instead of white, that the instrument is given individuality. On the contrary, individuality is in the tone, the lines of the case, the beauty of the finish, the character of responsiveness of the action. These things must be understood by the salesmen, in order that they may retain and transmit to their customers their pride in the individuality of the product, and have an additional pride which comes from the knowledge of the improved quality and lower cost made possible by standardization.

There is no manufactured product which must combine mechanical perfection and artistic qualities to a greater degree than the piano. Like the pipe organ, the phonograph and other musical instruments, it has become an essential part of social, religious, educational and home life. There are instruments de luxe. There are also the great majority of pianos, which are purchased by persons to whom rigid economy is essential, and who therefore demand low price, as well as quality and an artistic product. The typical musical instrument is not found in the homes of the wealthy, where the greatest care is given it. The typical piano is pounded and abused by youngsters who are obtaining a part of their education from it; it is banged about in smoky factories where music has become a part of industry; it must endure the dampness and the extremes of heat and cold in churches, chapels and other public places; it must withstand constant and hard use in theatres, movie houses, schools and conservatories.

If the musical instrument, which must conform to the most rigid artistic requirements of design and finish, have mechanical perfection, always be dependable under the most unfavorable conditions, and be cheap enough in price to furnish an economical means of education, entertainment and relaxation for the poor man, can be standardized and yet retain its individuality, then standardization certainly can be developed successfully in any trade. In order to develop it in any industry, however, the raw material, assembling and selling branches of the trade, and all allied trades, must cooperate. Standardization is a trade problem.

III. AS A PLANT ECONOMY

By Willard E. Freeland[1]

One of the by-products of the war period has been the spread of understanding of the importance of standardization of products as a plant economy. The war taught us the advantages of having but one rifle at the front so that there need be no necessity of carrying a multiplicity of repair parts; also of having the same cartridge fit machine rifles and machine guns. At home the standardization of the tools with which munitions were made enabled plants to lend tools to other plants which were temporarily short of needed tools.

One of the most quickly realized benefits of standardization of products is the reduction of inventories and the possibility of contracting for raw materials far in advance of the time of use. In fact, the possibility of making sales, production, financial and personnel plans far in advance is greatly enhanced by such standardization, and we will all acknowledge that the ability to plan far in advance of production is one of the prime elements in successful management. Standardization of products leads to standardization of raw materials and thus to possible reductions in raw material inventories.

Sales engineering, properly organized, establishes the standards of products, but upon manufacturing engineering falls the task of establishing standards of components, tools, machines, materials, processes and inspection. Let us review for a few minutes the results of such engineering upon work in process, worked materials and finished goods.

Let us presume that a plant, as in our own case, is planning new lines of products. The standardization of these lines as established by sales engineering is usually accomplished by eliminating those items for which there is not sufficient market demand to warrant the investment in tools necessary in modern mass-production. Sometimes such study will lead to the combination of two or more items into one by minor modifications of or additions to a single item. Prior to the war, one of the leading pocket knife makers was manufacturing over 6,000 different patterns; we believe that we are covering the entire service needs of this country with 129 patterns. Similarly, a leading maker of flashlight cases was making 77 patterns; our line comprises 18 patterns. That we are heading in the right direction is made evident by the fact that we are being followed closely by our competitors. By reducing the number of items we are enabled to place factory orders for larger lot sizes and thus to obtain a better flow with a decrease in the inventory of work in process and at the same time tool up to eliminate handicraft methods and thus lessen the importance of the human factor in the maintenance of quality.

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The first task of manufacturing engineering is to study the components that make up a line of products. One of the first discoveries usually ensuing is that there is a great similarity in the components for different items and that there is a possibility of standardizing one component for several different items. For example, in our line of fishing reels we have found great opportunities for standardizing components. A part which may be used in several brass or nickel-plated reels will be placed in Component Stores in a polished condition. When an order is received to assemble nickel-plated reels of which this part is a component, the part is drawn from Component Stores and nickeled as a part of the assembling operation. If at a future time the brass reels should be dropped from the line, then the engineer would change his plan of manufacture so that the part would be placed in Component Stores in a nickel-plated condition, as it must always be his aim to have performed upon a component before it is placed in stores as many operations as possible without affecting the use of the part in the maximum number of product items. A direct result of the standardization of components is a reduction of the Worked Materials inventory. This is accomplished not alone by the reduction in the number of components carried in stores but also by the reduction in the quantity of any particular component necessary to prevent a break in the assembling operations. By standardizing components, it is possible to keep a considerable part of the inventory liquid in the form of Component Stores, assembling these on short notice to meet the sales demand. I need not comment on the interest of the sales organization in maintaining such liquid condition of the inventory that it can best serve the customers of the business in the quickest time, and at the same time be more free from the everpresent and sometimes pressing problem of foreseeing and meeting sales demands caused to fluctuate continuously by influences beyond its control.

The standardization of products and components, it has been pointed out, results in longer runs when the machines and tools have been set up and adjusted, with a resultant saving in idle machine time. One of the great savings, however, is the reduction in the variety of tools, jigs, fixtures and gauges which must be designed, made and kept in repair. This brings about a decrease in the tool inventory and a further decrease in the number of highly-paid designers and toolmakers on the payroll.

We have occasion to build much special machinery and here, again, we are constantly striving to expand the limits of standardization. As large users of machine tools, we have reason to praise the efforts of machine tool builders to standardize their products. It is regrettable that so many makers of general and special machinery are trailing in this matter of standardization. A manufacturer need only compare the cost of maintaining a battery of machines which are exactly alike, and assembled so far as possible from standard components, with a similar number of unstandardized machines, to appreciate the economy resulting from the purchase of machines which have been standardized by their manufacturers.

Standardization of manufacturing processes is no small factor in the reduction of production costs. It is futile to look to the engineers alone for action in this direction. The lowliest employee on the production staff may be inspired with an idea that will revolutionize a production process. Good management provides a way to gather good ideas from any source and suitably to reward the man responsible. The elimination of unnecessary operations is the most common result of studies in standardization of manufacturing processes. Sometimes two or three operations can be combined into a single unit of operating time.

In large plants it is not uncommon for an outside observer to see in one department an operation which is a time saver and find other departments doing the same work by older and more costly methods. A few years ago in one big automobile plant I found the same grinding operation being performed in four different ways in four separate tool rooms, and four different kinds of grinding wheels being carried in stores because of this lack of standardization. If nothing else resulted from the study of standardization of manufacturing processes in many plants, enough small leaks would be discovered to offset a considerable portion of the cost. In some types of manufacture there exist certain troublesome peak production loads due to the seasonable character of the products and hence there arises the problem of shifting operating personnel from product to product. Here standardization of manufacturing processes helps not only in the ability to quickly shift help from product to product but also in creating a saving in the time and cost of training new workers.

The effect of standardizing manufacturing processes and the tools of production is most marked in the assembling operations. In the pocket knife industry, the king pin is the cutler, who, with the aid