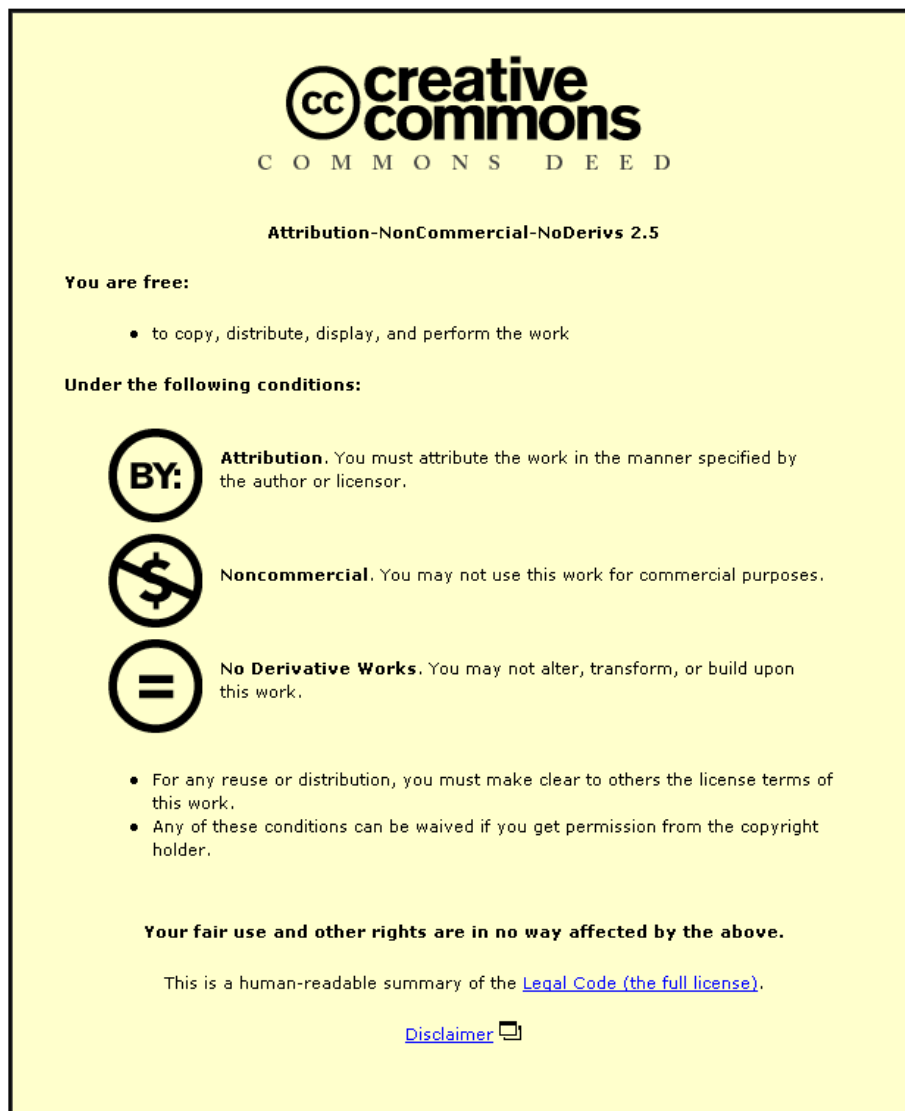


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AN INVESTIGATION OF METHODS-TIME MEASUREMENT SYSTEMS  
FOR WORK MEASUREMENT APPLICATION

by

Kenneth Knott

A Doctoral Thesis

VOLUME II

APPENDIX A TO APPENDIX V

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APPENDIX A: FURTHER ANALYSIS ON THE REPRODUCIBILITY  
OF MTM-1 DATA BY WHITE (1950)

Note: As a result of research carried out by Raphael (1952, 1953, 1954, 1955, 1956, 1957) some minor adjustments were made to the original MTM data card published by Maynard et al. (1948). Since this data was in use at the time White carried out his research, the original data will be used in this Appendix.

The data for check studies on R-B and M-C have been extracted from White's report (1950) and are reproduced in Figures A-1 and A-3 respectively. The MTM data card values are also reproduced in these tables as appropriate. A single factor analysis of variance was carried out on the data in each of these tables and the ANOVA tableaux are given as Figures A-2 and A-4. The null hypothesis in these analyses was that there was no significant difference between the original data and that developed by White (1950). Clearly this was substantiated, justifying the claim that the MTM data was reproducible.

White (1950) carried out a further comparison of the original and reproduced data. This comparison consisted of determining a percentage difference between the two items of data, such that:

$$\% \text{ Difference} = \frac{\text{MTM Data Card TMU} - \text{Check Study TMU}}{\text{Data Card TMU}} \times 100$$

This comparison was restricted to a certain distance range and no mention was made of R-D. The distance range is quoted as 5" to 30" and 8" to 30", so it is not possible to be sure which is the correct range. It can be assumed, however, that R-D was not excluded but was implicit in the R-C values. The comparison is only given in the form of a histogram and is shown here as Figure A-6. The values given in Figure A-4 have been estimated from this figure.

A calculation will show that this data has a standard deviation of 26.24, which sets a confidence interval of  $\pm 4.27\%$  of the mean.

Figure A-1: Comparison of Elemental Motion Times from a Check Study for R-B: Extracted from Table I of White's Data (1950)

Distance (Inches)	Check Study (TMU)	MTM Data Card (TMU)
1	1.9	2.1
2	3.9	4.3
3	5.4	5.9
4	6.6	7.1
5	7.6	7.8
6	8.5	8.6
7	9.3	9.3
8	10.1	10.1
9	10.8	10.8
10	11.6	11.6
12	13.0	12.9
14	14.5	14.4
16	16.0	15.8
18	17.5	17.2
20	19.0	18.6
22	20.5	20.1
24	22.0	21.5
26	23.5	22.9
28	24.9	24.4
30	26.4	25.8

Figure A-2: Single Factor Analysis of Variance of Data given in Table A-1: ANOVA Tableau

Source	d.f.	S.S.	M.S	Fexp.
Between Error	1 38	0.081 1932.798	0.81 50.86	Not Sig
Total	39	1932.879		

Figure A-3: Comparison of Elemental Motion Times from a Check Study for M-C: Extracted from Table II of White's Data (1950)

Distance (Inches)	Check Study (TMU)	MTM Data Card (TMU)
1	2.2	1.7
2	4.1	4.2
3	5.6	5.7
4	6.9	7.3
5	8.1	8.7
6	9.1	9.7
7	10.1	10.8
8	11.0	11.8
9	12.0	12.7
10	12.9	13.5
12	14.7	15.2
14	16.6	16.8
16	18.5	18.7
18	20.3	20.4
20	22.2	22.1
22	24.1	23.8
24	26.0	25.5
26	27.9	27.3
28	29.7	29.0
30	31.6	30.7

Figure A-4: Single Factor Analysis of Variance of Data given in Table A-3: ANOVA Tableau

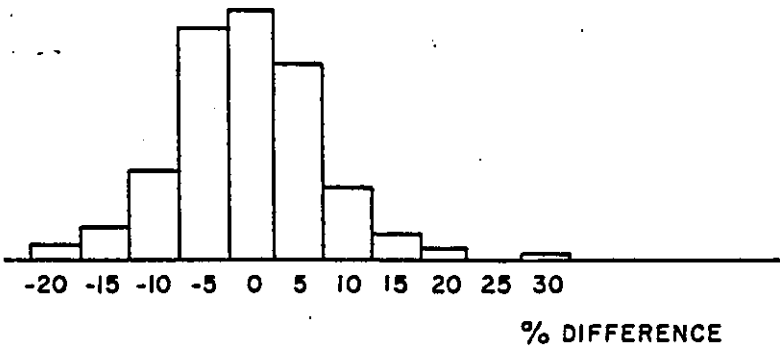
Source	d.f.	S.S.	M.S.	Fexp.
Between	1	0.1	0.1	Not Sig.
Error	38	2928.264	77.06	
Total	39	2928.364		

Further, this sample data shows a bias of 0.77%, ie. the reproduced data was less than 1% tight.

Figure A-5: Estimated Frequency of Percentage Difference in Time for Reaches and Moves: Based on Data by White (1950)

% Difference d	Frequency f
-20	2
-15	5
-10	14
-5	36
0	38
5	30
10	11
15	4
20	2
25	0
30	1
Total Observations	145

Figure A-6: Histogram of Percentage Differences in Times for Reaches and Moves by White (1950)



APPENDIX B: AN ANALYSIS OF THE ANALYTIC APPROACH TO DETERMINING  
THE SYSTEM VARIANCE OF THE BASIC MANUAL MOTION REACH

The whereabouts of the original research data for the MTM-1 system has not been known for a number of years and the variance of the data card values was not determined at the time of the original research. In an attempt to fill this gap, Hancock (1970) proposed an analytic approach which has since been used either in its original or some modified form by a number of other authors, the most notable of whom is Brinkloe (1975, 1975, 1975, 1978, 1979, 1979).

This approach has formed the basis of such a methodology of application of the MTM systems that it is discussed in detail in the body of this thesis. This appendix provides the theoretical basis to the discussion.

While the same reasoning given here can be extended to all of the MTM-1 motions, for the sake of brevity, the analysis presented here will be restricted to the Basic Manual Motion Reach.

#### B.1.0 ELEMENTS OF VARIANCE IN TIME DATA SYSTEMS

Two principal components can be recognized in making up the total variance of a PMTS. These are:

1. The Applicator Variance. This is attributable to the errors made by the person carrying out the MTM analysis in establishing distances, weights and cases incorrectly; in reading values from the data card incorrectly, etc.
2. The System Variance. This is due to the distribution of the actual time values around the data card value and to the limited number of choices offered by the data card.

Thus:

$$\sigma_{\text{TOTAL}}^2 = \sigma_{\text{SYSTEM}}^2 + \sigma_{\text{APPLIC.}}^2 \quad (\text{Eq. B-1})$$

Where:

$\sigma_{\text{TOTAL}}^2$  = Total Variance

$\sigma_{\text{SYSTEM}}^2$  = System Variance

$\sigma_{\text{APPLIC.}}^2$  = Applicator Variance

Only the system variance will be considered here.

#### B.2.0 ANALYTIC DETERMINATION OF THE VARIANCE OF REACH

The system variance for the Basic Manual Motion Reach also has two components, as follows:

1. The variance due to Distance.
2. The variance due to Case.

The MTM-1 data card values for Type I Reaches and their associated curves are shown in Figure B-1. The identification of the two components of variance will be developed referring to the data in this Figure.

The data card values were selected, in some convenient way, from a continuous distance/time relationship and tabulated in the form shown. Again, presumably as a matter of convenience, Hancock (1970) chose to consider these curves as a step function, where the steps were between two neighbouring data card values. To illustrate this point, consider the motion R3B. The relative values of R2B, R3B and R4B are shown in Figure B-2. Hancock then assumed that all the values in the range are equally likely, and therefore that the distribution must be rectangular, with the midpoint of the range being the mean.

It can be shown that in such a case, if

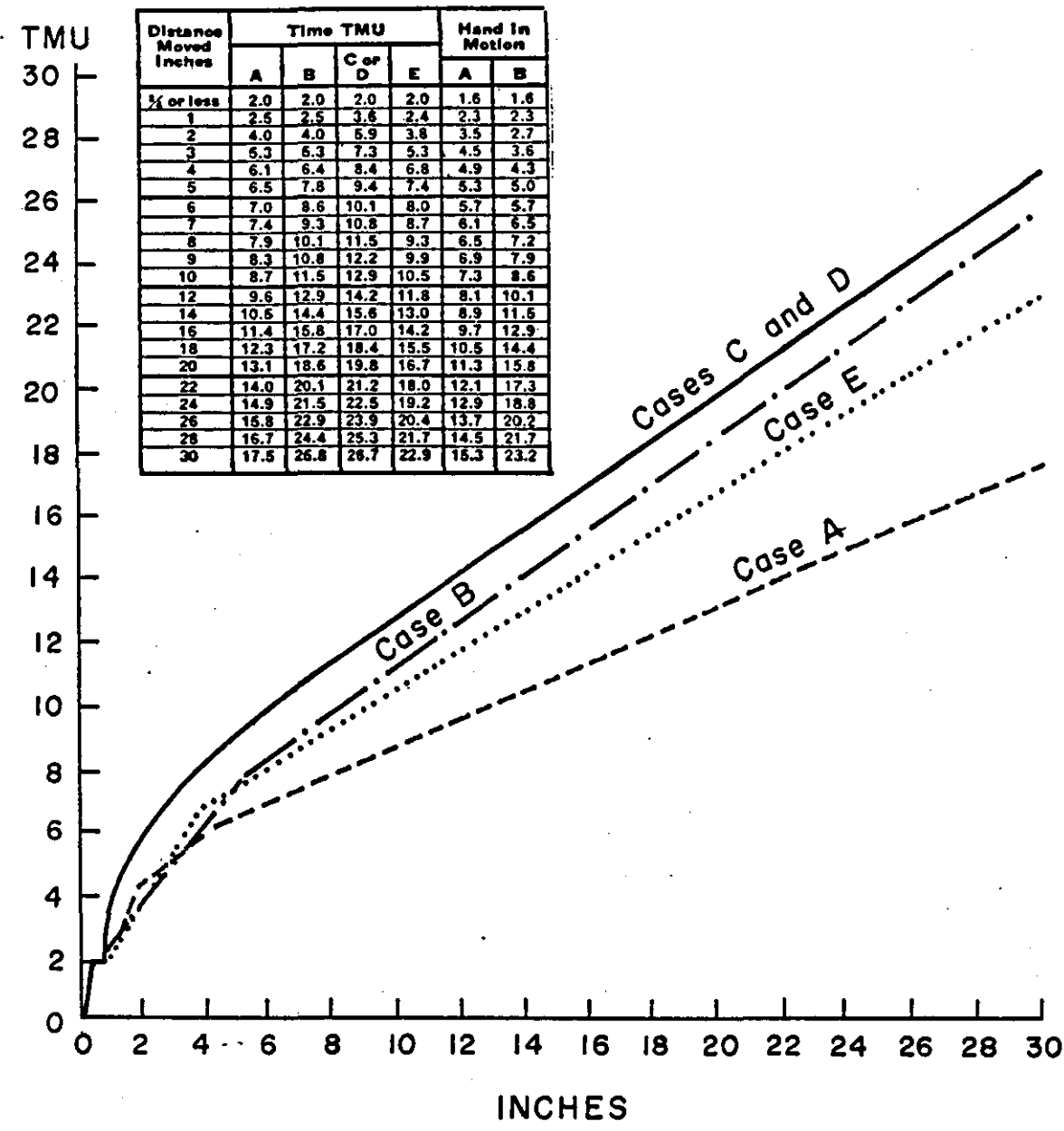
a = lower time value of the range

b = upper time value of the range

h = b - a

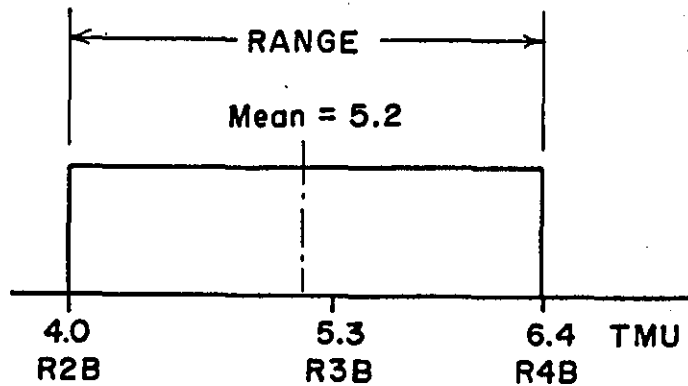
$\sigma_x^2$  = variance about the midpoint

Figure B-1: Data Card Values and Curves for Type I  
Basic Manual Motion Reach



$$\sigma^2_x = \int_{-\frac{h}{2}}^{\frac{h}{2}} x^2 f(x) dx = \frac{h^2}{12} \quad (\text{Eq. B-2})$$

Figure B-2: Distribution Associated with the Distance Variable for R3B: Hancock (1970)

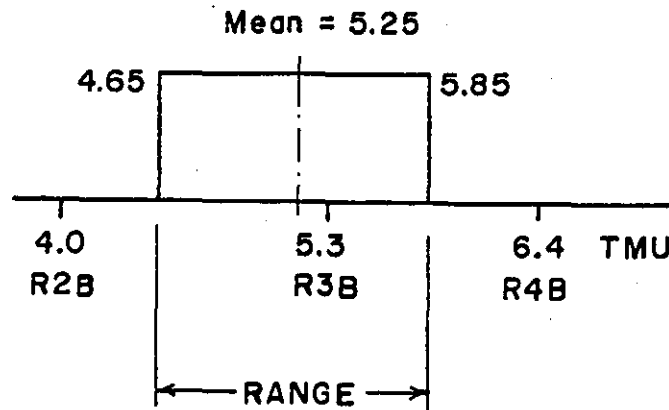


The variance calculated about this assumed mean, based upon Eq. B-2 would be:

$$\text{Variance} = \frac{[\frac{1}{2}(6.4 - 4.0)]^2}{12} = 0.120$$

Brinkloe (1975), while accepting the general principle proposed by Hancock (1970) adapted a slightly different approach in two ways. The first is in the method used to establish the range as illustrated in Figure B-3. Here the limits for the range are set half way between the data value and its neighboring value:

Figure B-3: Distribution Associated with the Distance Variable for R3B: Brinkloe (1975)



Brinkloe (1975) differed from Hancock (1970) in one other respect, in that Brinkloe considered the effect of the off-set of the data card values from the mid-point of the range of the distribution. To do this, a generalized form of Eq. B-2 has to be used.

Consider  $E(x)$  to be some value about which the variance of the distribution is to be determined, where

$$a \leq E(x) \leq b \quad (\text{Eq. B-3})$$

further;

$$E(x) - a = ph \quad (\text{Eq. B-4})$$

$$b - E(x) = h - ph \quad (\text{Eq. B-5})$$

then if

$\sigma^2$  = variance of the distribution in the generalized case

$$\sigma^2 = \int_{-ph}^{h-ph} x^2 \cdot f(x) dx = \frac{h^2}{3} \left[ 3p^2 - p + 1 \right] \quad (\text{Eq. B-5})$$

Values of variance for all data card Reach values, calculated according to Hancock (1970) are given in Figure B-4. Similar data developed based on the modified approach by Brinkloe (1970) are given in Figure B-5.

A comparison of these two sets of data shows that the modified approach proposed by Brinkloe (1975) has only a minor effect.

### B.3.0 DETERMINING THE VARIANCE OF REACH DUE TO ITS CASE

In determining the variance due to the case of Reach, both Hancock (1970) and Brinloe (1975) used basically the same approach as they did in variance component due to the distance. Both assume a uniform distribution but differ in the manner in which they determine the value of the range.

