8-1985

The Use of Job Aids as an Alternative to Training New Employees

William D. Powers
Western Michigan University

Follow this and additional works at: https://scholarworks.wmich.edu/masters_theses

Part of the Industrial and Organizational Psychology Commons

Recommended Citation
https://scholarworks.wmich.edu/masters_theses/1389

This Masters Thesis-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Master's Theses by an authorized administrator of ScholarWorks at WMU. For more information, please contact maira.bundza@wmich.edu.
THE USE OF JOB AIDS AS AN ALTERNATIVE
TO TRAINING NEW EMPLOYEES

by

William D. Powers

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Psychology

Western Michigan University
Kalamazoo, Michigan
August 1985
THE USE OF JOB AIDS AS AN ALTERNATIVE TO TRAINING NEW EMPLOYEES

William D. Powers

Western Michigan University, 1985

Lack of knowledge required to perform a job, has often been dealt with by implementing some sort of training program. However, some businesses cannot afford to implement training. This study tested the effectiveness of using job aids as an alternative to training two new employees at a small business which had no training program. Step-by-step instructional aids were developed for rebuilding Series 40 MT Delco starters and Series 10 SI Delco alternators. A multiple-base-line between subjects design, with an ABABAB reversal, was used.

The data showed the average time required by the new employees to rebuild Series 40 MT Delco starters dropped 9.22 percent. The average time required to rebuild Series 10 SI Delco alternators dropped 22.75 percent. The time the foreman spent helping the new employees with these tasks dropped an average 30.33 percent per unit. The total cost of developing and implementing these job aids was $42.
INFORMATION TO USERS

This reproduction was made from a copy of a document sent to us for microfilming. While the most advanced technology has been used to photograph and reproduce this document, the quality of the reproduction is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help clarify markings or notations which may appear on this reproduction.

1. The sign or “target” for pages apparently lacking from the document photographed is “Missing Page(s)”. If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure complete continuity.

2. When an image on the film is obliterated with a round black mark, it is an indication of either blurred copy because of movement during exposure, duplicate copy, or copyrighted materials that should not have been filmed. For blurred pages, a good image of the page can be found in the adjacent frame. If copyrighted materials were deleted, a target note will appear listing the pages in the adjacent frame.

3. When a map, drawing or chart, etc., is part of the material being photographed, a definite method of “sectioning” the material has been followed. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.

4. For illustrations that cannot be satisfactorily reproduced by xerographic means, photographic prints can be purchased at additional cost and inserted into your xerographic copy. These prints are available upon request from the Dissertations Customer Services Department.

5. Some pages in any document may have indistinct print. In all cases the best available copy has been filmed.
PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark √.

1. Glossy photographs or pages ______
2. Colored illustrations, paper or print ______
3. Photographs with dark background ______
4. Illustrations are poor copy ______
5. Pages with black marks, not original copy ______
6. Print shows through as there is text on both sides of page ______
7. Indistinct, broken or small print on several pages √
8. Print exceeds margin requirements ______
9. Tightly bound copy with print lost in spine ______
10. Computer printout pages with indistinct print ______
11. Page(s) ___________ lacking when material received, and not available from school or author.
12. Page(s) ___________ seem to be missing in numbering only as text follows.
13. Two pages numbered ______. Text follows.
14. Curling and wrinkled pages ______
15. Dissertation contains pages with print at a slant, filmed as received ______
16. Other___________________________________________________________________________

________________________________________________________________________________

University
Microfilms
International
# TABLE OF CONTENTS

LIST OF FIGURES .................................................. iii

CHAPTER

I. INTRODUCTION .............................................. 1

II. METHOD ....................................................... 9

   Subjects ..................................................... 9
   Setting ...................................................... 9
   Materials .................................................... 9
   Independent Variable ...................................... 10
   Dependent Variables ...................................... 11
   Experimental Design ...................................... 12
   Reliability .................................................. 12

III. RESULTS ..................................................... 14

IV. DISCUSSION .................................................. 19

APPENDICES

A. Step-by-step Instructional Job Aid for
   Series 40 MT Delco Starters ................................ 24

B. Step-by-step Instructional Job Aid for
   Series 10 Si Delco Alternators .............................. 30

BIBLIOGRAPHY ..................................................... 35

ii
LIST OF FIGURES

1. Graph of Average Minutes to Rebuild Series
   40 MT Delco Starters ............................................. 15

2. Graph of Average Minutes to Rebuild Series
   10 SI Delco Alternators .......................................... 17

3. Graph of Average Minutes, Per Unit,
   Foreman Helped Subjects .......................................... 18
CHAPTER I

INTRODUCTION

Goldstein (1980) suggested that personnel training was "the acquisition of skills, concepts, or attitudes that results in improved performance in an on-the-job environment" (p. 230). This study was designed to improve the performance of two new employees by providing them with job aids in lieu of training.

