routing, planning and control, we are striving to make conditions in the job shop approach those of the continuous process shop. Where machines are turning out one product continuously you have an almost complete absence of the mechanisms of planning and control. Providing flow of material and maintaining equipment are all that are necessary. If we had a classification of industries we would not have people assuming that the technique which Mr. Bryant describes is being advocated to satisfy the needs of the continuous process industry.

The principles are the same, as was brought out in a paper I heard at a local section meeting of the A. S. M. E. in San Francisco. The paper described what was being done in the Hall Scott Motor Company, an organization in the job shop class. They had worked out a very ingenious application of the methods developed in the automotive industry. After carefully routing a job on the basis of time study they would temporarily set up machines for the execution of every part of the job. In other words they established temporary continuous flow conditions for the particular job.

I have been having a rather interesting time recently in my new connection. In one of our divisions reorganization plans had been laid, tools and machines had been standardized, routing improved, the Stevens feed table developed, detailed instruction cards for each step in the work prepared, and so forth. We realized, however, that it would be a year and a half or more before we could hope for a complete application of the ideal methods. And in the meantime along came a sudden influx of work. As a temporary expedient we decided to install the Halsey wage premium plan and did it overnight. Incidentally, a firm of industrial engineers had put in a bid to do the job at a cost of about $30,000 and would have taken about six months to install it. We did it in thirty-six hours. I waited in fear and trembling to hear a report and was most surprised to learn that the result of this temporary expedient was a 30 to 40 per cent increase in production. And in addition it served as the stimulus for a more rapid introduction of the permanent features of tool and machine improvement that were to follow. For example, a man at a drill press had been doing a certain operation in a most inefficient way at frequent intervals for years. In order to counterbore an inch and a half hole he had been using a three-quarter inch drill and counterboring with it, then running the inch and a half drill through, because he had a lead tip to fit the three-quarter inch drill but not the other. He had called this condition to the attention of his foreman until he got weary and gave it up. When he found he could earn a little more money by having the right tool he complained until something was done. The result was that the works manager looked the shop over and found from 150 to 200 lead tips that had never been used, many of which were of the needed size for this operation. This brings out two of Mr. Bryant's points—the one concerning the standardization and improvement of small tools and the other concerning the effects of incentive wage systems.

In another of our plants we had three Bullard Boring Mills. The consensus of opinion had been that these mills should have been scrapped a long time ago, that you could not expect to get any decent work out of them, or any speed. This view was accepted and we were on the verge of spending money for new machines. By putting a man in charge of speeds, the introduction of an element of functional foremanship, however, the production of these old machines was increased by 40 per cent. This has a bearing on Mr. Bryant's discussion of new machines versus old. On another machine the feed and speed combination was increased by something over 100 per cent by the use of properly forge-treated and ground tools.

These things that are essential to profit are being neglected in the shops of successful companies all around us. It was this sort of thing I had in mind when I said this morning that we must in some way awaken American industry to the possibility of progress beyond the point it has reached. The organizations that are represented here today are the progressive ones. For the sake of American industry and American progress in general we must get our knowledge of scientific management across to the organizations who are not represented here today.

George D. Babcock.[8] Two things affect the utilization of equipment. The first is the primary assumption that our product is sufficient in quantity to utilize our equipment economically. Another is the possibility of using completely depreciated machines, with the aid of a little repair work, to

[8]Manufacturing Engineer, Chunn's Cove, Asheville, N. C.

serve as the driving force for the operation of new self-contained fixtures. This may be an especially valuable use when the worn machine does not occupy such land or building space as makes this a factor of cost.

We have worried a great deal about fixed charges because of continued depreciation of reappraised values of machines. Often this has continued for a long time after their true value has been used. But none of the depreciation reserve has been allowed for the replacement of the machine. This I consider bad. Depreciation funds should be utilized for machine replacement and extraordinary repairs. If such funds are in excess of the needs they can be diverted to other uses, but the machines should have the first claim. I cannot help but think, in comparison, of the gasoline tax that the states levy for the maintenance of roads and then divert to political uses. I feel that great stress should be laid on the maintenance of machines in good condition. When this is done consistently we shall not have to worry about old machines. Unfortunately many manufacturers do not do this because they could not operate profitably if full repair maintenance depreciation were taken. Consequently they wreck the machines.

The flow of materials between machines, which has been mentioned by Mr. Younger and others, depends on the length of time per piece and the number of pieces to be produced. The question is whether the usage of a machine for a particular operation is sufficient to pay for the depreciation on that machine and yield a profit. Would another set-up yield a greater profit? If you have a permanent machine set-up and a permanent sequence of operations, then you can use conveyor control to real advantage, but the thing depends on the number of pieces you have to turn out. You cannot reduce production below a certain point and keep going under conveyor control.

In 1907 I was connected with an automobile plant that manufactured seven cars per day and we thought that was some load. In 1915 we had moved up to the larger amount of fifteen. Even this difference meant a complete revolution in our machine and material flow practice. We were forced to obtain the maximum utilization of our equipment with no excess. A very rapid turnover of a great variety of parts for a variety of assemblies was necessary. The problem in a nutshell was to turn out from seven to fifteen cars of three distinct chassis—motor transmissions, axles, steering devices, etc.—and eleven different body styles per day. You know that to do that it would not be possible to utilize any system of conveyors. The great difference in length of separate operations on a piece necessitated the storage of many parts in process throughout the shop.

Shortly after the war I had to do with the manufacture of a caterpillar tractor and strangely enough started in at seven a day on that. But we had a load there that was sufficient to put more than half of our material on progressive lines. And for this reason the machine time of operation on each piece was from five to fifteen times longer than on any piece used in the automobile. The automobile parts were small and light involving few problems of moving. In the case of the tractor the parts were large, heavy and a small quantity required a full machine time. That and the difference in time per operation made it desirable to install a fixed transportation system between operations. Frequently machines retained fixed set-ups.

As soon as the caterpillar tractor program had been studied and simplified so as to give each machine a larger burden per operation the quantity of output increased very rapidly, and the increased quantity decreased cost and sales prices for two reasons. The sales force sold more in order to load the shop and the quicker turnover of inventories released funds to be used for advertising. Another advantage of progressive manufacture is that it permits ready changes in design. It is possible to get new parts under way while old ones are still coming off the line.

An automobile company had a small assembly plant in Toronto where English labor was utilized. In this plant the cars were moved by hand from position to position and materials delivered to their respective positions. In reconstructing the plant a conveyor system was put in for the final assembly. Later one was installed for the body also, and as a result the whole organization was keyed up. Materials were still being moved in lots by trucks, but the whole organization felt a stimulation and ease and schedules were met with a consistency which had hitherto been unknown. The mechanical conveyor is undoubtedly a pace setter if its installation has been preceded by the work of organization