The way in which each of these authors ranked the cases so that the range could be calculated is open to some question, however. In ascending order, the ranking they used was as follows:

R-A; R-E; R-B; R-C/D

It can only be assumed that the reasoning behind this is that the ranking is based upon their ascending values of their data card times, which can be seen by referring to the data card values in Figure B-1. For example:

R6A < R6E < R6B < R6C/D

7.0 < 8.0 < 8/6 < 10.1

Figure B-4: Variance Component of the Basic Manual Motion Reach due to Distance Based upon Hancock (1970)

Distance	R-A		R-B		R-C/D		R-E	
	TMU	VAR	TMU	VAR	TMU	VAR	TMU	VAR
f	2.0	.021	2.0	.021	2.0	.213	2.0	.013
1	2.5	.083	2.5	.083	3.6	.317	2.4	.068
2	4.0	.163	4.0	.163	5.9	.285	3.8	.175
3	5.3	.092	5.3	.120	7.3	.130	5.3	.188
4	6.1	.030	6.4	.130	8.4	.092	6.8	.092
5	6.5	.017	7.8	.101	9.4	.060	7.4	.030
6	7.0	.017	8.6	.083	10.1	.041	8.0	.035
7	7.4	.017	9.3	.047	10.8	.041	8.7	.035
8	7.9	.017	10.1	.047	11.5	.041	9.3	.030
9	8.3	.013	10.8	.041	12.2	.041	9.9	.030
10	8.7	.035	11.5	.092	12.9	.083	10.5	.075
12	9.6	.068	12.9	.175	14.2	.152	11.8	.130
14	10.5	.068	14.4	.175	15.6	.163	13.0	.120
16	11.4	.068	15.8	.163	17.0	.163	14.2	.130
18	12.3	.060	17.2	.163	18.4	.163	15.5	.130
20	13.1	.060	18.6	.175	19.8	.163	16.7	.130
22	14.0	.068	20.1	.175	21.2	.152	18.0	.130
24	14.9	.068	21.5	.163	22.5	.152	19.2	.120
26	15.8	.068	22.9	.175	23.9	.163	20.4	.130
28	16.7	.060	24.4	.175	25.3	.163	21.7	.130
30	17.5	.053	25.8	.163	26.7	.163	22.9	.130

Figure B-5: Variance Component of the Basic Manual Motion Reach due to the Distance Based upon Brinkloe (1975)

DISTANCE (Inches)	CASE A				CASE B				CASE C/D				CASE E			
	DATA CARD	RANGE		VAR	DATA CARD	RANGE		VAR	DATA CARD	RANGE		VAR	DATA CARD	RANGE		VAR
		LOW	HIGH			LOW	HIGH			LOW	HIGH			LOW	HIGH	
f	2.0	1.75	2.25	.021	2.0	1.75	2.25	.021	2.0	1.20	2.80	.213	2.0	1.80	2.20	.013
1	2.5	2.25	3.25	.146	2.5	2.25	3.25	.146	3.6	2.80	4.75	.347	2.4	2.20	3.10	.130
2	4.0	3.25	4.65	.166	4.0	3.25	4.65	.166	5.9	4.75	6.60	.336	3.8	3.10	4.55	.176
3	5.3	4.65	5.70	.107	5.3	4.65	5.85	.122	7.3	6.60	7.85	.136	5.3	4.55	6.05	.187
4	6.1	5.70	6.30	.040	6.4	5.85	7.10	.136	8.4	7.85	8.90	.092	6.8	6.05	7.10	.142
5	6.5	6.30	6.75	.017	7.8	7.10	8.20	.123	9.4	8.90	9.75	.066	7.4	7.10	7.70	.030
6	7.0	6.75	7.20	.017	8.6	8.20	8.95	.047	10.1	9.75	10.45	.041	8.0	7.70	8.35	.036
7	7.4	7.20	7.65	.017	9.3	8.95	9.70	.047	10.8	10.45	11.15	.041	8.7	8.35	9.00	.036
8	7.9	7.65	8.10	.017	10.1	9.70	10.45	.047	11.5	11.15	11.85	.041	9.3	9.00	9.60	.030
9	8.3	8.10	8.50	.013	10.8	10.45	11.15	.041	12.2	11.85	12.55	.041	9.9	9.60	10.20	.030
10	8.7	8.50	9.15	.051	11.5	11.15	12.20	.122	12.9	12.55	13.55	.106	10.5	10.20	11.15	.106
12	9.6	9.15	10.05	.067	12.9	12.20	13.65	.176	14.2	13.55	14.90	.152	11.8	11.15	12.40	.131
14	10.5	10.05	10.95	.067	14.4	13.65	15.10	.176	15.6	14.90	16.30	.163	13.0	12.40	13.60	.120
16	11.4	10.95	11.85	.067	15.8	15.10	16.50	.163	17.0	16.30	17.70	.163	14.2	13.60	14.85	.131
18	12.3	11.85	12.85	.086	17.2	16.50	17.90	.163	18.4	17.70	19.10	.163	15.5	14.85	16.10	.131
20	13.1	12.85	13.70	.076	18.6	17.90	19.35	.176	19.8	19.10	20.50	.163	16.7	16.10	17.35	.131
22	14.0	13.70	14.45	.052	20.1	19.35	20.80	.176	21.2	20.50	21.85	.152	18.0	17.35	18.60	.131
24	14.9	14.45	15.35	.067	21.5	20.80	22.20	.163	22.5	21.85	23.20	.152	19.2	18.60	19.80	.120
26	15.8	15.35	16.25	.067	22.9	22.20	23.65	.176	23.9	23.20	24.60	.163	20.4	19.80	21.05	.131
28	16.7	16.25	17.10	.061	24.4	23.65	25.10	.176	25.3	24.60	26.00	.163	21.7	21.05	22.30	.131
30	17.5	17.10	17.90	.053	25.8	25.10	26.50	.1633	26.7	26.00	27.40	.163	22.9	22.30	23.50	.1200

The nature of the different cases of the motion, it could be argued, are reflected in its control characteristics. This basis of classification would appear to be a far more logical basis for ranking the cases of Reach.

An algorithm which is widely used to determine the case of Reach is shown in Figure B-6, which is a simplification of that which was published by the MTM Association for Standards and Research (1970). The first question in this algorithm establishes very clearly that R-E has a completely different character. Since the purpose of the motion is not to gain control of an object the hand will normally be moving away from the object, or will be limited out by some other motion or action. It can, therefore, be argued that there is little possibility of confusion of R-E with other cases; thus, the case component of variance due to R-E is unlikely to exist. It is therefore proposed that the ranking of cases should be:

R-A; R-B; R-C/D

Figure B-6: Algorithm for Determining the Case of Reach

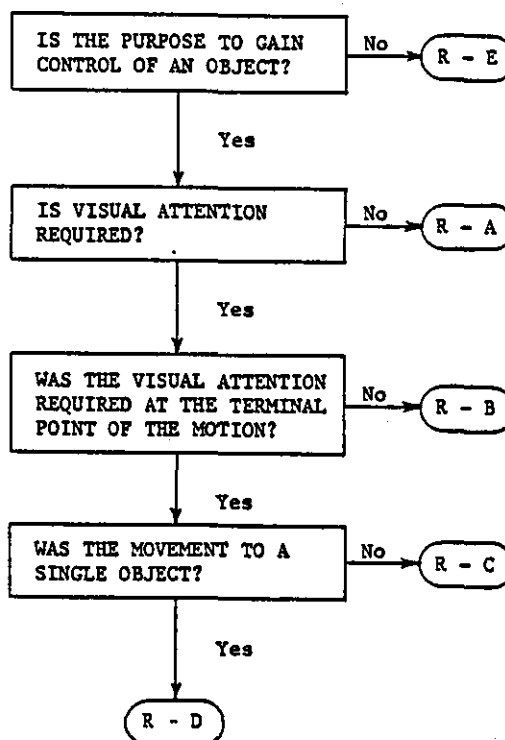


Figure B-7 has been derived based upon this ranking of the case of Reach. The same basis was used to compute the variance as before, the range of R-B being the halfway distance between the neighbouring cases. The range of R-A and R-C/D is assumed to be symmetric about the data card value. This method differs from those used by Hancock (1970) and Brinkloe (1975); however, it can be argued that it has a more logical basis.

#### B.4.0 DETERMINING THE TOTAL VARIANCE OF THE REACH MOTION

In accordance with Equation B-1, the total variance of the Reach motion is the sum of the variances of the two components, which appear in Figures B-4 and B-5. The total variance, in Figure B-8 has been computed in this way.

Comparison of data in Figure B-8 shows clearly that the principal source of variance of the Basic Manual Motion Reach is its case, a result which would surprise all except the most knowledgeable of the MTM practitioners. To emphasize the relationship between the distance of the motion and the cases of Reach, Figure B-9 has been constructed from the total variance values in Figure B-8.

#### B.5.0 THE "AVERAGE VARIANCE" OF THE REACH MOTION

In view of the extensive writing on this topic by both Hancock (1970, 1973, 1974) and Brinkloe (1975, 1975, 1975, 1978, 1979, 1979) it is surprising that neither author considered it important to bring this relationship to the attention of the readers. It must be assumed that both were either knowledgeable enough in the area of PMTS or thorough enough in their analysis to be aware of it, since both used an "Average Variance" for all values of Reach.

Hancock (1970) was responsible for this idea which was readily followed by Brinkloe. This dependence of the variance of Reach, and Move, upon the distance was accommodated in Hancock's (1970) calculator by "... averaging long and short distance values".

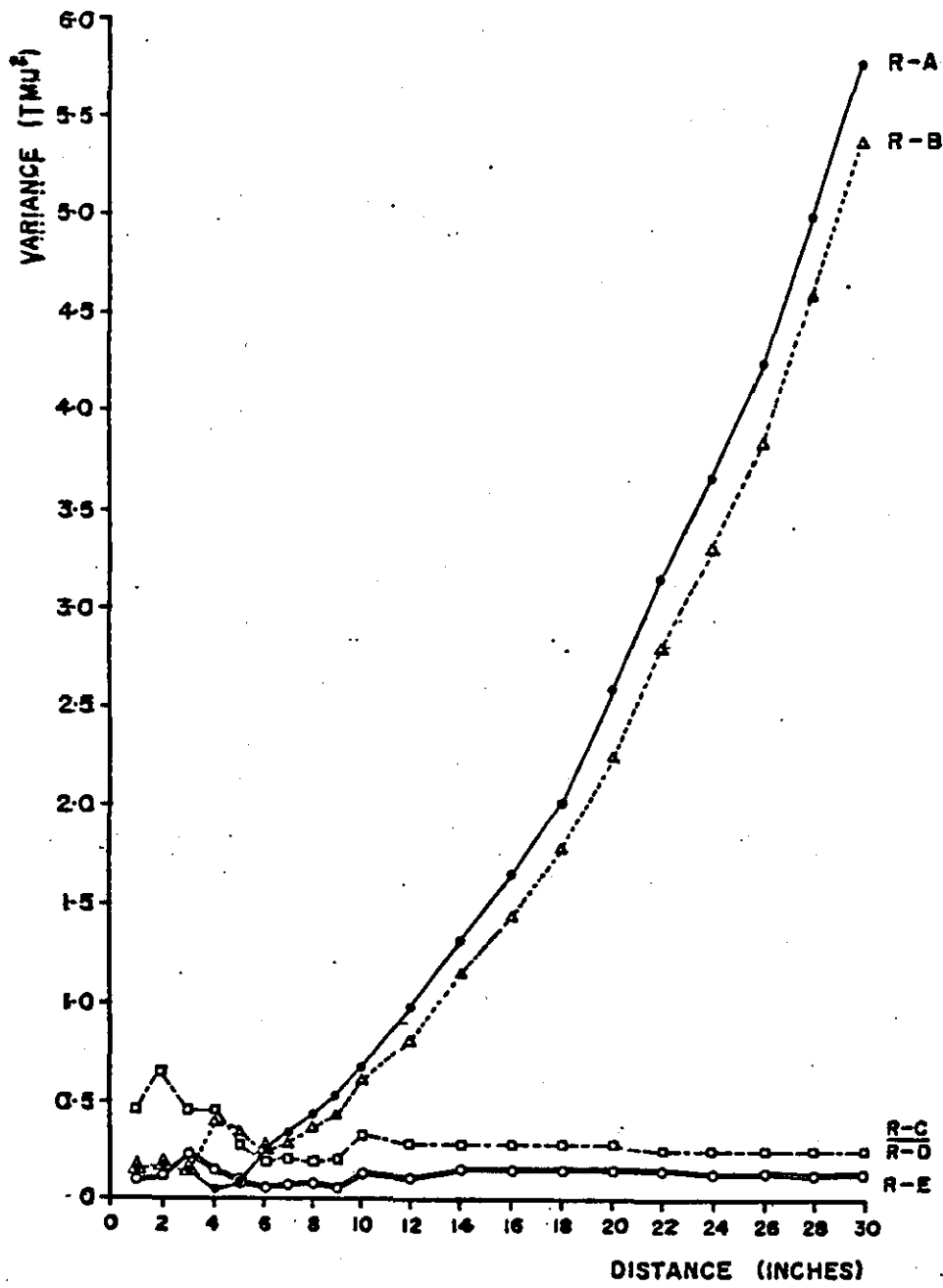
DISTANCE (Inches)	CASE A				CASE B				CASE C/D				CASE E			
	DATA CARD	RANGE		VAR	DATA CARD	RANGE		VAR	DATA CARD	RANGE		VAR	DATA CARD	RANGE		VAR
		LOW	HIGH			LOW	HIGH			LOW	HIGH			LOW	HIGH	
1	2.0	-	-	-	2.0	-	-	-	2.0	-	-	-	2.0	-	-	
1	2.5	-	-	-	2.5	-	3.05	-	3.6	3.05	4.15	.101	2.4			
2	4.0	-	-	-	4.0	-	4.95	-	5.9	4.95	6.85	.301	3.8			
3	5.3	-	-	-	5.3	-	6.30	-	7.3	6.30	8.30	.333	5.3			
4	6.1	5.95	6.25	.008	6.4	6.25	7.40	.291	8.4	7.40	9.40	.333	6.8			
5	6.5	6.10	6.90	.053	7.8	6.90	8.60	.243	9.4	8.60	10.20	.213	7.4			
6	7.0	6.2	7.80	.213	8.6	7.80	9.35	.201	10.1	9.35	10.85	.187	8.0			
7	7.4	6.45	8.35	.300	9.3	8.35	10.05	.251	10.8	10.05	11.55	.187	8.7			
8	7.9	6.80	9.00	.403	10.1	9.00	10.80	.310	11.5	10.80	12.2	.163	9.3			
9	8.3	7.05	9.55	.521	10.8	9.55	11.50	.392	12.2	11.50	12.9	.163	9.9			
10	8.7	7.3	10.10	.653	11.5	10.10	12.00	.503	12.9	12.00	13.00	.243	10.5	APPLICABLE	APPLICABLE	APPLICABLE
12	9.6	7.95	11.25	.907	12.9	11.25	13.55	.691	14.2	13.55	14.85	.141	11.8	NOT	NOT	NOT
14	10.5	8.55	12.45	1.267	14.4	12.45	15.00	.997	15.6	15.00	16.20	.120	13.0			
16	11.4	9.2	13.60	1.613	15.8	13.60	16.40	1.293	17.0	16.40	17.60	.120	14.2			
18	12.3	9.85	14.75	2.001	17.2	14.75	17.80	1.631	18.4	17.80	19.00	.120	15.5			
20	13.1	10.35	15.85	2.521	18.6	15.85	19.20	2.091	19.8	19.20	20.40	.120	16.7			
22	14.0	10.95	17.05	3.101	20.1	17.05	20.65	2.642	21.2	20.65	21.75	.101	18.0			
24	14.9	11.60	18.20	3.630	21.5	18.20	22.00	3.163	22.5	22.00	23.00	.083	19.2			
26	15.8	12.25	19.35	4.201	22.9	19.35	23.40	3.692	23.9	23.40	24.40	.070	20.4			
28	16.7	12.85	20.55	4.941	24.4	20.55	24.85	4.431	25.3	24.85	25.75	.067	21.7			
30	17.5	13.35	21.65	5.741	25.8	21.65	26.25	5.186	26.7	26.25	27.15	.067	22.9			

Figure B-7: Variance Component on the Basic Manual Motion Reach due to the Case

Figure B-8: Total Variance of the Basic Manual Motion Reach

DISTANCE (Inches)	CASE A			CASE B			CASE C/D			CASE E		
	CASE	DIS- TANCE	TOTAL	CASE	DIS- TANCE	TOTAL	CASE	DIS- TANCE	TOTAL	CASE	DIS- TANCE	TOTAL
F	-	.021	.021	-	.021	.021	-	.213	.213	-	.013	.013
1	-	.146	.146	-	.146	.146	.101	.347	.448	-	.130	.130
2	-	.166	.166	-	.166	.166	.301	.336	.637	-	.176	.176
3	-	.107	.107	-	.122	.122	.333	.136	.469	-	.187	.187
4	.008	.040	.048	.291	.136	.427	.333	.092	.425	-	.142	.142
5	.053	.017	.070	.243	.123	.366	.213	.066	.279	-	.030	.030
6	.213	.017	.230	.201	.047	.248	.187	.041	.228	-	.036	.036
7	.300	.017	.317	.251	.047	.298	.187	.041	.228	-	.036	.036
8	.403	.017	.420	.310	.047	.357	.163	.041	.204	-	.030	.030
9	.521	.013	.534	.392	.041	.433	.163	.041	.204	-	.030	.030
10	.653	.051	.674	.503	.122	.625	.243	.106	.349	-	.106	.106
12	.907	.067	.974	.691	.176	.867	.141	.152	.293	-	.131	.131
14	1.267	.067	1.334	.997	.176	1.173	.120	.163	.283	-	.120	.120
16	1.613	.067	1.680	1.293	.163	1.456	.120	.163	.283	-	.131	.131
18	2.001	.086	2.087	1.631	.163	1.794	.120	.163	.283	-	.131	.131
20	2.521	.076	2.597	2.091	.176	2.267	.120	.163	.283	-	.131	.131
22	3.101	.052	3.153	2.642	.176	2.818	.101	.152	.253	-	.131	.131
24	3.630	.067	3.697	3.163	.163	3.326	.083	.152	.235	-	.120	.120
26	4.201	.067	4.268	3.692	.176	3.868	.070	.163	.233	-	.131	.131
28	4.941	.061	5.002	4.431	.176	4.607	.067	.163	.230	-	.131	.131
30	5.741	.053	5.794	5.186	.163	5.349	.067	.163	.230	-	.120	.120

Figure B-9: Curves of Total Variance for the Basic Manual Motion Reach



The motions used for this averaging in the Basic Manual Motion Reach were R3B, R3C, R26B and R26C. - (For the Basic Manual Motion Move, the values used were M3B5, M3C5, M26B40 and M26C40.)

Examination of the curves shown in Figure B-9 makes this averaging process suspect due to the wide variation of the values. It seems incomprehensible that neither Hancock, Brinkloe nor other students of the MTM systems paid serious attention to this when developing accuracy concepts for MTM based data systems.

APPENDIX C: MTM-1, MTM-2 and MTM-3 ANALYSIS OF BASIC  
FIELD DATA WORK TASKS

This Appendix contains the MTM-1 and MTM-2 analyses of the work tasks which have been classified as Basic Field Data. The work station layouts of these tasks are also shown.

