INTRODUCTION TO PRODUCTION

1225

29 January 1954

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COLONEL DIEHL: Gentlemen, today we launch the Production Unit of your course. Each of you probably have your own definition of production. One frequently heard is this--how to build the stuff we have no requirements for in the quantities we can't determine in time to dispose of it as surplus just before we find out we need it.

A more prosaic definition is found in The Production Monograph--R171, which you received Wednesday, defines industrial production, which is what we are primarily concerned with, as "A significant volume of durable and consumers' goods resulting from organized groups in companies and industries."

Other definitions could be given, but the important thing to remember, I believe, is that mass production is the result of a group effort. Mass production requires those five M's you've learned to associate with economic mobilization--manpower, machines, materials, management, and money.

The Production Unit fits right into the middle of your college curriculum--timewise and otherwise. This unit completes the foundation upon which your mobilization studies will be based. And it amplifies and augments those studies you've already pursued. Technology is again pointed up as a tool for greater productivity--our eternal goal. For example, one machine company, through its research, has found that metal cutting efficiency can be stepped up from 30 to 300 percent--and this on existing tools--through a high-velocity turning technique.

The ability of the scientist and the management team to increase the productivity of the individual goes a long way toward alleviating manpower problems. If we can just increase this type of productivity faster than we increase the number of people to feed, clothe, house, and pension, then we are compounding interest upon interest.

I believe also that the Production Unit will give you a greater appreciation of why you labored so long and diligently during the opening weeks of the Industrial College over economics. In this Unit you will see practical applications of these studies--a large company doesn't invest millions of dollars in new tooling as one did this year if it doesn't expect a handsome return.

But I believe most important of all to you is the fact that your production studies will reveal the necessity of establishing realistic

requirements. And that our procurement policies must be based on a detailed knowledge of the capabilities and limitations of industry.

This very knowledge of the capabilities and limitations of industry will enable you to assess the potential for war of the various countries of the world, a study that follows production.

On Monday Colonel Barnes gave you the mobilization problem for this year. It is needless for me to point out that without an appreciation of the problems faced by industry, your solution would be rather meaningless.

Here I want to stress what I've already inferred. The strength of this Nation lies in its productivity. This is the strength that won World Wars I and II. This is the strength Russia fears more than any other one thing. This is the strength, I believe, that has so far prevented an outbreak of another large-scale war. To paraphrase Teddy Roosevelt, he who carries a big stick may wear a velvet glove. An understanding and appreciation of this strength--its capabilities and its limitations--is the primary purpose of this unit.

Our objective is to develop a realistic approach to the general problems of mobilizing our industrial resources--to evaluate the critical weaknesses of our productive complex--and to study the reasons for, and effects of, Government controls upon industry. This last objective will cover both partial and full mobilization, emphasizing the period of full mobilization, however.

I ask you now to think back to remarks made by Admiral Radford, General McCormack, and Mr. Cherne, to point to but a few. Just as our concept of the conduct of war is undergoing change in the light of technological achievements, so too must the place of industry and its contribution to national security and economic stability be re-examined. The success of one depends upon the accomplishments of the other.

A remark made by a previous speaker stands out indelibly in my mind. He said,

> "I assume 'wartime' means an experience quite unlike that we have ever previously experienced. I am assuming that wartime means anything ranging from the substantial to the total involvement of American society. I am assuming that wartime means physical destruction on the American continent. I am assuming that substantial industrial damage, and, likely repetitive industrial damage will be fundamental characteristics of what we are contemplating in the phrase 'wartime'."

I go along with that thinking. Colonel Barnes obviously does--otherwise he wouldn't have handed you that neat little package that he did--and I believe most of you, willingly or not, must concede that these assumptions do have some merit.

If we can accept that, then the problem becomes: how to keep industry functioning so that it performs its vital role in modern community life, in basic civilian living, and in support of whatever the nature of the military effort in which we are involved.

