Online Instructor's Manual
to accompany

Quality Control

Eighth Edition

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10 9 8 7 6 5 4 3 2 1

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CONTENTS

PREFACE

This manual has been published to simplify the instructor's tasks of developing learning activities and evaluating performance. It is based on the experience of the author and is meant to serve as a guide. Each instructor will need to modify this information for the particular course objectives and the ability level of the students.

For those teachers who are familiar with the *Seventh Edition* of the textbook, information on the major changes to the *Eighth Edition* is provided. This information should simplify the transition to the latest edition.

A typical course outline for a three-semester hour course is shown on Page 3. The learning activities are based on 45 class meetings of 50 minutes each. Since it is difficult to cover all of the material in a typical three-semester hour course, this outline concentrates on the quantifiable aspects of quality control. The instructor may wish to place greater emphasis on the first three chapters, which are non-quantifiable and build a transition to the statistical aspects of quality..

Solutions for the problems start on Page 4. The author has found it advantageous to post the solutions. This action allows students to determine if their methods and answer are correct.

Typical multiple-choice test questions are given and an asterisk indicates the correct answer. These questions can be modified in a number of ways depending on the creativity of the instructor. Answers to test problems are also given. Since the tables in the body of the text and in the Appendix are needed to solve the problems, an open-book type examination should be considered. The instructor may also consider providing copies of the tables and using a closed-book format. Regardless, the multiple-choice questions can be given in the closed-book format. The author has found that allowing the students 3x5 cards for formulas and other information is a great learning experience.

Major Changes to the Eighth Edition

General

1. Problems to exercises.
2. Objectives added to each chapter.
3. Where appropriated changed product to product or service.
4. Where appropriated changed company to organization
5. Footnotes are provided for more advanced topics.
6. Changed exercise notation to include the chapter such as 1-1, ···,1-6; 2-1, ···, 2-8, etc.

Chapter 1

1. Added ASQ definition of quality.
2. Changed slide projector to plasma TV in Table 1-1.
3. Modified Figure 1-1.
4. Added exercises.

Chapter 2

1. Added Lean to Figure 2-1 along with other modifications.
2. Added time line to annual quality improvement program.
3. Added that performance measures should not be used as a "whip."
4. Clarified Figure 2-7 with a footnote.
5. Revised Figure 2-8 and Table2-4

Chapter 3

1. Moved scatter diagram to Chapter 4

Chapter 4

1. Changed weekly wage numbers for example on range
2. Added coefficient of variation to other measures
3. Added least squares calculations to scatter diagram.

Chapter 5

1. Added additional statistical information to six sigma.
2. Added exponential moving average chart with exercises.
3. Added ARL

Chapter 6

1. Added footnotes as links to recent literature on T^2 multivariate chart and deviation chart.

Chapter 7

1. Added mean and standard deviation formulas to hypergeometric, binomial, and Poisson distributions.
2. Added exercises 17 and 18 and renumbered the rest.
3. Eliminated examples and exercises concerning approximation techniques because they are obsolete.

Chapter 8

1. Added information on sample size and confidence limits.

Chapter 9

1. Changed meaning of AQL

Chapter 10

1. Latest standards revision.

Chapter 11

1. Added a section on test design with footnotes to advanced material.

Chapter 12

1. Added footnotes to information on use of these techniques for innovative design.

TYPICAL COURSE OUTLINE

Meeting	Topic	Chapter
1	Introduction to Quality	1
2 and 3	TQM - Principle practices	2
4	TQM - Tools & Techniques	3
5 thru 9	Fundamentals of Statistics	4
10 thru 15	Control Charts for Variables	5
16	Examination I	
17 and 18	Additional SPC Techniques for Variables	6
19 thru 23	Fundamentals of Probability	7
24 thru 28	Control Charts for Attributes	8
29	Examination II	
30 thru 39	Lot-by-Lot Acceptance Sampling by Attributes	9
40 thru 43	Acceptance Sampling Plan Systems	10
44	Reliability (non quantitative)	11
45	Examination III	

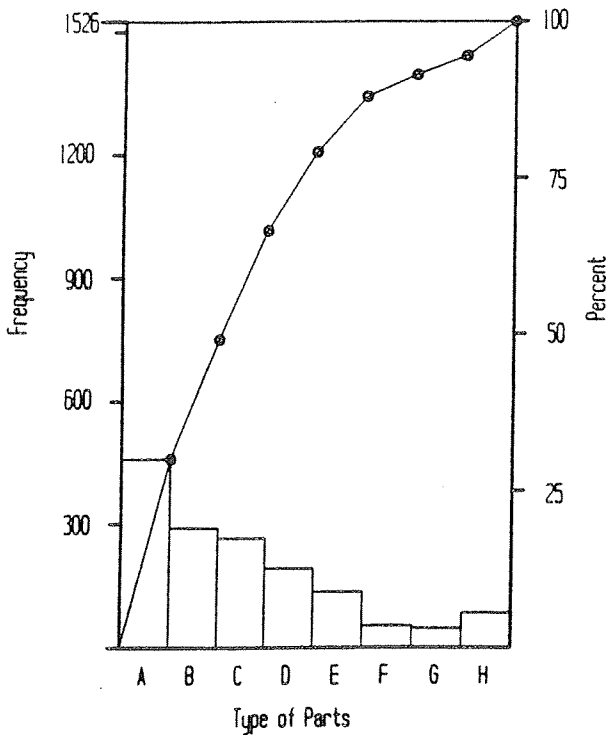
1. Replacement Parts: (6-month period)

		Frequency	Percent	Cumulative Frequency	Cumulative Percent
A.	front burners	460	.30	460	.30
B.	rear burners	290	.19	750	.49
C.	oven regulators	265	.17	1015	.66
D.	oven door	193	.13	1208	.79
E.	burner control	135	.09	1343	.88
F.	timer	53	.03	1396	.91
G.	drawer rollers	46	.03	1442	.94
H.	All others	84	.06	1526	1.00
		1526	1.00		

2. Downtime Costs: (3-month period)
in thousands of dollars

		Frequency	Percent	Cumulative Frequency	Cumulative Percent
A.	lost cooling	52	.45	52	.45
B.	back pressure reg.	30	.26	82	.71
C.	adjust feed worm	15	.13	97	.84
D.	valve replacement	8	.07	105	.91
E.	jam copperhead	6	.05	111	.96
F.	All others	5	.04	116	1.00
		116	1.00		

(1)



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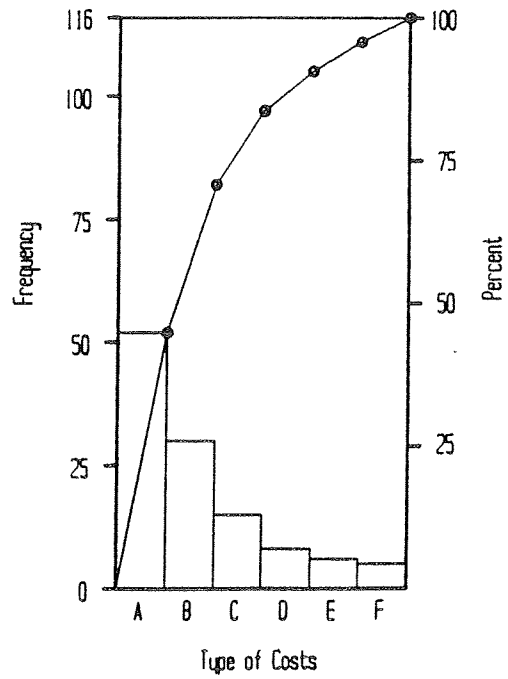


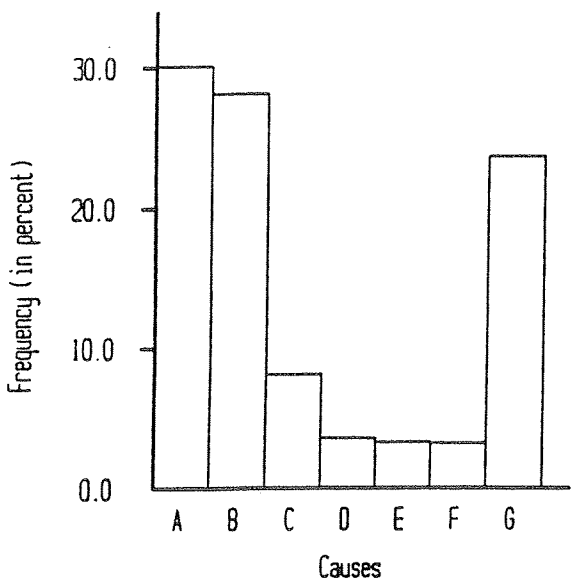
3 Cause of accident — in percent

a.	right-of-way violation	30.1
b.	driving too fast for condition	28.1
c.	following too closely	8.1
d.	improper turn	3.6
e	driving left of center	3.3
f.	improper overtaking	3.2
g.	all other	23.6
		100.0