## METHODS ANALYSIS

Title: GRIND BALANCE STAFF AND PIN ASSEMBLY- Ref. No. P01/1  
LOAD PART TO MACHINE Sheet No. 1 of 2 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM -1 6.980 MTM -2 7.800 MTM -3 9.800 C-M 47.4

Description	No.	LH	TMU	RH	No.	Description
DD-LOAD COMPONENT INTO MACHINE			(MTM-1)			
From RH and orientate.		G3 G2	6.4	M4B	6	Tweeze to next pc. and search
			17.4	MLB		
			2.0	Mfc		Locate part
			14.7	PISSD		
			2.0	MFA		Close tweezers To LH
			12.2	M10B		
			5.6	MFA	2	Open tweezers
			5.6			
			14.7	PISSD		Take with tweezers
			2.0	MFA		
Part		RL1	2.0			
		R2A	4.0			
Open ejector		G1A	2.0			
		MFA	2.0			
Spindle lever		RL1 R2A G1A	5.2	M2C	2	Part to chuck
			26.6	P2NSD		
			2.0	RL1		Tweezers
			11.2	G2		
				R2A		Spring to back
			2.0	G1A		
			2.0	MFA		Wheels lever
			2.0	RL1		
			7.9	R8A		After el 2
			2.0	G1A		
			2.0	RL1		
		TOTAL	139.6			

Ref. No. P01/1Sheet 2 of 2 Sheets

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
DE-LOAD COMPONENT INTO MACHINE (MTM-2)						
From RH and orientate		GB5 R	6	PA15	6	} locate part P.U. with tweezers To LH
			18	PA5		
			21	PC5		
			3	PA5		
			11	PA30		
			7			
Open ejector		GB5 PA5	6		2	Take part with tweezers  Part to chuck Tweezers Spring back Wheel lever
			21	PC5		
			3	PA5		
			7			
			3			
			21	PC5		
		GB5	12	R		
			3	GB5		
			14	PA5		
				GB30		
		TOTAL	156			
DF-LOAD COMPONENT INTO MACHINE (MTM-3)						
From RH: Orientate		HA15	7	TA15	6	Locate par  Pick up with tweezers To LH
			42	TA15		
			21	TB15		
			7	TA15		
			16	TA80		
			18			
Open ejector		HA15	7	TA15		Take part with tweezer  Part to chuck Spring back
			21	TB15		
			18			
			21	TB15		
			18	HA15		
		TOTAL	196			

## METHODS ANALYSIS

Title: MILL SLOT IN PAWL: UNLOAD SIX PAWLS  
FROM THE MACHINE

Ref. No. P01/3

Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 2.520 MTM-2 2.750 MTM-3 3.450 C-M 11.2

Description	No.	LH	TMU	RH	No.	Description
DA: UNLOAD PIN FROM MACHINE (MTM-1)						
Eject finished part		M-A RL2	7.9	R8A	}	Open clamp
			2.0	G1A		
			2.0	MfA		
			2.0	RL1		
			5.6	G2	}	Tweezers To component Grasp with tweezers To catch pan Open tweezers
				<del>M2C</del>		
			14.7	P1SSD		
			2.0	MfA		
			12.2	M10B		
			2.0	MfA		
TOTAL		50.4				
DB: UNLOAD PIN FROM MACHINE (MTM-2)						
Eject finished part		PA-	14	GB30	}	Open clamp
			3	PA5		
			26	PC15	}	Component with tweezers To catch pan Release
			9	<del>K</del>		
				PA30		
			3	PA5		
			TOTAL			
DC: UNLOAD PIN FROM MACHINE (MTM-3)						
Eject finished part		HA-	18	HA15	}	Open clamp Tweezers to part Close tweezers to catch pan release part
			21	TB15		
			7	TA15		
			16	TA80		
			7	TA15		
			TOTAL			

METHODS ANALYSIS

Title: COUNTERBORE AND CHAMFER HAIRSPRING  
TIMER TUBE - UNLOAD HAIRSPRING TUBE  
FROM MACHINE

Ref. No. P06/1  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 3.215 MTM-2 3.050 MTM-3 3.500 C-M 11.5

Description	No.	LH	TMU	RH	No.	Description			
DY: UNLOAD PART (MTM-1)									
Stop machine	{	R4A	6.1	R-		To work area			
		G5	-						
Open chuck	{	M2B	4.6					Remove from Chuck Aside to pan	
		RL2	-						
		R12A	9.6						
		G5	-						
		M3A	4.9						
			11.5						
			2.0						
			3.6						
		20.6	R10B						
		2.0	G1A						
			M2A						
			M24B						
			RL1						
		TOTAL	64.9						
DZ: UNLOAD PART (MTM-2)									
Stop machine	{	GA15	6	G-		Work area			
		PA5	3						
Open chuck	{	GA30	9					Remove from chuck and aside	
		PA15	6						
			14						
			3						
			20						
		TOTAL	61						
EA: UNLOAD PART (MTM-3)									
Stop machine		HA15	18	HA15 TA80		Remove from chuck Aside			
		HA15	18						
Open chuck			18						
			16						
		TOTAL	70						

## METHODS ANALYSIS

Title: COUNTERBORE AND CHAMFER HAIRSPRING  
TIMER TUBE - UNLOAD HAIRSPRING TUBE  
 FROM MACHINE

Ref. No. P06/2  
 Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 5.890 MTM-2 6.100 MTM-3 4.000 C-M 16.9

Description	No.	LH	TMU	RH	No.	Description
<u>EB: LOAD PART INTO THE MACHINE (MTM-1)</u>						
			17.0	R16C		P.U. part
			9.1	G4B		
			18.7	M16C		Into machine
			19.7	P2SSE		
			2.5	M1A		Seat
			10.6	AP2		
			-	RL2		Clear from work area
Close chuck and seat		M3A	4.9	R-E		
		AP2	10.6			
		RL2A	9.6			
		GLA	2.0			
Start machine		D1E	7.5			
		M2A	3.6			
		RL1	2.0			
		TOTAL	117.8			
<u>ED: LOAD PART INTO MACHINE (MTM-2)</u>						
			27	GC45		Dart into chuck
			36	PC45		
			3	PA5		
			14	A		
Close chuck		PA15	6	G-		
		A	14			
		GB30	14			
Start machine		GW5	5			
		PA5	3			
		TOTAL	122			
<u>EE: LOAD PART INTO THE MACHINE (MTM-3)</u>						
			48	HB80		Part into machine Insert
			7	TA15		
Close chuck		TA15	7			
Start machine		HA15	18			
		TOTAL	80			

## METHODS ANALYSIS

Title: ASSEMBLE AND PRESS: PLATE AND SPACERRef. No. P07/1ASSEMBLY - PRESSED PART TO BIN ANDSheet No. 1 of 1 SheetsASSEMBLE THREE PINS

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 8.275 MTM-2 10.050 MTM-3 8.900 C-M 36.6

Description	No.	LH	TMU	RH	No.	Description	
EF: FINISHED PART ASIDE AND ASSEMBLE THREE PINS (MTM-7)							
P.U. (3) Pins	2	R8C	11.5	R10A	3	Remove from fixture and aside	
Pins to Work area		G4B	9.1	G1A			
		M4B	13.4	M12B			
(1) Pin forward			2.0	RL1			
		G2	9.6	R12A		To pin	
(1) Pin forward			16.8	G3		Pin from LH	
			28.2	M5C		Pin to fixture	
			65.4	P2SD			
			6.0	RL1		To next pin	
		G2	6.5	R5A			
		TOTAL	165.5				
EG: FINISHED PART ASIDE AND ASSEMBLE THREE PINS (MTM-2)							
P.U. (3) Pins	2	GC30	23	GB30	3	Finished part aside	
Pins to Work area		PA15	15	PA45			
		R	27	GC45			
Feed (1) pin forward			90	PC30			Pin to fixture
Feed (1) pin forward		R	46	GC30			Pin from LH
		TOTAL	201				
EH: FINISHED PART ASIDE AND ASSEMBLE THREE PINS (MTM-2)							
P.U. (3) Pins		HA15	34	HA80	3	Finished part aside	
			144	HB80			(3) Pins to fixture
		TOTAL	178				

METHODS ANALYSIS

Title: ASSEMBLE AND PRESS: PLATE AND SPACER  
ASSEMBLY - PLATE AND SPACER ASSEMBLY  
INTO POSITION

Ref. No. PO7/2  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 3.245 MTM-2 3.200 MTM-3 3.500 C-M 16.9

Description	No.	LH	TMU	RH	No.	Description
EJ: PLATE AND SPACER ASSEMBLY INTO POSITION (MTM-1)						
P.U. plate and to RH		R5C	9.4	R-		To LH  From LH Orientate  Into fixture
		G4A	7.3			
		M5A	7.3			
		<del>GZ</del>				
			5.6			
			5.6			
			6.7			
			21.0			
			2.0			
		TOTAL	64.9			
EK: PLATE AND SPACER ASSEMBLY INTO POSITION (MTM-2)						
Plate to RH		GC15	19	G- GB5 R PC15		Plate to fixture
		PA15	6			
			7			
			6			
			26			
		TOTAL	64			
EL: PLATE AND SPACER ASSEMBLY INTO POSITION (MTM-3)						
P.U. plate to RH		HA15	18	HA15 HB15		Orientate Plate into fix- ture
			18			
			34			
		TOTAL	70			

# METHODS ANALYSIS

Title: ASSEMBLE AND PRESS PLATE AND SPACER  
ASSEMBLY - POSITION LOWER PLATE AND  
SHAFT ASSEMBLY

Ref. No. P07/3  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 3.915 MTM-2 3.500 MTM-3 3.850 C-M 20.3

Description	No.	LH	TMU	RH	No.	Description
<u>EM: POSITION LOWER PLATE AND SHAFT ASSEMBLY (MTM-1)</u>						
P.U. Plate	}	R4C	8.4		2	To LH Part from LH Orientate  Part into fixture
To RH		G4A	7.3			
		M4A	6.1			
		<del>G2</del>		R-		
			5.6	G3		
			11.2	G2		
			6.7	M3C		
			21.0	P2NSE		
			2.0	RL1		
		TOTAL	78.3			
<u>EN: POSITION PLATE AND LOWER SHAFT ASSEMBLY (MTM-2)</u>						
	}	GC15	19		2	
		PA15	6	G-		
			7	GB5		
			12	R		
			26	PC15		
		TOTAL	70			
<u>EP: POSITION PLATE AND LOWER SHAFT ASSEMBLY (MTM-3)</u>						
P.U. plate to RH		HA15	18			Orientate  Into fixture
			18	HA15		
			7	TA15		
			34	HB15		
		TOTAL	77			

METHODS ANALYSIS

Title: ASSEMBLE AND PRESS: PLATE AND SPACER Ref. No. P07/4  
ASSEMBLY - ASSEMBLE LOCK PIN AND BOTTOM Sheet No. 1 of 2 Sheets  
PLATE

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 6.755 MTM-2 6.850 MTM-3 6.300 C-M 32.4

Description	No.	LH	TMU	RH	No.	Description
ER: ASSEMBLE ROTOR LOCK PIN AND BOTTOM PLATE (MTM-1)						
Bottom Plate		R8C	5.6	G2		Regrasp tweezers
			3.4	M		P.U. Rotor Lock Pin
			25.3	M1C		
			2.0	P2SSD		Close tweezers
			7.3	MfA		Part to fixture
To Right Hand	G4A	4.9	M3C	Open tweezers		
		21.8	P2SD		Palm tweezers	
		2.0	MfA	Part from LH		
		9.7	G2		Part into fixture	
		To help control part	M8A	5.6		G3
6.7	M3C					
Operate	RfA			21.0	P2NSE	
				2.0	RL1	
				11.4	RL6A	
		-	G5			
		10.6	AP2			
TOTAL			135.3			
ES: ASSEMBLE ROTOR LOCK PIN AND BOTTOM PLATE (MTM-2)						
Bottom plate		GB5	6	R		Tweezers
			21	PC5		P.U. Part
			3	PA5		
			7			Part to fixture
			To right hand	PA30		
3	PA5	To fixture				
11					Operate	
7	GB5					
Operate	GA45	26			PC15	
		13	GA45			
		A	A			
		14				
		TOTAL			137	

Ref. No. P07/4

Sheet 2 of 2 Sheets

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND	
ET: ASSEMBLE ROTOR LOCK PIN AND BOTTOM PLATE (MTM-3)							
Bottom plate to RH  Operate		HA80      HA15  TOTAL	7	TA15	}	Regrasp tweezers	
			21	TB15		P.U. Rotor lock	
			7	TA15		pin	
			21	TB15		To fixture	
			7	TA15		Open tweezers	
			34				
			21	HB15		Part into fixture	
			18	HA15		Operate	
			126				

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE SPACER

Ref. No. P09/1

Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 4.095    MTM-2 3.700    MTM-3 3.850    C-M 18.9

Description	No.	LH	TMU	RH	No.	Description
<u>EX: ASSEMBLE SPACER (MTM-1)</u>						
P.U. part from box		R8C	11.5	R8C		To fixture
To fixture		G4A	7.3	G4A		
		M8C	7.3	M8C		
		<del>GZ</del>	11.8	<del>GZ</del>		
		P2NSE	21.0	P2NSE		
			21.0			
		RL1	2.0	RL1		
TOTAL		81.9				
<u>EY: ASSEMBLE SPACER (MTM-2)</u>						
		GC30	23	G-		
		PC30	30	GC5		
			21	P-		
		TOTAL	74	PC5		
<u>EZ: ASSEMBLE SPACER (MTM-3)</u>						
		HB80	48	H-		
			29	TB/5		
		TOTAL	77			

## METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE  
INTERLOCK DETENT

Ref. No. P09/2  
 Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 2.950 MTM-2 2.900 MTM-3 2.750 C-M 15.8

Description	No.	LH	TMU	RH	No.	Description
FA: ASSEMBLE INTERLOCK DETENT (MTM-1)						
To RH		<u>RA</u>	16.8	G2	3	Feed part forward
Part from LH		G3	5.6			
		M4C	8.0			
Part to assembly {		P2NSD	26.6			
		RL1	2.0			
		TOTAL	59.0			
FB: ASSEMBLE INTERLOCK DETENT (MTM-2)						
Part to assembly {		<u>G</u>	18	R	3	Feed part forward
		GC5	14			
		PC15	26			
		TOTAL	58			
FD: ASSEMBLE INTERLOCK DETENT (MTM-3)						
Part to assembly		HB15	21 34	TA15	3	Feed part forward
		TOTAL	55			

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE  
INTERLOCK INDENT

Ref. No. P09/3  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM -1 3.125 MTM-2 3.100 MTM-3 2.600 C-M 12.5

Description	No.	LH	TMU	RH	No.	Description
FE: ASSEMBLE SPIN DETENT (MTM-1)						
From RH		G3	10.1	R6D		} P.U. Part
			3.5	G1B		
			4.8	T75S		
			5.6			
			4.5	T75		
Part to assembly {		M4C P2NSE RL1	2.0	G1A		} To part  Assist LH
			8.0	M4C		
			21.0	P2NSE		
			2.0	RL1		
		TOTAL	62.5			
FF: ASSEMBLE SPIN DETENT (MTM-2)						
Part from RH		GB5	19	GC15		} P.U. Part
			3	PA5		
			7			
			7	GB5		
Assemble part		PC15	26	PC15		Part Assist LH
		TOTAL	62			
FG: ASSEMBLE SPIN DETENT (MTM-3)						
Assemble part		HB15	18	HA15		P.U. part and transfer Assist LH
			34	HB15		
		TOTAL	52			

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE  
ESCAPE GEAR

Ref. No. P09/4  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM -1 3.095 MTM -2 2.900 MTM -3 2.800 C-M 13.4

Description	No.	LH	TMU	RH	No.	Description	
FH: ASSEMBLE ESCAPE GEAR (MTM-1)							
			8.4	M4C	}	P.U. part - tweezers	
			16.2	P2SE			
			2.0	MFA			
			8.0	M4C			
			25.3	P2SSD			
			2.0	MFA	}	Assemble part	
		TOTAL	61.9				
FF: ASSEMBLE ESCAPE GEAR (MTM-2)							
			26	PC15	}	P.U. gear	
			3	PA5			
			26	PC15	}	Assemble gear	
			3	PA5			
		TOTAL	58				
FG: ASSEMBLE ESCAPE GEAR (MTM-2)							
			21	TB15	}	P.U. gear	
			7	TA15			
			21	TB15	}	Assemble gear	
			7	TA15			
		TOTAL	56				

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE GEAR  
AND PINION

Ref. No. P09/5  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 3.095 MTM-2 2.900 MTM-3 2.800 C-M 13.4

Description	No.	LH	TMU	RH	No.	Description
FH: ASSEMBLE GEAR AND PINION (MTM-1)						
			8.4	M4C		} P.U. part - tweezers
			16.2	P2SE		
			2.0	MfA		
			8.0	M4C		
			25.3	P2SSD		} Assemble part
			2.0	MfA		
		TOTAL	61.9			
FF: ASSEMBLE GEAR AND PINION (MTM-2)						
			26	PC15		} P.U. part
			3	PA5		
			26	PC15		} Assemble part
			3	PA5		
		TOTAL	58			
FG: ASSEMBLE GEAR AND PINION (MTM-3)						
			21	TB15		}
			7	TA15		
			21	TB15		
			7	TA15		
		TOTAL	56			

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE  
LEVER ASSEMBLY

Ref. No. P09/6  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 3.230 MTM-2 2.900 MTM-3 2.800 C-M 13.7

Description	No.	LH	TMU	RH	No.	Description
FH: ASSEMBLE LEVER ASSEMBLY (MTM-1)						
			8.4	M4C		} P.U. part
			16.2	P2SE		
			2.0	MFA		
			8.4	M4C		} Assemble part
			26.6	P2NSD		
			2.0	MFA		
		TOTAL	62.6			
FJ: ASSEMBLE LEVER ASSEMBLY (MTM-2)						
			26	PC15		} P.U. part
			3	PA5		
			26	PC15		} Assemble part
			3	PA5		
		TOTAL	58			
FK: ASSEMBLE LEVER ASSEMBLY (MTM-3)						
			21	TB15		} P.U. part
			7	TA5		
			21	TB15		} Assemble part
			7	TA5		
		TOTAL	56			

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE  
ROTOR ASSEMBLY

Ref. No. P09/7  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 3.065 MTM-2 2.500 MTM-3 2.950 C-M 13.9

Description	No.	LH	TMU	RH	No.	Description
FL: ASSEMBLE ROTOR ASSEMBLY (MTM-1)						
Feed part forward		G3	7.3	R3D		P.U. part - to LH
			3.5	G1B		
			2.0	MfA		
			5.6			
			2.0	RfA		
		G2	5.6	G3		Orientate
			6.7	M3C		
			26.6	P2NSD		
			2.0	RL1		
			TOTAL	61.3		
FM: ASSEMBLE ROTOR ASSEMBLY (MTM-2)						
Part from RH		GB5	7	GB5		Part to LH
			3	PA5		
			7			
		G2	7	GB5		Orientate
			26	PC15		
		TOTAL	50			Assemble
		FP: ASSEMBLE ROTOR ASSEMBLY (MTM-3)				
Orientate		HA15	7	TA15		P.U. part
			18			
			34	HB15		
		TOTAL	59			Assemble

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE  
INTERLOCK SPRING

Ref. No. P09/8  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 4.945 MTM-2 6.300 MTM-3 4.900 C-M 30.3

Description	No.	LH	TMU	RH	No.	Description
FR: ASSEMBLE SPRING (MTM-1)						
P.U. spring and orientate	2	R6C	10.1	R-		Pick up spring and orientate
		G4C	12.9			
Spring to assembly		G2	11.2	G3		Seat
		<del>M3B</del>				
		R-	5.6	G2		
		G3	5.6			
		M3C	6.7	R-		
		P2NSD	26.6			
			2.0	G5		
			10.6			
		RL1	2.0	MfC		
				AP2		
				RL2		
		TOTAL	98.9			
FS: ASSEMBLE SPRING (MTM-2)						
P.U. part		GC15	19			
Orientate spring		2R	12			
		P-				
Spring to assembly			14	GC5		Orientate spring
			6			
		GC5	14	R		
		PC15	26			
			21	PC5		Assemble
			14			
		TOTAL	126			
FT: ASSEMBLE SPRING (MTM-3)						
P.U. spring and orientate		HA15	18			Orientate
		TA15	7			
to assembly			18	HA15		
		HB15	34			
			21	TB15		Assemble
		TOTAL	98			

# METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE  
SPRING TO SPIN DETENT

Ref. No. P09/9  
 Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 3.135 MTM-2 2.950 MTM-3 3.400 C-M 17.2

Description	No.	LH	TMU	RH	No.	Description
<u>FU: ASSEMBLE SPRING (MTM-1)</u>						
P.U. part - to LH		R-	11.5	M8C		} Assemble part
			16.2	P2SE		
			2.0	RL1		
		R1C	3.6			
		G4C	12.9			
		M4A	7.9	R8A		P.U. part
			5.6	G3		
			62.7			
<u>FV: ASSEMBLE SPRING (MTM-2)</u>						
P.U. part - to RH			26	PC15		Assemble part
		GC5	14			
		P-	19	GC15		Part from LH
		TOTAL	59			
<u>FW: ASSEMBLE SPRING (MTM-3)</u>						
P.U.			34	HB15		Assemble
		HB15	34			
		TOTAL	68			

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - ASSEMBLE  
BOTTOM PLATE

Ref. No. P09/10  
Sheet No. 1 of 2 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM -1 6.145 MTM -2 4.000 MTM -3 6.150 C-M 29.1

Description	No.	LH	TMU	RH	No.	Description
FX: ASSEMBLE BOTTOM PLATE (MTM-1)						
Feed part forward	2	G2	11.2			Orientate
		M-	7.0	R6A		
			5.6	G3		
			4.8	T75S		
		G3	5.6			Position
			4.8	T75		
			5.6	G3		
			10.3	M6C		
			53.4	P3NSD		Assemble
			2.0	RL1		
			2.0	RfA		
			-	G5		
			10.6	AP2		
			-	RL2		
			TOTAL	122.9		
FY: ASSEMBLE BOTTOM PLATE (MTM-2)						
Feed part forward		2R	12			Orientate
			10	GB15		
			3	PA5		
		GB5	7			
			7	GB5		Assemble
			26	PC15		
			3	PA5		
			14	A		
			TOTAL	82		