Job aids are devices that provide the employee with the necessary information needed to perform the task at hand (Chalupsky & Koph, 1967). These job aids come in a variety of styles such as queries, checklists, algorithms, flow-charts, and instruction sheets. In the every day world job aids take the form of phone books, traffic signals, 'how-to' manuals, and recipe cards (Bullock, 1982; Gilbert, 1978a, 1978b; Horabin, 1972; Lineberry, 1977; Tillman, 1985). Porta (1979) even distinguished between non-deductive and deductive job aids. Non-deductive job aids are basically instruction sheets that don't provide any theory about the job. These job aids help the user perform the job, but if a situation not specifically dealt with by the job aid arises, the user may not have the information needed to finish the job. Deductive job aids provide the theory of what the job is about, but not
detailed instruction sheets on how to perform it. People using deductive job aids need a higher level of skill than those using non-deductive job aids, but they have the information needed to deal with situations not specifically mentioned in the job aid. This study used non-deductive step-by-step instructional job aids. The skill level needed to use these job aids was one of general mechanical ability and the ability to use tools. These job aids did not provide the new employees with any basic automotive electrical systems theory. The decision not to explain how starters and alternators work was because the job aids would have become too complex and difficult to use. Decisions about what to include in job aids start with organization, job, and task analyses.

The goals and objectives of the organization have to be taken into account when determining a learning format for the employees (Gilbert, 1978b; McGehee & Thayer, 1961; Robinson, 1982). Gilbert (1978b) designed a "performance engineering matrix" (p. 136). This matrix was designed to assist the analyst in developing a good view of the goals of the company, the jobs needed to accomplish the goals, and the tasks needed to fulfill the jobs. The organization, job, and task analyses were divided into levels of policy, strategy, and tactics respectively (Gilbert, 1978b, pp. 111-142).

The policy level is used to analyze the organization. The organization's goals are determined along with how it is attempting to fulfill
those goals. This analysis will help determine if there are ways of improving how the company attempts to fulfill its goals (Gilbert, 1978b). The author in the present study knew that the goals of the company were to supply quality automotive electrical parts and services to the industrial, automotive, marine, agricultural, and trucking industries in the area. One job that has to be performed well, to accomplish these goals, is the rebuilding of electrical units such as starters and alternators.

Gilbert (1978b) uses the strategy level to analyze the jobs that help fulfill company goals. The job analysis will help identify what the job is to accomplish and how it may be made more effective. In this study the author focused on the job of rebuilding the electrical automotive parts. This job required that the employees knew how to rebuild a multitude of different types of units. However, when new employees were hired there were no formal training programs that taught them how to perform their jobs. This lack of training provided an opportunity to attempt to increase the performance of the new employees. This attempt had to be in the form of some sort of educational program. In order to determine the best type of program a task analysis was needed. The logistics of attempting to teach the new employees how to rebuild the thousands of different types of units they might encounter forced the author to focus on two specific tasks. The two tasks chosen,
due to the fact that they are often required, were the rebuilding of Series 40 MT Delco starters and Series 10 SI Delco alternators.

The task analysis is contained in Gilbert's (1978b) "tactics" level of his "performance engineering matrix" (p. 136). The task analysis is a vital part in determining the needs of the employees in terms of the skills they will need to perform the task (Wexley, 1984). The behaviors that are required in order to perform the task in the most efficient manner in terms of time, energy, and cost have to be determined. Systematic analysis of the actual performances of a person doing a task may help determine the behaviors required to perform it (Broadwell, 1975; Bullock, 1980; Dowdle, 1973; Foley, 1973; Latham, 1982; Lineberry, 1977; Shoemaker, 1973; Short, 1973; Yarusso, 1984).

Johnson (1967) suggested breaking down each task into a "logical sequence" (p. 18), and then, by determining the necessity of each step, devising the best procedure for performing the task. Short (1973) took a total of 2000 observations during a task analysis of 40 job assignments that employees at the Bell System's Long Lines Plant Department were required to be able to perform. Another method of task analysis involves questioning the employees who perform the task.

The author in the current study conducted both types of task analysis. By observing the foreman rebuild and by asking him questions the author was able to determine the steps necessary to rebuild Series 40
MT Delco starters and Series 10 SI Delco alternators.

In the present study the author also had to take into account the fact that the owner of the business did not want any formal training to take place because of potential costs and the time the new employees might have to spend away from their work. Lineberry (1977) claimed that time and money constraints may allow the use of job aids but not more extensive training. Gilbert (1978b) however, claimed that a formal training program could actually be more economical than informal on-the-job training. Formal training could cause the employee productivity levels to rise quicker and higher than an informal on-the-job training approach. The increased productivity could pay off the training expenses and help the company's profits increase. However, formal training is all too often inefficient and doesn't pay for itself (Gilbert, 1978b pp. 224-226). The present study was under economic and time restraints. The company where the study took place would not pay for any special materials nor allow time off for training. These constraints made the use of job aids more attractive.