4. Reason for Shipment Return: (quarter)
in thousands

		Frequency	Percent	Cumulative Frequency	Cumulative Percent
A.	refused	195	.585	195	.59
B.	wrong address	68	.20	263	.79
C.	wrong selection	50	.15	313	.94
D.	order canceled	5	.02	318	.96
E.	All other	15	.045	333	1.00
		333	1.00		

(3)



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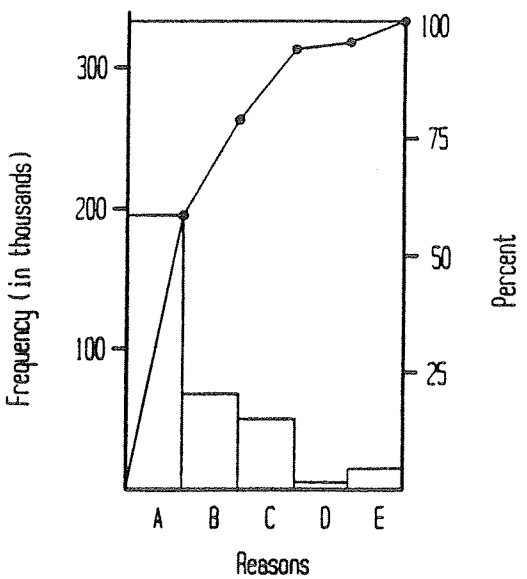
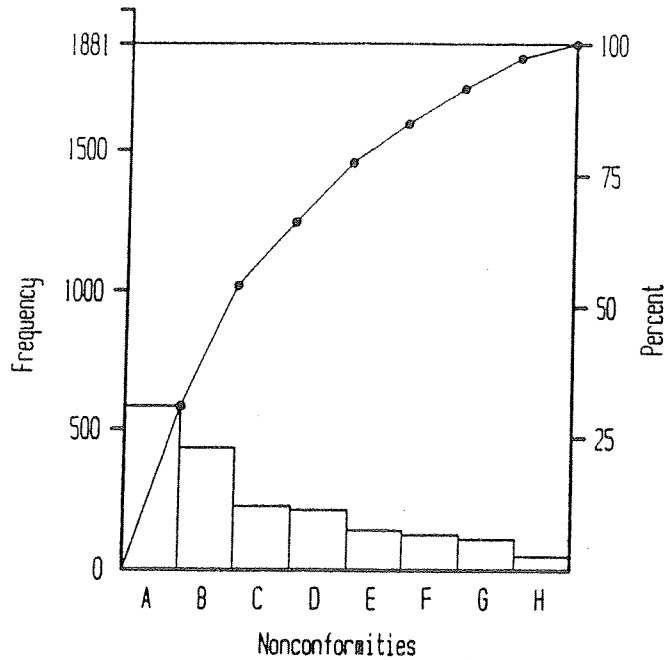


5. Paint Nonconformities: (1-month)

		Frequency	Percent	Cumulative Frequency	Cumulative Percent
A.	light spray	582	.31	582	.31
B.	runs	434	.23	1016	.54
C.	drips	227	.12	1243	.66
D.	blisters	212	.11	1455	.77
E.	splatter	141	.07	1596	.84
F.	bad paint	126	.07	1722	.91
G.	overspray	109	.06	1831	.97
H.	All others	50	.03	1881	1.00
		1881	1.00		



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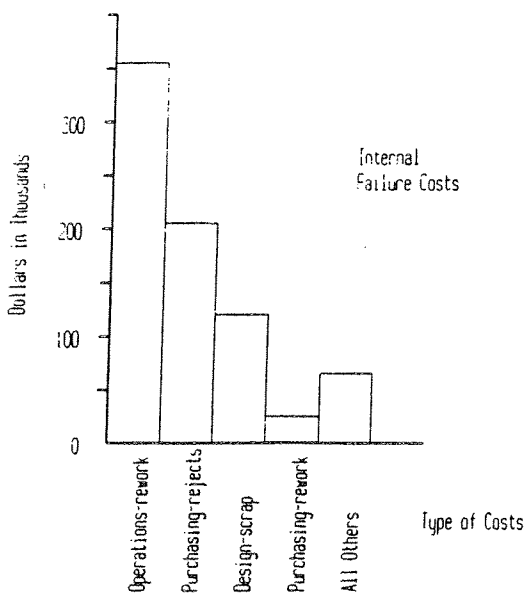

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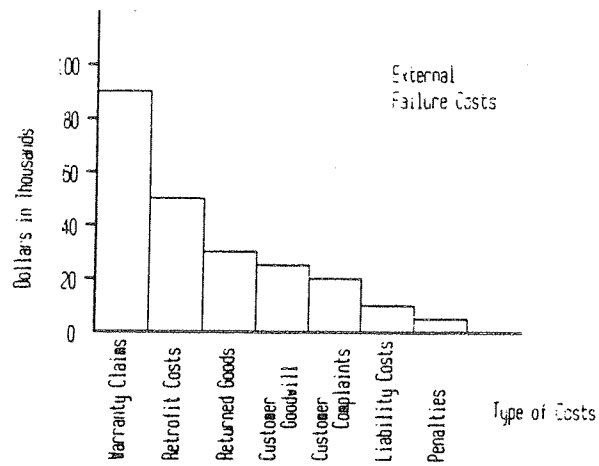

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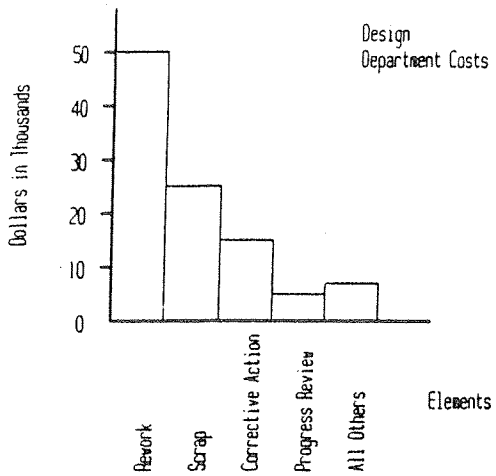
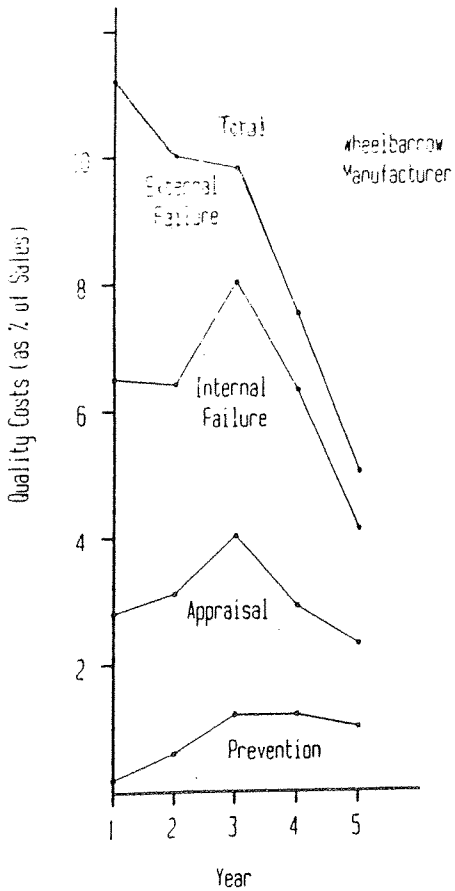
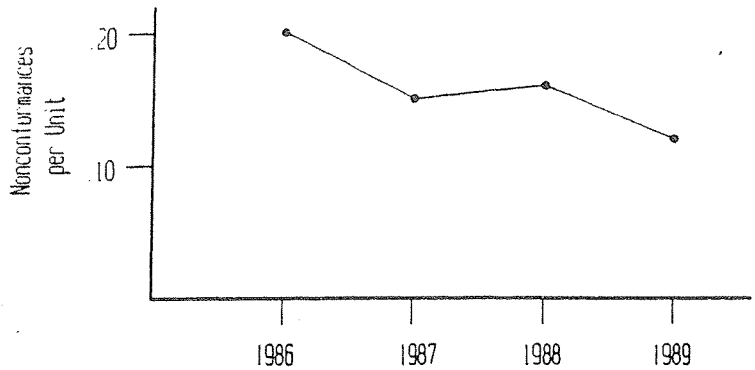

Design
Department Costs
Dollars in thousands
50
40
30
20
10
0
Rework
Scrap
Corrective Action
Progress Review
All Others
Elements

9.


Total
Wheelbarrow
Manufacturer
External
Failure
Internal
Failure
Appraisal
Prevention
Quality Costs (as % of Sales)
8
6
4
2
1
2
3
4
5
Year

10.



There is a downward trend over the four years.

11-13. See pages 79-82 for examples.