Ref. No. PO9/10

Sheet 2 of 2 Sheets

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>FZ: ASSEMBLE BOTTOM PLATE (MTM-3)</u>						
Feed part forward	2	TA15	14	TA15		}
			7			
		HA15	18			
			18			
			48			
			18	HB80		}
				HA15		
		TOTAL	123			Assemble Seat

METHODS ANALYSIS

Title: ASSEMBLE GEAR TRAIN - PARTS ASIDE  
TO TRAY

Ref. No. P09/11  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM -1 3.550 MTM -2 3.25 MTM -3 3.85 C-M 9.3

Description	No.	LH	TMU	RH	No.	Description
EU: REMOVE PARTS FROM TRACK (MTM-1)						
P.U. Assembly		R1OB	11.5	R1OB		P.U. assembly
To tray		G1A	2.0	G1A		
		M1OC	13.5	M1OC		
		P2NSE	21.0	P2NSE		
			21.0			
		RL1	2.0	RL1		
TOTAL		71.0				
EV: REMOVE PARTS FROM TRACK (MTM-2)						
P.U. Assembly		GB30	14	GB30		P.U. assembly
To tray		PC30	30	P-		To tray
			21	PC5		
		TOTAL	65			
EW: REMOVE PARTS FROM TRACK (MTM-3)						
To tray		HB80	48	H-		To tray
			29	TB15		
		TOTAL	77			

METHODS ANALYSIS

Title: ARMING AND NON-ARMING TEST: FUSE -  
REMOVE PART FROM FIXTURE

Ref. No. P10/1  
Sheet No. 1 of 2 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM -1 6.645 MTM -2 7.300 MTM -3 8.100 C-M 28.6

Description	No.	LH	TMU	RH	No.	Description
GE: REMOVE PART FROM FIXTURE (MTM-1)						
Move hood up		M12A	12.9	R- G5		Swing arm aside
			7.3	M5A		
		RL1	2.0	RL2		
		R- G1A	8.7	R10A		
Open clamp			2.0	G1A		Open clamp
			10.6	AP2		
			2.0	MfA		
		RL1	2.0	RL1		
Release chips on fixture		R3A	5.3	R3A		Remove clamp
		G5	2.0	G1A		
		AF	3.4			
			7.5	D2E		
			9.7	M8B		Aside clamp
		RF	3.0			
		RL1	2.0	RL1		
		R2A	7.0	R6A		
Release fixture chips		G5	2.0	G1A		Remove fuse
		AF	3.4			
			7.5	D2E		
		RF	3.0			
From RH		R6A	8.1	M6A		To LH
		G3	5.6			
Into tray		M6C	10.3			
		M2A	3.6			
		RL1	2.0			
		TOTAL	132.9			

Ref. No. P10/1Sheet 2 of 2 Sheets

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>GF: REMOVE PART FROM FIXTURE (MTM-2)</u>						
Hood up		PA30	11	G-		Swing arm
			6	PA15		aside
Open clamp		GB-	14	GB30		
			14	A		Open clamp
			3	PA5		
		GA5	7	GB5		
		A	14			Remove clamp
			5	GW5		
			6	PA15		
			11	PA30		Aside clamp
			10	GB15		
		A	14			Remove fuse
			5	GW5		
			6	PA15		
		G-	6	PA15		To LH
From LH		GB5	7			
Fuse into tray		PB15	15			
		PA5	3			
		TOTAL	146			
<u>GG: REMOVE PART FROM FIXTURE (MTM-3)</u>						
Hood up		TAB0	16			
			7	TA15		Swing arm aside
			18	HA15		Open clamp
			7	TA15		
Release chips		HA15	18			
			7	TA15		Remove clamp
			16	TAB0		Aside
Release chips		TA15	7			Remove fuse
			18	HA15		
			7	TA15		To LH
Fuse into tray		HB15	34			
		TA15	7			
		TOTAL	162			

## METHODS ANALYSIS

Title: ARMING AND NON ARMING TEST-FUSE:Ref. No. P10/2LOAD PART TO FIXTURESheet No. 1 of 2 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 10.165 MTM-2 11.450 MTM-3 70.300 C-M 38.5

Description	No.	LH	TMU	RH	No.	Description
GH: LOAD PART TO FIXTURE (MTM-1)						
Open clips	{	R- G1A AF	8.6	R6B	{	P.U. part
			2.0	G1A		To fixture
			13.5	M10C		
			21.0	P2NSE		
Release clips	{	RLF RL1 R4A G1A MfB RL1 R1A G1A	2.0	MfC	{	Seat down
			3.0			To clamp
			2.0	RL1		
			7.9	R8A		
Move fixture into position	{	G1A MfB RL1 R1A G1A	2.0	G1A	{	
			2.0			
			2.0			
			2.5			
Open clips	{	G1A AF	15.2	M12C G2	{	Clamp over fuse
			3.4			Position fuse
			21.0	P2NSE		
Close clips	{	RLF RL1	3.0		{	
			2.0	RL1		Knob
			7.0	R6A		
			2.0	G1A		
Clamp	{	G1A	2.0	MfA	{	Push in
			2.0	MfA		Lock
			2.0			
			10.2	AP2		
Hood	{	RL1 R12A G1A	2.0	RL1	{	
			9.6	R10A		Swing arm to position
			2.0	G1A		
			7.3	M5A		
Hood down	{	M12A RL1	2.0	RL1	{	
			12.9			Reset button
			2.0			
			4.0	R2A		
	{		-	G5	{	
			10.6	AP2		Start button
			-	RL2		
			4.0	R2A		
	{		-	G5	{	
			10.6	AP2		Start button
			-	RL2		
		TOTAL	203.3			

Ref. No. P10/2Sheet 2 of 2 Sheets

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
<b>GJ: LOAD PART TO FIXTURE (MTM-2)</b>						
Open chips		G-	10	GB15		} Part to fixture insert To clamp
		A	30	PC30		
			10	PB5		
Position fixture		G-	14	GB30		
		PA5	3			
Open clips		G-	24	PB45		Clamp over fuse
		A	14			
			21	PC5		Position fuse
		GB15	10	GB15		Knob
			3	PA5		Push in
			3	PA5		Lock
			14	A		
Close hood		GB45	18	G-		} Position swing arm
			6	PA15		
		PA45	15			
			3	GA5		} Reset button
			14	A		
			3	GA5		Start button
			14	A		
		TOTAL	229			
<b>GK: LOAD PART TO FIXTURE (MTM-3)</b>						
			48	HB80		Part to fixture
			21	TB15		Insert
Position fixture		TA15	7			
			29	TB80		Clamp over fuse
			21	TB15		Position fuse
			18	HA15		Push in
			7	TA15		Lock
			7	TA15		Position arm
Close hood		HA80	34			
			7	TA15		Reset button
			7	TA15		Start button
		TOTAL	206			

METHODS ANALYSIS

Title: INSERT RETAINING RING - UNLOAD AND  
LOAD FUSE TO FIXTURE

Ref. No. P11/1  
Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 4.710 MTM-2 4.550 MTM-3 6.250 C-M 15.8

Description	No.	LH	TMU	RH	No.	Description		
<u>GA: UNLOAD AND LOAD FUSE (MTM-1)</u>								
			7.8	R5B	}	Remove part from press To tray Insert		
			2.0	G1A				
			4.0	D1E				
			18.7	M16C				
			3.6	M2A				
			2.0	RL1				
Locate in fixture	}	M8C	11.8					
		P2NSE	21.0					
Seat in fixture	}	M3C	6.7					
		M4A	6.1					
		M2A	3.6					
		M3A	4.9					
		RL1	2.0					
		TOTAL	94.2					
<u>GB: UNLOAD AND LOAD FUSE (MTM-2)</u>								
			7	GB5	}	Remove from press to tray Insert		
			5	GW5				
			3	PA5				
			10	PB45				
			3	PA5				
	}	PC30	30					
		PB15	15					
		PA15	18					
		TOTAL	91					
<u>GD: UNLOAD AND LOAD FUSE (MTM-3)</u>								
			18	HA15			}	Remove from press to tray
			29	TB80				
			7	TA15				
	}	TB80	29					
		TB15	21					
		TA15	21					
		TOTAL	125					

## METHODS ANALYSIS

Title: STAKE RING - LOAD FUSE INTO THE  
FIXTURE

Ref. No. P12/1  
 Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 4.470 MTM-2 4.900 MTM-3 4.200 C-M 7.5

Description	No.	LH	TMU	RH	No.	Description	
<u>GL: FUSE INTO THE FIXTURE (MTM-1)</u>							
Part from tray	{	R16B	16.8	R- G-	{	Assist LH	
		G1A	8.0				
To fixture		ML6C	18.7				
Insert	{	P2NSE	21.0	P2NSE	{	Operate start	
		P1SE	5.6	P1SE			
		R10A	8.7	R10A			
Operate start	{	G5	-	G5	{	Operate start	
		AP2	10.6	AP2			
		RL2	-	RL2			
		TOTAL	89.4				
<u>GM: FUSE INTO THE FIXTURE (MTM-2)</u>							
Assist RH	{	GB45	18	PC45	{	Assist RH	
		PC45	36				PC5
		PC5	21				GA30
Operate start	{	GA30	9	GA30	{	Operate start	
		A	14	A			
		TOTAL	98				
<u>GP: FUSE INTO FIXTURE (MTM-3)</u>							
Fuse into fixture	{	HB80	48	T- TA15	{	Assist LH	
		TB80	29				
Operate start		TA15	7				
		TOTAL	84				

# METHODS ANALYSIS

Title: STAKE RING - REMOVE THE FUSE FROM  
THE FIXTURE AND ADJUST

Ref. No. P12/2  
 Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM -1 3.925 MTM -2 4.150 MTM -3 4.800 C-M 14.7

Description	No.	LH	TMU	RH	No.	Description
(PROCESS TIME LIMITED OUT)						
(GR: REMOVE AND ADJUST (MTM-1))						
Assist RH		R10A	8.7	R10A		Fuse from fixture
		G1A	2.0	G1A		
		M2A	3.6	M2A		
		R-	6.1	M4A		
		G-				
Aside part to tray			2.0	RL1		To work area
			10.3	M6C		
			19.7	P2SSE		
			2.0	MfC		
		M20C	22.1			
		RL1	2.0			
		TOTAL	78.5			
(GS: REMOVE AND ADJUST (MTM-2))						
Assist RH		GB30	14	GB30		Fuse from fixture
		PA5	3	PA5		
		GB5	6	PA15		
			26	PC15		
			10	PB5		
Aside to tray		PB45	24			Adjust
		TOTAL	83			
(GT: REMOVE AND ADJUST (MTM-3))						
Aside			18	4A15		Fuse from fixture
			7	TA15		
			21	TB15		
			21	TB15		
		TB80	29			
		TOTAL	96			

## METHODS ANALYSIS

Title: APPLY SILASTIC TO FUSE ASSEMBLY -  
LOAD FUSE TO FIXTURE

Ref. No. P13/1  
 Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 3.270 MTM-2 4.400 MTM-3 4.200 C-M 8.5

Description	No.	LH	TMU	RH	No.	Description
<u>GW: LOAD INTO FIXTURE (MTM-1)</u>						
P.U. part		R-	25.8	R30B		P.U. part
		GLA	2.0	GLA		
To fixture		M-	20.4	M18C		To fixture
			5.6	P1SE		
Insert		P1SE	5.6			Insert
		M2A	4.0	M2A		
		RL1	2.0	RL1		
		TOTAL	65.4			
<u>GX: LOAD INTO FIXTURE (MTM-2)</u>						
Part into fixture		G-	23	GB80		Part into fixture
			41	PC80		
Insert		PC5	21			Insert
		PA5	3	PA5		
		TOTAL	88			
<u>GY: LOAD PART INTO FIXTURE (MTM-3)</u>						
Part into fixture			48	HB80		Part into fixture
		TB15	29			
Insert		TA15	7	TA15		Insert
		TOTAL	84			

## METHODS ANALYSIS

Title: APPLY SILASTIC TO FUSE ASSEMBLY -  
UNLOAD FUSE FROM FIXTURE

Ref. No. P13/3  
 Sheet No. 1 of 1 Sheets

Predicted Time: Decimal Minutes @ 100 BSI

MTM-1 2.615 MTM-2 3.400 MTM-3 3.800 C-M 9.6

Description	No.	LH	TMU	RH	No.	Description
<u>GZ: UNLOAD FUSE FROM FIXTURE (MTM-1)</u>						
P.U. part		R8A	7.9	R8A		P.U. part
		G1A	2.0	G1A		
			20.4	M18C		
			5.6	P1SE		
Into tray		M2C	5.2			Into tray
		P1SE	5.6			
		M2A	3.6	M2A		
		RL1	2.0	RL1		
		TOTAL	52.3			
<u>HA: UNLOAD FUSE FROM FIXTURE (MTM-2)</u>						
Part to tray Insert		G-	14	GB30		Part to tray
			30	PC45		
		PC5	21			Insert
		PA5	3	PA5		
		TOTAL	68			
<u>HB: UNLOAD FUSE FROM FIXTURE (MTM-3)</u>						
Part to tray Insert			48	HB80		Part to tray
		TB15	21			
		TA15	7	TA15		Insert
		TOTAL	76			

Figure C-1: Workplace Layout for Work Tasks 1 and 2



Figure C-2: Workplace Layout for Work Tasks 3 and 4



Figure C-3: Workplace Layout for Work Tasks 5 to 8



Figure C-4: Workplace Layout for Work Tasks 9 to 19



Figure C-5: Workplace Layout for Work Tasks 20 and 21



Figure C-6: Workplace Layout for Work Task 22



Figure C-7: Workplace Layout for Work Tasks 23 and 24



Figure C-8: Workplace Layout for Work Tasks 25 and 26



#### APPENDIX D: OBSERVED TIMES ON FIELD DATA

The data appearing in this Appendix is the actual observed times for the jobs classified as field data. The "Study No." is the same as that identified throughout the dissertation. Where two sets of data have the same Study No., it indicates that the job was observed on two different occasions; however, in each case the same operator performed the task.

All time values in this Appendix are expressed in decimal minutes.

## Study P01/1: Grind Pin - Load Pin into the Machine

NO.	ELAPSED	ACTUAL
1	8.000	8.000
2	20.000	12.000
3	32.000	12.000
4	40.000	8.000
5	49.000	9.000
6	59.000	10.000
7	68.000	9.000
8	76.000	8.000
9	85.000	9.000
10	94.000	9.000
11	101.000	7.000
12	109.000	8.000
13	122.000	13.000
14	132.000	10.000
15	142.000	10.000
16	151.000	9.000
17	159.000	8.000
18	169.000	10.000
19	178.000	9.000
20	191.000	13.000
21	202.000	11.000
22	208.000	6.000
23	217.000	9.000
24	225.000	8.000
25	233.000	8.000
26	242.000	9.000
27	254.000	12.000
28	267.000	13.000
29	279.000	12.000
30	294.000	15.000
31	306.000	12.000
32	315.000	9.000
33	323.000	8.000
34	337.000	14.000
35	347.000	10.000
36	362.000	15.000
37	376.000	14.000
38	383.000	7.000
39	392.000	9.000
40	403.000	11.000
41	419.000	16.000
42	425.000	6.000
43	437.000	12.000
44	447.000	10.000
45	463.000	16.000
46	471.000	8.000
47	479.000	8.000
48	490.000	11.000

49	505.000	15.000
50	520.000	15.000
51	530.000	10.000
52	535.000	5.000
53	544.000	9.000
54	556.000	12.000
55	567.000	11.000
56	581.000	14.000
57	591.000	10.000
58	600.000	9.000
59	607.000	7.000
60	615.000	8.000
61	625.000	10.000
62	634.000	9.000
63	646.000	12.000
64	657.000	11.000
65	670.000	13.000
66	679.000	9.000
67	691.000	12.000
68	702.000	11.000
69	715.000	13.000
70	726.000	11.000
71	738.000	12.000
72	749.000	11.000
73	760.000	11.000
74	769.000	9.000
75	785.000	16.000
76	796.000	11.000
77	810.000	14.000
78	825.000	15.000
79	835.000	10.000
80	842.000	7.000
81	850.000	8.000
82	861.000	11.000
83	870.000	9.000
84	880.000	10.000
85	894.000	14.000
86	908.000	14.000
87	919.000	11.000
88	931.000	12.000
89	941.000	10.000
90	955.000	14.000
91	963.000	8.000
92	974.000	11.000
93	983.000	9.000
94	991.000	8.000
95	1008.000	17.000
96	1027.000	19.000
97	1038.000	11.000
98	1049.000	11.000
99	1059.000	10.000
100	1068.000	9.000
101	1076.000	8.000
102	1092.000	16.000
103	1102.000	10.000
104	1111.000	9.000
105	1127.000	16.000
106	1134.000	7.000
107	1145.000	11.000
108	1161.000	16.000

109	1169.000	8.000
110	1182.000	13.000
111	1204.000	22.000
112	1213.000	9.000
113	1224.000	11.000
114	1232.000	8.000
115	1243.000	11.000
116	1255.000	12.000
117	1266.000	11.000
118	1276.000	10.000
119	1282.000	6.000
120	1295.000	13.000
121	1305.000	10.000
122	1317.000	12.000
123	1326.000	9.000
124	1336.000	10.000
125	1345.000	9.000
126	1355.000	10.000
127	1361.000	6.000
128	1382.000	21.000
129	1395.000	13.000
130	1407.000	12.000
131	1419.000	12.000
132	1425.000	6.000
133	1445.000	20.000
134	1449.000	4.000
135	1464.000	15.000
136	1480.000	16.000
137	1492.000	12.000
138	1504.000	12.000
139	1523.000	19.000
140	1536.000	13.000
141	1546.000	10.000
142	1551.000	5.000
143	1570.000	19.000
144	1583.000	13.000
145	1603.000	20.000
146	1612.000	9.000
147	1621.000	9.000
148	1636.000	15.000
149	1672.000	36.000
150	1685.000	13.000
151	1696.000	11.000
152	1703.000	7.000
153	1710.000	7.000
154	1719.000	9.000
155	1729.000	10.000
156	1739.000	10.000
157	1761.000	22.000
158	1775.000	14.000
159	1782.000	7.000
160	1792.000	10.000
161	1801.000	9.000
162	1810.000	9.000
163	1823.000	11.000
164	1832.000	9.000
165	1845.000	13.000
166	1855.000	10.000
167	1862.000	7.000
168	1871.000	9.000

169	1883.000	12.000
170	1897.000	14.000
171	1907.000	10.000
172	1923.000	16.000
173	1927.000	4.000

## Study P01/3: Grind Pin - Unload the Machine

NO.	ELAPSED	ACTUAL
1	5.000	5.000
2	9.000	4.000
3	13.000	4.000
4	20.000	7.000
5	24.000	4.000
6	43.000	19.000
7	49.000	6.000
8	53.000	4.000
9	57.000	4.000
10	61.000	4.000
11	68.000	7.000
12	77.000	9.000
13	81.000	4.000
14	80.000	9.000
15	94.000	4.000
16	98.000	4.000
17	102.000	4.000
18	107.000	5.000
19	112.000	5.000
20	116.000	4.000
21	122.000	6.000
22	129.000	7.000
23	134.000	5.000
24	139.000	5.000
25	142.000	3.000
26	145.000	3.000
27	149.000	4.000
28	156.000	7.000
29	162.000	6.000
30	167.000	5.000
31	174.000	7.000
32	177.000	3.000
33	182.000	5.000
34	187.000	5.000
35	191.000	4.000
36	197.000	6.000
37	202.000	5.000
38	209.000	7.000
39	213.000	4.000
40	216.000	3.000
41	222.000	6.000
42	226.000	4.000
43	230.000	4.000
44	234.000	4.000
45	238.000	4.000
46	244.000	6.000
47	249.000	4.000
48	254.000	6.000

