ARE THE FACTORS INHIBITING INDUSTRIAL ENGINEERING USE ?

Assuming that the use of industrial engineering is beneficial, why is it not used more fully and more frequently? Some pilot research work (Sparg[5]) provided some possibly controversial findings. These are in order of priority:-

(1) The lack of dissatisfaction and the low priority given to increasing productivity by upper to middle management.

(2) The lack of understanding by workers, at all levels, of the benefits to them of increased productivity.

(3) The lack of real communication and the rather destructive nature of relations with trade unions.

(4) The short supply of skilled labour in South Africa.

(5) The lack of availability of high quality materials and also supply problems.

(6) The lack of sufficient training due to finance and time constraints.

(7) The lack of capital to purchase higher performance equipment. This was ascribed to the economic downturn, the low value of the rand and to import duties.

(8) The lack of long term policies to improve productivity.

(9) Social problems such as distance of travel, unreliability of transport and stayaways.

(10) Tax and legislative problems.

The above findings are contrary to the reasons normally given by the business media for low productivity, which include lack of skilled labour, political problems and so on. The findings do, however, have a marked similarity to those given by the survey of the American Institute of Industrial Engineers [7] -see Appendix A, and by Judson [8], from his survey of American managers -see Appendix B.

Following from the research carried out by Oakland and Sohal in Great Britain [6 & 10] which had tended to highlight "no knowledge" as a reason for not using the techniques, they followed up with two more detailed surveys [9]. A summary conclusion for the first survey was:

"A barrier is presented by senior manaement who lack commitment and motivation, leading to a lack of knowledge and understanding of the applicability of the techniques. Many of the production managers who make no or low use of the techniques and concepts have no knowledge of them. This in turn is due to the production managers being poorly educated, their qualifications not meeting their status, and/or lack of training in production management. Production managers who do have knowledge of the techniques and concepts, in general lack understanding and appreciation of their application."

The second survey examined specific in-company project work and Table 2 (Oakland and Sohal[10]) gives the results found:-

TABLE 2 - IN COMPANY PROJECT WORK AND BARRIERS ENCOUNTERED

Company	Project Undertaken	Barriers Encountered
1	Activity sampling	None from senior or middle management. Some objection from employees due to insufficient information.
2	Statistical process control.	None from management. Problems were technical.
3	Activity sampling	Poor internal management- no active part taken in project. Severe industrial relations problems with shop floor/middle m'gement
	Plant layout	Senior managements lack of knowledge and understanding of benefits to be derived from a systematic approach.
4	Statistical process control	Lack of commitment from senior and line management.
5	None (proposed-variety reduction,computerised production/stock control)	Lack of commitment from senior management.
6	None proposed	Reluctance to change by production management.
7	None (computerised prod'n /stock control proposed)	Lack of computer understanding and interest

The conclusions reached were that:-"the major barriers preventing the introduction and usage of the techniques are concerned primarily with top management. Lack of knowledge is not a permanent barrier as it can be overcome by providing sufficient training, for example by a research team. However, smaller companies either have no-one able to undertake training, lack financial resources for training or have to employ outside consultants. In the latter case they often have difficulties in locating centres of expertise or consultants."

6. ARE INDUSTRIAL ENGINEERS BEING UTILISED IN THE CORRECT WAY ?

This is a difficult question to answer, but certain factors have emerged in the research which suggest problems may exist. The research work carried out by Clancy [4], touched on aspects such as the representation of industrial engineers and their training. In the companies surveyed, industrial engineers represented a tiny 0,004% of all employees. In larger companies (over 400 employees) this proportion averaged 0,6%.

Of the industrial engineering employees, only 18% were university graduates, while 52% had obtained varying levels of technikon training. The training of the remainder was essentially "on the job". The manager responsible for the engineering function was generally two or three levels below the managing director of the company.

Some comments made during the survey which were indicative of problems were:-

"In many previous projects the advice of the department has been ignored with preference being given to a particular managers own ideas."

"We (the industrial engineering department) should play a more active role in the decision making process."

"Follow up measurement (a post audit) is very rarely done to verify the profitability of implemented plans."

Industrial engineering was sometimes undertaken by managers or staff other than in a specific industrial engineering department. These departments generally agreed that their role should be mainly an advisory one. Industrial engineers worked on individual assignments, rather than as a member of an industrial engineering team.

Managers considered that:-

(1) University and technikon courses are too theoretical with not enough industry related problems being tackled.

(2) Not enough people management,industrial relations and management courses were being taught.

(3) Graduates should be trained in how to train others.

Only 22% of the graduates in the industrial engineering departments felt they had been adequately trained for the work they were doing in industry.

Another study by Franks[11] was carried out on working graduate mechanical engineers, many of whom are involved in industrial engineering work. This study examined the functions performed by engineers in relation to their training. The study concluded that not only is there a shortage of graduate engineers, but that a around 38% of their capability is wasted. This amount is "that time which is spent on activities which do not employ the unique training of engineers." These tasks could be performed by persons with other qualifications, eg technicians.

Lack of suitably trained and directed support staff could therefore lead to the wastage of expensive personnel. Indeed,the main reason for poor utilisation pinpointed by this research was "not enough suitable support personnel available".

