United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

General Technical
Report NE-102

1985

# DESIM Data Manual:
## A Procedural Guide for Developing Equipment Processing and Down Time Data

Edward L. Adams

**The Author**

Edward L. Adams is a forest products technologist with the Northeastern Forest Experiment Station's Forestry Sciences Laboratory at Princeton, West Virginia. He received a B.S. degree in forest management and an M.S. degree in forest mensuration at West Virginia University. He worked for the USDA Forest Service in Oregon from 1960 to 1963 and joined the Northeastern Station in 1968.

Manuscript received for publication 16 November 1984

**Abstract**

A procedural guide for developing the equipment processing and down time information required by the DESIM computerized system for designing and simulating hardwood sawmills. Instructions are provided for collecting and processing data for the different types of sawmill equipment to assure that the information matches the procedures used in the system. These instructions must be followed to obtain realistic results from the simulator.

# DESIM Data Manual: A Procedural Guide for Developing Equipment Processing and Down Time Data

## Contents

## Introduction

The computerized system DESIM[1] (DEsign SIMulator) is available for designing and simulating the operation of hardwood sawmills. It can be used to: (1) design new mills, (2) modify existing mills, and (3) analyze the operation of existing mills. To aid in the understanding and use of the system, two general technical reports are available—a general discussion and a user's manual (Adams 1984a, b).

The system consists of three computer programs and two support data files. The first program provides data forms for recording the information needed to set up a sawmill system. The second program uses a question-and-answer technique to aid the user in transferring information from the data forms into a computer data file. The third program uses the data file to simulate the operation of the sawmill system. The two support data files consist of: (1) standard machine times and rates for different types of sawmill equipment, and (2) lumber grade yield information (Hanks 1973, Hanks et al. 1980).

To use DESIM, it is necessary to have equipment processing time and down time information for each machine center in the proposed sawmill. Some of this information is already available in the system's equipment data file. However, when the information is not available or if the user is not satisfied with the available information, it must be developed. When developing the information, the procedures presented in this report should be used to assure that the data matches the procedures used in the simulator. This will also standardize the information allowing confident use and trading of the data between users.

[1] The computer programs described in this publication are available on request with the understanding that the U.S. Department of Agriculture cannot assure their accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent them to anyone as other than Government-produced computer programs.

## Procedure

The procedure for collecting and analyzing equipment processing and down time information will be discussed separately for each type of sawmill equipment. The equipment types are:

1—Forklift (raw material handler)

2—Crane (raw material handler)

3—Bucksaw

4—Debarker (Rosserhead-type)

5—Debarker (ring-type)

6—Headrig (band and circular)

7—Headrig (Scragg and gang)

8—Edger (standard and combination)

9—Resaw (gang, centerline, and line-bar)

10—Special product station

11—Trimsaws

12—Green chain

13—Chipper

14—Transfer station

The procedure given for each equipment type should be followed closely. When collecting the data, be sure to record all times in minutes and hundredths of a minute and record all piece lengths in feet and tenths of a foot. Record log and bolt diameters as indicated in the instructions.

In these procedures, most of the resulting values fall into one of two categories—a mean value or a set of lognormal parameters. The mean value is simply an arithmetic average of a set of data. The lognormal parameters for a set of data consists of a mean, minimum value, maximum value, and standard deviation of the logarithms of the individual data values. Appendix A provides: (1) a discussion of the parameters, (2) instructions for obtaining a computer program for calculating them, and (3) instructions for using the program. In the following procedures when lognormal parameters are to be calculated, use the method and computer program shown in this Appendix.

As in any study, sample size is important when developing the processing and down time information required for the various pieces of equipment. Whether collecting data for a mean value or for lognormal parameters, I recommend taking at least 30 observations (based on the central-limit theorem).

For each piece of equipment, DESIM allows processing and down time information to be entered separately for 12 different species. The species codes are:

1—Northern red oak

2—Black oak

3—Scarlet oak

4—White oak

5—Chestnut oak

6—Sugar maple

7—Red maple

8—Yellow-poplar

9—Basswood

10—Black cherry

11—Yellow birch

12—Beech

However, if species does not significantly affect the processing and down times, the information can be entered with a species code of 13. This indicates that the information is for all species combined.