49	258.000	4.000
50	265.000	7.000
51	270.000	5.000
52	274.000	4.000
53	284.000	10.000
54	297.000	13.000
55	302.000	5.000
56	305.000	3.000
57	320.000	15.000
58	324.000	4.000
59	329.000	5.000
60	336.000	7.000
61	343.000	7.000
62	348.000	5.000
63	353.000	5.000
64	370.000	17.000
65	375.000	5.000
66	381.000	6.000
67	388.000	7.000
68	392.000	4.000
69	397.000	5.000
70	403.000	6.000
71	407.000	4.000
72	410.000	3.000
73	414.000	4.000
74	421.000	7.000
75	427.000	6.000
76	432.000	5.000
77	440.000	8.000
78	445.000	5.000
79	449.000	4.000
80	453.000	4.000
81	459.000	6.000
82	467.000	3.000
83	474.000	7.000
84	481.000	7.000
85	486.000	5.000
86	490.000	4.000
87	496.000	6.000
88	500.000	4.000
89	506.000	6.000
90	512.000	6.000
91	517.000	5.000
92	523.000	6.000
93	528.000	5.000
94	534.000	6.000
95	540.000	6.000
96	546.000	6.000
97	550.000	4.000
98	554.000	4.000
99	558.000	4.000
100	563.000	5.000
101	569.000	6.000
102	573.000	4.000
103	578.000	5.000
104	584.000	6.000
105	589.000	5.000
106	594.000	5.000
107	599.000	5.000
108	604.000	5.000

109	610.000	6.000
110	616.000	6.000
111	620.000	4.000
112	624.000	4.000
113	629.000	5.000
114	635.000	6.000
115	643.000	8.000
116	648.000	5.000
117	654.000	6.000
118	658.000	4.000
119	669.000	11.000
120	675.000	6.000
121	681.000	6.000
122	687.000	6.000
123	691.000	4.000
124	697.000	6.000
125	702.000	5.000
126	706.000	4.000
127	711.000	5.000
128	715.000	4.000
129	721.000	6.000
130	726.000	5.000
131	741.000	15.000
132	746.000	5.000
133	750.000	4.000
134	756.000	6.000
135	761.000	5.000
136	766.000	5.000
137	771.000	5.000
138	777.000	6.000
139	782.000	5.000
140	787.000	5.000
141	793.000	6.000
142	797.000	4.000
143	801.000	4.000
144	815.000	14.000
145	821.000	6.000
146	826.000	5.000
147	831.000	5.000
148	837.000	6.000
149	840.000	3.000
150	845.000	5.000
151	853.000	8.000
152	857.000	4.000
153	863.000	6.000
154	867.000	4.000
155	871.000	4.000
156	876.000	5.000
157	883.000	7.000
158	887.000	4.000
159	895.000	8.000
160	910.000	5.000
161	905.000	5.000
162	911.000	6.000
163	918.000	7.000
164	925.000	7.000
165	931.000	6.000
166	937.000	6.000
167	941.000	4.000
168	945.000	4.000

169	949.000	4.000
170	953.000	4.000
171	958.000	5.000
172	967.000	9.000
173	972.000	5.000
174	978.000	6.000
175	987.000	9.000

Study P06/1: Counter Bore and Chamfer Hairspring  
Tuner Tube - Unload Hairspring From the  
Machine

NO.	ELAPSED	ACTUAL
1	2.000	2.000
2	6.000	4.000
3	8.000	2.000
4	10.000	2.000
5	12.000	2.000
6	14.000	2.000
7	16.000	2.000
8	18.000	2.000
9	21.000	3.000
10	24.000	3.000
11	26.000	2.000
12	28.000	2.000
13	31.000	3.000
14	34.000	3.000
15	37.000	3.000
16	39.000	2.000
17	41.000	2.000
18	44.000	3.000
19	46.000	2.000
20	50.000	4.000
21	52.000	2.000
22	54.000	2.000
23	56.000	2.000
24	59.000	3.000
25	61.000	2.000
26	64.000	3.000
27	67.000	.000
28	69.000	2.000
29	71.000	2.000
30	73.000	2.000
31	76.000	3.000
32	78.000	2.000
33	81.000	3.000
34	84.000	3.000
35	87.000	3.000
36	90.000	3.000
37	92.000	2.000
38	94.000	2.000
39	96.000	2.000
40	98.000	2.000
41	99.000	1.000
42	101.000	2.000
43	103.000	2.000
44	105.000	2.000
45	108.000	3.000
46	110.000	2.000
47	113.000	3.000
48	115.000	2.000

49	117.000	2.000
50	120.000	3.000
51	123.000	3.000
52	126.000	3.000
53	128.000	2.000
54	130.000	2.000
55	132.000	2.000
56	134.000	2.000
57	137.000	3.000
58	140.000	3.000
59	142.000	2.000
60	145.000	3.000
61	147.000	2.000
62	149.000	2.000
63	152.000	3.000
64	155.000	3.000
65	158.000	3.000
66	161.000	3.000
67	163.000	2.000
68	165.000	2.000
69	167.000	2.000
70	170.000	3.000
71	173.000	3.000
72	175.000	2.000
73	177.000	2.000
74	179.000	2.000
75	181.000	2.000
76	183.000	2.000
77	185.000	2.000
78	188.000	3.000
79	190.000	2.000
80	192.000	2.000
81	195.000	3.000
82	197.000	2.000
83	200.000	3.000
84	202.000	2.000
85	204.000	2.000
86	206.000	2.000
87	208.000	2.000
88	211.000	3.000
89	213.000	2.000
90	216.000	3.000
91	218.000	2.000
92	221.000	3.000
93	223.000	2.000
94	225.000	2.000
95	228.000	3.000
96	230.000	2.000
97	232.000	2.000
98	235.000	3.000
99	238.000	3.000
100	240.000	2.000
101	242.000	2.000
102	245.000	3.000
103	247.000	2.000
104	250.000	3.000
105	252.000	2.000
106	254.000	2.000
107	257.000	3.000
108	259.000	2.000

109	261.000	2.000
110	264.000	3.000
111	266.000	2.000
112	269.000	3.000
113	271.000	2.000
114	274.000	3.000
115	277.000	3.000
116	279.000	2.000
117	281.000	2.000
118	283.000	2.000
119	286.000	3.000
120	289.000	3.000
121	291.000	2.000
122	294.000	3.000
123	297.000	3.000
124	300.000	3.000
125	302.000	2.000
126	305.000	3.000
127	307.000	2.000
128	310.000	3.000
129	313.000	3.000
130	315.000	2.000
131	317.000	2.000
132	320.000	3.000
133	322.000	2.000
134	325.000	3.000
135	329.000	4.000
136	332.000	3.000
137	334.000	2.000
138	336.000	2.000
139	338.000	2.000
140	341.000	3.000
141	343.000	2.000
142	346.000	3.000
143	347.000	1.000
144	350.000	3.000
145	352.000	2.000
146	354.000	2.000
147	356.000	2.000
148	359.000	3.000
149	361.000	2.000
150	363.000	2.000
151	365.000	2.000
152	368.000	3.000
153	370.000	2.000
154	372.000	2.000
155	376.000	4.000
156	379.000	3.000
157	381.000	2.000
158	383.000	2.000
159	385.000	2.000

Study P06/1: Counter Bore and Chamfer Hairspring  
Tuner Tube - Unload Hairspring From the  
Machine

NO.	ELAPSED	ACTUAL
1	3.000	3.000
2	6.000	3.000
3	9.000	3.000
4	12.000	3.000
5	15.000	3.000
6	18.000	3.000
7	21.000	3.000
8	24.000	3.000
9	26.000	2.000
10	28.000	2.000
11	30.000	2.000
12	33.000	3.000
13	35.000	2.000
14	37.000	2.000
15	40.000	3.000
16	43.000	3.000
17	45.000	2.000
18	49.000	4.000
19	51.000	2.000
20	54.000	3.000
21	57.000	3.000
22	61.000	4.000
23	65.000	4.000
24	67.000	2.000
25	69.000	2.000
26	71.000	2.000
27	74.000	3.000
28	77.000	3.000
29	80.000	3.000
30	83.000	3.000
31	86.000	3.000
32	89.000	3.000

Study P09/6: Assemble Gear Train - Assemble Lever  
Assembly

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	8.000	4.000
3	12.000	4.000
4	15.000	3.000
5	19.000	4.000
6	23.000	4.000
7	29.000	6.000
8	34.000	5.000
9	39.000	5.000
10	44.000	5.000
11	48.000	4.000
12	52.000	4.000
13	55.000	3.000
14	60.000	5.000
15	64.000	4.000
16	69.000	5.000
17	73.000	4.000
18	77.000	4.000
19	81.000	4.000
20	85.000	4.000
21	89.000	4.000
22	95.000	6.000
23	100.000	5.000
24	104.000	4.000
25	108.000	4.000
26	112.000	4.000
27	117.000	5.000
28	122.000	5.000
29	126.000	4.000
30	132.000	6.000
31	135.000	3.000
32	139.000	4.000
33	142.000	3.000
34	145.000	3.000
35	148.000	3.000
36	153.000	5.000
37	158.000	5.000
38	162.000	4.000
39	166.000	4.000
40	169.000	3.000
41	173.000	4.000
42	176.000	3.000
43	180.000	4.000
44	185.000	5.000
45	189.000	4.000
46	193.000	4.000
47	197.000	4.000
48	202.000	5.000

49	208.000	6.000
50	213.000	5.000
51	219.000	6.000
52	222.000	3.000
53	227.000	5.000
54	233.000	6.000
55	238.000	5.000
56	245.000	7.000
57	249.000	4.000
58	256.000	7.000
59	260.000	4.000
60	265.000	5.000
61	269.000	4.000
62	275.000	6.000
63	277.000	2.000
64	281.000	4.000
65	284.000	3.000
66	287.000	3.000
67	291.000	4.000
68	295.000	4.000
69	299.000	4.000
70	302.000	3.000
71	306.000	4.000
72	309.000	3.000
73	313.000	4.000
74	318.000	5.000
75	324.000	6.000
76	327.000	3.000
77	331.000	4.000
78	335.000	4.000
79	339.000	4.000
80	345.000	6.000
81	351.000	6.000
82	355.000	4.000
83	359.000	4.000
84	364.000	5.000
85	371.000	7.000
86	375.000	4.000
87	382.000	7.000
88	387.000	5.000
89	391.000	4.000
90	394.000	3.000
91	398.000	4.000
92	402.000	4.000
93	408.000	6.000
94	411.000	3.000
95	417.000	6.000
96	421.000	4.000
97	425.000	4.000
98	427.000	8.000
99	439.000	6.000
100	443.000	4.000
101	448.000	5.000
102	451.000	3.000
103	454.000	3.000
104	458.000	4.000
105	462.000	4.000
106	466.000	4.000
107	471.000	5.000
108	477.000	6.000

109	482.000	5.000
110	488.000	6.000
111	492.000	4.000
112	496.000	4.000
113	501.000	5.000
114	506.000	5.000
115	511.000	5.000
116	515.000	4.000
117	518.000	3.000
118	521.000	3.000
119	525.000	4.000
120	529.000	4.000
121	532.000	3.000
122	539.000	7.000
123	543.000	4.000
124	546.000	3.000
125	550.000	4.000
126	554.000	4.000
127	557.000	3.000
128	562.000	5.000
129	566.000	4.000
130	570.000	4.000
131	575.000	5.000
132	579.000	4.000
133	582.000	3.000
134	586.000	4.000
135	589.000	3.000
136	593.000	4.000
137	597.000	4.000
138	601.000	4.000
139	604.000	3.000
140	608.000	4.000
141	612.000	4.000
142	617.000	5.000
143	621.000	4.000
144	627.000	6.000
145	631.000	4.000
146	634.000	3.000
147	637.000	3.000
148	643.000	6.000
149	648.000	5.000
150	653.000	5.000
151	658.000	5.000
152	662.000	4.000
153	665.000	3.000
154	670.000	5.000
155	674.000	4.000
156	678.000	4.000

Study P06/2: Counterbase and Chamfer Hairspring Tuner  
Tube - Load Hairspring Tuner Tube into  
the Machine.

NO.	ELAPSED	ACTUAL
1	3.000	3.000
2	7.000	4.000
3	11.000	4.000
4	14.000	3.000
5	18.000	4.000
6	22.000	4.000
7	25.000	3.000
8	28.000	3.000
9	32.000	4.000
10	36.000	4.000
11	41.000	5.000
12	45.000	4.000
13	49.000	4.000
14	53.000	4.000
15	56.000	3.000
16	58.000	2.000
17	61.000	3.000
18	64.000	3.000
19	67.000	3.000
20	71.000	4.000
21	75.000	4.000
22	79.000	4.000
23	81.000	2.000
24	87.000	6.000
25	91.000	4.000
26	95.000	4.000
27	101.000	6.000
28	104.000	3.000
29	107.000	3.000
30	110.000	3.000
31	114.000	4.000
32	117.000	3.000

Study P07/1: Assemble and Press Plate and Spacer  
 Assembly - Finished Part to Pin and  
 Assemble Three Pins

NO.	ELAPSED	ACTUAL
1	9.000	9.000
2	18.000	9.000
3	28.000	10.000
4	36.000	8.000
5	45.000	9.000
6	54.000	9.000
7	62.000	8.000
8	72.000	10.000
9	90.000	18.000
10	99.000	9.000
11	106.000	7.000
12	117.000	11.000
13	126.000	9.000
14	136.000	10.000
15	146.000	10.000
16	157.000	11.000
17	168.000	11.000
18	177.000	9.000
19	184.000	7.000
20	199.000	15.000
21	208.000	9.000
22	217.000	9.000
23	226.000	9.000
24	237.000	11.000
25	250.000	13.000
26	261.000	11.000
27	269.000	8.000
28	279.000	10.000
29	289.000	10.000
30	298.000	9.000
31	309.000	11.000
32	325.000	16.000
33	336.000	11.000
34	343.000	7.000
35	352.000	9.000
36	362.000	10.000
37	371.000	9.000
38	379.000	8.000
39	388.000	9.000
40	400.000	12.000
41	410.000	10.000
42	415.000	5.000
43	424.000	9.000
44	433.000	9.000
45	446.000	13.000
46	456.000	10.000
47	466.000	10.000
48	475.000	9.000

49	484.000	9.000
50	497.000	13.000
51	501.000	4.000
52	512.000	11.000
53	524.000	12.000
54	533.000	9.000
55	541.000	8.000
56	542.000	1.000
57	556.000	14.000
58	565.000	9.000
59	575.000	10.000
60	579.000	4.000
61	591.000	12.000
62	599.000	8.000
63	610.000	11.000
64	614.000	4.000
65	622.000	8.000
66	632.000	10.000
67	643.000	11.000
68	652.000	9.000
69	662.000	10.000
70	671.000	9.000
71	680.000	9.000
72	693.000	13.000
73	702.000	9.000
74	710.000	8.000
75	718.000	8.000
76	727.000	9.000
77	740.000	13.000
78	743.000	3.000
79	753.000	10.000
80	762.000	9.000
81	771.000	9.000
82	781.000	10.000
83	791.000	10.000
84	803.000	12.000
85	807.000	4.000
86	816.000	9.000
87	824.000	8.000
88	834.000	10.000
89	844.000	10.000
90	854.000	10.000
91	869.000	15.000
92	879.000	10.000
93	888.000	9.000
94	899.000	11.000
95	908.000	9.000
96	919.000	11.000
97	928.000	9.000
98	940.000	12.000
99	950.000	10.000
100	960.000	10.000
101	970.000	10.000
102	981.000	11.000
103	990.000	9.000
104	1000.000	10.000
105	1008.000	8.000
106	1016.000	8.000
107	1025.000	9.000
108	1036.000	11.000

Study P07/1: Assemble and Press Plate and Spacer  
Assembly - Finished Part to Pin and  
Assemble Three Pins

NO.	ELAPSED	ACTUAL
1	12.000	12.000
2	24.000	12.000
3	36.000	12.000
4	45.000	9.000
5	54.000	9.000
6	67.000	13.000
7	76.000	9.000
8	86.000	10.000
9	96.000	10.000
10	104.000	8.000
11	116.000	12.000
12	126.000	10.000
13	136.000	10.000
14	145.000	9.000
15	156.000	11.000
16	159.000	3.000
17	168.000	9.000
18	178.000	10.000
19	190.000	12.000
20	199.000	9.000
21	210.000	11.000
22	221.000	11.000
23	234.000	13.000
24	251.000	17.000
25	259.000	8.000
26	267.000	8.000
27	274.000	7.000
28	287.000	13.000
29	291.000	4.000
30	301.000	10.000
31	310.000	9.000
32	322.000	12.000
33	334.000	12.000
34	348.000	14.000
35	358.000	10.000
36	369.000	11.000
37	382.000	13.000
38	392.000	10.000
39	402.000	10.000
40	411.000	9.000
41	422.000	11.000
42	430.000	8.000
43	441.000	11.000
44	450.000	9.000
45	464.000	14.000
46	473.000	9.000
47	484.000	11.000
48	492.000	8.000

49	504.000	12.000
50	514.000	10.000
51	522.000	8.000
52	532.000	10.000
53	543.000	11.000
54	552.000	9.000
55	562.000	10.000
56	573.000	11.000
57	582.000	9.000
58	591.000	9.000
59	604.000	13.000
60	612.000	8.000
61	615.000	3.000
62	624.000	9.000
63	631.000	7.000
64	641.000	10.000
65	651.000	10.000
66	661.000	10.000
67	670.000	9.000
68	680.000	10.000
69	692.000	12.000
70	697.000	5.000
71	708.000	11.000
72	719.000	11.000
73	728.000	9.000
74	736.000	8.000
75	745.000	9.000
76	755.000	10.000
77	765.000	10.000
78	779.000	14.000
79	788.000	9.000
80	798.000	10.000
81	807.000	9.000
82	816.000	9.000
83	827.000	11.000

Study P07/2: Assemble and Press Plate and Spacer  
 Assembly - Plate and Spacer Assembly  
 into Position

NO.	ELAPSED	ACTUAL
1	3.000	3.000
2	6.000	3.000
3	8.000	2.000
4	9.000	1.000
5	13.000	4.000
6	15.000	2.000
7	17.000	2.000
8	19.000	2.000
9	21.000	2.000
10	24.000	3.000
11	27.000	3.000
12	31.000	4.000
13	33.000	2.000
14	36.000	3.000
15	38.000	2.000
16	41.000	3.000
17	44.000	3.000
18	46.000	2.000
19	48.000	2.000
20	51.000	3.000
21	54.000	3.000
22	57.000	3.000
23	60.000	3.000
24	63.000	3.000
25	65.000	2.000
26	66.000	1.000
27	70.000	4.000
28	72.000	2.000
29	75.000	3.000
30	78.000	3.000
31	85.000	7.000
32	88.000	3.000
33	91.000	3.000
34	93.000	2.000
35	95.000	2.000
36	97.000	2.000
37	100.000	3.000
38	103.000	3.000
39	107.000	4.000
40	110.000	3.000
41	114.000	4.000
42	116.000	2.000
43	118.000	2.000
44	125.000	7.000
45	128.000	3.000
46	130.000	2.000
47	132.000	2.000
48	135.000	3.000

49	140.000	5.000
50	142.000	2.000
51	144.000	2.000
52	145.000	1.000
53	153.000	8.000
54	155.000	2.000
55	156.000	1.000
56	158.000	2.000
57	161.000	3.000
58	173.000	12.000
59	176.000	3.000
60	178.000	2.000
61	179.000	1.000
62	188.000	9.000
63	191.000	3.000
64	194.000	3.000
65	197.000	3.000
66	199.000	2.000
67	202.000	3.000
68	204.000	2.000
69	207.000	3.000
70	210.000	3.000
71	212.000	2.000
72	214.000	2.000
73	217.000	3.000
74	220.000	3.000
75	224.000	4.000
76	226.000	2.000
77	229.000	3.000
78	234.000	5.000
79	236.000	2.000
80	238.000	2.000
81	246.000	8.000
82	248.000	2.000
83	250.000	2.000
84	253.000	3.000
85	256.000	3.000
86	259.000	3.000
87	262.000	3.000
88	264.000	2.000
89	268.000	4.000
90	271.000	3.000
91	273.000	2.000
92	275.000	2.000
93	280.000	5.000
94	282.000	2.000
95	285.000	3.000
96	287.000	2.000
97	291.000	4.000
98	294.000	3.000
99	296.000	2.000
100	301.000	5.000
101	303.000	2.000
102	306.000	3.000
103	308.000	2.000
104	311.000	3.000
105	314.000	3.000
106	316.000	2.000
107	319.000	3.000
108	322.000	3.000