Hirsch [12] has also pointed out that in their study in the United States, a further 30% of the engineers work was unproductive due to:-

assignments of little or no value or,
time spent on unassigned activities or,
duplication of effort or,
employee turnover or,
physical facilities limitations

The research by Franks [11] also examined the types of functions performed and how these tended to change with seniority/age. Tables 3 and 4 (Franks [11]) illustrate the need for continuing education and career development.

Table 3 -PERCENTAGE OF TIME DEVOTED TO FUNCTIONS

GROUP OF FUNCTIONS	PROFESSIONAL ENGINEER	GRADUATE ENGINEER	TECHNOLOGIST
THEORETICAL ENGINEERING	26	34	32
PRACTICAL ENGINEERING	20	20	22
MANAGEMENT	54	46	46
	100	100	100

Table 4 -VARIATION IN TIME SPENT ON ACTIVITIES WITH INCREASING EXPERIENCE

ACTIVITIES	YEARS OF EXPERIENCE				
	0	10	20	30	40
THEORY	62	38	28	26	26
PRACTICAL	11	12	10	10	12
MANAGEMENT	27	50	62	64	62
	100%	100%	100%	100%	100%

7. HOW TO IMPROVE THE EFFECTIVENESS AND UTILISATION OF THE INDUSTRIAL ENGINEERING FUNCTION

Based on the summarised and varied research outlined above, what actions could be taken to improve the effectiveness and utilisation of the industrial engineering function?

Here are some key elements (No-one is saying they are necessarily easy to accomplish, but they can be worked at):-

(1) Continually work on top management to:
- be dissatisfied with current levels of productivity.
- be committed to continual improvement of productivity.
- motivate everyone in the company to improve productivity.
- support all efforts (whether successful or not), to improve productivity.

Faull [13] says the answer to the question " How can we improve productivity ?" is to "Never stop asking the question." Create a questioning culture.

(2) Do everything you can to ensure that everyone in the company understands what would be meant by "improved productivity" in their environment, and, importantly, how they could personally benefit from it. If you cannot identify these real benefits, then it is unlikely that significant improvements in productivity can be obtained.

Faull [13] suggests that participation has giving and receiving dimensions, so that the concepts of job security,collaborative problem identification, and a reward system are vitally important. Work this aspect out thoroughly before starting a productivity improvement programme. Include the Trade Unions in this.

(3) Set and agree realistic, measurable, achievable goals, expressed in realistic criteria, and set against a realistic timeframe.

(4) Prepare and regularly update a productivity improvement programme. Use probability accounting to compensate for unknown factors in the programme.

(5) Apply a proper measurement system to evaluate proposed productivity programmes. Apply a multi disciplinary team to this.(Involve accountants, production foremen, etc). Also carry out follow up measurements (Post-Audits). Use these as a learning experience. Do not delude yourself.

(6) Pay a great deal of attention to, and spend a lot of time on, clear, comprehensive and meaningful communications. Nourish good industrial relations and make sure all employees are informed about objectives.

(7) Train yourself,those who work for you and all those who will be affected by your work (including top management). For the techniques to be properly implemented and used, there must be an in-depth knowledge and understanding of the techniques. If necessary learn how to train others.

(8) Do everything you can to ensure that you have sufficient resources for the programmes you are undertaking. Specifically, obtain, train and thoroughly supervise the necessary support staff. Persuade your company to follow the example of a large American company which found it could reduce its professional engineering staff by 15%, get more work done by happier engineers and pay them better, by relieving them of non technical duties. The hiring of a few more clerks, secretaries and technicians did the trick.(Davidson [14]).

(9) Experiment. This will provide a learning experience, arouse awareness and activate action.

(10) Encourage long term planning, and in particular, the formulation of policies to improve productivity.

(11) Manage yourself. Avoid unproductive work like that mentioned by Hirsch [12], and keep yourself up to date by attending continuing education programmes.

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APPENDIX A OBSTACLES TO PRODUCTIVITY IMPROVEMENT IN THE U.S.A.

1. Inability of labour and management to work towards common productivity goals

2. Management failing to understand how productivity can be improved

3. High interest rates squeezing investment of sufficient capital to improve productivity

4. Management failing to authorise sufficient manpower to direct productivity improvement

5. Management failing to apply proper measurement programmes in order to evaluate productivity improvement

6. Insufficient training programmes

Source: A.I.I.E. Survey [7]

APPENDIX B - THE SINGLE MOST IMPORTANT REASONS FOR AMERICA'S DECLINING PRODUCTIVITY

Reason	% Selected
Management's ineffectiveness in addressing this problem within separate organisations	30%
Management's excessive concern with short term results	30%
Decline in the work ethic	8%
An adversary relationship between business and government	7%
Insufficient participation by the workforce in decisions affecting production	7%
Inadequate tax incentives for saving and investment	6%
Government regulation	5%
Obsolete plant and equipment	5%
Labour unions	3%

Source: Judson [8]

APPENDIX C - INDUSTRIAL ENGINEERING ACTIVITIES

1. Selection of processes and assembling methods
2. Selection and design of tools and equipment
3. Design of facilities, incluidng layout of buildings, machines, and equipment; material handling equipment; raw materials and product storage facilities. Services (e.g. power, light, water, etc)
4. Design and/or improvement of planning and control systems for distribution of goods and services, production, inventory, quality, plant maintenance and engineering, or any other function
5. Development of cost control systems such as budgetary controls, cost analysis, capital expenditure evaluations, and standard cost systems