In connection with this latter, the support of the military effort must be given to ferreting out those industries which, by virtue of their location, characteristics, or singleness of facility would, if destroyed, have a crippling effect upon our entire productive effort. Such vital industries add to the seriousness of the problem.

We have one very important mineral that is both strategic and critical. It is processed in only one place in the United States--and this is in a very vulnerable and strategically important location. We have a large stockpile of the ore but what immediate good is that if the only processing facility is destroyed.

On the credit side, planning, which I shall discuss later, is being done to change this picture.

So much for the problems. The following is an outline of the framework around which the Unit will be presented:

"a. Fundamentals of Production

(1) Organization.
(2) Production Engineering.

(a) Product engineering.
(b) Production planning and control.
(c) Tooling for production.
(d) Plant layout.
(e) Scheduling, including lead time.

(3) Quality Control and Inspection.
(4) Administration and Execution of Government Contracts.
(5) Support Areas.

(a) Automation.
(b) Industrial reporting.
(c) Packing and packaging.
(d) Materials handling.
(e) Components and spare parts production.

"b. Wartime Production Planning and Operations

(1) Allocation of Facilities.
(2) Reserve Plants and Equipment.
(3) Site Selection (including supply of power, water, and other utilities).
(4) Conservation and Standardization.
(5) Program Scheduling, Including Lead Time.
(6) Priorities and Allocations as They Affect Industry.
(7) Expansion, Conversion, and Reconversion.
(8) Industrial Continuity, Internal Security, and Civil Defense."

You have looked at your curriculum book, I am sure. Fourteen areas of study have been selected out of many logical ones. These areas of study selected are, we feel, the most important production problem areas existing today. But they serve primarily as a vehicle. We do not want to make you production experts in any of these areas. What we do want is to enhance your appreciation and understanding again of the capabilities and limitations of our industrial complex.

You will notice it is broken down into two major groupings--fundamentals and wartime planning and operations. A knowledge of the first is considered essential before an intelligent appraisal of the second can be made.

Since this same information is contained in your curriculum book I am not going to belabor it further now, except to repeat that the area studies will be developed around this framework.

Let's now look at production itself. Industrial production falls into three general classifications. The first, which we call "primary production" is that which is devoted principally to the extracting of basic materials from their natural sources. This includes mining, lumbering, fishing, crude petroleum, and agriculture. Second, "intermediate production" is that which is devoted principally to the processing of these basic materials to semifinished forms suitable for end-item fabrication, it also provides end products for use in industrial processes. Examples here are smelting and refining of metals, petroleum refining, industrial chemicals, textiles, abrasives, and the like. Third, "final production" is the fabrication and assembly of end items for the consumer.

Our Unit contains studies of all three of these production classifications. The fundamentals of production and governmental controls apply to all three types. Emphasis may vary somewhat among the three, however.

Production may be further classified as to method. These are job lot production and mass production. Job lot production goods are produced

to definite customer orders. There is usually no assurance of a renewed order and the volume required for each order is relatively small. The production effort of the Naval Gun Factory is a fine example of a job lot production operation.

Mass production is the method used for large volume items where demand for the same item is long continued and can be forecast with reasonable accuracy. This is the method by which the bulk of military end items and consumers' goods is produced. It is the method that we will be primarily concerned with in this Unit.

The key to mass production is the bringing to a focus on a proposed product all the engineering, technical, and managerial skills available. This has three objectives.

First, to break the product down into parts that will fit the manufacturing capabilities and in the time required.

Second, to assess those manufacturing resources and facilities that can be made available, both in amount and in quality. This includes the men, machines, material, and methods.

Third, to plan the group teamwork that will create the product. If the breakdown of the product is not adaptable to the manufacturing resources, then changes may be necessary. These changes may be simple process changes, such as stampings for castings, aluminum for steel. They might or might not affect the utility of the development model or prototype. If such changes do affect its use and technology cannot meet the situation, then the planned use as expressed in military characteristics may have to be changed.

At this point it takes a lot of judgment and close liaison between the research and development engineer and the production engineer. It should be emphasized that this liaison does not and should not have to wait until this point in the time sequence to be initiated.