Job aids also allowed the employees to learn while they were performing the tasks they had to be able to do. Wehrenberg (1983) mentioned the theory that the closer the training simulates the actual job the more effective it would be. This theory implies that on-the-job learning experiences, such as using job aids, could be more effective
than training situations that occur away from the actual job. All these factors helped the author decide upon using job aids as the method to teach the new employees.

There are three basic types of job aids to choose from. The query is a complex job aid used for complex jobs. The query has questions on it that the user has to answer. The procedures that the user will perform depend upon how the questions are answered. The ensembler is a job aid that has basic rules that the user can apply to the task at hand, but doesn't supply the user with direct step-by-step instructions. The directory does provide the user with direct step-by-step instructions on how to perform the task (Gilbert, 1978b).

When designing the job aid all the information that was gathered in the task analysis has to be reduced to the basic information that will be on the job aid (Harmon & King, 1979; Holden, 1980). This step is important because too much information will make the job aid bulky and complex. Scanland and Scanland (1981) not only concentrated on reducing the information contained in a job aid but, also the actual size of the job aid. The job aid was used by sailors while onboard ship and due to the limited amount of room at the job site the aid had to be physically small.

The job aids in this study consisted of six pages for the Series 40 MT Delco starters and four pages for the Series 10 SI Delco
alternators. The information in these aids was reduced by leaving out minor procedures such as which tools to use. The job aids that were designed for this study were step-by-step instructional job aids.

Complex tasks can be more easily performed if the task is broken down into smaller steps. By using the step-by-step instructional job aids the new employees were able to complete each step of the task before proceeding to the next step. This procedure allowed the employees to finish the complex tasks of rebuilding starters and alternators by following the steps in the job aids. By being able to finish these tasks the new employees also avoided potential aversive consequences associated with failure to perform. The employees were given a varying number of units to rebuild each day, depending upon customer orders and stock needs. When these units were not completed the employees were subject to aversive consequences from other personnel or customers. Thus, the employees were potentially reinforced for using the job aids because they avoided the potential aversive consequences of not finishing units.

The purpose of this study was to design job aids that could be used by new employees at a small automotive parts rebuilding company. These aids were needed to teach the new employees how to rebuild Series 40 MT Delco starters and Series 10 SI Delco alternators, because the company had no form of training yet, the new employees
needed more help than the foreman had time to give them. This study also was designed to add to the literature concerning the use of job aids in an industrial setting. The literature in this area is lacking of sound experimental procedures and data collection. This study used experimental procedures and data collection in an effort to enhance the literature in this area by providing the objective data needed to support the use of job aids.
CHAPTER II

METHOD

Subjects

The subjects were two normal adult males, 19 and 40. They had been employed at the company for less than two months at the beginning of the study. The foreman of the company, who had been employed there approximately ten years, was also involved in the study.

Setting

The study was conducted at a small automotive electrical parts rebuilding company located in Benton Harbor, Michigan. The employees used their step-by-step instructional job aids at their work benches.

Materials

The employees were required to know how to rebuild Series 40 MT Delco starters and Series 10 SI Delco alternators. Through task analysis, which included observing the "exemplar", the person who best performs the task (Gilbert, 1978b), it was determined that there were 12 basic steps required to rebuild the Series 40 MT Delco starters and
eight basic steps required to rebuild the Series 10 SI Delco alternators. These steps were checked for accuracy by the foreman who was the exemplar, and was responsible for the new employees. This type of verification of the task analysis can increase its reliability (Mac-Donald & Stewart, 1983). These step-by-step instructional job aids, (see Appendices A & B), gave detailed instructions for the tasks the new employees were expected to perform.

Independent Variable

The independent variable was the use of step-by-step instructional job aids. New employees previously were expected to learn their jobs through a trial and error procedure that was augmented with help from the foreman. That procedure caused the foreman to have to leave his work and help the new employees whenever problems arose.

During the baseline and reversal phases the subjects were told which units they were expected to rebuild that day. The subjects had to attempt to rebuild the units without using a job aid. Whenever a subject had a question concerning a unit the foreman would go help that employee for as long as it took that employee to understand enough to go work on his own. The job aids were first introduced to the subjects on the morning that they were to start using them. A quick five minute explanation was given to the subjects by the author.
concerning the sections of the job aids and how to use them. The author answered any questions concerning the job aids at this point, but questions that arose later, after the subjects were using the aids, were dealt with by the foreman.

During the intervention phases the author and the foreman made periodic checks to determine if the subjects were using the job aids when they were supposed to. These checks, which consisted of observing the subjects and talking to them about the aids, indicated that the job aids were being used. Another indication that the job aids were being used was that the subjects often requested new copies to replace old ones which became dirty, torn, and hard to read.