1. 0.86, 0.63, 0.15, 0.48

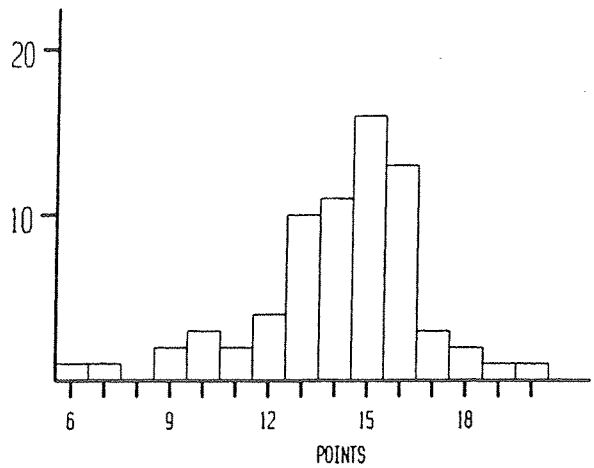
2, 3.

Number	Boundaries	Precision	g.p.e.	r.e.
(a) 8.24	8.235 < 8.24 < 8.45	0.01	0.005	0.0006
(b) 522	521.5 < 522 < 522.5	1	0.5	0.001
(c) 6.3 x 10	625 < 630 < 635	10	5	0.002
(d) 0.02	0.015 < 0.02 < 0.025	0.01	0.005	0.3

4. 2.84×10^2, 22, 0.64, 0.8937, 0.9

5. 66.4, 379.1, 5, 4.652, 6.2×10^2

6.



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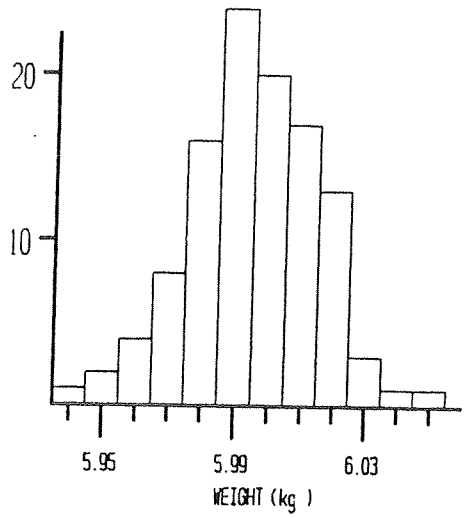
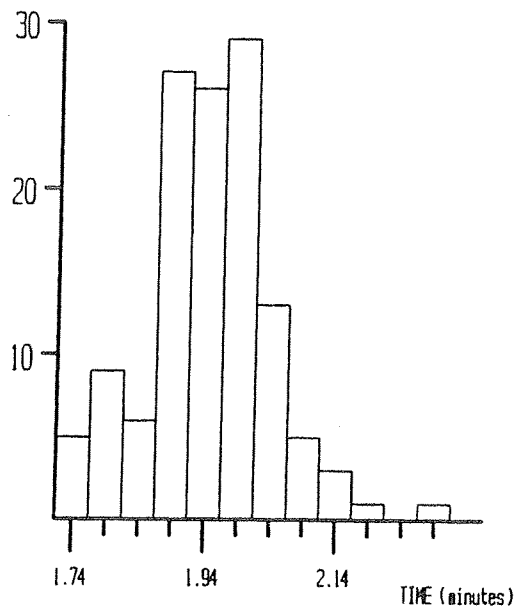


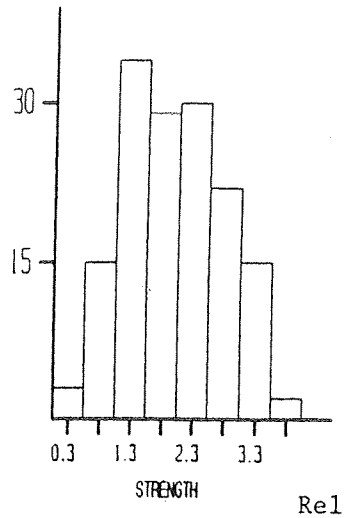
8.

Cell Boundaries	Cell Midpoint	Frequency
1.72-1.76	1.74	5
1.77-1.81	1.79	9
1.82-1.86	1.84	6
1.87-1.91	1.89	27
1.92-1.96	1.94	26
1.97-2.01	1.99	29
2.02-2.06	2.04	13
2.07-2.11	2.09	5
2.12-2.16	2.14	3
2.17-2.21	2.19	1
2.22-2.26	2.24	0
2.27-2.31	2.29	1



9.

Cell Boundaries	Cell Midpoints	Frequency
0.05-0.54	0.3	3
0.55-1.04	0.8	15
1.05-1.54	1.3	34
1.55-2.04	1.8	29
2.05-2.54	2.3	30
2.55-3.04	2.8	22
3.05-3.54	3.3	15
3.55-4.04	3.8	2



10.

Scores	Freq.	Relative Freq.	Cumulative Freq.	Relative Cumulative Freq.
6	1	1/70 = 0.014	0+1 = 1	1/70 = 0.014
7	1	1/70 = 0.014	1+1 = 2	2/70 = 0.029
8	0	0/70 = 0	2+0 = 2	2/70 = 0.029
9	2	2/70 = 0.029	2+2 = 4	4/70 = 0.057
10	3	3/70 = 0.043	4+3 = 7	7/70 = 0.100
11	2	2/70 = 0.029	7+2 = 9	9/70 = 0.129
12	4	4/70 = 0.057	9+4 = 13	13/70 = 0.186
13	10	10/70 = 0.143	13+10 = 23	23/70 = 0.329
14	11	11/70 = 0.157	23+11 = 34	34/70 = 0.486
15	16	16/70 = 0.229	34+16 = 50	50/70 = 0.714
16	13	13/70 = 0.186	50+13 = 63	63/70 = 0.900
17	3	3/70 = 0.043	63+3 = 66	66/70 = 0.943
18	2	2/70 = 0.029	66+2 = 68	68/70 = 0.971
19	1	1/70 = 0.014	68+1 = 69	69/70 = 0.986
20	1	1/70 = 0.014	69+1 = 70	70/70 = 1.000
	70	1.00		

Graph not shown, but similar to Problem 13

11.

Weights	Freq.	Relative Freq.	Cumulative Freq.	Relative Cumulative Freq.
5.94	1	1/110 = 0.9%	0+1 = 1	1/110 = 0.9%
5.95	2	2/110 = 1.8	1+2 = 3	3/110 = 2.7
5.96	4	4/110 = 3.6	3+4 = 7	7/110 = 6.4
5.97	8	8/110 = 7.3	7+8 = 15	15/110 = 13.6
5.98	16	16/110 = 14.5	15+16 = 31	31/110 = 28.2
5.99	24	24/110 = 21.8	31+24 = 55	55/110 = 50.0
6.00	20	20/110 = 18.2	55+20 = 75	75/110 = 68.2
6.01	17	17/110 = 15.5	75+17 = 92	92/110 = 83.6
6.02	13	13/110 = 11.8	92+13 = 105	105/110 = 95.4
6.03	3	3/110 = 2.7	105+3 = 108	108/110 = 98.2
6.04	1	1/110 = 0.9	108+1 = 109	109/110 = 99.1
6.05	1	1/110 = 0.9	109+1 = 110	110/110 = 100.0%
	110	99.9%		

Graph not shown, but similar to Problem 13

12.

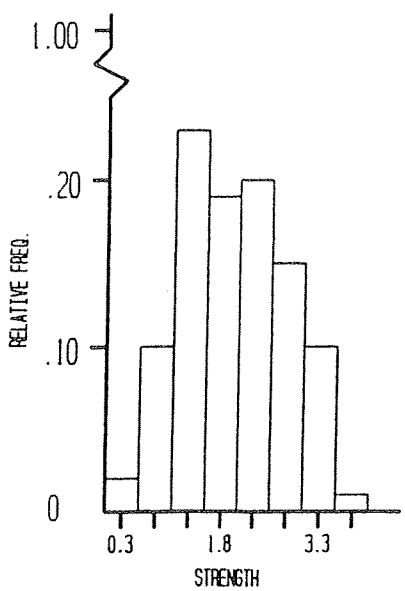
Cell Midpoint	Freq.	Relative Freq.	Cumulative Freq.	Relative Cumulative Freq.
1.74	5	5/125 = 0.040	0+5 = 5	5/125 = 0.040
1.79	9	9/125 = 0.72	5+9 = 14	14/125 = 0.112
1.84	6	6/125 = 0.048	14+6 = 20	20/125 = 0.160
1.89	27	27/125 = 0.216	20+27 = 47	47/125 = 0.376
1.94	26	26/125 = 0.208	47+26 = 73	73/125 = 0.584
1.99	29	29/125 = 0.232	73+29 = 102	102/125 = 0.816
2.04	13	13/125 = 0.104	102+13 = 115	115/125 = 0.920
2.09	5	5/125 = 0.040	115+5 = 120	120/125 = 0.960
2.14	3	3/125 = 0.024	120+3 = 123	123/125 = 0.984
2.19	1	1/125 = 0.008	123+1 = 124	124/125 = 0.992
2.24	0	0/125 = 0	124+0 = 124	124/125 = 0.992
2.29	1	1/125 = 0.008	124+1 = 125	125/125 = 1.000
	125	1.000		

Graph not shown, but similar to Problem 13

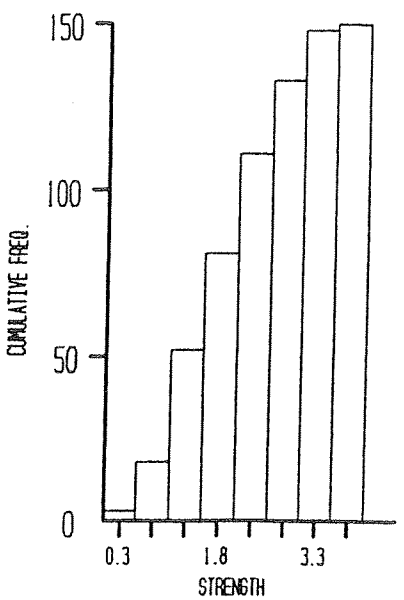
13.