Let us take a brief look at one important aspect of our production picture. This is the problem faced by an organization when it undertakes to produce an item developed by another. It was a situation that confronted industry many times during World War II.

It follows logically, actually happened, that a fully acceptable, producible product that is made by one manufacturer cannot necessarily be duplicated, or even satisfactorily made by another. Why? Because his manufacturing resources are different. Such differences are usually in his organization: his management, his know-how, or most commonly in his facilities--machine tools and tooling. For example, where one manufacturer required 45 hours and 21 different machines to produce a breech ring, another took only 15 minutes on 4 machines. The first used a forging; the second, a broaching process.

When a manufacturer's means are different, his costs will be different. In short the same product usually presents a completely different production problem to every manufacturer. It will also present a different problem to the same manufacturer at different times. This is because of changes in his plant, almost day-to-day changes in machines, tools, equipment, and layout. This is one of the problems that face us always--the problem of gradual plant obsolescence versus instant readiness. It is a problem that is giving ODM a headache.

In order to get a good look at the elements of mass production, let us check off some of its basic characteristics. These are not ordinarily typical of job lot production. There are at least five of these, as follows:

1. To break down productive effort into simple elements.

2. The extensive use of semiskilled and unskilled workers.

3. The extensive use of complicated and automatic machinery and equipment.

4. The interchangeability of parts.

5. Highly detailed plans and organization. I could add a sixth one that is highly important to the military--time, usually lead time.

Historically, our mass production methods were born in 1800 when Eli Whitney first successfully demonstrated the practicability of interchangeability. Significantly, he did it when he produced 10,000 muskets for the military.

When a new design is considered for manufacture, here are some of the factors that must be analyzed. They fall broadly into two categories.

1. That nasty word "requirements" which says: how many, including spares? starting when? and, at what rate?

2. "Production capability," meaning raw materials; machines, tooling, and gages; facilities; materials handling equipment; manpower.

These are analyzed in order to arrive at the production design. Production design includes drawing, specifications, and the plan for manufacture, inspection, and testing.

This is the problem which production engineering must attack and it is a team job for it draws on many skills.

Its starting point is an acceptable development model. For military end items this model has met the military characteristics and presumably it can be produced in quantity. Sometimes this is a big presumption. The K radar bombing-navigation system now utilized in our modern bombers is just one such example. Or the starting design in a few rare cases may be an item of foreign design and manufacture. The Martin B-57--the British Canberra--is a current example of this. The Rolls Royce aircraft engine used extensively in World War II is another example.

Most often, however, the starting point is a production item and the problem is--to produce it in greater quantities and more cheaply, or perhaps to use different machines, materials, or methods.

New model changes are routine in the automobile industry. But even here such a repetitive job as the design, production engineering, and manufacturing of new models has not been reduced to a routine procedure. Once management has decided to make a new car, a considerable portion of the organization launches into what has been called "one and a half years of organized chaos." This is the "make ready" period.

"Make ready" is the time needed for physical preparation of plant and facilities prior to the start of manufacture.

"Tooling up" in this "make ready" operation is the designing, making, and installing of ready-to-operate machine tools. These tools must then have initial production runs to prove that they can produce at required tolerances--tolerances frequently measured in ten-thousandths of an inch.

Depending on the market at the time, it may take from 6 to 18 months, sometimes even more, to get the machine tools.

And here a word about machine tools--essentially they are the machines for making machines; they do it with simple operations or combinations--turning, drilling, grinding, milling, planning.

A general-purpose tool, such as a lathe can perform one operation, turning, on many kinds of jobs.

A special-purpose tool performs a combination of basic machining jobs at the same time and in a sequence. The most complex tool is but a coordinated means for doing a number of these basic, general-purpose machine-tool jobs over and over again. Without such tools, modern mass production is unattainable. However, until production designs are firm, these tools cannot be made. Here is a recurrent source of industrial mobilization bottlenecks.