Dependent Variables

Two dependent variables were studied. The first one was the amount of time required by the new employees to rebuild the starters and alternators. The second dependent variable was the amount of time the foreman spent helping the new employees learn how to perform their tasks. The third measure concerned costs, to the company, of having this step-by-step instructional job aid format developed, designed, and implemented. Data was collected by the subjects, foreman, and author. The subjects recorded the amount of time it took to rebuild the units on a piece of paper. They would write down the time they started a unit and
the time they finished it. The subjects were not put under any time
constraints on how long they had to finish a unit, thus they were able
to correctly monitor their times without fear of taking too long on any
certain unit. The foreman recorded the amount of time he spent with
each subject on a piece of paper. The foreman also took reliability
checks on the amount of time the subjects took to rebuild units. The
author took reliability checks on both the subjects and the foreman to
determine the accuracy of their data.

Experimental Design

Multiple-baseline between subjects and reversal designs have been
successfully used in a number of studies involving the acquisition of
skills at the work place (Bacon, Fulton, Malott, 1982; Brown, Malott,
Dillon, & Keeps, 1980; Komaki, 1977; Komaki, Barwick, & Scott, 1978;
Komaki, Heinzmann, & Lawson, 1980; Komaki, Waddell, & Pearce,
1977; Krumhus & Malott, 1980; Miller & Lewin, 1980). This study in-
corporated a multiple-baseline between subjects design with an ABAB-
AB reversal design for one of the subjects.

Reliability

A self-recording technique was used in this study. This technique
involved the new employees recording the amount of time they took to complete their tasks and the foreman recorded the amount of time he spent with the new employees on these specific tasks. Both the foreman and the researcher took reliability. The foreman would randomly time one task per new employee per day and the researcher randomly timed the employees and the foreman once a week. Reliability was calculated as the number of agreements divided by the number of agreements and disagreements then multiplied by 100. Agreements were when the times recorded were the same (+ or - one minute). There were a total of 92 reliability observations with an agreement rate of 88.04 percent.
CHAPTER III

RESULTS

The cost of developing, designing, and implementing the step-by-step instructional job aids for the Series 40 MT Delco starters and the Series 10 SI Delco alternators was $42.00. Forty dollars were paid to the author as the normal wages for an eight hour work day. Two dollars covered the cost of the materials used in designing and developing the first sets of job aids.

The instructional job aid for the Series 40 MT Delco starters proved effective in reducing the amount of time needed by the new employees to rebuild the starters. Subject 1, who left the company three weeks into the study, showed a mean of 11.42 minutes, or 7.73 percent, reduction in time needed to rebuild a Series 40 MT Delco starter. Subject 2 was able to rebuild Series 40 MT Delco starters a mean of 24.31 minutes, or 16.55 percent, faster during the last intervention phase than during baseline (see Figure 1).

The instructional job aid for the Series 10 SI Delco alternators also proved effective in reducing the amount of time the new employees needed to rebuild alternators. There was a mean reduction of 12 minutes, or 17.48 percent, in the time Subject 1 needed to rebuild a Series
Figure 1. Average Minutes to Rebuild Series 40 MT Delco Starters
10 SI Delco alternator while using the job aid. Subject 2 reduced the
time needed to rebuild an alternator from a mean of 68.83 minutes in
baseline to a mean of 39.0 minutes during the last intervention. This
was a reduction in mean of 29.83 minutes, or 43.34 percent, during
the 53 day study (see Figure 2).

The amount of time that the foreman needed to help the new employ-
ees also reduced when the step-by-step instructional job aids were
used. The foreman provided as much help to the subjects as they needed
regardless of whether they were using the job aids or not. This data
reflected the amount of time, per unit, that the subjects requested as-
sistance. Subject 1 required an average of 4.15 minutes less, per
unit, help from the foreman while using the aids. This is a 23.61 per-
cent reduction in time over three weeks. Subject 2 decreased the
amount of time requiring the foreman's help by 9.81 minutes, or 55.18
percent, per unit, between baseline and the last intervention phase (see
Figure 3).
Figure 2. Average Minutes to Rebuild Series 10 SI Delco Alternators
Figure 3. Average Minutes, Per Unit, Foreman Helped Subjects

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
CHAPTER IV

DISCUSSION

Job aids can be financially beneficial to a company not only by increasing the effectiveness of the employees, but also by being relatively inexpensive when compared to training costs. Mager (1973) reported that the U.S. Public Dental Health Service of San Francisco was able to develop job aids for identifying conditions of periodontal disease at a price of $18.00 per set. These job aids were in a questionnaire form that the patient filled out. By placing colored overlays on the questionnaires, dentists were given information on how to proceed with their patients. These job aids allowed dentists to competently diagnose periodontal disease without having to go through a training program that was anticipated to last between three and six months. The low cost of developing, designing, and implementing the step-by-step instructional job aids in the present study was due to the fact that the author had been involved with the company since its inception in 1975. The author knew the needs and resources of the company and had a thorough working knowledge of the starters and alternators dealt with in the study. The author was able to develop and design the instructional aids during the course of a normal working day. The
company's expenses only involved that day's wages and materials. Even if the cost of conducting the task and organizational analysis plus the cost of designing and developing the job aids had been higher, the job aids themselves were inexpensive. The job aids were a total of ten pages long and were easily reproduced for five cents a page. These job aids can be used for new employees in the future at practically no expense at all. A training program that has already been established can still cost the company a lot of money to implement for each group of trainees. Because job aids are less expensive than training programs doesn't necessarily mean they should always be used in place of training. Job aids can only be economical if they are effective.