Cell Midpoint	Freq.	Relative Freq.	Cumulative Freq.	Relative Cumulative Freq.
0.3	3	3/150 = 0.020	0+3 = 3	3/150 = 0.020
0.8	15	15/150 = 0.100	3+15 = 18	18/150 = 0.120
1.3	34	34/150 = 0.227	18+34 = 52	52/150 = 0.347
1.8	29	29/150 = 0.193	52+29 = 81	81/150 = 0.540
2.3	30	30/150 = 0.200	81+30 = 111	111/150 = 0.740
2.8	22	22/150 = 0.147	111+22 = 133	133/150 = 0.888
3.3	15	15/150 = 0.100	133+15 = 148	148/150 = 0.987
3.8	2	2/150 = 0.013	148+2 = 150	150/150 = 1.000
	150	1.000		

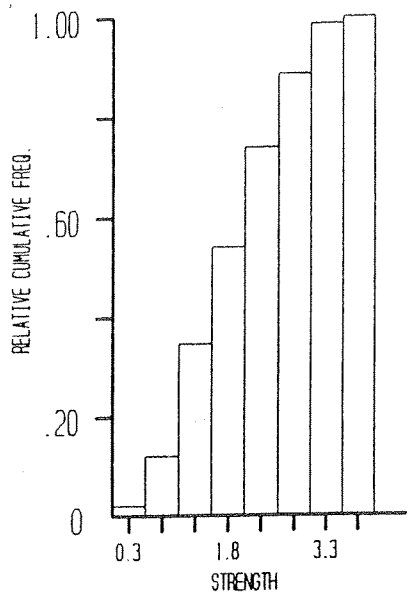
13a



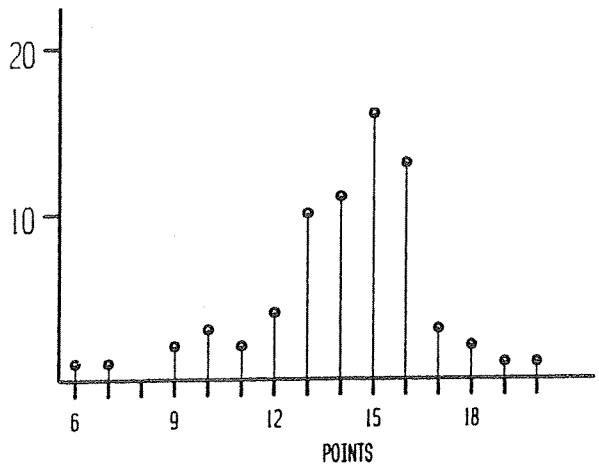
13b



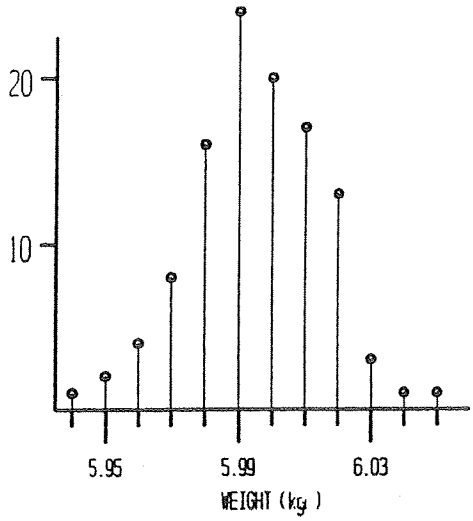
13c



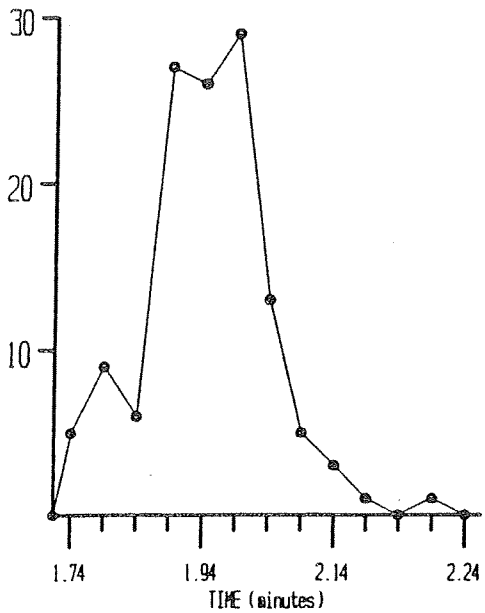
14a



14b



15a



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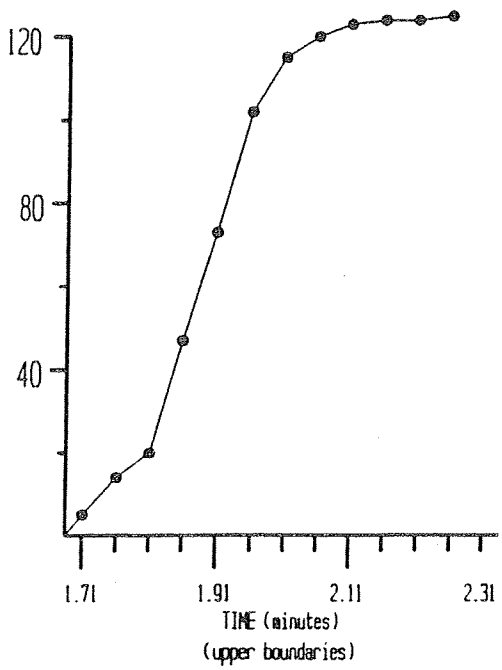
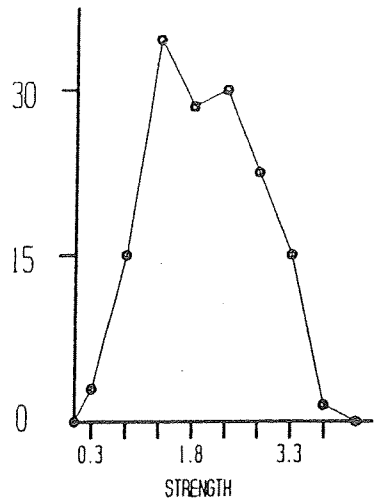
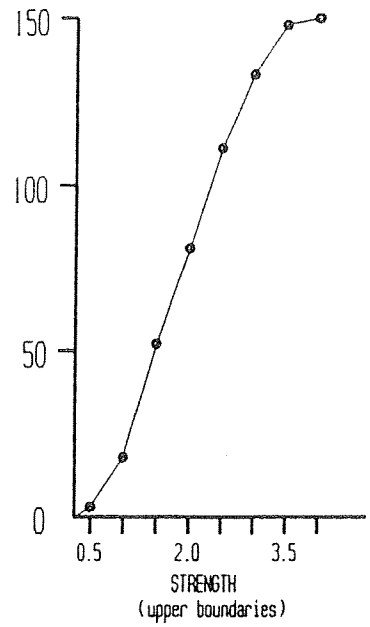


16a



16b



17. $\bar{x} = \Sigma x/n = \frac{115 + 113 + 121 + 115 + 116}{5} = 116$ volts

18. $\bar{x} = \frac{\Sigma x}{n} = \frac{25.6 + 24.8 + 22.6 + 21.3 + 19.6 + 18.5 + 16.2 + 15.5}{8} = 20.5$ m

19.

x	f	fx
148	2	296
139	3	417
130	8	1,040
121	11	1,331
112	27	3,024
103	35	3,605
94	43	4,042
85	33	2,805
76	20	1,520
67	12	804
58	6	348
49	4	196
40	2	80
	206	19,508

$\bar{x} = \frac{\Sigma fx}{n}$

$= \frac{19,508}{206}$

$= 95$ db

20.

x	f	fx
3.5	6	21.0
3.8	9	34.2
4.1	18	73.8
4.4	14	61.6
4.7	13	61.1
5.0	5	25.0
	65	276.7

