ANALYSTS ON FACTORY PLANNING

LUNCH-TIME TALK TO N.S.W. BRANCH OF AUSTRALIAN SOCIETY OF SECURITY ANALYSTS ON FACTORY PLANNING

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Though the same basic principles apply to planning large primary and material producing industries such as mining and steel making, in this talk on "Factory Planning" the finished product manufacturing industries will be considered, as these form the vast majority of individual plants. With the exception of the motor car and related industries and other large manufacturers of finished products, be they aircraft, domestic appliances, food, chemical products, pharmaceuticals or soap, the degree of factory planning is relatively less in finished product manufacturing than in mining, steel making and the like.

The following table, taken from information in Commonwealth Bureau of Census and Statistics 1966-1967 "Summary of Principal statistics of Factories", and the "Consumer Price Index", shows that the average total number of persons employed in all factories, including the large and highly efficient, is 21 in 1966-1967.

	1962-63	1963-64	1964-65	1965-66	1966-67
Number of factories	59,147	59,375	61,042	61,686	62,501
Persons employed	1,167,553	1,209,920	1,268,935	1,293,823	1,309,458
Persons per factory	19.7	20.4	20.7	21.0	21.0
Output $ million	11,474.7	12,642.7	14,037.4	14,689.8	15,914.3
Output per person $	9,850	10,460	11,100	11,320	12,180
Percentage increase/ person 1962-63 = 100%	100%	106.2%	112.7%	115.0%	123.4%
Percentage increase in Consumer price index 1962-63 = 100%	100%	101%	104.7%	108.4%	111.2%

It will be seen that taking 1962-63 as the base year the percentage in output per person has increased by 23.4% whilst at the same time the "consumer price index" has increased by 11.2% — whilst not strictly comparable it does indicate that factory efficiency is increasing.

Obviously if the average number of employees for all factories was 21 in 1966-67 these average factories will not plan either their layouts or operations to the same extent as do the large factories.

It is a truism that to survive, factories must grow; it is also a truism that to grow, planning and control must be careful and precise—the extent to which planning and control are effectively applied in the average factory — that is one employing about 21 persons—will be one of the major factors determining their growth potential.

The essential constituents of factory planning are:—

1. The products and their volume of production based on a five to 10 years' forecast.
2. The target ex-factory prices of the products.
3. The division of the products into raw material and component purchases and parts to be manufactured in the factory.
4. The equipment necessary to manufacture the factory produced parts based on methods study.
5. The space required for raw material and purchased component storage, component manufacture, work-in-progress storage, product assembly, material movement and finished product packing and storage.
6. The layout of manufacturing equipment for efficient production based on work study and the provision of adequate handling facilities.
7. The provision of adequate material, component and product inspection and testing facilities.
8. The design of the factory building and grounds to meet the above requirements and provide good working conditions having due regard for expansion and possible diversification.
9. The choice of the site with respect to particular zoning requirements, transport facilities, material, power supplies and markets.
10. The proximity to the required personnel resources.
11. The finance required and available.
12. The planned completion dates of the factory and starting of production.
13. The selection of such additional factory management personnel which can be used both for planning and subsequent factory operation.

The division of the products into raw material, purchased semi-finished and finished components leave the balance of parts and finished products which must be efficiently manufactured in the proposed factory. These should be produced with the most suitable and modern plant. The suitability of the plant and the selection of purchased requirements, which must be available to meet the production schedule, will determine the space requirements and their relative disposition in primary, work in progress and finished products storage.

In an engineering works, suppose castings are purchased and stored adjacent to the first machining process—an excess of poor castings could cause a storage and handling problem at the start of production or at any subsequent machining operation with consequent production and operator time loss.

Dimensionally inaccurate purchased or factory produced parts similarly cause delays in assembly, again creating storage and handling problems.

The probability of such difficulties occurring must be considered by the factory planner and provision made for controlling them.

The importance of economically handling material cannot be overemphasised and the facilities provided must be integrated into the production layout.

Economical handling can range from hand trucks, through fork-lift trucks and stacking machines to all types of gravity and power-operated floor, bench and overhead conveyors, overhead cranes of many types and capacities — even the humble hand-operated roller conveyor has a valuable place in efficient handling, particularly in low volume production lines.

Material, component and product inspection must be pre-planned and integrated with production flow to minimise delays — unacceptable material must be rejected at once and not be reconditioned in a production flow line. Layouts may be either product or process orientated. In the former, different processes are arranged in sequence so that components are produced to meet the requirements of product assembly and it has advantages in reducing delays in material handling and simplifying material move records. Production time is generally lower and space can be saved.

Workers and supervisors can generally be more quickly trained.

The disadvantages are that machines may be duplicated, and when demand falls, machine idleness may result if the same type machine is used on a number of different production lines. Machine breakdown in a given production line can disrupt production.