To determine the effectiveness of the instructional job aids used in this study the author used a multiple-baseline between subjects, with an ABABAB reversal for one of the subjects, experimental design. Multiple-baseline between subjects designs are effective tools in determining causal relations between the subject's behavior and the intervention. If the behaviors of a subject change only after the intervention is implemented, while the behaviors of the other subject, who is not in an intervention phase, remains the same, then a causal relation can be inferred between the intervention and the behaviors (Ko- maki, 1977). In this study Subject 1 showed a 5.2 percent reduction.
in the average time needed to rebuild 40 MT Delco starters between baseline in week one and intervention in week two. During these same two weeks Subject 2 remained in baseline and only showed a mean reduction of 0.57 percent between week one and week two. However, when Subject 2 started intervention in week three he showed a mean reduction of 4.44 percent in the time required to rebuild 40 MT Delco starters between weeks two and three. Similar data occurred for the 10 SI Delco alternators and the amount of time the foreman spent helping the new employees.

Reversal designs show causal relationships in a way similar to multiple-baseline designs. If the behaviors of the subject changes when intervention occurs and then returns towards baseline when intervention is removed, then a causal relation can be inferred between the intervention and the behaviors (Komaki, 1977). In this study only Subject 2 went through any reversals because Subject 1 left the company three weeks after the study began. Subject 2 showed a reduction in the amount of time needed to rebuild 40 MT Delco starters by a mean of 10.08 minutes between baseline and the first intervention phase. However, when the job aids were removed, during the first reversal, the time increased by an average of 4.77 minutes per starter. When Subject 2 entered the second intervention phase the time again dropped by a mean of 16.18 minutes per starter. The second reversal phase showed that
an average of 8.58 minutes more per starter was required by the subject. The final intervention phase again showed that the subject needed less time to rebuild 40 MT Delco starters, this time by an average of 11.4 minutes per starter. Similar results can be seen with the 10 SI Delco alternators and the amount of time the foreman had to help the subject. The data generated by this study showed that the step-by-step instructional job aids were responsible for reducing the amount of time required by the new employees to rebuild 40 MT Delco starters and 10 SI Delco alternators. The job aids were also responsible for reducing the amount of time the foreman had to help the new employees, thus allowing him more time for his own work.

Most of the questions directed to the foreman by the new employees, in the beginning of the study, had to do with procedures. For example, when rebuilding a 40 MT Delco starter the drive-end housing is the last part of the assembly prior to the first testing procedure. With most other starters the drive-end housing is clamped into a vise and the rest of the starter is assembled on top of it. These types of variations in how to rebuild these particular units often caused confusion with the new employees. As the study progressed the questions became more specific in nature. For example, if a housing had a small crack in it and the subject wasn't sure if it was bad enough to discard or still good enough to use, he would ask the foreman. The foreman was also asked
more questions concerning part numbers during baseline and reversal phases than during the intervention phases.

Subject 2 took longer to rebuild units during the reversal phases than during the intervention phases that immediately preceded them, yet not as long as the previous reversal and baseline phases. Subject 2 also claimed that he didn't have to follow the procedural part of the job aids as closely towards the end of the study as he had to in the beginning of the study, although he used the interchange lists about the same throughout the study. This information implies that the subject learned at least some of the basic steps to rebuild the starters and alternators by using the job aids. When the job aids were removed the subject was able to rebuild the starters and alternators, albeit not as well or as easily, but he had to rely on the foreman for part numbers. An interesting extension to this study could be the removal of the procedural part of the job aids to determine the effect the interchange list alone has on the rebuilding time of the subject.
Appendix A

Step-by-step Instructional Job Aid for Series 40 MT Delco Starters

Delco Remy
SERVICE PARTS CATALOG

CRANKING MOTOR
Appendix A. continued.