We hear a lot about shortages, sometimes I think we are overly concerned in the wrong way about our shortages. We find that we don't

have enough materials, or we don't have enough men. We rarely have enough when we hang on to old outmoded methods. The challenge to management is to find better means and better methods. I gave you one example from the last war of how industry solved such a problem by using new techniques in production.

Another company found it could use the seamless steel tubing method to make guns. The job of forging and machine gun barrels used to take from 750 to 15,000 man-hours, depending on the caliber. By using the seamless steel tubing method the time was cut down to as little as one-half man-hours in one case to 20 man-hours in the larger guns. And this does not say anything about the machine tools or the materials that were saved. Nor do the figures emphasize the great importance of the man-hours that were saved. Yes, the type of tools and the methods to be used have terrific impact in determining our manufacturing capabilities.

Let's look at this military example: Here is the Thompson sub-machine gun--I'm sure its familiar to all of you. It has had about 20 years' development behind it. It has 73 parts in it. It is complicated. The initial production cost was around $200 and this amount was never reduced appreciably. What is more, its complexity made it difficult to maintain. If we were to ignore its undesirable operating characteristics, we still couldn't afford to live with it in mass production.

So what was the answer? A proven skilled production unit, one that had never made a gun, however, was given a contract. Here is the result.

This is the M-3 submachine gun--the so-called grease gun. You all saw it at Aberdeen last fall. This weapon was exposed to water, dust and mud. Then you saw it fired. Certainly this was a desirable improvement in military characteristics over the Thompson gun it replaced. But from the production point of view, it was even more amazing. Its cost is less than $20; it has a very small number of parts, comparatively, and they are primarily easily made stampings. Time of manufacture was cut down tremendously.

This is why I speak with emphasis on our need to know something of production engineering. This is why knowledge of the fundamentals of production is considered so essential in our Unit. It has terrific military impact.

In reviewing these fundamentals, then, the production engineer must set down in precise detail, how each part is to be made. He must determine (1) what materials, (2) how it is to be worked, (3) on which machine, (4) with what tools, (5) checked with what gages, and (6) in how long a time.

And what is the pay-off? The pay-off is increased volume, quality, lowered costs, and, so very important to us, an overall reduction in lead time.

I just mentioned gages, so lets discuss them and quality control. Gages are simply special kinds of measuring tools. Their use by the workman helps him get the precision and uniformity needed for interchangeability. They are also the tools of inspection. They are precision instruments that take time to design and a longer time to manufacture. They are vital to the production process. You will see them so frequently during your visits to industrial plants that we have scheduled a full period for a discussion of them. Mr. Clifford Kennedy of Federal Products will talk to you and demonstrate typical precision gages next Tuesday morning.

Quality control is the other very important tool of the production process. "Quality" as used in the expression "Statistical quality control" is not quality in the sense that this one building is better than another. It is quality in the sense that a product is made to conform to the characteristics that have been specified. Statistical quality control has been said to be "one of the sharpest management tools developed in half a century." This relatively new science came about through the application of mathematics and statistics to the problem of inspection. Inspection rejects products after defects occur. Quality control, on the other hand, through a coordinated and systematic use of process information prevents the defects from occurring in the first place.

Because of its importance we have asked you to read Dr. Juran's lecture on "Quality Control." It is included as essential reading in this Unit. Tolerances, gages, inspection, and quality control are very closely related. What is more, they bear directly on costs. It has been said that "he who sets the tolerances decides the costs." This is a most important point for us to remember.

Tuesday afternoon, a film covering this subject in considerable detail will be shown to you.

I have talked at some lengths on the tooling problems facing the production engineer. I've also mentioned that our productivity is somewhat hamstrung if we hang on to the old methods--that the challenge to management is to find better means and better methods. A most promising solution appears to be in the field of automation. Now automatic factories are not new by any means. The chemical and petroleum industries have long been in this category, where the worker's principal duties are to watch the gages and turn valves. But now automation is gaining greater acceptance in all of the major industries. Problems are introduced--big headaches to be sure--but the pay-off again is greater

productivity, greater quantities, and lower costs--a shortening of lead time plus a saving in manpower requirements.