After developing the processing and down time information for a given piece of equipment, it either can be used directly as input to the DESIM system or can be entered into the DESIM equipment data file. Appendix B shows an example from the equipment data file and discusses the procedure for changing existing information or entering new information.

**1. Forklift (Raw Material Handler)**

This is a forklift for loading raw material onto a log or bolt deck at the input end of a mill. The information needed for this machine is:

Species . . . . XX
Processing time (minutes) . . . . XXX.XX
Processing time distribution:

| | | Lognormal Distribution | | | |
|---|---|---|---|---|---|
| | | Mean | Minimum | Maximum | SD |
| Down time | . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down | . . . . | XX.XXX | | | |

*1.1 Processing time (minutes).* This is the average time per piece required to load raw material onto a log or bolt deck. In collecting the data, record the round-trip time required by the forklift to travel from the deck to storage, return with a load of material, and place the material onto the deck. Also, record the number of pieces in the load. Repeat this procedure at least 30 times. Next, sum both the times and the number of pieces. Then, calculate the required average processing time by dividing the total time by the total number of pieces.

*1.2 Down time (lognormal parameters and percent down).* The instructions in this section not only apply to the forklift, but also apply to all other pieces of equipment. The nonscheduled down time information consists of two parts: a "percent down" and parameters for a lognormal frequency distribution. The "percent down" represents the frequency that the machine can be expected to go down. The parameters represent the lognormal frequency distribution of the lengths of time the machine can be expected to be down once it goes down. To collect the down time data, tally the number of pieces processed ($N_p$) by the machine during the study period. Also, tally the number of times ($N_d$) that a piece is available but cannot be processed (that is, machine is down). Each time the machine is down, record the length of the down time. A machine should be considered down only when the inability to process a piece of material is due to problems directly related to the machine or its operator. This includes problems with the machine's buffer or conveyor systems. Do not consider the machine down when: (1) scheduled down times occur, (2) material is not available, or (3) the machine is blocked down stream due to the production rates of other machines or other machines being down. The down time study should cover at least 1 full workday. A full workweek would be much better. The lognormal parameters for the down time frequency distribution should be based on no less than 30 observations.

Down time (lognormal parameters)—These parameters include a mean, minimum value, maximum value, and standard deviation for a lognormal frequency distribution of the down times collected during the above study. Use the procedure and computer program in Appendix A to calculate the parameters.

Percent down—To determine the required "percent down," divide the down count ($N_d$) by the processing count ($N_p$) from the above study. For example, if during the study period a machine went down 50 times while processing 1,000 pieces, the "percent down" would be 5.0 percent.

**2. Crane (Raw Material Handler)**

This is a crane or knuckle-boom loader for loading raw material onto a deck or conveyor at the input end of a mill. The information needed for this machine is:

Species .... XX
Processing time (minutes) .... XXX.XX
Processing time distribution:

| | | Lognormal Distribution | | | |
|---|---|---|---|---|---|
| | | Mean | Minimum | Maximum | SD |
| Down time | .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down | .... | XX.XXX | | | |

*2.1 Processing time (minutes).* This is the average time it takes to load a piece of raw material onto a deck or conveyor. To obtain the data, record the round-trip time required to reach for, pick up, and place material onto the deck or conveyor, and tally the number of pieces for the trip. Repeat this procedure at least 30 times. Next, sum both the times and the number of pieces. Then determine the required average processing time by dividing the total time by the total number of pieces.

*2.2 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**3. Bucksaw** This is a saw for bucking long-length logs into standard sawlogs and/or bolts. The information needed for this machine is:

Species . . . . XX
Feed rate (inches/minute) . . . . XXX.XX
Processing time distributions:

| | | Lognormal Distributions | | | |
|---|---|---|---|---|---|
| | | Mean | Minimum | Maximum | SD |
| Load time | . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Down time | . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down | . . . . | XX.XXX | | | |

*3.1 Feed rate (inches/minutes).* This is the average feed rate of the saw used to buck long-length pieces into logs or bolts. To obtain the data, record the time required for the saw to make the buck cut. Also record the diameter (to the nearest inch) of the piece at the buck cut. Repeat this procedure at least 30 times over the range of diameters usually bucked. For each buck cut, divide the diameter by the time to get the individual feed rates. To obtain the required average feed rate, sum the individual feed rates and divide by the number of buck cuts in the sample.