<table>
<thead>
<tr>
<th>Step #</th>
<th>Picture #</th>
<th>Description</th>
<th>Procedures for 40 MT Delco Starters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>Fields</td>
<td>Use the light bulb tester to check for shorts by placing one of the test leads on the case and the other lead to each of the field leads. The two grounded field leads should cause the light to illuminate while the two other leads should leave the bulb dark. Repeat the procedure except have the one test lead on the terminal stud instead of the case. The grounded field leads should not cause the bulb to illuminate while the other field leads should cause it to. If fields are good go to next step. If bad remove the field shoes (#69) by unscrewing the field shoe bolts (#30). When reinstalling the field shoes make sure their tabs point towards the drive-end side of the case. Use insulation (#'s 52 &amp; 53) between any exposed copper and the case. Tighten field shoe bolts securely.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Armature</td>
<td>Use the light bulb tester to check for shorts by placing one of the leads to the commutator and the other to the armature shaft. Replace armature if light illuminates. Visually inspect for wear and damage of shaft. If good, turn the armature on the lathe and undercut the commutator. Use the growler test by running metal strip over the armature body. If strip becomes magnetized replace armature</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>Starter drive</td>
<td>Replace.</td>
</tr>
<tr>
<td>Step #</td>
<td>Picture #</td>
<td>Description</td>
<td>Procedures for 40 MT Delco Starters</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>-------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>Drive-end housing</td>
<td>Visually inspect for wear and damage. If good replace bushing (#43). If bad replace housing and bushing.</td>
</tr>
<tr>
<td>5</td>
<td>5 &amp; 56</td>
<td>Lever housing assembly</td>
<td>Visually inspect for wear and damage. Replace bad parts. Replace bushing (#44) and seals (#'s 59 &amp; 77). Inspect knobs on yoke end of shift lever (#56), if worn replace shift lever.</td>
</tr>
<tr>
<td>6</td>
<td>1 &amp; 9</td>
<td>Commutator end assembly</td>
<td>Visually inspect for wear and damage. Replace bad parts. Replace brushes (#10), bushing (#42), and seal (#58).</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Main assembly</td>
<td>Visually inspect plunger assembly (#'s 11, 38, 41, 71, 76, 70, 74, &amp; 22). Replace bad parts. Put starter case horizontally into vise and tighten vise. Grease armature shaft and place armature into case making sure the commutator end is by the field leads. Install washer (#40) and slide lever housing (#5) onto armature shaft. Bolt lever housing to case. Slide break washer (#32) and starter drive (#6) onto armature shaft. Place gasket (#50) on housing.</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Commmutator end assembly</td>
<td>Put washer (#39) on armature shaft and grease shaft. Slide commutator assembly on and bolt. Put in brushes (#10) (8 required), and attach field leads to brush holder. These leads are seen through the inspection holes on the sides of the case. Attach brush cover plates (#62) using gaskets (#48).</td>
</tr>
</tbody>
</table>
## Procedures for 40 MT Delco Starters

<table>
<thead>
<tr>
<th>Step #</th>
<th>Picture #</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>7 &amp; the starter</td>
<td>Drive-end assembly</td>
<td>Use the guide marks on the drive-end and lever-housing assemblies to position them together and bolt tightly.</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Testing</td>
<td>Securely clamp starter into vise on test bench. Attach black (ground) cable to commutator-end and the red (hot) cable to battery post. Set ammeter to 200 Pos. Grd. and the ground polarity switch to Neg. Touch the voltage switch to 12 or 24 volts (depending on the starter's voltage). Starter should spin freely. Go to next step if good or see foreman if bad.</td>
</tr>
<tr>
<td>11</td>
<td>8</td>
<td>Solenoid switch</td>
<td>Using a new switch, slide it over plunger (#11) and bolt it to case. Attach connector (#47) from &quot;Motor&quot; terminal on switch to field terminal stud (#4). Attach a small wire from the &quot;GRD&quot; terminal on the switch to the commutator end terminal stud (#9).</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Final testing</td>
<td>Test starter as before except, put the red cable to the &quot;Batt&quot; terminal on the solenoid switch and the test wire to the &quot;SW&quot; terminal on the solenoid switch. Place voltage switch into appropriate voltage clamp. Press test button, located beneath the vise, and the starter should spin freely as the starter drive engages forward. Test the starter drive by pressing a wooden bar against its teeth. A good drive will file down the bar. Put good starter into stock, if problems see foreman.</td>
</tr>
</tbody>
</table>
### Interchange List for 40 MT Delco Starters

<table>
<thead>
<tr>
<th>Picture #</th>
<th>Description</th>
<th>Delco No.</th>
<th>Ace No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Comm-End Frame</td>
<td>1951073</td>
<td>C-3152</td>
</tr>
<tr>
<td>2</td>
<td>Armature (12 Volt)</td>
<td>1945500</td>
<td>83060</td>
</tr>
<tr>
<td>2</td>
<td>Armature (24 Volt)</td>
<td>1961320</td>
<td>83058</td>
</tr>
<tr>
<td>3</td>
<td>Field Coil (12 Volt)</td>
<td>1949109</td>
<td>ST-865</td>
</tr>
<tr>
<td>3</td>
<td>Field Coil (24 Volt)</td>
<td>1945496</td>
<td>ST-860</td>
</tr>
<tr>
<td>4</td>
<td>Terminal Stud</td>
<td>1950561</td>
<td>S-183</td>
</tr>
<tr>
<td>5</td>
<td>Lever Housing</td>
<td>1970900</td>
<td>C-2799</td>
</tr>
<tr>
<td>6</td>
<td>Starter Drive</td>
<td>800069</td>
<td>4-853</td>
</tr>
<tr>
<td>7</td>
<td>Drive-End Housing</td>
<td>1949606</td>
<td>C-2793</td>
</tr>
<tr>
<td>8</td>
<td>Solenoid Switch (12 V.)</td>
<td>1119879</td>
<td>19879</td>
</tr>
<tr>
<td>8</td>
<td>Solenoid Switch (24 V.)</td>
<td>1119848</td>
<td>19848</td>
</tr>
<tr>
<td>9</td>
<td>Brush Plate Assembly</td>
<td>1948515</td>
<td>S-2260</td>
</tr>
<tr>
<td>10</td>
<td>Brushes (12 Volt)</td>
<td>1906988</td>
<td>R-102</td>
</tr>
<tr>
<td>10</td>
<td>Brushes (24 Volt)</td>
<td>1906986</td>
<td>R-101</td>
</tr>
<tr>
<td>11</td>
<td>Plunger</td>
<td>1948522</td>
<td>S-2253</td>
</tr>
<tr>
<td>11</td>
<td>Plunger Assembly</td>
<td>--------</td>
<td>S-2255</td>
</tr>
<tr>
<td>32</td>
<td>Brake Washer</td>
<td>1911644</td>
<td>S-2286</td>
</tr>
<tr>
<td>40</td>
<td>Washer</td>
<td>1936466</td>
<td>S-2288</td>
</tr>
<tr>
<td>41</td>
<td>Boot Plunger</td>
<td>801077</td>
<td>S-2254</td>
</tr>
</tbody>
</table>
**Appendix A. continued.**