$\bar{x} = \frac{\Sigma fx}{n}$

$= \frac{276.7}{65}$

$= 4.3$ kg

21. $\bar{x}_w = \Sigma w\bar{x}/\Sigma w$

$= \frac{(3)\ (3320) + (2)\ (3180)}{3 + 2}$

$= 3264$ h

22. $\bar{\chi}_w = \Sigma w\bar{\chi}/\Sigma w$

$$= \frac{(24)\ (1.75) + (18)\ (1.79) + (29)\ (1.68)}{24 + 18 + 29}$$

$$= 1.73 \text{ m}$$

23. a. 8, 11, 15, 18, 22; Md = 15
    b. 28, 33, 35, 36, 38, 43; Md = $\frac{35 + 36}{2} = 35.5$

24. a. $Md = L + \left(\frac{\frac{n}{2} - cf}{f}\right)i = 1.915 + \left(\frac{\frac{125}{2} - 47}{26}\right)0.05 = 1.94$

    b. Md = $= 1.55 + \left(\frac{\frac{150}{2} - 52}{29}\right)0.5 = 1.95$

    c. Md = $= 90 + \left(\frac{\frac{206}{2} - 77}{43}\right)9 = 95$ db

    d. Md = $= 4.0 + \left(\frac{\frac{65}{2} - 15}{18}\right).3 = 4.3$

    e. Md = $= 1.60 + \left(\frac{\frac{88}{2} - 39}{12}\right)0.3 = 1.73$

    f. Md = $= 1450 + \left(\frac{\frac{77}{2} - 19}{22}\right)300 = 1716$

25. 55, none, 14 and 17

26. 15, 5.99, 1.99, 1.3, 94, 4.1

27. a. R = H - L = 25 - 14 = 11
    b. R = = 45 - 39 = 6
    c. R = H - L = 20 - 6 = 14
    d. R = = 6.05 - 5.94 = 0.11

28. $s = \sqrt{\frac{n\Sigma\chi^2 - (\Sigma\chi)^2}{n(n-1)}} = \sqrt{\frac{5(7152350) - (5980)^2}{5(5-1)}} = 8.2$ vib/sec

29. $s = = \sqrt{\frac{4(0.024) - (.308)^2}{4(4-1)}} = 0.004$ mm

30.

Mid-point (x)	Freq. (f)	(f_x)	(f_x^2)
.5	1	.5	0.3
.8	16	12.8	10.2
1.1	12	13.2	14.5
1.4	10	14.0	19.6
1.7	12	20.4	34.7
2.0	18	36.0	72.0
2.3	16	36.8	84.6
2.6	3	7.8	20.3
	88	141.5	256.2

$$s = \sqrt{\frac{n\sum f X^2 - (\sum f X)^2}{n(n-1)}}$$

$$= \sqrt{\frac{88(256.2) - (141.5)^2}{88(88-1)}}$$

$= .57\%$

31a.

Mid-point (x)	Freq. (f)	(fx)	(fx^2)
0.3	3	0.9	0.27
0.8	15	12.0	9.60
1.3	34	44.2	57.46
1.8	29	52.2	93.96
2.3	30	69.0	158.70
2.8	22	61.6	172.48
3.3	15	49.5	163.35
3.8	2	7.6	28.88
	150	297.0	684.70

$$s = \sqrt{\frac{n\sum f X^2 - (\sum f X)^2}{n(n-1)}}$$

$$= \sqrt{\frac{150(684.7) - (297.0)^2}{150(150-1)}}$$

$= 0.8$

31b

Mid-point (x)	Freq. (f)	(fx)	(fx^2)
148	2	296	43,808
139	3	417	57,963
130	8	1,040	135,200
121	11	1,331	161,051
112	27	3,024	338,688
103	35	3,605	371,315
94	43	4,042	379,948
85	33	2,805	238,425
76	20	1,520	115,520
67	12	804	53,868
58	6	348	20,184
49	4	196	9,604
40	2	80	3,200
	206	19,508	1,928,774

$$s = \sqrt{\frac{n\sum f X^2 - (\sum f X)^2}{n(n-1)}}$$

$$= \sqrt{\frac{206(1,928,774) - (19,508)^2}{206(206-1)}}$$

$= 20$ db

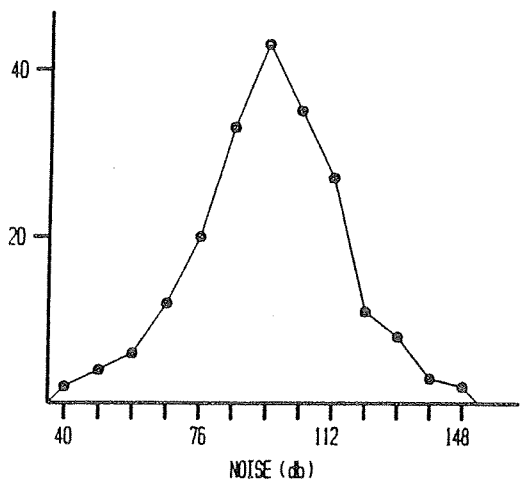
32.

Mid-point (χ)	Freq. (f)	($f\chi$)	($f\chi^2$)
1000	6	6000	6.00×10^6
1300	13	16900	21.97×10^6
1600	22	35200	56.32×10^6
1900	17	32300	61.37×10^6
2200	11	24200	53.24×10^6
2500	8	20000	50.00×10^6
	77	134.6×10^3	248.9×10^6

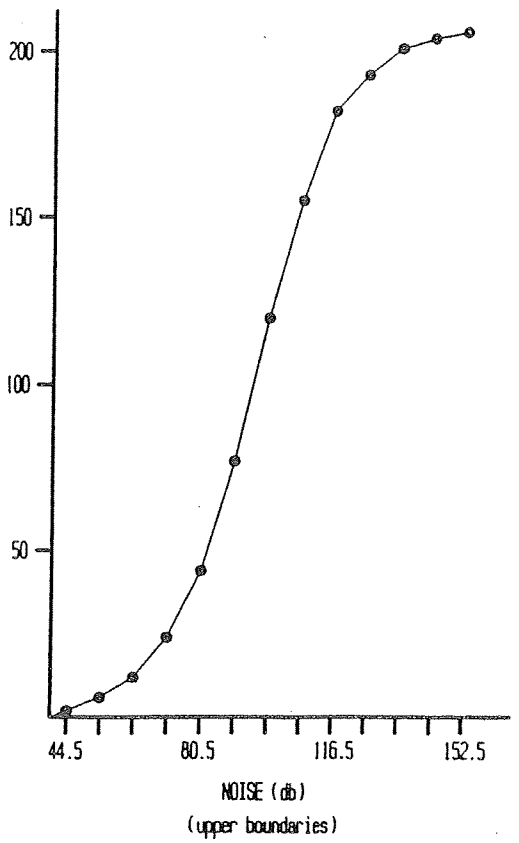
$\bar{\chi} = \Sigma f\chi/n = 134.6 \times 10^3/77 = 1748$ inspections

$$s = \sqrt{\frac{n\Sigma f\chi^2 - (\Sigma f\chi)^2}{n(n-1)}} = \sqrt{\frac{77(248.9 \times 10^6) - (134.6 \times 10^3)^2}{77(77-1)}} = 423$$