*3.2 Load time (lognormal parameters).* These parameters represent a lognormal frequency distribution of the times required to position a long-length piece to be bucked into logs and/or bolts. To obtain the necessary data, record the time between the finish of one buck cut and the start of the next. Repeat this procedure at least 30 times. Make sure that a proportionate number of these times includes the time between the last cut or one long-length piece and the first cut on the next. For example, if 10 long-length pieces are processed during the collection of the 30 load times, at least 10 of these times should represent the time between the last cut on one long-length piece and the first cut on the next. Use this time data to determine the required load-time lognormal parameters.

*3.3 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**4. Debarker (Rosserhead-Type)**

The following information is needed for Rosserhead-type debarkers:

Species . . . . XX

Processing time (minutes/10 ft$^2$) . . . . XXX.XX

Processing time distributions:

| | | Lognormal Distributions | | | |
|---|---|---|---|---|---|
| | | Mean | Minimum | Maximum | SD |
| Load time | . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Down time | . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down | . . . . | XX.XXX | | | |

*4.1 Processing time (minutes/10 ft$^2$).* This is the average processing time (in minutes per 10 ft$^2$ of surface area) required to debark logs and/or bolts on a Rosserhead-type debarker. This processing time is scaled by a factor of 10 to eliminate a decimal place when entering the value into the DESIM system. The time required to load the piece is not included in this time. To obtain the necessary data for each study piece, time the period from the start of debarking (that is, when the debarker head hits the piece) until the piece leaves the debarker. For the piece also record both end diameters (in feet and tenths of a foot) and the length. Repeat this procedure for at least 30 pieces over the range of sizes usually processed. Once the data have been collected, use the following procedure: For a study piece, average the two end diameters and use the resulting average diameter to determine the average circumference. Multiply this circumference by the piece length to obtain an estimate of the surface area in square feet. Divide the processing time by the estimated surface area and multiply by 10 to obtain the processing time in minutes per 10 ft$^2$ of surface area. Repeat this procedure for each piece. Finally, sum these individual processing times and divide by the number of study pieces to obtain the required average processing time in minutes per 10 ft$^2$ of surface area.

*4.2 Load time (lognormal parameters).* These parameters represent a lognormal frequency distribution of the times required to load a log or bolt onto the debarker. To obtain the necessary data, record the time between one piece leaving the debarker and the next piece hitting the debarker head. Repeat this procedure for at least 30 pieces. Use these recorded times to determine the required load-time lognormal parameters.

*4.3 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**5. Debarker (Ring-Type)** The following information is needed for ring-type debarkers:

Species. . . .XX
Feed rate (feet/minute). . . .XXX.XX
Processing time distributions:

| | Lognormal Distributions | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Load time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Down time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down .... | XX.XXX | | | |

*5.1 Feed rate (feet/minute).* This is the average feed rate (in feet per minute) for pieces being fed through a ring-type debarker. To obtain the necessary data, record the time that it takes to debark the piece. This time must not include the time to position or load the piece. Also, record the piece length. Repeat this procedure for at least 30 pieces. Once the data have been collected, divide the debarking time by the piece length to get the individual feed rate for each study piece. Then sum these individual feed rates and divide by the number of study pieces to obtain the required average feed rate.

*5.2 Load time (lognormal parameters).* See instructions in Section 4.2 for collecting and processing the data for this required information.

*5.3 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**6. Headrig (Circular and Band)** The DESIM system can handle both circular and band headrigs. It can also handle these headrigs with or without a vertical edger. And the DESIM equipment data file will accept data for all four situations. The following information is needed for each of these headrig situations:

Species. . . .XX
Processing time distributions:

| | Lognormal Distributions | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Load time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Turn time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Slab time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Line time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Down time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down .... | XX.XXX | | | |

*6.1 Load time (lognormal parameters).* These parameters represent a lognormal frequency distribution of the time required to load logs and/or bolts onto a headrig carriage. In collecting the data, start timing a loading sequence when the carriage stops after returning from the last cut on a previous log or bolt. Stop the time as soon as the piece has been loaded and dogged for the first pass at the saw. Record the elapse time. Repeat this procedure for at least 30 loading sequences. Use these recorded times for determining the required lognormal parameters.

