ORTHOPEDIC LEG BRACES:

Analyses of Fabrication Methods

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The Prosthetic Testing and Development Laboratory has been conducting systematic studies of orthopedic bracing for a period of four years. These studies are chiefly analyses of leg brace designs. From such investigations, the Laboratory attempts to illustrate structural and functional limitations in present designs and to emphasize advantageous design details. Such investigatory work, besides developing the present brace technology, provides a base for researchers who strive for constant improvement in orthopedic bracing.

Studies of brace designs encompass the problems of fabrication methodology. The fabrication procedure for an orthopedic leg brace depends, to a great extent, on the choice of constituent materials and components. There are many combinations of materials and parts which can be utilized; therefore, there are many fabrication methods. Rather than attacking the problems of each and every method of fabrication, it is sound procedure for a research and development laboratory to analyze the general management treatment of fabrication needs. Results of such an evaluation are contained in these three Laboratory reports:

(1) Prosthetic Testing and Development Laboratory, Special Report 18-3, *Analysis of Orthopedic Leg Brace Fabrication*, October 1, 1953.

(2) Prosthetic Testing and Development Laboratory, Special Report 18-31, *Time Required to Fabricate a Leg Brace Using Prefabricated, Mass-Produced Parts*, October 15, 1953.

(3) Prosthetic Testing and Development Laboratory, Special Report 18-32, *Cost Analysis of Leg Brace Fabrication*, October 19, 1953.

This article summarizes the procedures and the findings of these three reports.

Evaluation Procedure

As a beginning, one fabrication method was selected for analysis: a method requiring fabrication of a "typical" ischial weight-bearing, leg-thigh brace with bilateral bail lever lock knee joints. In this typical fabrication, all components (except standardized parts such as screws, rivets, etc.) were constructed utilizing medium carbon steel. (These studies did not include the required leather work and plating.) But in performing the analysis, cognizance was made of an alternate fabrication method—one utilizing prefabricated, mass-produced parts. Consideration was also given to possibilities of work division among two or more technicians. In the final analysis, cost comparisons were made.

These investigations were carried out consecutively:

Step 1. Utilizing one skilled orthotist, the operations required to fabricate the "typical" brace including operations required to make all components, were timed and analyzed. (Report 18-3)

Step 2. The overall time required to fabricate a duplicate "typical" leg brace (in which prefabricated, mass-produced parts were utilized) was measured. (Report 18-31)

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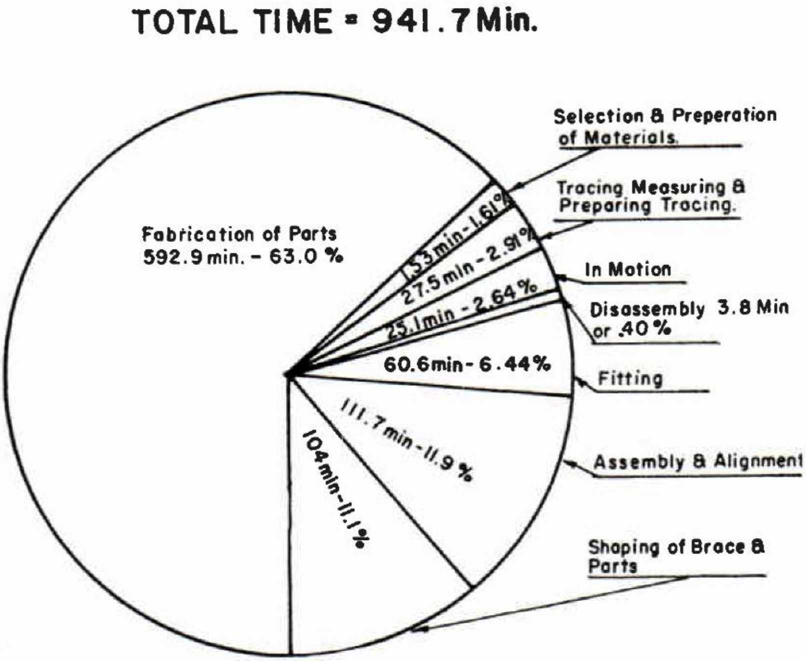


Figure 1. Graph of Operation Types Showing Time Consumed on each (in minutes and in percentage of total consumed time.)