The process layout groups the same kinds of machines together—in an engineering works, saws, lathes, drilling machines, planers and shapers, milling machines, gear cutting machines, broaching machines, etc., would be concentrated in a machine shop, and by this means the minimum investment in machine tools could be achieved, material handling cost would be increased and delays would increase in given processes when the plant reached optimum capacity. Supervisor and operator training on single types of machines would take longer because a greater variety of work would have to be dealt with. Product layouts are more likely with large products where moving heavy components is difficult and costly. Process layouts are suited to small product manufacture where the cost per piece of material movement is very low. Most layouts in the engineering and similar industries are a combination of each type of layout. On the other hand, chemical and food producing industries are mainly product layouts, whilst textiles and clothing are generally process layouts.

Factory buildings are, in every sense, an overhead expense, and the problem of providing an economically and aesthetically satisfactory solution still eludes us. Having determined a layout we proceed to mount this on a floor and cover it with a building in which there is the usual conflict of low capital and maintenance cost and optimum utility.

Obviously, a completely clear span building in which manufacturing facilities and handling equipment such as overhead cranes and conveyors could be located for greatest efficiency is highly desirable, it is, however, economically highly unlikely.

We, therefore, must compromise between maximum production layout efficiency and economical building cost and by skilled structural design the result is usually satisfactory.

Industrial buildings, as you know, invariably finish up as rectangles or squares!

All services, such as light, power, compressed air, water, fire protection—heating and cooling (if any), must be located accessibly in the building frame and be flexible in the provision of service points for supplying production machines, portable power tools, light and test points and the like.

A factory should be a clean and pleasant place in which to work and each employee should feel that his personal needs for accommodation, sustenance and safety are amply met.

Factory cleanliness and efficient maintenance of equipment, services and environment are significant morale builders. Apart from the other factors involved in the siting of a factory, that of environment and winter-summer temperature range merit some consideration. The temperature range for efficient work is small, probably between 60° and 85°F., with relative humidity not exceeding 50% at the upper limit—in the future, much more attention will be given to controlling factory atmosphere in the interest of increased safety and efficiency (see Reference 3).

Having acquired a first class modern factory which has been adequately and practically planned to perform a given function in terms of products, production and price and having the nucleus of top technical and administrative management, the next step is to obtain competent assistants and department managers. Again, proper specifications for all these appointments with their duties and responsibilities must be prepared and the value of co-operation and integration, within the all too well-known human frailties, must subtly be stressed.

The employment of a competent personnel manager is vitally important even with a relatively small work force.

In the pre-planning of the factory, purchasing, production planning and control, cost and general accounting, wage and salary payment and related matters will have been organised. There will be the usual difficulties in getting these jobs under way, even when the best mechanical and electronic aids are available and such functions as wages and material control are computerised.

There will be an urgent need for staff training as well as operator training within the factory.

The entire paperwork system used should be documented and flow diagrams of each and every piece of paper used should be made showing the relationship between all office and factory operations; all personnel concerned should be thoroughly instructed in their part of the activity and should be aware of its importance in the overall efficient running of the factory.

The systems used to cover all facets of operation will be peculiar to the factory and must be tailor-made for minimum clerical work, maximum clarity of communication and accuracy of information.

Though the factory has been designed for a range of products or even a single basic product produced in various models; with time, demand will change and product mix vary. New products or models will be introduced and starting with production engineering a series of changes will be initiated covering new tooling, plant and layout, new testing facilities — new production planning and control and purchases.

All these innovations must be profitably absorbed into current activities, and depending on their magnitude, can impose considerable strains on the running of the factory. Even with the most careful initial forecasting and planning, situations will arise which will tax management skills, storage and production facilities and quite likely financial resources.

One of management's dilemmas will be deciding on the advisability of using incentive payments, it has been assumed that planning and control are adequate. The difficulty will be in maintaining the necessary volume of work to make payments continuously, and at about the same level whilst preserving management's share of the cost saving.

In many industries, particularly in engineering, machining processes will become more subject to automatic numerical control — digital computers will provide the necessary information for financial, wages, stock, material and production control. Tapes will be produced from the same equipment for latter innovation will considerably routine technical calculations and the control of machine tools—this affect investment in special jigs and fixtures and will reduce space requirements due to the greater output of the tape-controlled machines. They will generate a new problem, however, in the removal of swarf and offcuts which may then have to be mechanised! Finally, the nature of industrial processes, particularly in engineering and allied industries, is changing and factory management has to be alert to these new techniques.

To name but a few:—

1. Explosion forming of metal in lieu of pressing.
2. Cold forming and investment casting in place of machining.
3. Shell moulding in place of sand moulding.
4. The substitution of plastics for metals.
5. The "designing" of revolutionary new types of materials whose properties will be so superior, particularly in "stiffness", to those currently available that they will profoundly influence product design and manufacturing methods.

REFERENCES:

(1) Introduction to Work Study. Published by the International Labour Office, Geneva, 1968.

(2) The New Science of Strong Materials by J. E. Gordon, 1968. Penguin Books Australia Ltd., Ringwood, Victoria.

(3) N.S.W. Department of Labour & Industry. Regulations, Orders and Certain Proclamations in Force under The Factories, Shops and Industries Act 1962. Pages 10, 11 and 12.