*6.2 Turn time (lognormal parameters).* These parameters represent a lognormal frequency distribution of the times required to turn a log or bolt on a headrig carriage. In collecting the data, start timing the turn sequence when the carriage stops after returning from sawing a line or making a slab cut. Stop the time as soon as the piece has been turned and dogged for the next pass at the saw. Record the elapse time. Repeat this procedure for at least 30 turning sequences. Use these recorded times for determining the required lognormal parameters.

*6.3 Slab time (lognormal parameters).* These parameters represent a lognormal frequency distribution of the processing rates (in minutes per 10-foot log length) for sawing slabs from logs or bolts. In collecting the data, start timing the slab sequence as soon as the piece has been dogged for a pass at the saw. Stop the time as soon as the carriage returns from the slab cut and stops. Record the elapse time and the length of the piece from which the slab was cut. Repeat this procedure for at least 30 slabbing sequences for pieces representing the range of diameters and lengths usually processed. Once the data have been collected, use the following procedure: For a slab cut, divide the time by the length of the piece and multiply the result by 10. This multiplication by 10 is used to scale the data for calculation purposes. Repeat this procedure for each slabbing sequence. The resulting times per 10-foot log length are used for determining the required lognormal parameters.

*6.4 Line time (lognormal parameters).* These parameters represent a lognormal frequency distribution of the processing rates (in minutes per 10-foot log length) required to saw a line. In collecting the data, start timing the line sequence as soon as the piece has been dogged for a pass at the saw. Stop the time as soon as the carriage returns from the cut and stops. Record the elapse time and the length of the piece on which the cut was made. Repeat this procedure for at least 30 line sequences from pieces representing the range of lengths and diameters usually processed. Once the data have been collected, use the following procedure: For a line cut, divide the time by the piece length and multiply the result by 10. This multiplication by 10 is used to scale the data for calculation purposes. Repeat this procedure for each line sequence. The resulting times per 10-foot log length are used for determining the required lognormal parameters.

*6.5 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**7. Headrig (Scragg and Gang)**

The DESIM system can also handle both Scragg and gang headrigs. And the DESIM equipment data file will accept data for both. The following information is needed for each of these headrigs:

Species. . . .XX
Feed rate (feet/minute). . . .XXX.XX
Processing time distributions:

| | Lognormal Distributions | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Load time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Down time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down . . . . | XX.XXX | | | |

*7.1 Feed rate (feet/minute).* This is the average feed rate (in feet per minute) for pieces being fed through the machine. To obtain the necessary data, record the time that it takes for the piece to pass through the saws. The time starts when the piece hits the saws and stops when it leaves the saws. This time must not include the time to position or load the piece. Also record the piece length. Repeat this procedure for at least 30 pieces. Once the data have been collected, divide the sawing time by the piece length to get the individual feed rate for each piece. Then sum these individual feed rates and divide by the number of pieces to obtain the required average feed rate.

*7.2 Load time (lognormal parameters).* These parameters represent the lognormal frequency distribution of the times required to load and/or position a log or bolt to be processed by the machine. To obtain the necessary data, record the time interval from the time the previous piece leaves the saws until the next piece hits the saws. Repeat this procedure for at least 30 pieces. Use these recorded times to calculate the required load-time lognormal parameters.

*7.3 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**8. Edgers (Standard and Combination)**

The DESIM system can handle both standard and combination edgers. A standard edger has movable saws for edging boards only. A combination edger has movable saws for edging boards on one side and a set of saws for gang sawing cants on the other. The following procedure is for a combination edger. If this procedure is to be used for a standard edger, just eliminate the parts for determining the "cant feed rate" and the "cant load time (lognormal parameters)." The DESIM equipment data file will accept data for both edger types. The following information is needed:

Species. . . .XX
Feed rate (feet/minute):

| Board | Cant |
|---|---|
| XXX.XX | XXX.XX |

Processing time distributions:

| | Lognormal Distributions | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Board load time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Cant load time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Down time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down . . . . | XX.XXX | | | |

*8.1 Board or cant feed rate (feet/minute).* Use this procedure to determine the feed rate for both boards and cants. This is the average feed rate in feet per minute for pieces being processed by the edger. To obtain the necessary data, record the time that it takes for the piece to pass through the saws. The time starts when the piece hits the saws and stops when it leaves the saws. This time must not include the time to position or load the piece. Piece length is also recorded. Repeat this procedure for at least 30 pieces. Once the data have been collected, divide the sawing time by the piece length to get the individual feed rates. Then sum these individual feed rates and divide by the number of pieces to obtain the required average feed rate.