Step 3. Cost analyses of six fabrication methods were developed for the "typical" brace. (Report 18-32)

Findings of Step 1:

a) The operations required for a bracefitter or bracemaker to fabricate a leg brace can be grouped by operation-types. (See Figure I.)

b) The largest *number* of operations are those of the "in motion" type.

c) The most time consuming operation-type is "fabrication of parts." (Approximately 9 hours and 53 minutes out of a total of approximately 15 hours and 42 minutes, as shown in Figure I.)

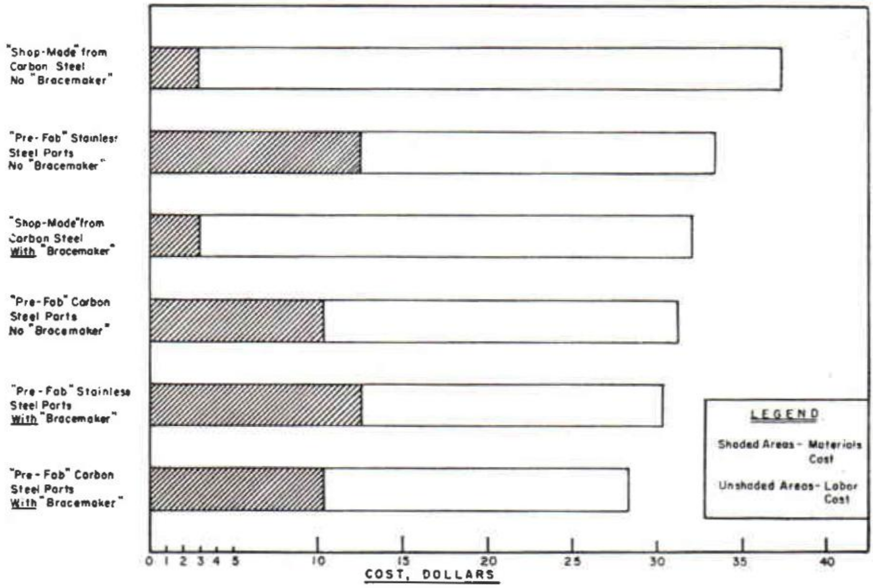
d) A large percentage (over 27%) of the time needed for parts fabrication is consumed by two simple and routine operations: the cutting of parts and the grinding and bevelling of parts.

e) A large part (over 60%) of the time needed in parts fabrication probably would not be necessary if prefabricated, mass-produced parts were used. The amount of machinery and equipment needed for leg brace fabrication using prefabricated, mass-produced parts would be considerably less than that needed for fabrication using "shop-made" parts.

f) Each of the many operations requires different degrees of fabricating skill. Two levels of skill seem indicated as with a classification differentiation between bracemakers and bracefitters.

As shown in (e) above, over 60% of parts fabrication time can probably be eliminated by using prefabricated parts. This means that about 6 hours of the total 9 hours and 53 minutes needed for parts construction would be unnecessary. The time required for the entire fabrication was

FIGURE 2.
CHART OF LEG BRACE FABRICATION COSTS



15 hours and 42 minutes. Subtracting the estimated 6 hour saving from the time for complete fabrication would reduce the overall fabrication time, when using prefabricated parts, to an *estimated* time slightly over 9½ hours.

Findings of Step 2:

a) The time, as measured, for fabrication of a similar "typical" brace (as in Step 1) but with the use of prefabricated parts was 9 hours and 40 minutes.

b) The proximity of this *measured* time to the *estimated* time tended to substantiate the operation by operation classifications made in Step 1.

Findings of Step 3:

Figure 2, *Chart of Leg Brace Fabrication Costs*, shows the six methods for which analyses of approximate expenditures were made. These analyses were developed after making a work division as suggested by finding (f) of Step 1 (above). In three of the six methods, a bracefitter has the assistance of a lower level technician or bracemaker; in the other three, the fitter has no assistance. Assumptions were made regarding the magnitude of labor rates, and no consideration was given to fringe expenses and to overhead and sales costs.

a) As is shown in Figure 2, the "team-effort" with work division between bracefitter and bracemaker decreases the overall cost of leg brace fabrication.

b) The use of prefabricated components, chiefly by lowering labor costs, results in a leg brace of lower overall fabrication cost.

From these findings, it is possible to make certain conclusions. If a suitable leg brace can be obtained using existing prefabricated, mass-produced components, the use of such a method seems indicated. However, it must be ascertained that the prefabricated parts are of equivalent quality to parts which can be self-produced. Present Laboratory studies of such quality indicate, in general, that currently available mass-produced components are being made