Let me give you a few examples of the latest applications--not theoretical developments--in this field. Columbia records furnish us with a fine comparison of the old versus the new look. On one floor of their Bridgeport, Connecticut, plant 250 grimy men labor amid the ear-shattering hammer of hydraulic presses and the stench of burned rubber turning out phonographic records. On the floor below, four neatly dressed men stand by 16 softly purring machines. The four seemingly do nothing but watch the machines work. Yet in an eight hour shift each man turns out five times as many records as the entire sweating crew on the floor above.

This "automated" line means that skilled press operators no longer need go through six steps to make a record. The new machine does the job in an uninterrupted flow--it automatically feeds the right amount of plastic into a mold, cools it, and ejects a record. Each machine costs $25,000 compared to $3,000 for the old-style press, but they make better records about 30 percent faster, with only, as I said before, four men watching over the machines.

One large automobile company now has a line of 26 linked machines that broach, drill, hone, and prepare the engine block ready for assembly fully automatically. This line does in less than three hours with 41 machinists what formerly took four and one-half hours and 117 men.

MIT has developed a servo-controlled milling machine so flexible that it can make 150 different products. You can have one for your basement shop, to augment your drill and saw, for $400,000.

What now appears to be the greatest immediate field for automation is in electronics. Raytheon has a chassis assembly line geared to turn out 1,000 units a day. It is run with two workers where formerly 200 were needed.

The AEC plants are beautiful examples of automated industry. Unfortunately, not one of them is included in those plants we visit this spring. Some semiautomatic and some fully automatic plants will be seen, however.

Automation offers so many possibilities that I cannot emphasize its growing importance too strongly. Its implications are far reaching, not only for increased productivity, but also in the labor-management field.

We now arrive at a consideration of wartime production planning and controls. This is the phase of study where your imagination and intellectual deductions are given the green light. How far and how fast you go is entirely up to you. We are setting no boundaries. We will review what has happened in the past. We will analyze carefully what is being done today. But we expect your thinking on future planning to be reflected in your reports at the conclusion of this Unit.

ODM, our present top planning agency for wartime mobilization, states that the essence for such planning is to have at all times a strategic plan based on the maximum striking power that our resources can support.

Before Pearl Harbor we had not expanded our manufacturing facilities enough to support our strategic plan, consequently we had to divert a large part of our resources into building capacity instead of armament. This extended the time required to equip our military machine. And then after the war, in a rosy glow of optimism we practically threw away or reconverted our military production capacity. But with world tensions increasing and Korea thrust upon us, we have now come a long way in expanding the resources that will be needed for war. These resources make up what we call our production mobilization base. A measurement of these resources serves as the basis for strategic planning and, where we are primarily concerned, for the actions necessary to fill gaps in this production mobilization base.

How this is being done is explained very clearly and graphically in this pamphlet issued by ODM and distributed to each of you. Look it over carefully. It is your guide to our present planning.

Let me point out, that this plan depends upon periodic review to avoid obsolescence. However, that is a truism applicable to all plans. This plan to be of value, has to conform to our ever-changing resources, strategy, and technological progress.

And as further evidence of planning being accomplished in this production field, let me quote from a Department of Defense directive of 22 December 1953. The subject is "Defense Production Security Program Guidance."

The stated objective is this:

> "In the event of war it is assumed that an enemy will mark for early destruction those production facilities of greatest importance to the military effort of the United States. The objective of the Defense Production Security Program is to minimize loss of vital wartime production. This goal is to be achieved through the application of vulnerability reduction measures, passive

defense measures, and restorative measures to industrial facilities on the Department of Defense Key Facility List."

Here we see the application of plant diversion, internal security, and Civil Defense to the assurance of continuity of production.

The Production Unit therefore asks you to analyze how these goals are to be realized and to evaluate how effective they may be in the face of the assumptions made here, by previous speakers.

Thank you.

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