*8.2 Board or cant load time (lognormal parameters).* Use this procedure to determine the load time for both boards and cants. These parameters represent the lognormal frequency distribution of the times required to load and/or position the piece to be processed through the edger. To obtain the necessary data, record the time between one piece leaving the saws and the next piece hitting the saws. Repeat this procedure for at least 30 pieces. Use these recorded times to determine the required load-time lognormal parameters.

*8.3 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**9. Resaw (Gang, Centerline, and Line-Bar)**

The DESIM system can handle gang, centerline, and line-bar type resaws. And the DESIM equipment data file will accept data for all three types. The following information is needed for each:

Species. . . .XX
Feed rate (feet/minute). . . .XXX.XX
Processing time distributions:

| | Lognormal Distributions | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Load time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Down time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down . . . . | XX.XXX | | | |

*9.1 Feed rate (feet/minute).* See instructions in Section 7.1 for collecting and processing the data for the required information.

*9.2 Load time (lognormal parameters).* See instructions in Section 7.2 for collecting and processing the data for the required information.

*9.3 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for the required information.

**10. Special Product Station**

This machine center processes boards or cants by cutting them into shorter pieces; for example, the production of coal mine headers and half headers. The following information is needed:

Species. . . .XX
Processing time (minutes). . . .XXX.XX
Processing time distribution:

| | Lognormal Distribution | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Down time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down . . . . | XX.XXX | | | |

*10.1 Processing time (minutes).* This is the average processing time (in minutes per piece) required to produce a short piece from a board or cant. To obtain the data, count the number of short pieces produced during a given period (for example, 1 hour). If any down, idle, or blocked times occur during the time period, subtract these times from the study time period. Record the resulting time and the number of pieces produced. Then to obtain the required average processing time, divide the recorded time by the number of pieces produced.

*10.2 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**11. Trimsaws** This machine center has two or more saws for trimming boards and cants to specific lengths. The information needed for this machine is:

Species. . . .XX
Processing time (minutes). . . .XXX.XX
Processing time distribution:

| | Lognormal Distribution | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Down time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down . . . . | XX.XXX | | | |

*11.1 Processing time (minutes).* This is the average processing time (in minutes per piece) required to trim a piece. To obtain the data, count the number of pieces trimmed during a given period of time (for example, 1 hour). If any down, idle, or blocked times occur during the time period, subtract these times from the study time period. Record the resulting time and number of pieces trimmed. Then to obtain the required average processing time, divide the recorded time by the number of pieces trimmed.

*11.2 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**12. Green Chain** Although the green chain is not a machine center, it is treated as one by DESIM. The information needed for the green chain is:

Species. . . .XX
Processing time (minutes). . . .XXX.XX
Processing time distribution:

| | Lognormal Distribution | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Down time . . . . | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down . . . . | XX.XXX | | | |

*12.1 Processing time (minutes).* This is the average processing time (in minutes per piece) required to pull both boards and cants from the green chain and stack them. To obtain the data, count the number of pieces pulled and stacked during a given time period (for example, 1 hour). If any down, idle, or blocked times occur during the time period, subtract these times from the study time period. Record the resulting time and the number of pieces processed. Then to obtain the required average processing time, divide the recorded time by the number of pieces processed.

*12.2 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**13. Chipper** The following information is needed for the chipper:

Species. . . .XX
Feed rate (feet/minute). . . .XXX.XX
Processing time distribution:

| | Lognormal Distribution | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Down time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down . . . . | XX.XXX | | | |

*13.1 Feed rate (feet/minute).* This is the average feed rate (in feet per minute) for slabs processed by the chipper. To obtain the necessary data, record the piece length and the time required to actually chip the piece. Repeat this procedure for at least 30 slabs. Once the data have been collected, divide the chipping time by the slab length to get the individual feed rate for each slab. Then sum these individual feed rates and divide by the number of slabs to obtain the required average feed rate.