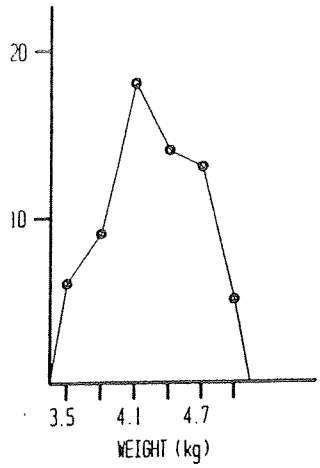
33a



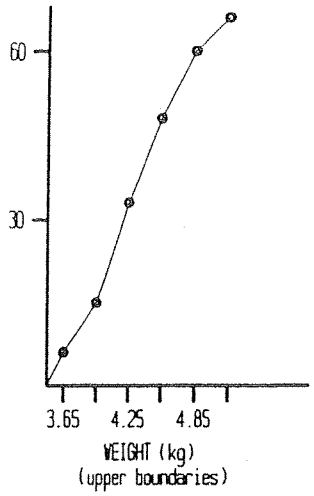
33b



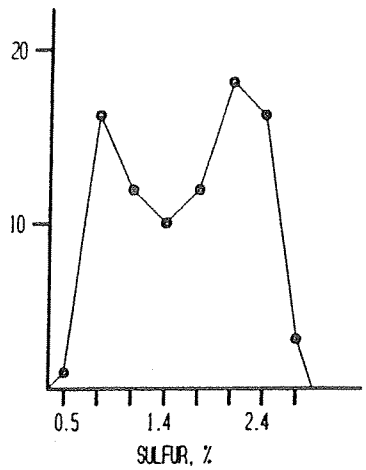
34a



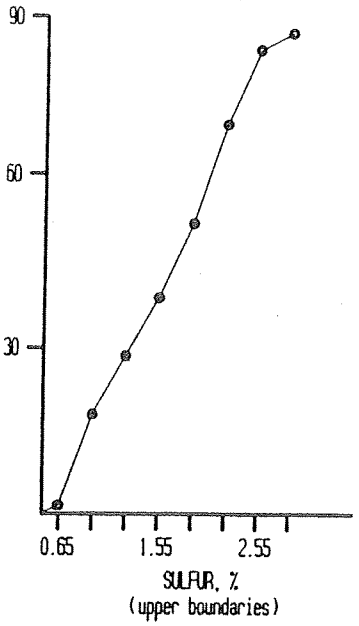
34b



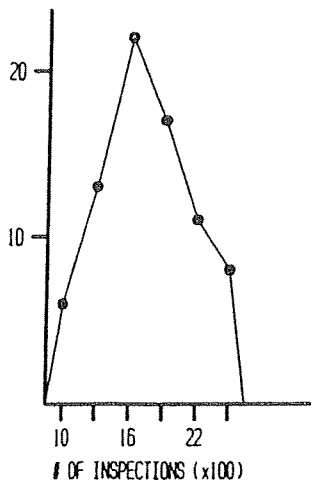
35a



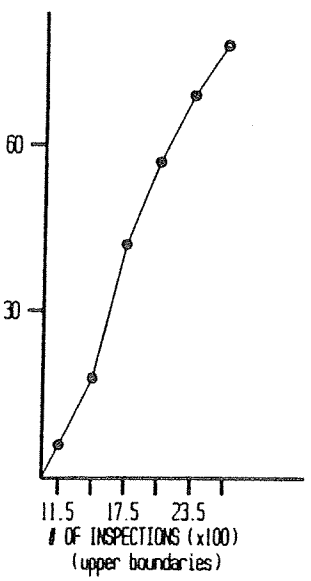
35b



36a



36b



37.

Cell Mid-point	Freq.	Relative Freq.	Cumulative Freq.	Relative Cumulative Freq.
40	2	2/206 = 0.010	0+2 = 2	2/206 = 0.010
49	4	4/206 = 0.019	2+4 = 6	6/206 = 0.029
58	6	6/206 = 0.029	6+6 = 12	12/206 = 0.058
67	12	12/206 = 0.058	12+12 = 24	24/206 = 0.117
76	20	20/206 = 0.097	24+20 = 44	44/206 = 0.214
85	33	33/206 = 0.160	44+33 = 77	77/206 = 0.374
94	43	43/206 = 0.209	77+43 = 120	120/206 = 0.583
103	35	35/206 = 0.170	120+35 = 155	155/206 = 0.752
112	27	27/206 = 0.131	155+27 = 182	182/206 = 0.883
121	11	11/206 = 0.053	182+11 = 193	193/206 = 0.937
130	8	8/206 = 0.039	193+8 = 201	201/206 = 0.976
139	3	3/206 = 0.015	201+3 = 204	204/206 = 0.990
148	2	2/206 = 0.010	204+2 = 206	206/206 = 1.000
	206	1.000		

38.

Cell Mid-point	Freq.	Relative Freq.	Cumulative Freq.	Relative Cumulative Freq.
3.5	6	6/65 = 0.092	0+6 = 6	6/65 = 0.092
3.8	9	9/65 = 0.138	6+9 = 15	15/65 = 0.231
4.1	18	18/65 = 0.277	15+18 = 33	33/65 = 0.508
4.4	14	14/65 = 0.215	33+14 = 47	47/65 = 0.723
4.7	13	13/65 = 0.200	47+13 = 60	60/65 = 0.923
5.0	5	5/65 = 0.077	60+5 = 65	65/65 = 1.000
	65	0.999		

39.

Cell Mid-point	Freq.	Relative Freq.	Cumulative Freq.	Relative Cumulative Freq.
0.5	1	1/88 = 0.011	0+1 = 1	1/88 = 0.010
0.8	16	16/88 = 0.182	1+16 = 17	17/88 = 0.156
1.1	12	12/88 = 0.136	17+12 = 29	29/88 = 0.330
1.4	10	10/88 = 0.114	29+10 = 39	39/88 = 0.443
1.7	12	12/88 = 0.136	39+12 = 51	51/88 = 0.580
2.0	18	18/88 = 0.205	51+18 = 69	69/88 = 0.784
2.3	16	16/88 = 0.182	69+16 = 85	85/88 = 0.966
2.6	3	3/88 = 0.034	85+3 = 88	88/88 = 1.000
	88	1.000		

40.

Cell Mid-point	Freq.	Relative Freq.	Cumulative Freq.	Relative Cumulative Freq.
1000	6	6/77 = 0.078	0+6 = 6	6/77 = 0.078
1300	13	13/77 = 0.169	6+13 = 19	19/77 = 0.247
1600	22	22/77 = 0.286	19+22 = 41	41/77 = 0.532
1900	17	17/77 = 0.221	41+17 = 58	58/77 = 0.753
2200	11	11/77 = 0.143	58+11 = 69	69/77 = 0.896
2500	8	8/77 = 0.104	69+8 = 77	77/77 = 1.000
	77	1.001		

41a

χ	f	$(\chi_i - \bar{\chi})$	$f(\chi_i - \bar{\chi})^3$	$f(\chi_i - \bar{\chi})^4$
6	1	-8.13	-537.37	4,368.80
7	1	-7.13	-362.47	2,584.39
8	0	-6.13	0	0
9	2	-5.13	-270.01	1,385.16
10	3	-4.13	-211.33	872.81
11	2	-3.13	- 61.33	191.96
12	4	-2.13	- 38.65	82.33
13	10	-1.13	- 14.43	16.30
14	11	-0.13	- 0.02	0
15	16	0.87	10.54	9.17
16	13	1.87	85.01	158.97
17	3	2.87	70.92	203.54
18	2	3.87	115.92	448.62
19	1	4.87	115.50	562.49
20	1	5.87	202.26	1,187.28
	70		-895.46	12,071.82

$\bar{\chi} = 14.13$ $\quad s = 2.53$

$$a_3 = \frac{\Sigma f(\chi_i - \bar{\chi})^3/n}{s^3} = \frac{-895.46/70}{2.53^3} = -0.79$$

$$a_4 = \frac{\Sigma f(\chi_i - \bar{\chi})^4/n}{s^4} = \frac{12071.82/70}{2.53^4} = 4.21$$

Distribution is very peaked and quite skewed to the left.

41b

χ	f	$(\chi_i - \bar{\chi})$	$f(\chi_i - \bar{\chi})^3$	$f(\chi_i - \bar{\chi})^4$
-6	1	-5.54	-170.03	941.97
-5	2	-4.54	-187.15	849.68
-4	4	-3.54	-177.45	628.16
-3	8	-2.54	-131.10	332.99
-2	16	-1.54	- 58.44	89.99
-1	24	-0.54	- 3.78	2.04
0	20	.46	1.95	.90
1	17	1.46	40.45	59.06
2	13	2.46	193.53	476.08
3	3	3.46	124.26	429.96
4	1	4.46	88.72	395.68
5	1	5.46	162.77	888.73
	110		-116.27	5,171.72

Note: χ is coded from 6.00.

$\bar{\chi} = -0.46$ $\quad$ True $\bar{\chi} = 5.9954$ $\quad s = 1.97$

$$a_3 = \frac{\Sigma f(\chi_i - \bar{\chi})^3/n}{s^3} = \frac{-116.27/110}{1.97^3} = -0.14$$

$$a_4 = \frac{\Sigma f(\chi_i - \bar{\chi})^4/n}{s^4} = \frac{5171.72/110}{1.97^4} = 3.11$$

Distribution is slightly skewed to the left and not quite as peaked as normal.

41c

χ	f	$(\chi_i - \bar{\chi})$	$f(\chi_i - \bar{\chi})^3 \times 10^3$	$f(\chi_i - \bar{\chi})^4 \times 10^3$
1.74	5	-.2032	-41.9509	8.5244
1.79	9	-.1532	-32.3608	4.9577
1.84	6	-.1032	- 6.5946	.6806
1.89	27	-.0532	- 4.0654	.2163
1.94	26	-.0032	- .0009	nil
1.99	29	.0468	2.9726	.1391
2.04	13	.0968	11.7915	1.1414
2.09	5	.1468	15.8179	2.3221
2.14	3	.1968	12.8663	4.5001
2.19	1	.2468	15.0326	3.7101
2.24	0	.2968	0	0
2.29	1	.3468	41.7097	14.4649
	125		$+25.218 \times 10^3$	40.6567×10^3

$\bar{\chi} = 1.9432$ $\quad s = .096249$

$$a_3 = \frac{\Sigma f(\chi_i - \bar{\chi})^3/n}{s^3} = \frac{25.218 \times 10^3/125}{.096249^3} = +0.23$$

$$a_4 = \frac{\Sigma f(\chi i - \bar{\chi})^4/n}{s^4} = \frac{40.6567 \times 10^3/125}{.096249^4} = 3.79$$

Distribution is slightly skewed to the right and somewhat peaked.