Study P07/2: Assemble and Press Plate and Spacer  
Assembly - Plate and Spacer Assembly  
into Position

NO.	ELAPSED	ACTUAL
1	3.000	3.000
2	6.000	3.000
3	9.000	3.000
4	11.000	2.000
5	17.000	6.000
6	19.000	2.000
7	22.000	3.000
8	24.000	2.000
9	26.000	2.000
10	28.000	2.000
11	32.000	4.000
12	34.000	2.000
13	36.000	2.000
14	38.000	2.000
15	41.000	3.000
16	43.000	2.000
17	49.000	6.000
18	50.000	1.000
19	54.000	4.000
20	57.000	3.000
21	59.000	2.000
22	62.000	3.000
23	65.000	3.000
24	68.000	3.000
25	71.000	3.000
26	73.000	2.000
27	76.000	3.000
28	79.000	3.000
29	82.000	3.000
30	85.000	3.000
31	95.000	10.000
32	97.000	2.000
33	99.000	2.000
34	101.000	2.000
35	104.000	3.000
36	107.000	3.000
37	110.000	3.000
38	113.000	3.000
39	114.000	1.000
40	116.000	2.000
41	119.000	3.000
42	122.000	3.000
43	124.000	2.000
44	126.000	2.000
45	128.000	2.000
46	129.000	1.000
47	130.000	1.000
48	132.000	2.000

49	134.000	2.000
50	138.000	4.000
51	141.000	3.000
52	142.000	1.000
53	144.000	2.000
54	146.000	2.000
55	148.000	2.000
56	151.000	3.000
57	153.000	2.000
58	155.000	2.000
59	158.000	3.000
60	160.000	2.000
61	162.000	2.000
62	164.000	2.000
63	168.000	4.000
64	172.000	4.000
65	179.000	7.000
66	181.000	2.000
67	184.000	3.000
68	186.000	2.000
69	188.000	2.000
70	191.000	3.000
71	194.000	3.000
72	196.000	2.000
73	209.000	13.000
74	211.000	2.000
75	214.000	3.000
76	217.000	3.000
77	220.000	3.000
78	222.000	2.000
79	224.000	2.000
80	226.000	2.000
81	231.000	5.000
82	233.000	2.000
83	236.000	3.000
84	238.000	2.000
85	240.000	2.000
86	243.000	3.000
87	246.000	3.000

Study P07/3: Assemble and Press Plate and Spacer -  
Position Lower Plate and Shaft Assembly

NO.	ELAPSED	ACTUAL
1	1.000	1.000
2	2.000	1.000
3	4.000	2.000
4	6.000	2.000
5	10.000	4.000
6	12.000	2.000
7	15.000	3.000
8	17.000	2.000
9	20.000	3.000
10	22.000	2.000
11	24.000	2.000
12	25.000	1.000
13	27.000	2.000
14	29.000	2.000
15	31.000	2.000
16	33.000	2.000
17	34.000	1.000
18	45.000	11.000
19	49.000	4.000
20	53.000	4.000
21	56.000	3.000
22	60.000	4.000
23	64.000	4.000
24	66.000	2.000
25	70.000	4.000
26	73.000	3.000
27	76.000	3.000
28	78.000	2.000
29	80.000	2.000
30	92.000	2.000
31	84.000	2.000
32	86.000	2.000
33	88.000	2.000
34	91.000	3.000
35	93.000	2.000
36	95.000	2.000
37	97.000	2.000
38	99.000	2.000
39	102.000	3.000
40	104.000	2.000
41	107.000	3.000
42	109.000	2.000
43	111.000	2.000
44	112.000	1.000
45	115.000	3.000
46	120.000	5.000
47	122.000	2.000
48	124.000	2.000

49	130.000	6.000
50	132.000	2.000
51	135.000	3.000
52	136.000	1.000
53	138.000	2.000
54	143.000	5.000
55	145.000	2.000
56	148.000	3.000
57	151.000	3.000
58	152.000	1.000
59	153.000	1.000
60	156.000	3.000
61	160.000	4.000
62	162.000	2.000
63	164.000	2.000
64	167.000	3.000
65	168.000	1.000
66	170.000	2.000
67	172.000	2.000
68	174.000	2.000
69	176.000	2.000
70	179.000	3.000
71	182.000	3.000
72	183.000	1.000
73	185.000	2.000
74	186.000	1.000
75	189.000	3.000
76	191.000	2.000
77	196.000	5.000
78	198.000	2.000
79	201.000	3.000
80	204.000	3.000
81	206.000	2.000
82	207.000	1.000
83	209.000	2.000
84	212.000	3.000
85	214.000	2.000
86	215.000	1.000
87	217.000	2.000
88	219.000	2.000
89	223.000	4.000
90	225.000	2.000
91	227.000	2.000
92	231.000	4.000
93	233.000	2.000
94	236.000	3.000
95	238.000	2.000
96	240.000	2.000
97	242.000	2.000
98	245.000	3.000
99	247.000	2.000
100	250.000	3.000
101	252.000	2.000
102	254.000	2.000
103	257.000	3.000
104	259.000	2.000
105	261.000	2.000
106	264.000	3.000

Study P07/3: Assemble and Press Plate and Spacer -  
Position Lower Plate and Shaft Assembly

NC.	ELAPSED	ACTUAL
1	2.000	2.000
2	11.000	9.000
3	14.000	3.000
4	16.000	2.000
5	19.000	3.000
6	24.000	5.000
7	26.000	2.000
8	29.000	3.000
9	33.000	4.000
10	35.000	2.000
11	38.000	3.000
12	41.000	3.000
13	44.000	3.000
14	46.000	2.000
15	49.000	3.000
16	51.000	2.000
17	55.000	4.000
18	57.000	2.000
19	59.000	2.000
20	61.000	2.000
21	62.000	1.000
22	64.000	2.000
23	66.000	2.000
24	68.000	2.000
25	70.000	2.000
26	72.000	2.000
27	75.000	3.000
28	78.000	3.000
29	81.000	3.000
30	83.000	2.000
31	85.000	2.000
32	87.000	2.000
33	90.000	3.000
34	92.000	2.000
35	94.000	2.000
36	97.000	3.000
37	99.000	2.000
38	103.000	4.000
39	105.000	2.000
40	107.000	2.000
41	110.000	3.000
42	113.000	3.000
43	117.000	4.000
44	119.000	2.000
45	122.000	3.000
46	125.000	3.000
47	128.000	3.000
48	131.000	3.000

49	133.000	2.000
50	135.000	2.000
51	139.000	4.000
52	142.000	3.000
53	145.000	3.000
54	148.000	3.000
55	151.000	3.000
56	153.000	2.000
57	156.000	3.000
58	158.000	2.000
59	162.000	4.000
60	165.000	3.000
61	169.000	4.000
62	171.000	2.000
63	173.000	2.000
64	176.000	3.000
65	178.000	2.000
66	180.000	2.000
67	182.000	2.000
68	186.000	4.000
69	190.000	4.000
70	193.000	3.000
71	195.000	2.000
72	198.000	3.000
73	203.000	5.000
74	206.000	3.000
75	207.000	1.000
76	210.000	3.000
77	212.000	2.000
78	214.000	2.000
79	216.000	2.000
80	217.000	1.000
81	219.000	2.000
82	221.000	2.000
83	223.000	2.000
84	226.000	3.000
85	229.000	3.000
86	231.000	2.000

Study P07/4: Assemble and Press Plate and Spacer  
 Assembly - Assemble Rotor Pins and  
 Bottom Plate

NO.	ELAPSED	ACTUAL
1	11.000	11.000
2	17.000	6.000
3	25.000	8.000
4	32.000	7.000
5	38.000	6.000
6	43.000	5.000
7	51.000	8.000
8	58.000	7.000
9	63.000	5.000
10	67.000	4.000
11	74.000	7.000
12	80.000	6.000
13	88.000	8.000
14	94.000	6.000
15	99.000	5.000
16	104.000	5.000
17	109.000	5.000
18	125.000	16.000
19	131.000	6.000
20	140.000	9.000
21	150.000	10.000
22	155.000	5.000
23	160.000	5.000
24	165.000	5.000
25	170.000	5.000
26	176.000	6.000
27	183.000	7.000
28	190.000	7.000
29	196.000	6.000
30	199.000	3.000
31	204.000	5.000
32	211.000	7.000
33	218.000	7.000
34	222.000	4.000
35	228.000	6.000
36	233.000	5.000
37	237.000	4.000
38	242.000	5.000
39	246.000	4.000
40	253.000	7.000
41	258.000	5.000
42	268.000	10.000
43	278.000	10.000
44	283.000	5.000
45	288.000	5.000
46	295.000	7.000
47	300.000	5.000
48	308.000	8.000

49	309.000	1.000
50	317.000	8.000
51	323.000	6.000
52	330.000	7.000
53	338.000	8.000
54	346.000	8.000
55	352.000	6.000
56	359.000	7.000
57	365.000	6.000
58	370.000	5.000
59	376.000	6.000
60	383.000	7.000
61	388.000	5.000
62	393.000	5.000
63	397.000	4.000
64	403.000	6.000
65	408.000	5.000
66	413.000	5.000
67	419.000	6.000
68	423.000	4.000
69	429.000	6.000
70	434.000	5.000
71	440.000	6.000
72	447.000	7.000
73	452.000	5.000
74	458.000	6.000
75	464.000	6.000
76	469.000	5.000
77	477.000	8.000
78	483.000	6.000
79	487.000	4.000
80	491.000	4.000
81	499.000	8.000
82	503.000	4.000
83	508.000	5.000
84	513.000	5.000
85	519.000	6.000
86	523.000	4.000
87	529.000	6.000
88	538.000	9.000
89	544.000	6.000
90	548.000	4.000
91	554.000	6.000
92	559.000	5.000
93	567.000	8.000
94	572.000	5.000
95	576.000	4.000
96	581.000	5.000
97	586.000	5.000
98	591.000	5.000
99	597.000	6.000
100	601.000	4.000
101	606.000	5.000
102	610.000	4.000
103	615.000	5.000
104	623.000	8.000

Study P07/4: Assemble and Press Plate and Spacer  
 Assembly - Assemble Rotor Pins and  
 Bottom Plate

NO.	ELAPSED	ACTUAL
1	5.000	5.000
2	13.000	8.000
3	17.000	4.000
4	23.000	6.000
5	31.000	8.000
6	36.000	5.000
7	40.000	4.000
8	45.000	5.000
9	48.000	3.000
10	55.000	7.000
11	63.000	8.000
12	67.000	4.000
13	71.000	4.000
14	80.000	9.000
15	86.000	6.000
16	92.000	6.000
17	97.000	5.000
18	101.000	4.000
19	105.000	4.000
20	109.000	4.000
21	116.000	7.000
22	121.000	5.000
23	128.000	7.000
24	139.000	11.000
25	146.000	7.000
26	153.000	7.000
27	159.000	6.000
28	164.000	5.000
29	171.000	7.000
30	177.000	6.000
31	183.000	6.000
32	192.000	9.000
33	195.000	3.000
34	207.000	12.000
35	210.000	3.000
36	213.000	3.000
37	219.000	6.000
38	224.000	5.000
39	228.000	4.000
40	233.000	5.000
41	239.000	6.000
42	246.000	7.000
43	254.000	8.000
44	258.000	4.000
45	264.000	6.000
46	274.000	10.000
47	278.000	4.000
48	288.000	10.000

49	293.000	5.000
50	298.000	5.000
51	305.000	7.000
52	313.000	8.000
53	319.000	6.000
54	324.000	5.000
55	329.000	5.000
56	335.000	6.000
57	340.000	5.000
58	351.000	11.000
59	357.000	6.000
60	363.000	6.000
61	368.000	5.000
62	374.000	6.000
63	382.000	8.000
64	388.000	6.000
65	390.000	2.000
66	395.000	5.000
67	400.000	5.000
68	406.000	6.000
69	414.000	8.000
70	419.000	5.000
71	425.000	6.000
72	430.000	5.000
73	436.000	6.000
74	441.000	5.000
75	446.000	5.000
76	451.000	5.000
77	452.000	1.000
78	460.000	8.000
79	465.000	5.000
80	471.000	6.000
81	486.000	15.000
82	493.000	7.000
83	498.000	5.000
84	503.000	5.000
85	508.000	5.000
86	513.000	5.000
87	521.000	8.000

## Study P09/1: Assemble Gear Train - Assemble Spacer

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	9.000	5.000
3	17.000	8.000
4	22.000	5.000
5	27.000	5.000
6	31.000	4.000
7	35.000	4.000
8	38.000	3.000
9	42.000	4.000
10	51.000	9.000
11	56.000	5.000
12	62.000	6.000
13	65.000	3.000
14	69.000	4.000
15	72.000	3.000
16	75.000	3.000
17	80.000	5.000
18	84.000	4.000
19	87.000	3.000
20	90.000	3.000
21	101.000	11.000
22	105.000	4.000
23	108.000	3.000
24	112.000	4.000
25	117.000	5.000
26	120.000	3.000
27	123.000	3.000
28	129.000	6.000
29	133.000	4.000
30	136.000	3.000
31	140.000	4.000
32	143.000	3.000
33	147.000	4.000
34	150.000	3.000
35	154.000	4.000
36	158.000	4.000
37	168.000	10.000
38	177.000	9.000
39	186.000	9.000
40	190.000	4.000
41	194.000	4.000
42	197.000	3.000
43	202.000	5.000
44	206.000	4.000
45	209.000	3.000
46	212.000	3.000
47	215.000	3.000
48	217.000	2.000

49	222.000	5.000
50	225.000	3.000
51	229.000	4.000
52	232.000	3.000
53	234.000	2.000
54	238.000	4.000
55	244.000	6.000
56	248.000	4.000
57	252.000	4.000
58	255.000	3.000
59	258.000	3.000
60	262.000	4.000
61	265.000	3.000
62	269.000	4.000
63	272.000	3.000
64	276.000	4.000
65	279.000	3.000
66	283.000	4.000
67	285.000	2.000
68	288.000	3.000
69	298.000	10.000
70	301.000	3.000
71	304.000	3.000
72	307.000	3.000
73	310.000	3.000
74	315.000	5.000
75	319.000	4.000
76	328.000	9.000
77	331.000	3.000
78	335.000	4.000
79	339.000	4.000
80	341.000	2.000
81	345.000	4.000
82	351.000	6.000
83	354.000	3.000
84	358.000	4.000
85	361.000	3.000
86	365.000	4.000
87	370.000	5.000
88	373.000	3.000
89	377.000	4.000
90	380.000	3.000
91	383.000	2.000
92	387.000	1.000
93	390.000	3.000
94	397.000	7.000
95	400.000	3.000
96	406.000	6.000
97	410.000	4.000
98	413.000	3.000
99	418.000	5.000
100	423.000	5.000
101	427.000	4.000
102	440.000	12.000
103	445.000	5.000
104	449.000	4.000
105	452.000	3.000
106	456.000	4.000
107	459.000	3.000
108	463.000	4.000

109	466.000	3.000
110	469.000	3.000
111	471.000	2.000
112	477.000	6.000
113	481.000	4.000
114	485.000	4.000
115	489.000	4.000
116	492.000	3.000
117	495.000	3.000
118	502.000	7.000
119	520.000	18.000
120	535.000	15.000
121	542.000	7.000
122	545.000	3.000

Study P09/2: Assemble Gear Train - Assemble Interlock  
Detent

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	7.000	3.000
3	11.000	4.000
4	14.000	3.000
5	16.000	2.000
6	18.000	2.000
7	20.000	2.000
8	23.000	3.000
9	26.000	3.000
10	28.000	2.000
11	31.000	3.000
12	33.000	2.000
13	37.000	4.000
14	40.000	3.000
15	42.000	2.000
16	44.000	2.000
17	46.000	2.000
18	49.000	3.000
19	52.000	1.000
20	55.000	3.000
21	58.000	3.000
22	60.000	2.000
23	63.000	3.000
24	66.000	3.000
25	69.000	3.000
26	73.000	4.000
27	75.000	2.000
28	78.000	3.000
29	83.000	5.000
30	87.000	4.000
31	90.000	3.000
32	93.000	3.000
33	96.000	3.000
34	99.000	3.000
35	102.000	3.000
36	105.000	3.000
37	109.000	4.000
38	111.000	2.000
39	114.000	3.000
40	116.000	2.000
41	118.000	2.000
42	121.000	3.000
43	124.000	3.000
44	127.000	3.000
45	129.000	2.000
46	132.000	3.000
47	134.000	2.000
48	137.000	3.000

49	140.000	3.000
50	144.000	4.000
51	147.000	3.000
52	150.000	3.000
53	151.000	1.000
54	157.000	6.000
55	160.000	3.000
56	163.000	3.000
57	166.000	3.000
58	169.000	3.000
59	171.000	2.000
60	174.000	3.000
61	179.000	5.000
62	182.000	3.000
63	187.000	5.000
64	190.000	3.000

Study P09/3: Assemble Gear Train - Assemble Spin  
Detent

NO.	ELAPSED	ACTUAL
1	0.0	0.0
2	2.000	2.000
3	5.000	3.000
4	9.000	4.000
5	11.000	2.000
6	17.000	6.000
7	21.000	4.000
8	24.000	3.000
9	27.000	3.000
10	30.000	3.000
11	34.000	4.000
12	37.000	3.000
13	41.000	4.000
14	44.000	3.000
15	49.000	5.000
16	52.000	3.000
17	57.000	5.000
18	60.000	3.000
19	65.000	5.000
20	68.000	3.000
21	73.000	5.000
22	76.000	3.000
23	79.000	3.000
24	82.000	3.000
25	87.000	5.000
26	92.000	5.000
27	95.000	3.000
28	98.000	3.000
29	103.000	5.000
30	106.000	3.000
31	109.000	3.000
32	112.000	3.000
33	118.000	6.000
34	122.000	4.000
35	125.000	3.000
36	129.000	4.000
37	132.000	3.000
38	136.000	4.000
39	139.000	3.000
40	142.000	3.000
41	145.000	3.000
42	149.000	4.000
43	152.000	3.000
44	155.000	3.000
45	159.000	4.000
46	163.000	4.000
47	169.000	6.000
48	172.000	3.000

49	175.000	3.000
50	178.000	3.000
51	182.000	4.000
52	185.000	3.000
53	191.000	6.000
54	193.000	2.000
55	196.000	3.000
56	199.000	3.000
57	203.000	4.000
58	207.000	4.000
59	209.000	2.000
60	212.000	3.000
61	214.000	2.000
62	219.000	5.000

Study P09/4: Assemble Gear Train - Assemble Escape  
Gear

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	11.000	7.000
3	15.000	4.000
4	19.000	4.000
5	25.000	6.000
6	30.000	5.000
7	36.000	6.000
8	41.000	5.000
9	46.000	5.000
10	49.000	3.000
11	52.000	3.000
12	58.000	6.000
13	62.000	4.000
14	65.000	3.000
15	69.000	4.000
16	72.000	3.000
17	75.000	3.000
18	79.000	4.000
19	84.000	5.000
20	88.000	4.000
21	93.000	5.000
22	97.000	4.000
23	104.000	7.000
24	109.000	5.000
25	112.000	3.000
26	116.000	4.000
27	120.000	4.000
28	126.000	6.000
29	131.000	5.000
30	134.000	3.000
31	139.000	5.000
32	145.000	6.000
33	151.000	6.000
34	154.000	3.000
35	157.000	3.000
36	162.000	5.000
37	167.000	5.000
38	170.000	3.000
39	175.000	5.000
40	178.000	3.000
41	182.000	4.000
42	188.000	6.000
43	191.000	3.000
44	196.000	5.000
45	199.000	3.000
46	205.000	6.000
47	209.000	4.000
48	213.000	4.000