*13.2 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

**14. Transfer Station** This is a station for transferring material from one conveyor system to another conveyor system. DESIM treats these stations as machine centers. The information needed for a transfer station is:

Species. . . .XX
Processing time (minutes). . . .XXX.XX
Processing time distribution:

| | Lognormal Distribution | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Down time .... | XX.XXX | XX.XXX | XX.XXX | XX.XXX |
| Percent down . . . . | XX.XXX | | | |

*14.1 Processing time (minutes).* This is the average time required to pass material through the station. To obtain the data, record the time required to transfer the piece from a conveyor or buffer to another conveyor. Repeat this procedure for at least 30 pieces. Then to obtain the required average processing time, sum the individual times and divide by the number of pieces.

*14.2 Down time (lognormal parameters and percent down).* See instructions in Section 1.2 for collecting and processing the data for this required information.

## Literature Cited


Adams, Edward L. DESIM: **A system for designing and simulating hardwood sawmill systems**. Gen. Tech. Rep. NE-89. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984a. 10 p.

Adams, Edward L. DESIM User's Manual: **A procedural guide for designing and simulating hardwood sawmill systems**. Gen. Tech. Rep. NE-94. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984b. 44 p.

Hanks, L. F. **Green lumber grade yields for subfactory class hardwood logs**. Res. Pap. NE-256. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1973. 8 p.

Hanks, L. F.; Gammon, G. L.; Brisbin, R.L.; Rast, E. D. **Hardwood log grades and lumber grade yields for factory lumber logs**. Res. Pap. NE-468. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1980. 92 p.

Schreuder, H. T.; Hafley, W. L.; Whitehorne, Edward W.; Dare, B. Jean. **Maximum likelihood estimation for selected distributions (MLESD)**. Tech. Rep. No. 61. Raleigh, NC: North Carolina State University; 1978. 26 p.

## Appendix A—Lognormal Parameters

### Discussion of Lognormal Parameters

Much of the processing and down time information required by the DESIM system comes from data having frequency distributions that are skewed to the right. Because these distributions are difficult to use in the simulation process, the data are transformed by taking the natural log of the individual values. These transformed data have frequency distributions that are normally distributed (lognormal frequency distributions) making them much easier to use. For each of the lognormal frequency distributions, DESIM requires a mean, minimum value, maximum value, and standard deviation. The DESIM User's Manual (Adams 1984b) shows a hand calculator method for developing these parameters. However, I suggest using the computer program discussed here. Not only will the program make the task easier, but it will also reduce the chance of error and provide additional information on how well the lognormal frequency distribution fits the data.

### Obtaining Lognormal Computer Program

This computer program is a shortened version of the MLESD program (Schreuder et al. 1978). This program and a sample data set have been added to the 9-track DESIM computer tape discussed in the DESIM User's Manual (Adams 1984b). To obtain the program, move it from the sixth location on the DESIM tape to your conversational monitor system (CMS) file with the designation "LONO FORTRAN A1". To obtain the sample data set, move it from the seventh location to your CMS file with the designation "TIME DATA A1". If you are using an IBM[2] computer system, this can be done by creating a file designated "GET CNTL A1" and inputting the following statements:

```
//BVVVV JOB          WWWWW, XXXXXXX
/*PRIORITY          STANDARD
/*LONGKEY           YYYYYYY
/*ROUTE PRINT       VM1.ZZZZZZZ
//STEP1 EXEC         PGM=IEBGENER
//SYSPRINT DD        SYSOUT=A
//SYSUT1 DD          DISP=(OLD,KEEP)
//                   VOL=SER=DESIM1,
//                   UNIT=TAPE,
```

[2]The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

```
//                      DCB=(RECFM=FB,LRECL=80,BLKSIZE=
                        6000,DEN=3)
//                      LABEL=(6,NL)
//SYSUT2 DD             SYSOUT=B
//SYSIN DD              DUMMY
//
```

In the first statement "VVVV" is to be replaced with your user's box number, "WWWWW" is to be replaced with your user's account number, and "XXXXXXX" is to be replaced with your name. In the LONGKEY statement, "YYYYYYY" is to be replaced with your password. In the ROUTE PRINT statement, "ZZZZZZZ" is to be replaced with your CMS user's identification (ID) name. Once these statements have been input to "GET CNTL A1", save the file.