**Interchange List for 40 MT Delco Starters**

<table>
<thead>
<tr>
<th>Picture #</th>
<th>Description</th>
<th>Delco No.</th>
<th>Ace No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Comm-End Bushing</td>
<td>38273</td>
<td>4284-PR</td>
</tr>
<tr>
<td>43</td>
<td>Drive-End Bushing</td>
<td>1945509</td>
<td>4481-PF</td>
</tr>
<tr>
<td>44</td>
<td>Lever Housing Bushing</td>
<td>1894637</td>
<td>4485-PF</td>
</tr>
<tr>
<td>47</td>
<td>Connector</td>
<td>1945468</td>
<td>S-2281</td>
</tr>
<tr>
<td>48</td>
<td>Gasket</td>
<td>1964857</td>
<td>S-2282</td>
</tr>
<tr>
<td>50</td>
<td>Gasket</td>
<td>1945476</td>
<td>S-2293</td>
</tr>
<tr>
<td>52</td>
<td>Insulator</td>
<td>1955990</td>
<td>S-2264</td>
</tr>
<tr>
<td>56</td>
<td>Shift Lever</td>
<td>1945484</td>
<td>S-2122</td>
</tr>
<tr>
<td>58 &amp; 59</td>
<td>&quot;O&quot; Ring</td>
<td>1916272</td>
<td>S-2261</td>
</tr>
<tr>
<td>62 &amp; 63</td>
<td>Plug</td>
<td>1945356</td>
<td>S-2294</td>
</tr>
<tr>
<td>69</td>
<td>Pole (Field) Shoe</td>
<td>1934478</td>
<td>S-2299</td>
</tr>
<tr>
<td>72</td>
<td>Seal (in Lever Housing)</td>
<td>1918047</td>
<td>S-2259</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
### Procedures for 10 SI Delco Alternators

<table>
<thead>
<tr>
<th>Step #</th>
<th>Picture #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td><strong>Rotor</strong> Use light bulb tester to check for shorts by touching one lead to the slip-rings and the other to the rotor shaft. If the light illuminates replace the rotor, if not, visually inspect shaft for wear and damage. If the shaft is good then turn the rotor on the lathe sanding the shaft and slip-rings.</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td><strong>Stator</strong> Use light bulb tester to check for shorts by putting one lead on the stator frame and touching the other lead to each of the three stator leads. If the light illuminates replace the stator, Next, test each stator lead with the other two using the test leads. The light should illuminate about the same for all of the stator lead combinations. Check the amperage draw at the main test bench. Set the ammeter to 100 Neg. and the voltage to 12. Touch each lead with the ground cable while touching another lead with the hot cable. Each of the possible combinations should register the same on the ammeter (+ or - 2 amps) if they don't replace stator.</td>
</tr>
<tr>
<td>3</td>
<td>1 &amp; 4</td>
<td><strong>Drive-end and Slip-ring end frames</strong> Visually inspect frames for wear, breakage, cracks, or similar damage. Replace as necessary.</td>
</tr>
<tr>
<td>4</td>
<td>6 &amp; 7</td>
<td><strong>Diode Trio and Rectifier</strong> Replace Diode Trio (#6). Check the rectifier by using the Diode/Condensor tester. Put the test clip on one side of the rectifier. Put the selector switch to &quot;Diode&quot; and touch each of the diode leads with the test prod. The meter should read &quot;O.K.&quot; for each diode. Repeat test with test clip on the other...</td>
</tr>
</tbody>
</table>
Appendix B, continued.