Study P09/4: Assemble Gear Train - Assemble Escape Gear

NO.	FLAPSED	ACTTAL
1	3.000	3.000
2	5.000	2.000
3	7.000	2.000
4	11.000	4.000
5	13.000	2.000
6	17.000	4.000
7	20.000	3.000
8	24.000	4.000
9	27.000	3.000
10	33.000	6.000
11	36.000	3.000
12	39.000	3.000
13	43.000	4.000
14	49.000	6.000
15	55.000	6.000
16	58.000	3.000
17	64.000	6.000
18	69.000	5.000
19	73.000	4.000
20	80.000	7.000
21	84.000	4.000
22	89.000	5.000
23	92.000	3.000
24	95.000	3.000
25	99.000	4.000
26	103.000	4.000
27	108.000	5.000
28	112.000	4.000
29	118.000	6.000
30	122.000	4.000
31	126.000	4.000
32	130.000	4.000
33	135.000	5.000
34	141.000	6.000
35	146.000	5.000
36	150.000	4.000
37	153.000	3.000
38	157.000	4.000
39	162.000	5.000
40	166.000	4.000
41	172.000	6.000
42	176.000	4.000
43	179.000	3.000
44	184.000	5.000
45	189.000	5.000
46	192.000	3.000
47	196.000	4.000
48	200.000	4.000

49	217.000	4.000
50	223.000	6.000
51	226.000	3.000
52	230.000	4.000
53	234.000	4.000
54	238.000	4.000
55	244.000	6.000
56	247.000	3.000
57	250.000	3.000
58	254.000	4.000
59	257.000	3.000
60	261.000	4.000
61	265.000	4.000
62	271.000	6.000
63	274.000	3.000
64	281.000	7.000
65	284.000	3.000
66	287.000	3.000
67	293.000	6.000
68	299.000	6.000
69	302.000	3.000
70	306.000	4.000
71	309.000	3.000
72	312.000	3.000
73	318.000	6.000
74	322.000	4.000
75	327.000	5.000
76	332.000	5.000
77	336.000	4.000
78	341.000	5.000
79	346.000	5.000
80	352.000	6.000
81	357.000	5.000
82	363.000	6.000
83	365.000	2.000
84	369.000	4.000
85	372.000	3.000
86	378.000	6.000
87	382.000	4.000
88	386.000	4.000
89	392.000	6.000
90	396.000	4.000
91	401.000	5.000
92	406.000	5.000
93	411.000	5.000
94	416.000	5.000
95	423.000	7.000
96	427.000	4.000
97	430.000	3.000
98	435.000	5.000
99	439.000	4.000
100	448.000	9.000
101	451.000	3.000
102	456.000	5.000
103	463.000	7.000
104	467.000	4.000
105	470.000	3.000
106	477.000	7.000
107	481.000	4.000
108	485.000	4.000

109	488.000	3.000
110	492.000	4.000
111	494.000	2.000
112	498.000	4.000
113	502.000	4.000
114	508.000	6.000
115	515.000	7.000
116	519.000	4.000
117	523.000	4.000
118	527.000	4.000
119	531.000	4.000
120	537.000	6.000
121	542.000	5.000
122	546.000	4.000

Study P09/5: Assemble Gear Train - Assemble Gear and  
Pinion

NO.	ELAPSED	ACTUAL
1	3.000	3.000
2	7.000	4.000
3	11.000	4.000
4	12.000	1.000
5	16.000	4.000
6	23.000	7.000
7	28.000	5.000
8	33.000	5.000
9	39.000	6.000
10	43.000	4.000
11	48.000	5.000
12	54.000	6.000
13	58.000	4.000
14	64.000	6.000
15	69.000	5.000
16	74.000	5.000
17	79.000	5.000
18	87.000	8.000
19	92.000	5.000
20	97.000	5.000
21	105.000	8.000
22	111.000	6.000
23	121.000	10.000
24	127.000	6.000
25	132.000	5.000
26	141.000	9.000
27	153.000	12.000
28	158.000	5.000
29	163.000	5.000
30	168.000	5.000
31	173.000	5.000
32	178.000	5.000
33	186.000	8.000
34	190.000	4.000
35	196.000	6.000
36	201.000	5.000
37	207.000	6.000
38	214.000	7.000
39	218.000	4.000
40	223.000	5.000
41	228.000	5.000
42	233.000	5.000
43	238.000	5.000
44	243.000	5.000
45	250.000	7.000
46	256.000	6.000
47	261.000	5.000
48	266.000	5.000

49	208.000	8.000
50	211.000	3.000
51	214.000	3.000
52	216.000	2.000
53	220.000	4.000
54	223.000	3.000
55	228.000	5.000
56	234.000	6.000
57	237.000	3.000
58	242.000	5.000
59	246.000	4.000
60	251.000	5.000
61	256.000	5.000
62	261.000	5.000
63	263.000	2.000
64	266.000	3.000
65	270.000	4.000
66	276.000	6.000
67	285.000	9.000
68	289.000	4.000
69	294.000	5.000
70	298.000	4.000
71	304.000	6.000
72	310.000	6.000
73	315.000	5.000
74	318.000	3.000
75	323.000	5.000
76	335.000	12.000
77	340.000	5.000
78	347.000	7.000
79	353.000	6.000
80	358.000	5.000
81	361.000	3.000
82	365.000	4.000
83	368.000	3.000
84	371.000	3.000
85	378.000	7.000
86	382.000	4.000
87	386.000	4.000
88	390.000	4.000
89	394.000	4.000
90	398.000	4.000
91	404.000	6.000
92	408.000	4.000
93	412.000	4.000
94	417.000	5.000
95	427.000	10.000
96	430.000	3.000
97	435.000	5.000
98	440.000	5.000
99	444.000	4.000
100	447.000	3.000
101	452.000	5.000
102	456.000	4.000
103	460.000	4.000
104	465.000	5.000
105	472.000	7.000
106	477.000	5.000
107	483.000	6.000
108	486.000	3.000

109	492.000	6.000
110	496.000	4.000
111	504.000	8.000
112	507.000	3.000
113	514.000	7.000
114	518.000	4.000
115	523.000	5.000
116	527.000	4.000
117	531.000	4.000
118	537.000	6.000
119	540.000	3.000
120	545.000	5.000
121	549.000	4.000
122	555.000	6.000
123	558.000	3.000
124	565.000	7.000
125	571.000	6.000
126	575.000	4.000
127	580.000	5.000
128	584.000	4.000
129	587.000	3.000

Study P09/5: Assemble Gear Train - Assemble Gear and Pinion

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	6.000	2.000
3	12.000	6.000
4	19.000	7.000
5	24.000	5.000
6	29.000	5.000
7	33.000	4.000
8	37.000	4.000
9	43.000	6.000
10	50.000	7.000
11	54.000	4.000
12	60.000	6.000
13	66.000	6.000
14	71.000	5.000
15	76.000	5.000
16	80.000	4.000
17	85.000	5.000
18	90.000	5.000
19	95.000	5.000
20	100.000	5.000
21	108.000	8.000
22	113.000	5.000
23	120.000	7.000
24	125.000	5.000
25	131.000	6.000
26	136.000	5.000
27	143.000	7.000
28	150.000	7.000
29	157.000	7.000
30	163.000	6.000
31	168.000	5.000
32	174.000	6.000
33	179.000	5.000
34	185.000	6.000
35	194.000	9.000
36	198.000	4.000
37	204.000	6.000
38	219.000	15.000
39	225.000	6.000
40	230.000	5.000
41	236.000	6.000
42	241.000	5.000
43	248.000	7.000
44	253.000	5.000
45	259.000	6.000
46	266.000	7.000
47	269.000	3.000
48	274.000	5.000

49	271.000	5.000
50	276.000	5.000
51	285.000	9.000
52	291.000	6.000
53	296.000	5.000
54	303.000	7.000
55	309.000	6.000
56	314.000	5.000
57	320.000	6.000
58	326.000	6.000
59	334.000	8.000
60	339.000	5.000
61	346.000	7.000
62	352.000	6.000
63	356.000	4.000
64	362.000	6.000
65	367.000	5.000
66	373.000	6.000
67	380.000	7.000
68	385.000	5.000
69	390.000	5.000
70	397.000	7.000
71	401.000	4.000
72	408.000	7.000
73	416.000	8.000
74	422.000	6.000
75	428.000	6.000
76	433.000	5.000
77	440.000	7.000
78	445.000	5.000
79	449.000	4.000
80	451.000	2.000
81	456.000	5.000
82	463.000	7.000
83	469.000	6.000
84	474.000	5.000
85	479.000	5.000
86	484.000	5.000
87	489.000	5.000
88	494.000	5.000
89	500.000	6.000
90	506.000	6.000
91	512.000	6.000
92	518.000	6.000
93	524.000	6.000
94	529.000	5.000
95	534.000	5.000
96	540.000	6.000
97	545.000	5.000
98	553.000	8.000
99	557.000	4.000
100	565.000	8.000
101	572.000	7.000
102	577.000	5.000
103	582.000	5.000
104	587.000	5.000
105	591.000	4.000
106	596.000	5.000
107	613.000	17.000
108	618.000	5.000

109	622.000	4.000
110	628.000	6.000
111	634.000	6.000
112	639.000	5.000
113	644.000	5.000
114	651.000	7.000
115	658.000	7.000
116	666.000	8.000
117	671.000	5.000
118	676.000	5.000

49	279.000	5.000
50	285.000	6.000
51	291.000	6.000
52	298.000	7.000
53	302.000	4.000
54	309.000	7.000
55	317.000	8.000
56	322.000	5.000
57	327.000	5.000
58	332.000	5.000
59	337.000	5.000
60	345.000	8.000
61	348.000	3.000
62	354.000	6.000
63	358.000	4.000
64	363.000	5.000
65	368.000	5.000
66	374.000	6.000
67	381.000	7.000
68	386.000	5.000
69	392.000	6.000
70	399.000	7.000
71	406.000	7.000
72	414.000	8.000
73	419.000	5.000
74	424.000	5.000
75	430.000	6.000
76	435.000	5.000
77	440.000	5.000
78	445.000	5.000
79	452.000	7.000
80	459.000	7.000
81	466.000	7.000
82	476.000	10.000
83	480.000	4.000
84	490.000	10.000
85	495.000	5.000
86	501.000	6.000
87	505.000	4.000
88	512.000	7.000
89	518.000	6.000
90	528.000	10.000
91	537.000	9.000
92	543.000	6.000
93	549.000	6.000
94	556.000	7.000
95	561.000	5.000
96	568.000	7.000
97	575.000	7.000
98	581.000	6.000
99	587.000	6.000
100	593.000	6.000
101	601.000	8.000
102	606.000	5.000
103	610.000	4.000
104	617.000	7.000
105	624.000	7.000
106	630.000	6.000
107	637.000	7.000
108	642.000	5.000

109	653.000	11.000
110	662.000	9.000
111	666.000	4.000
112	673.000	7.000
113	679.000	6.000
114	687.000	8.000
115	694.000	7.000
116	701.000	7.000
117	706.000	5.000
118	712.000	6.000
119	723.000	11.000

Study P09/6: Assemble Gear Train - Assemble Lever  
Assembly

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	8.000	4.000
3	11.000	3.000
4	14.000	3.000
5	19.000	5.000
6	26.000	7.000
7	29.000	3.000
8	33.000	4.000
9	39.000	6.000
10	44.000	5.000
11	50.000	6.000
12	54.000	4.000
13	56.000	2.000
14	60.000	4.000
15	64.000	4.000
16	67.000	3.000
17	70.000	3.000
18	73.000	3.000
19	76.000	3.000
20	79.000	3.000
21	84.000	5.000
22	87.000	3.000
23	90.000	3.000
24	94.000	4.000
25	97.000	3.000
26	100.000	3.000
27	102.000	2.000
28	104.000	2.000
29	107.000	3.000
30	110.000	3.000
31	112.000	2.000
32	114.000	2.000
33	117.000	3.000
34	121.000	4.000
35	124.000	3.000
36	126.000	2.000
37	129.000	3.000
38	134.000	5.000
39	136.000	2.000
40	139.000	3.000
41	142.000	3.000
42	145.000	3.000
43	149.000	4.000
44	152.000	3.000
45	155.000	3.000
46	159.000	4.000
47	163.000	4.000
48	165.000	2.000

NO.	ELAPSED	ACTUAL
1	2.000	2.000
2	5.000	3.000
3	9.000	4.000
4	12.000	3.000
5	15.000	3.000
6	19.000	4.000
7	24.000	5.000
8	27.000	3.000
9	33.000	6.000
10	37.000	4.000
11	43.000	6.000
12	45.000	2.000
13	48.000	3.000
14	52.000	4.000
15	55.000	3.000
16	59.000	4.000
17	62.000	3.000
18	65.000	3.000
19	70.000	5.000
20	73.000	3.000
21	76.000	3.000
22	78.000	2.000
23	81.000	3.000
24	87.000	6.000
25	89.000	2.000
26	93.000	4.000
27	99.000	6.000
28	102.000	3.000
29	105.000	3.000
30	108.000	3.000
31	111.000	3.000
32	118.000	7.000
33	121.000	3.000
34	125.000	4.000
35	130.000	5.000
36	133.000	3.000

49	169.000	3.000
50	172.000	4.000
51	175.000	3.000
52	178.000	3.000
53	180.000	2.000
54	183.000	3.000
55	186.000	3.000
56	189.000	3.000
57	192.000	3.000
58	194.000	2.000
59	197.000	3.000
60	200.000	3.000
61	202.000	2.000
62	204.000	2.000
63	208.000	4.000
64	212.000	4.000
65	216.000	4.000
66	218.000	2.000
67	221.000	3.000
68	227.000	6.000
69	230.000	3.000
70	232.000	2.000
71	235.000	3.000
72	238.000	3.000
73	241.000	3.000
74	245.000	4.000
75	248.000	3.000
76	250.000	2.000
77	254.000	4.000
78	256.000	2.000
79	259.000	3.000
80	263.000	4.000
81	265.000	2.000
82	268.000	3.000
83	272.000	4.000
84	276.000	4.000
85	278.000	2.000
86	281.000	3.000
87	285.000	4.000
88	288.000	3.000
89	291.000	3.000
90	294.000	3.000
91	297.000	3.000
92	300.000	3.000
93	303.000	3.000
94	306.000	3.000
95	312.000	6.000
96	315.000	3.000
97	318.000	3.000
98	321.000	3.000
99	324.000	3.000
100	325.000	1.000
101	328.000	3.000
102	332.000	4.000
103	335.000	3.000
104	337.000	2.000
105	339.000	2.000
106	340.000	1.000
107	343.000	3.000
108	346.000	3.000

109	349.000	3.000
110	352.000	3.000
111	355.000	3.000
112	359.000	4.000
113	361.000	2.000
114	364.000	3.000
115	367.000	3.000
116	370.000	3.000
117	373.000	3.000
118	376.000	3.000

Study P09/7: Assemble Gear Train - Assemble Rotor  
Assembly

NO.	ELAPSED	ACTUAL
1	2.000	2.000
2	4.000	2.000
3	7.000	3.000
4	10.000	3.000
5	13.000	3.000
6	15.000	2.000
7	17.000	2.000
8	20.000	3.000
9	23.000	3.000
10	26.000	3.000
11	30.000	4.000
12	33.000	3.000
13	35.000	2.000
14	40.000	5.000
15	45.000	5.000
16	51.000	6.000
17	54.000	3.000
18	57.000	3.000
19	58.000	1.000
20	61.000	3.000
21	69.000	8.000
22	71.000	2.000
23	74.000	3.000
24	76.000	2.000
25	79.000	3.000
26	86.000	7.000
27	89.000	3.000
28	91.000	2.000
29	94.000	3.000
30	96.000	2.000
31	98.000	2.000
32	102.000	4.000
33	107.000	5.000
34	111.000	4.000
35	115.000	4.000
36	118.000	3.000
37	120.000	2.000
38	125.000	5.000
39	128.000	3.000
40	131.000	3.000
41	133.000	2.000
42	135.000	2.000
43	138.000	3.000
44	143.000	5.000
45	145.000	2.000
46	148.000	3.000
47	151.000	3.000
48	153.000	2.000

49	154.000	1.000
50	160.000	6.000
51	163.000	3.000
52	165.000	2.000
53	167.000	2.000
54	170.000	3.000
55	177.000	7.000
56	182.000	5.000
57	184.000	2.000
58	194.000	10.000
59	196.000	2.000
60	200.000	4.000
61	204.000	4.000
62	207.000	3.000
63	209.000	2.000
64	213.000	4.000
65	216.000	3.000
66	220.000	4.000
67	222.000	2.000
68	225.000	3.000
69	229.000	4.000
70	231.000	2.000
71	235.000	4.000
72	240.000	5.000
73	245.000	5.000
74	247.000	2.000
75	250.000	3.000
76	254.000	4.000
77	257.000	3.000
78	259.000	2.000
79	262.000	3.000
80	268.000	6.000
81	272.000	4.000
82	274.000	2.000
83	276.000	2.000
84	278.000	2.000
85	281.000	3.000
86	283.000	2.000
87	289.000	6.000
88	292.000	3.000
89	296.000	4.000
90	299.000	3.000
91	302.000	3.000
92	305.000	3.000
93	308.000	3.000
94	310.000	2.000
95	312.000	2.000
96	315.000	3.000
97	318.000	3.000
98	320.000	2.000
99	325.000	5.000
100	327.000	2.000
101	331.000	4.000
102	338.000	7.000
103	341.000	3.000
104	344.000	3.000
105	347.000	3.000
106	350.000	3.000
107	352.000	2.000
108	355.000	3.000

109	358.000	3.000
110	361.000	3.000
111	363.000	2.000
112	366.000	3.000
113	369.000	3.000
114	372.000	3.000
115	374.000	2.000
116	376.000	2.000
117	379.000	3.000
118	380.000	1.000
119	383.000	3.000
120	386.000	3.000
121	388.000	2.000
122	393.000	5.000
123	395.000	2.000
124	398.000	3.000

## Study P09/8: Assemble Gear Train - Assemble Spring

NO.	ELAPSED	ACTUAL
1	1.000	1.000
2	6.000	5.000
3	15.000	9.000
4	19.000	4.000
5	24.000	5.000
6	30.000	6.000
7	36.000	6.000
8	41.000	5.000
9	45.000	4.000
10	51.000	6.000
11	56.000	5.000
12	63.000	7.000
13	67.000	4.000
14	73.000	6.000
15	78.000	5.000
16	84.000	6.000
17	88.000	4.000
18	95.000	7.000
19	99.000	4.000
20	104.000	5.000
21	109.000	5.000
22	113.000	4.000
23	123.000	10.000
24	134.000	11.000
25	139.000	5.000
26	144.000	5.000
27	151.000	7.000
28	158.000	7.000
29	162.000	4.000
30	167.000	5.000
31	171.000	4.000
32	180.000	9.000
33	189.000	9.000
34	194.000	5.000
35	206.000	12.000
36	212.000	6.000
37	219.000	7.000
38	225.000	6.000
39	231.000	6.000
40	237.000	6.000
41	244.000	7.000
42	249.000	5.000
43	254.000	5.000
44	262.000	8.000
45	269.000	6.000
46	276.000	8.000
47	282.000	6.000
48	286.000	4.000

49	291.000	5.000
50	300.000	9.000
51	307.000	7.000
52	311.000	4.000
53	317.000	6.000
54	323.000	6.000
55	328.000	5.000
56	333.000	5.000
57	339.000	6.000
58	346.000	7.000
59	352.000	6.000
60	358.000	6.000
61	364.000	6.000
62	371.000	7.000
63	378.000	7.000
64	385.000	7.000
65	391.000	6.000
66	391.000	0.0
67	395.000	4.000
68	400.000	5.000
69	406.000	6.000
70	411.000	5.000
71	415.000	4.000
72	422.000	7.000
73	430.000	8.000
74	437.000	7.000
75	444.000	7.000
76	448.000	4.000
77	455.000	7.000
78	465.000	10.000
79	471.000	6.000
80	479.000	8.000
81	488.000	9.000
82	493.000	5.000
83	500.000	7.000
84	509.000	9.000
85	516.000	7.000
86	519.000	3.000
87	523.000	4.000
88	529.000	6.000
89	534.000	5.000
90	540.000	6.000
91	545.000	5.000
92	553.000	8.000
93	561.000	8.000
94	564.000	3.000
95	569.000	4.000
96	575.000	7.000
97	580.000	5.000
98	586.000	6.000
99	589.000	3.000
100	596.000	7.000
101	603.000	7.000
102	605.000	2.000
103	612.000	7.000
104	617.000	5.000
105	623.000	6.000
106	627.000	4.000
107	633.000	6.000
108	643.000	10.000