To get the computer program, submit the "GET CNTL A1" file from the CMS terminal to the multiple virtual storage (MVS) operating system of the mainframe computer. As soon as the run has been completed, the program will be returned to your CMS reader file. Move the program to your CMS file by reading it from the reader file with the designation "LONO FORTRAN A1".

To get the sample data set, modify the "GET CNTL A1" file by changing "LABEL=(6,NL)" to "LABEL=(7,NL)". Submit "GET CNTL A1" to the MVS operating system. The sample data set will be returned to the reader file. Then move the data set to your CMS file with the designation "TIME DATA A1".

**Using Lognormal Computer Program**

To run the program (LONO FORTRAN A1) on your CMS system, create an EXEC file (LONO EXEC A1). This file must contain the statements required to control the execution of the program. First enter the statements necessary to erase the output file (LONO OUT A1) if it exists. Next make assignments for the input-output unit numbers used in the program. These assignments by unit numbers are:

05—"TIME DATA A1" file output (disk)
06—"LONO OUT A1" file input (disk)

Finally enter the statements necessary to load and run the program. If you are using an IBM system, the following EXEC file (LONO EXEC A1) will accomplish these tasks:

```
FORTGI LONO

EXSERV STATE LONO OUT A1

&IF &RETCODE NE 0 &GOTO -LABL

ERASE LONO OUT A1

-LABL

FI 05 DISK TIME DATA A1 (RECFM F LRECL 80 BLKSIZE 80)

FI 06 DISK LONO OUT A1 (RECFM F LRECL 130 BLKSIZE 130)

GLOBAL TXTLIB FORTXLIB

LOAD LOGNORM (CLEAR

START

ERASE LONO LISTING A1

ERASE LONO TEXT A1
```

With these statements entered and the "LONO EXEC A1" file saved, you are ready to run the program. This is done by entering "LONO" at the terminal keyboard.

As soon as the program has run, you will have a new file (LONO OUT A1) in your CMS file. This will be the program output that can be sent to the terminal screen and/or to a printer. To assure that the program is running properly on your system, compare this output with the output shown in Figure 1. At this point, if you want to save the data in the "TIME DATA A1" file and/or the output in the "LONO OUT A1" file, you must rename them. This is necessary after each run.

Once you are assured that the program is working properly, you are ready to determine the lognormal parameters for a set of your own data. First, if you have a file named "TIME DATA A1" in your CMS file, erase or rename it. Next create a new "TIME DATA A1" file and input the following information. The first line must have a data name of no more than 40 characters. The second line must have the double precision format under which the data will be entered. For example, (D5.2) indicates that the data will be entered as *XX.XX* in columns 1 through 5. Finally, the data are entered one value per line using this format. Once all of the data have been entered and the file saved, you are ready to run the program to obtain the required lognormal parameters.

```
 HEADRIG DOWN TIME (T)
 ************************************

*** RAW DATA STATISTICS ***

     OBS.MIN.X =    0.2300       MEAN =     1.9454
     OBS.MAX.X =   11.8900       VAR. =     5.4793
     NO. OF OBS.=      79.       ST. DEV. =     2.3408
            INDEX OF SKEWNESS =      2.1986
            INDEX OF KURTOSIS =      7.8006
            SKEWNESS SQUARED =       4.8338

*** LOGNORMAL DISTRIBUTION ***

    MEAN =  -0.29800
     VARIANCE =   1.94120
     STANDARD DEVIATION =   1.39327

*** OBSERVED VS. PREDICTED ***

     X1       X2     OBSERVED     PREDICTED     RESIDUAL
                     FREQUENCY    FREQUENCY     FREQUENCY

   0.218- 1.384       51.000       49.539         1.461
   1.384- 2.550        7.000       13.215        -6.215
   2.550- 3.716        9.000        5.744         3.256
   3.716- 4.882        3.000        3.110        -0.110
   4.882- 6.048        3.000        1.899         1.101
   6.048- 7.214        2.000        1.252         0.748
   7.214- 8.380        0.0          0.872        -0.872
   8.380- 9.546        3.000        0.633         2.367
   9.546-10.712        0.0          0.474        -0.474
  10.712-11.878        0.0          0.364        -0.364
  11.878-13.044        1.000        0.286         0.714

*** STATISTICAL TEST ***

                        (CALC.     (SIGNIFICANCE LEVEL)
                          VALUE)   (.01)  (.05)   (.10)
     KOLMOGOROV-SMIRNOV   0.0602   0.183  0.153   0.137


*************************************************************
*                                                           *
*         HEADRIG DOWN TIME (T)                             *
*                                                           *
*              (DESIM) LOGNORMAL PARAMETERS                 *
*               MEAN     MIN.     MAX.      SD             *
*              -0.298   -4.465    2.457    1.393           *
*                                                           *
*************************************************************
```

Figure 1.—Exampie of program output for lognormal frequency distribution.