41d

χ	f	$(\chi_i - \bar{\chi})$	$f(\chi_i - \bar{\chi})^3$	$f(\chi_i - \bar{\chi})^4$
0.3	3	-1.68	-14.2249	23.8978
0.8	15	-1.18	-24.6455	29.0816
1.3	34	-0.68	-10.6907	7.2697
1.8	29	-0.18	- .1691	.0304
2.3	30	.32	.9830	.3146
2.8	22	.82	12.1301	9.9467
3.3	15	1.32	34.4995	45.5394
3.8	2	1.82	12.0571	21.9439
	150		9.9395	138.0242

$\bar{\chi} = 1.98$ $\quad s = 0.8053512$

$$a_3 = \frac{\Sigma f(\chi_i - \bar{\chi})^3/n}{s^3} = \frac{9.9395/150}{.8053512^3} = +.13$$

$$a_4 = \frac{\Sigma f(\chi_i - \bar{\chi})^4/n}{s^4} = \frac{138.0242/150}{.8053512^4} = 2.19$$

Slightly skewed to the right and flatter than normal.

41e

χ	f	$(\chi_i - \bar{\chi})$	$f(\chi_i - \bar{\chi})^3$	$f(\chi_i - \bar{\chi})^4$
3.5	6	-0.7569	-2.6018	1.96927
3.8	9	-0.4569	- .8584	.3922
4.1	18	-0.1569	- .0695	.0109
4.4	14	0.1431	.0410	.0059
4.7	13	0.4431	1.1310	.5011
5.0	5	0.7431	2.0517	1.5246
	65		-0.306	4.4040

$\bar{\chi} = 4.2569$ $\quad s = 0.4212961$

$$a_3 = \frac{\Sigma f(\chi_i - \bar{\chi})^3/n}{s^3} = \frac{-.306/65}{0.4212961^3} = -0.06$$

$$a_4 = \frac{\Sigma f(\chi_i - \bar{\chi})^4/n}{s^4} = \frac{4.4040/65}{0.4212961^4} = 2.15$$

Distribution is essentially symmetrical and much flatter than normal.

41f

χ	f	$(\chi_i - \bar{\chi})$	$f(\chi_i - \bar{\chi})^3 \times 10^6$	$f(\chi_i - \bar{\chi})^4 \times 10^9$
1000	6	-748	-2511	1878
1300	13	-448	-1169	523
1600	22	-148	- 71	11
1900	17	+152	60	9
2200	11	+452	1015	459
2500	8	+752	3402	2558
	77		$+ 726 \times 10^6$	5438×10^9

$\bar{\chi} = 1748$ $\quad s = 423$

$$a_3 = \frac{\Sigma f(\chi_i - \bar{\chi})^3/n}{s^3} = \frac{726 \times 10^6/77}{423^3} = +0.10$$

$$a_4 = \frac{\Sigma f(\chi_i - \bar{\chi})^4/n}{s^4} = \frac{5438 \times 10^9/77}{423^4} = 2.21$$

Distribution is essentially symmetrical and much flatter than normal.

42. Max. of 134.5 db (χ_i)

from 17 $\bar{\chi} = 94.7$

$\sigma = 19.925$

$$z_1 = \frac{\chi_i - \mu}{\sigma}$$

$$z_1 = \frac{134.5 - 94.7}{19.925}$$

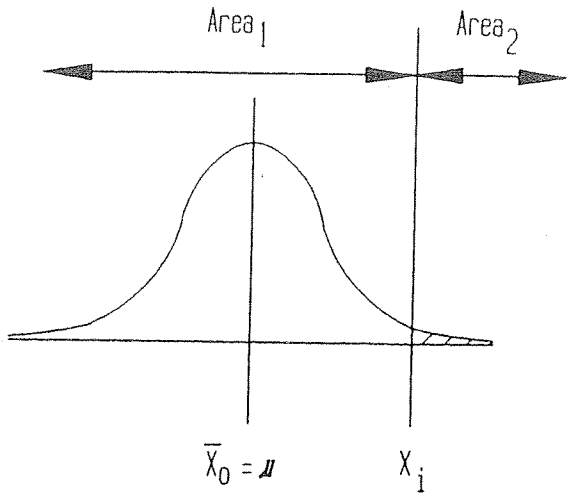
$z_1 = 2.00$

$Area_1 = 0.9773$

$Area_2 = 1.000 - Area_1$

$Area_2 = 1.00 - 0.9773$

$Area_2 = 0.0227$ or 2.8%



43. Min. of 3.65 (χ_i)

Max. of 4.85 (χ_i)