<table>
<thead>
<tr>
<th>Step #</th>
<th>Picture #</th>
<th>Description</th>
<th>Procedures for 10 SI Delco Alternators</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>6 &amp; 7</td>
<td>Diode Trio and Rectifier</td>
<td>side of rectifier. Check diode leakage by switching to the &quot;Diode Leakage 100 Volt&quot; setting and placing the test prod on the side of the rectifier and the test clip to each lead. Repeat with test prod on other side of rectifier. Replace if bad.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Slip-ring end assembly</td>
<td>Replace bearing (#10) and the two brushes (#8). Hold the brushes in place in their holder with a small straight wire. Next, put the rectifier (#7), new regulator (#5), brush holder (#8), Diode Trio (#6), stator (#3), and the bearing (#10) in the slip-ring end in that order.</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Drive-end assembly</td>
<td>Visually check the fan (#22) and pulley (#21) for wear or damage and replace as necessary. Put #’s 19, 11 (a new bearing), 17, 16, &amp; 30 into the frame. Put the rotor in, with the threads going through the bearing first, and attach the collar (#18), fan, pulley, lock washer, and nut.</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Final assembly</td>
<td>Assemble the drive-end and slip-ring end assemblies together making sure that the small mounting ear on the drive-end frame lines up with the regulator slot on the slip-ring end. Bolt together and remove the small wire holding the brushes inside the brush holder.</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Testing</td>
<td>Firmly secure the alternator in the alternator/generator vise on the main test bench. Attach the fan belt from the electric motor and tighten. Put the ammeter switch to 100 Negative</td>
</tr>
</tbody>
</table>
Appendix B. continued.

<table>
<thead>
<tr>
<th>Step #</th>
<th>Picture #</th>
<th>Description</th>
<th>Procedures for 10 SI Delco Alternators</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td></td>
<td>Testing</td>
<td>Ground. Plug test plug onto regulator, attach the red cable (Pos.) to the alternator's battery post, and the green cable to the red one. Set the voltage switch to 12, The red light should illuminate. Start the electric motor. The red light should darken and the ammeter should read between 45 and 60 amps. Pushing the test button under the red light should cause the amps to increase to between 60 and 90. The alternator test gauge should read &quot;O.K.,&quot; with the test selector on &quot;ALT.&quot; Turn the alternator test selector to &quot;TRIO&quot;. The Trio scale should read &quot;O.K.,&quot;. Check with the foreman about any problems and put the good alternators into stock.</td>
</tr>
</tbody>
</table>
## Interchange List for 10 SI Delco Alternators

<table>
<thead>
<tr>
<th>Picture #</th>
<th>Description</th>
<th>Delco No.</th>
<th>Ace No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slip Ring-End Frame</td>
<td>1971526</td>
<td>C-3266</td>
</tr>
<tr>
<td>2</td>
<td>Rotor</td>
<td>1846657</td>
<td>S-1385</td>
</tr>
<tr>
<td>3</td>
<td>Stator</td>
<td>1971639</td>
<td>C-3267</td>
</tr>
<tr>
<td>4</td>
<td>Drive-End Frame</td>
<td>800135</td>
<td>C-3265</td>
</tr>
<tr>
<td>5</td>
<td>Regulator</td>
<td>1116387</td>
<td>VR-1770</td>
</tr>
<tr>
<td>6</td>
<td>Diode Trio</td>
<td>1971528</td>
<td>S-1371</td>
</tr>
<tr>
<td>7</td>
<td>Rectifier Bridge</td>
<td>1852209</td>
<td>S-1375</td>
</tr>
<tr>
<td>8</td>
<td>Brush Holder Assembly</td>
<td>8014662</td>
<td>S-1380</td>
</tr>
<tr>
<td>9</td>
<td>Brush Spring</td>
<td>1964117</td>
<td>S-1334</td>
</tr>
<tr>
<td>10</td>
<td>Slip Ring-End Bearing</td>
<td>9436831</td>
<td>A-2430</td>
</tr>
<tr>
<td>11</td>
<td>Drive-End Bearing</td>
<td>907998</td>
<td>A-203-2S</td>
</tr>
<tr>
<td>14</td>
<td>Terminal Kit</td>
<td>1846900</td>
<td>S-1386</td>
</tr>
<tr>
<td>16</td>
<td>Retainer</td>
<td>1911263</td>
<td>S-1379</td>
</tr>
<tr>
<td>17</td>
<td>Bearing Collar</td>
<td>1963139</td>
<td>S-801</td>
</tr>
<tr>
<td>18</td>
<td>Outside Collar</td>
<td>1959991</td>
<td>S-1340</td>
</tr>
<tr>
<td>20</td>
<td>Thru Bolt</td>
<td>1956975</td>
<td>S-1312</td>
</tr>
<tr>
<td>21</td>
<td>Pulley (single)</td>
<td>1978065</td>
<td>1123-P</td>
</tr>
<tr>
<td>21</td>
<td>Pulley (double)</td>
<td>---------</td>
<td>1165-P</td>
</tr>
<tr>
<td>22</td>
<td>Fan</td>
<td>1978026</td>
<td>1160-P</td>
</tr>
</tbody>
</table>
BIBLIOGRAPHY