As mentioned earlier, Figure 1 shows an example of the output from a computer run. A great deal of information is shown in this output. The first section shows statistics for the raw or untransformed data. This information is self-explanatory. However, notice that it does indicate that the sample data were skewed to the right. The second section shows the mean, variance, and standard deviation for the transformed data. The third section shows a comparison between the lognormal frequency distribution of the transformed data and the resulting theoretical lognormal frequency distribution. This indicates how well the theoretical distribution fits the actual. The fourth section provides the calculated Kolmogorov-Smirnov value and the critical table values for three different significance levels. This provides the information for a goodness of fit test. If the calculated value is larger than the critical value for the chosen significance level, the lognormal frequency distribution does not fit the data. However, for the processing and down time information required by DESIM, this should not be a problem. Finally, boxed in at the bottom of the output are the required DESIM lognormal parameters.

## Appendix B—Equipment Data File

Once the required processing and down time information has been developed for a given piece of equipment, it can be either punched in as input during the design phase of the DESIM run or it can be entered into the equipment data file (EQ DATA A1). This section discusses the procedure for entering the information into the equipment data file.

To illustrate this procedure, assume that the required data have been collected and processed for a circular saw headrig (with vertical edger). The resulting processing and down time information for northern red oak is:

Species. . . .1
Processing time distributions:

| | Lognormal Distributions | | | |
|---|---|---|---|---|
| | Mean | Minimum | Maximum | SD |
| Load time. . . . | − 2.281 | − 5.116 | − 0.587 | 0.866 |
| Turn time. . . . | − 2.763 | − 5.404 | − 0.704 | 0.712 |
| Slab time. . . . | − 3.135 | − 5.521 | − 0.983 | 0.667 |
| Line time. . . . | − 3.463 | − 5.521 | − 1.496 | 0.788 |
| Down time. . . . | − 0.298 | − 4.465 | 2.457 | 1.393 |

Percent down. . . .2.000

To get this information in the equipment data file, you must first get the "EQ DATA A1" file into the EDIT mode on the CMS terminal. Then search down the file until the data for the circular saw headrig (with vertical edger) are found. Figure 2 shows what you can expect to see. The 8's in the left column represent the machine code used by the DESIM system for this headrig. The numbers 1 through 13 heading up the 13 groups of data represent the species codes. As you can see, for species code 1 (northern red oak) the data values are all zero's.

```
8    1 CIRCULAR SAW HEADRIG (W/VERTICAL EDGER)
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      00.000

8    2
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      00.000

8    3
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      00.000
                .
                .
                .

8   13
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      0.000  0.000  0.000  0.000
      00.000
```

Figure 2.—Equipment data file (EQ DATA A1) information for circular saw headrig (with vertical edger) before entering new information.

Now with the "EQ DATA A1" file in the EDIT mode, the new processing and down time information can be entered. It is only necessary to replace the zero values with the corresponding data keeping the decimal points in their existing locations. Once this has been done, this part of the "EQ DATA A1" file will appear as shown in Figure 3. To complete the procedure, it is only necessary to save the file. Using this procedure, the processing and down time information for any machine can be entered or changed.

```
8     1 CIRCULAR SAW HEADRIG (W/VERTICAL EDGER)
      -2.281 -5.116 -0.587  0.866
      -2.763 -5.404 -0.704  0.712
      -3.135 -5.521 -0.983  0.667
      -3.463 -5.521 -1.496  0.788
      -0.298 -4.465  2.457  1.393
       2.000


8     2
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       00.000


8     3
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       00.000
                 .
                 .
                 .
8    13
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       0.000  0.000  0.000  0.000
       00.000
```

Figure 3.—Equipment data file (EQ DATA A1) information for circular saw headrig (with vertical edger) after entering new information.