from 18 $\bar{X} = 4.25$

$\sigma = .4213$

$$z_1 = \frac{\chi_i - \mu}{\sigma}$$

$$z_1 = \frac{3.65 - 4.26}{.4213}$$

$z_1 = -1.45$

$Area_1 = 0.0734$

$$z_2 = \frac{\chi_i - \mu}{\sigma}$$

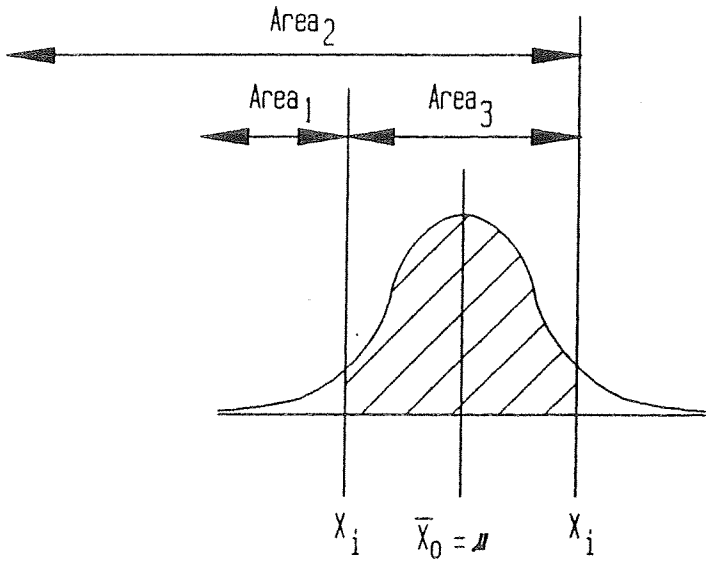
$$z_2 = \frac{4.85 - 4.26}{.4213}$$

$z_2 = 1.40$ $Area_2 = 0.9192$

$Area_3 = Area_2 - Area_1$

$Area_3 = 0.9192 - 0.0735$

$Area_3 = 0.8457$ or 84.6%



44. Max. of 2.25 (χ_i)

From 28 $\bar{\chi} = 1.65$

$\sigma = 0.617$

$$z_1 = \frac{\chi_i - \mu}{\sigma}$$

$$z_1 = \frac{2.25 - 1.65}{0.617}$$

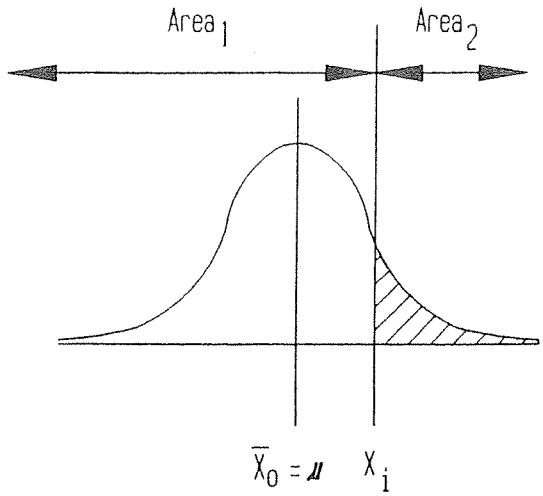
$$z_1 = 0.97$$

$\text{Area}_1 = 0.8340$

$\text{Area}_2 = 1.000 - \text{Area}_1$

$\text{Area}_2 = 1.000 - 0.8340$

$\text{Area}_2 = 0.166$ or 16.6%



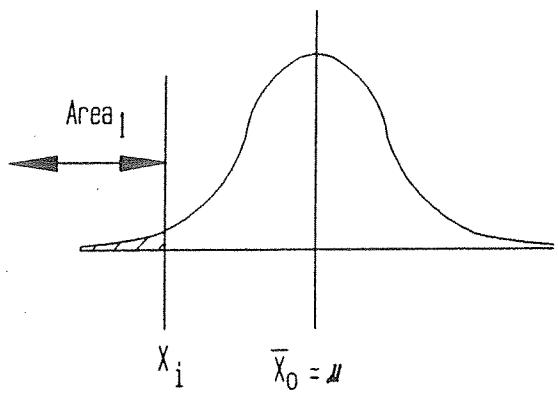
45a $$z = \frac{\chi_i - \mu}{\sigma}$$

$$z = \frac{8.30 - 9.07}{0.40}$$

$z = -1.93$ Rounded

From Table A_1

$\text{Area}_1 = 0.0268$ or 2.68%



45b $$z_1 = \frac{\chi_i - \mu}{\sigma}$$

$$z_1 = \frac{10.00 - 9.07}{0.40}$$

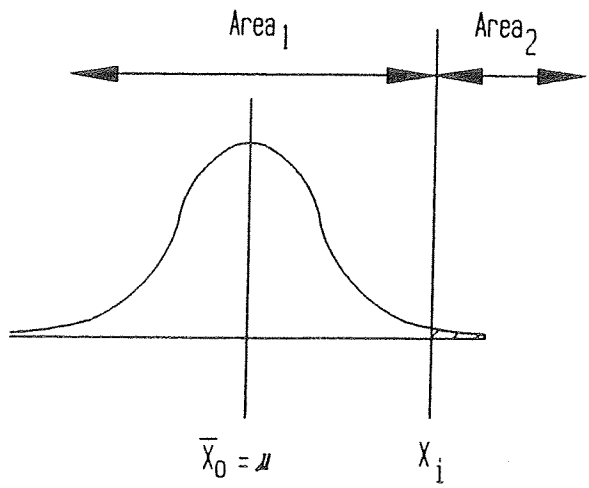
$z_1 = +2.33$ Rounded

$\text{Area}_1 = 0.9901$

$\text{Area}_2 = 1.000 - \text{Area}_1$

$\text{Area}_2 = 1.000 - 0.9901$

$\text{Area}_2 = 0.0099$ or 0.99%



45c $z_1 = \frac{x_i - \mu}{\sigma}$

$z_1 = \frac{8.00 - 9.07}{0.40}$

$z_1 = -2.68$

$Area_1 = 0.0037$

$z_2 = \frac{x_i - \mu}{\sigma}$

$z_2 = \frac{10.10 - 9.07}{0.40}$

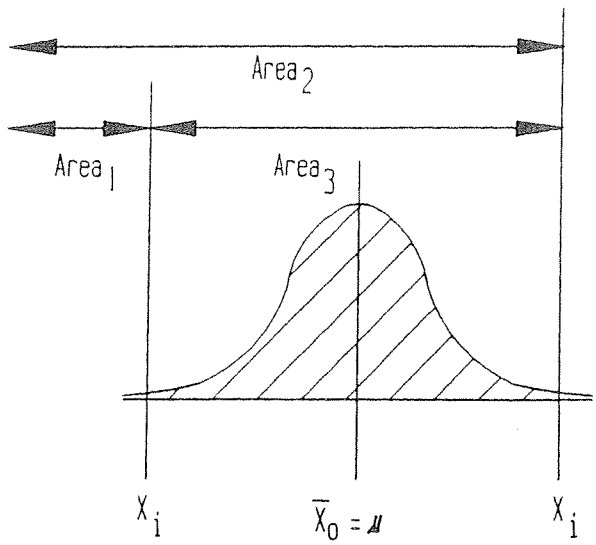
$z_2 = +2.58$

$Area_2 = 0.9951$

$Area_3 = Area_2 - Area_1$

$Area_3 = 0.9951 - 0.0037$

$Area_3 = 0.9914$ or 99.14%

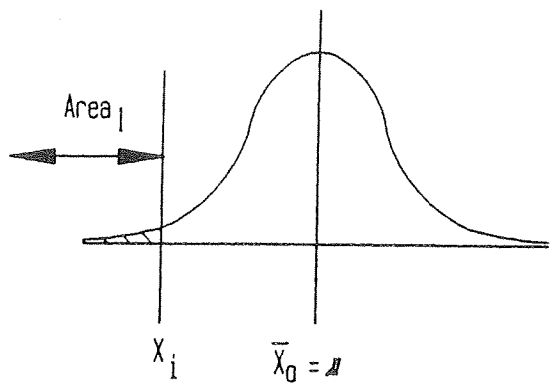


46a. $z_1 = \frac{x_i - \mu}{\sigma}$

$z_1 = \frac{13 - 16}{1.5}$

$z_1 = -2.00$

$Area_1 = 0.0228$ or 2.28%



46b. $z_1 = \frac{x_i - \mu}{\sigma}$

$z_1 = \frac{20 - 16}{1.5}$

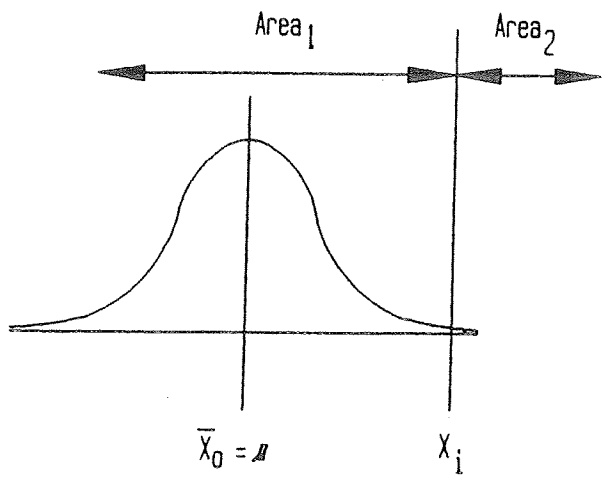
$z_1 = +2.67$

$Area_1 = 0.9962$

$Area_2 = 1.000 - Area_1$

$Area_2 = 1.000 - 0.9962$

$Area_2 = 0.0038$ or 0.38%



46c $\text{Area}_1 = 0.0228$

$$z_2 = \frac{x_i - \mu}{\sigma}$$

$$z_2 = \frac{20.5 - 16}{1.5}$$

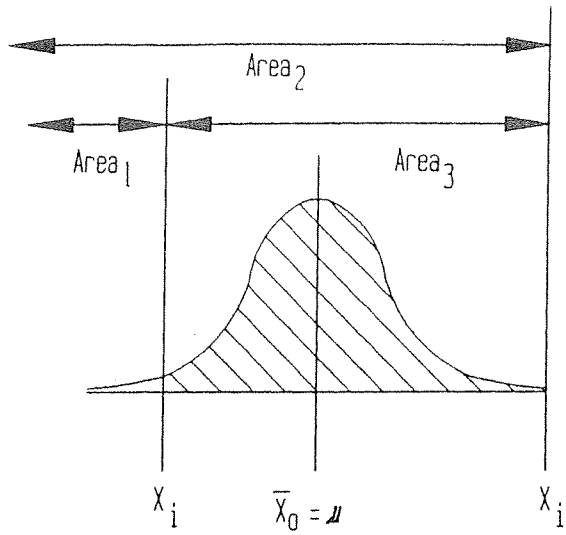
$$z_2 = +3.00$$

$\text{Area}_2 = 0.99865$

$\text{Area}_3 = \text{Area}_2 - \text{Area}_1$

$\text{Area}_3 = 0.99865 - 0.0228$

$\text{Area}_3 = 0.9759$ or 97.59%



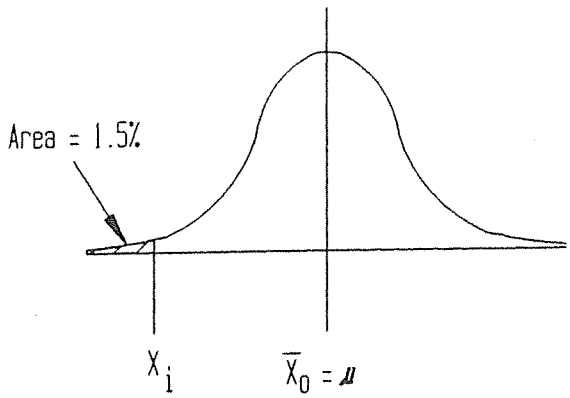
47. From Table A

For 1.5%, $z_1 = -2.17$

$$z_1 = \frac{x_i - \mu}{\sigma}$$

$$-2.17 = \frac{0.567 - \bar{x}_o}{0.018}$$

$\bar{x}_o = .606$ g

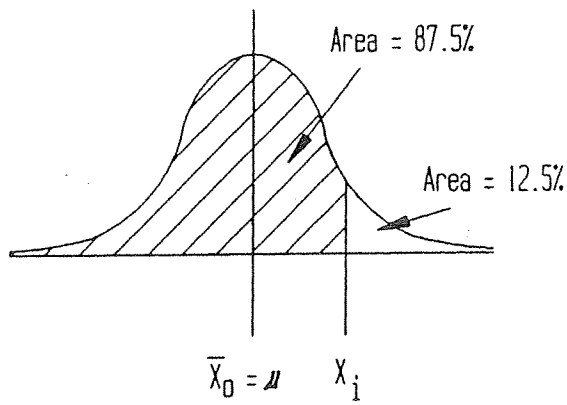


48. If rework % is 12.5%, Area to the left is 87.5% and has a Z value of +1.15.

$$z_1 = \frac{x_i - \mu}{\sigma}$$

$$1.15 = \frac{25.38 - \bar{x}_o}{0.01}$$

$\bar{x}_o = 25.37$ mm



49a Not normal

49b Normal

49c Not normal

49d Not normal, but symmetrical

49e Not normal, but symmetrical

49f Not normal, but symmetrical