109	649.000	6.000
110	654.000	5.000
111	659.000	5.000
112	666.000	7.000
113	671.000	5.000
114	680.000	9.000
115	685.000	5.000
116	690.000	5.000
117	694.000	4.000
118	700.000	6.000
119	706.000	6.000
120	713.000	7.000
121	719.000	6.000
122	724.000	5.000

## Study P09/9: Assemble Gear Train - Assemble Spring

TABLE OF RAW DATA - DECIMAL MINUTES

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	8.000	4.000
3	12.000	4.000
4	19.000	7.000
5	23.000	4.000
6	30.000	7.000
7	34.000	4.000
8	40.000	6.000
9	45.000	5.000
10	51.000	6.000
11	55.000	4.000
12	62.000	7.000
13	68.000	6.000
14	72.000	4.000
15	77.000	5.000
16	82.000	5.000
17	86.000	4.000
18	89.000	3.000
19	92.000	3.000
20	96.000	4.000
21	100.000	4.000
22	103.000	3.000
23	107.000	4.000
24	111.000	4.000
25	115.000	4.000
26	118.000	3.000
27	122.000	4.000
28	129.000	7.000
29	133.000	4.000
30	136.000	3.000
31	139.000	3.000
32	141.000	2.000
33	146.000	5.000
34	149.000	3.000
35	152.000	3.000
36	157.000	5.000
37	160.000	3.000
38	164.000	4.000
39	167.000	3.000
40	170.000	3.000
41	173.000	3.000
42	177.000	4.000
43	181.000	4.000
44	185.000	4.000
45	188.000	3.000
46	191.000	3.000
47	194.000	3.000
48	198.000	4.000

49	202.000	4.000
50	206.000	4.000
51	212.000	6.000
52	220.000	8.000
53	223.000	3.000
54	226.000	3.000
55	230.000	4.000
56	235.000	5.000
57	238.000	3.000
58	243.000	5.000
59	247.000	4.000
60	252.000	5.000
61	257.000	5.000
62	260.000	3.000
63	263.000	3.000
64	267.000	4.000
65	271.000	4.000
66	274.000	3.000
67	277.000	3.000
68	280.000	3.000
69	284.000	4.000
70	290.000	6.000
71	292.000	2.000
72	295.000	3.000
73	298.000	3.000
74	302.000	4.000
75	306.000	4.000
76	309.000	3.000
77	312.000	3.000
78	318.000	6.000
79	321.000	3.000
80	324.000	3.000
81	327.000	3.000
82	330.000	3.000
83	335.000	5.000
84	340.000	5.000
85	346.000	6.000
86	349.000	3.000
87	353.000	4.000
88	356.000	3.000
89	361.000	5.000
90	364.000	3.000
91	366.000	2.000
92	369.000	3.000
93	373.000	4.000
94	379.000	6.000
95	382.000	3.000
96	396.000	14.000
97	399.000	3.000
98	402.000	3.000
99	406.000	4.000
100	409.000	3.000
101	414.000	5.000
102	418.000	4.000
103	421.000	3.000
104	425.000	4.000
105	428.000	3.000
106	434.000	6.000
107	437.000	3.000
108	442.000	5.000

109	454.000	12.000
110	457.000	3.000
111	460.000	3.000
112	464.000	4.000
113	466.000	2.000
114	470.000	4.000
115	475.000	5.000
116	479.000	4.000
117	482.000	3.000
118	485.000	3.000
119	491.000	6.000

Study P09/10: Assemble Gear Train - Assemble Bottom  
Plate

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	13.000	9.000
3	21.000	8.000
4	30.000	9.000
5	38.000	8.000
6	45.000	7.000
7	52.000	7.000
8	57.000	5.000
9	64.000	7.000
10	68.000	4.000
11	73.000	5.000
12	84.000	11.000
13	90.000	6.000
14	94.000	4.000
15	99.000	5.000
16	106.000	7.000
17	112.000	6.000
18	119.000	7.000
19	125.000	6.000
20	130.000	5.000
21	136.000	6.000
22	142.000	6.000
23	150.000	8.000
24	156.000	6.000
25	161.000	5.000
26	167.000	6.000
27	180.000	13.000
28	185.000	5.000
29	193.000	8.000
30	198.000	5.000
31	204.000	6.000
32	213.000	9.000
33	222.000	9.000
34	227.000	5.000
35	233.000	6.000
36	239.000	6.000
37	247.000	8.000
38	253.000	6.000
39	261.000	8.000
40	268.000	7.000
41	277.000	9.000
42	285.000	8.000
43	291.000	6.000
44	298.000	7.000
45	304.000	6.000
46	317.000	13.000
47	325.000	8.000
48	331.000	6.000

49	337.000	6.000
50	343.000	6.000
51	354.000	11.000
52	362.000	8.000
53	369.000	7.000
54	375.000	6.000
55	386.000	11.000
56	392.000	6.000
57	399.000	7.000
58	406.000	7.000
59	411.000	5.000
60	427.000	16.000
61	434.000	7.000
62	444.000	10.000
63	452.000	8.000
64	459.000	7.000
65	465.000	6.000
66	471.000	6.000
67	478.000	7.000
68	487.000	9.000
69	496.000	9.000
70	503.000	7.000
71	510.000	7.000
72	516.000	6.000
73	523.000	7.000
74	531.000	8.000
75	539.000	8.000
76	547.000	8.000
77	554.000	7.000
78	561.000	7.000
79	570.000	9.000
80	577.000	7.000
81	583.000	6.000
82	592.000	9.000
83	604.000	12.000
84	609.000	5.000
85	617.000	8.000
86	622.000	5.000
87	631.000	9.000
88	640.000	9.000
89	646.000	6.000
90	654.000	8.000
91	659.000	5.000
92	666.000	7.000
93	673.000	7.000
94	679.000	6.000
95	686.000	7.000
96	696.000	10.000
97	703.000	7.000
98	714.000	11.000
99	720.000	6.000
100	727.000	7.000
101	729.000	2.000
102	734.000	5.000
103	743.000	9.000
104	747.000	4.000
105	756.000	9.000
106	762.000	6.000
107	770.000	8.000
108	776.000	6.000

109	782.000	6.000
110	786.000	4.000
111	794.000	8.000
112	802.000	8.000
113	808.000	6.000
114	819.000	11.000
115	827.000	8.000
116	838.000	11.000
117	848.000	10.000
118	856.000	3.000
119	862.000	6.000
120	868.000	6.000
121	877.000	9.000
122	884.000	7.000
123	894.000	10.000
124	901.000	7.000
125	909.000	8.000
126	916.000	7.000

Study P09/11: Assemble Gear Train - Part Aside to  
Tray

NO.	ELAPSED	ACTUAL
1	3.000	3.000
2	6.000	3.000
3	9.000	3.000
4	11.000	2.000
5	12.000	1.000
6	17.000	5.000
7	19.000	2.000
8	21.000	2.000
9	23.000	2.000
10	26.000	3.000
11	29.000	3.000
12	31.000	2.000
13	33.000	2.000
14	36.000	3.000
15	40.000	4.000
16	44.000	4.000
17	46.000	2.000
18	48.000	2.000
19	50.000	2.000
20	53.000	3.000
21	54.000	1.000
22	56.000	2.000
23	59.000	3.000
24	62.000	3.000
25	64.000	2.000
26	67.000	3.000
27	70.000	3.000
28	77.000	7.000
29	80.000	3.000
30	82.000	2.000
31	84.000	2.000
32	87.000	3.000
33	90.000	3.000
34	92.000	2.000
35	94.000	2.000
36	96.000	2.000
37	98.000	2.000
38	100.000	2.000
39	103.000	3.000
40	105.000	2.000
41	107.000	2.000
42	110.000	3.000
43	113.000	3.000
44	116.000	3.000
45	117.000	1.000
46	121.000	4.000
47	123.000	2.000
48	128.000	5.000

49	130.000	2.000
50	134.000	4.000
51	137.000	3.000
52	140.000	3.000
53	142.000	2.000
54	145.000	3.000
55	148.000	3.000
56	151.000	3.000
57	154.000	3.000
58	158.000	4.000
59	160.000	2.000
60	162.000	2.000
61	165.000	3.000
62	167.000	2.000
63	170.000	3.000
64	173.000	3.000
65	176.000	3.000
66	183.000	7.000
67	185.000	2.000
68	188.000	3.000
69	191.000	3.000
70	193.000	2.000
71	197.000	4.000
72	199.000	2.000
73	201.000	2.000
74	205.000	4.000

Study P10/1: Arming and Non-Arming Fuse - Remove the Fuse

NO.	ELAPSED	ACTUAL
1	6.000	6.000
2	13.000	7.000
3	21.000	8.000
4	27.000	6.000
5	34.000	7.000
6	41.000	7.000
7	48.000	7.000
8	56.000	8.000
9	63.000	7.000
10	70.000	7.000
11	73.000	3.000
12	78.000	5.000
13	85.000	7.000
14	91.000	6.000
15	99.000	8.000
16	106.000	7.000
17	111.000	5.000
18	116.000	5.000
19	122.000	6.000
20	127.000	5.000
21	134.000	7.000
22	140.000	6.000
23	148.000	8.000
24	153.000	5.000
25	169.000	16.000
26	176.000	7.000
27	184.000	8.000
28	191.000	7.000
29	197.000	6.000
30	203.000	6.000
31	208.000	5.000
32	214.000	6.000
33	221.000	7.000
34	227.000	6.000
35	234.000	7.000
36	241.000	7.000
37	246.000	5.000
38	250.000	4.000
39	255.000	5.000
40	263.000	8.000
41	270.000	7.000
42	277.000	7.000
43	282.000	5.000
44	288.000	6.000
45	301.000	13.000
46	306.000	5.000
47	308.000	2.000
48	314.000	6.000

49	320.000	6.000
50	329.000	9.000
51	337.000	8.000
52	345.000	8.000
53	352.000	7.000
54	357.000	5.000
55	363.000	6.000
56	369.000	6.000
57	376.000	7.000
58	382.000	6.000
59	393.000	11.000
60	399.000	6.000
61	405.000	6.000
62	410.000	5.000
63	417.000	7.000
64	423.000	6.000
65	429.000	6.000
66	435.000	6.000
67	442.000	7.000
68	448.000	6.000
69	455.000	7.000
70	466.000	11.000
71	472.000	6.000
72	478.000	6.000
73	487.000	9.000
74	493.000	6.000
75	500.000	7.000
76	507.000	7.000
77	511.000	4.000
78	517.000	6.000
79	522.000	5.000
80	529.000	7.000
81	537.000	8.000
82	543.000	6.000
83	556.000	13.000
84	562.000	6.000
85	568.000	6.000
86	574.000	6.000
87	581.000	7.000
88	588.000	7.000
89	595.000	7.000
90	600.000	5.000
91	607.000	7.000
92	613.000	6.000
93	621.000	8.000
94	629.000	8.000
95	635.000	6.000
96	641.000	6.000
97	647.000	6.000
98	655.000	8.000
99	661.000	6.000
100	669.000	8.000
101	674.000	5.000

Study P10/2: Arming and Non-Arming Fuse - Load the Fuse

NO.	ELAPSED	ACTUAL
1	7.000	7.000
2	17.000	10.000
3	25.000	8.000
4	36.000	11.000
5	43.000	7.000
6	51.000	8.000
7	60.000	9.000
8	70.000	10.000
9	79.000	9.000
10	88.000	9.000
11	96.000	8.000
12	105.000	9.000
13	113.000	8.000
14	122.000	9.000
15	130.000	8.000
16	138.000	8.000
17	146.000	8.000
18	153.000	7.000
19	163.000	10.000
20	171.000	8.000
21	178.000	7.000
22	187.000	9.000
23	196.000	9.000
24	212.000	16.000
25	220.000	8.000
26	228.000	8.000
27	236.000	8.000
28	245.000	9.000
29	253.000	8.000
30	261.000	8.000
31	269.000	8.000
32	277.000	8.000
33	285.000	3.000
34	296.000	11.000
35	305.000	9.000
36	312.000	7.000
37	320.000	8.000
38	327.000	7.000
39	336.000	9.000
40	344.000	8.000
41	353.000	9.000
42	360.000	7.000
43	369.000	9.000
44	380.000	11.000
45	384.000	4.000
46	396.000	12.000
47	405.000	9.000
48	413.000	8.000

49	423.000	10.000
50	434.000	11.000
51	441.000	7.000
52	450.000	9.000
53	463.000	13.000
54	472.000	9.000
55	477.000	5.000
56	487.000	10.000
57	498.000	11.000
58	507.000	9.000
59	512.000	5.000
60	519.000	7.000
61	526.000	7.000
62	532.000	6.000
63	541.000	9.000
64	549.000	8.000
65	557.000	8.000
66	565.000	8.000
67	574.000	9.000
68	585.000	11.000
69	592.000	7.000
70	597.000	5.000
71	608.000	11.000
72	617.000	9.000
73	623.000	6.000
74	632.000	9.000
75	640.000	8.000
76	649.000	9.000
77	659.000	10.000
78	666.000	7.000
79	675.000	9.000
80	682.000	7.000
81	694.000	12.000
82	698.000	4.000
83	708.000	10.000
84	717.000	9.000
85	725.000	8.000
86	739.000	14.000
87	747.000	8.000
88	755.000	8.000
89	765.000	10.000
90	773.000	8.000
91	782.000	9.000
92	790.000	8.000
93	797.000	7.000
94	806.000	9.000
95	815.000	9.000
96	821.000	6.000
97	830.000	9.000
98	838.000	8.000
99	846.000	3.000
100	853.000	7.000

Study P11/1: Insert Retaining Ring - Load the Fuse  
into the Fixture

NO.	ELAPSED	ACTUAL
1	6.000	6.000
2	10.000	4.000
3	15.000	5.000
4	16.000	1.000
5	19.000	3.000
6	25.000	6.000
7	28.000	3.000
8	30.000	2.000
9	33.000	3.000
10	38.000	5.000
11	42.000	4.000
12	49.000	7.000
13	55.000	6.000
14	58.000	3.000
15	67.000	9.000
16	70.000	3.000
17	73.000	3.000
18	77.000	4.000
19	82.000	5.000
20	92.000	10.000
21	94.000	2.000
22	95.000	1.000
23	99.000	4.000
24	105.000	6.000
25	112.000	7.000
26	116.000	4.000
27	120.000	4.000
28	124.000	4.000
29	126.000	2.000
30	129.000	3.000
31	132.000	3.000
32	135.000	3.000
33	139.000	4.000
34	143.000	4.000
35	146.000	3.000
36	148.000	2.000
37	152.000	4.000
38	154.000	2.000
39	159.000	5.000
40	160.000	1.000
41	164.000	4.000
42	168.000	4.000
43	170.000	2.000
44	173.000	3.000
45	176.000	3.000
46	180.000	4.000
47	185.000	5.000
48	189.000	4.000

49	191.000	2.000
50	196.000	5.000
51	199.000	3.000
52	204.000	5.000
53	209.000	5.000
54	214.000	5.000
55	218.000	4.000
56	221.000	3.000
57	223.000	2.000
58	228.000	5.000
59	232.000	4.000
60	235.000	3.000
61	240.000	5.000
62	245.000	5.000
63	250.000	5.000
64	252.000	2.000
65	257.000	5.000
66	261.000	4.000
67	264.000	3.000
68	267.000	3.000
69	269.000	2.000
70	274.000	5.000
71	282.000	8.000
72	285.000	3.000
73	286.000	1.000
74	288.000	2.000
75	291.000	3.000
76	296.000	5.000
77	301.000	5.000
78	306.000	5.000
79	309.000	3.000
80	313.000	4.000
81	317.000	4.000
82	323.000	6.000
83	326.000	3.000

## Study P12/1: Stake Ring - Load Fuse into the Fixture

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	8.000	4.000
3	13.000	5.000
4	19.000	6.000
5	23.000	4.000
6	27.000	4.000
7	33.000	6.000
8	37.000	4.000
9	43.000	6.000
10	48.000	5.000
11	51.000	3.000
12	57.000	6.000
13	62.000	5.000
14	67.000	5.000
15	72.000	5.000
16	78.000	6.000
17	82.000	4.000
18	88.000	6.000
19	93.000	5.000
20	96.000	3.000
21	100.000	4.000
22	105.000	5.000
23	110.000	5.000
24	115.000	5.000
25	120.000	5.000
26	125.000	5.000
27	127.000	2.000
28	133.000	6.000
29	140.000	7.000
30	145.000	5.000
31	149.000	4.000
32	154.000	5.000
33	158.000	4.000
34	166.000	8.000
35	174.000	8.000
36	178.000	4.000
37	184.000	6.000
38	189.000	5.000
39	194.000	5.000
40	197.000	3.000
41	205.000	8.000
42	208.000	3.000
43	213.000	5.000
44	218.000	5.000
45	223.000	5.000
46	236.000	13.000
47	243.000	7.000
48	248.000	5.000

49	252.000	4.000
50	257.000	5.000
51	261.000	4.000
52	267.000	6.000
53	272.000	5.000
54	277.000	5.000
55	282.000	5.000
56	290.000	8.000
57	295.000	5.000
58	299.000	4.000
59	303.000	4.000
60	308.000	5.000
61	315.000	7.000
62	320.000	5.000
63	327.000	7.000
64	332.000	5.000
65	338.000	6.000
66	342.000	4.000
67	347.000	5.000
68	351.000	4.000
69	356.000	5.000
70	360.000	4.000
71	365.000	5.000
72	371.000	6.000
73	377.000	6.000
74	383.000	6.000
75	390.000	7.000
76	395.000	5.000
77	399.000	4.000
78	404.000	5.000
79	409.000	5.000
80	414.000	5.000
81	420.000	6.000
82	423.000	3.000
83	428.000	5.000
84	433.000	5.000
85	438.000	5.000
86	442.000	4.000
87	447.000	5.000
88	452.000	5.000
89	458.000	6.000
90	464.000	6.000
91	469.000	5.000
92	473.000	4.000
93	478.000	5.000
94	484.000	6.000
95	490.000	6.000
96	495.000	5.000
97	500.000	5.000
98	503.000	3.000
99	508.000	5.000
100	513.000	5.000
101	518.000	5.000
102	523.000	5.000
103	527.000	4.000
104	532.000	5.000
105	539.000	7.000
106	549.000	10.000
107	555.000	6.000
108	559.000	4.000

109	562.000	3.000
110	568.000	6.000
111	574.000	6.000
112	578.000	4.000
113	587.000	9.000
114	592.000	5.000
115	596.000	4.000
116	601.000	5.000
117	606.000	5.000
118	612.000	6.000
119	619.000	7.000
120	624.000	5.000
121	630.000	6.000
122	635.000	5.000
123	641.000	6.000
124	646.000	5.000
125	651.000	5.000
126	656.000	5.000
127	663.000	7.000
128	670.000	7.000
129	676.000	6.000
130	679.000	3.000
131	683.000	4.000
132	689.000	6.000
133	694.000	5.000
134	701.000	7.000
135	707.000	6.000
136	712.000	5.000
137	718.000	6.000
138	724.000	6.000
139	728.000	4.000
140	732.000	4.000
141	736.000	4.000
142	740.000	4.000
143	746.000	6.000
144	753.000	7.000
145	761.000	8.000
146	768.000	7.000
147	774.000	6.000
148	778.000	4.000
149	803.000	25.000
150	810.000	7.000
151	816.000	6.000
152	820.000	4.000
153	825.000	5.000
154	830.000	5.000
155	835.000	5.000
156	840.000	5.000
157	845.000	5.000
158	850.000	5.000
159	855.000	5.000
160	867.000	12.000

Study P12/2: Stake Ring - Remove Fuse from the  
Fixture

NO.	ELAPSED	ACTUAL
1	5.000	5.000
2	12.000	7.000
3	17.000	5.000
4	22.000	5.000
5	27.000	5.000
6	32.000	5.000
7	37.000	5.000
8	46.000	9.000
9	51.000	5.000
10	55.000	4.000
11	60.000	5.000
12	64.000	4.000
13	69.000	5.000
14	74.000	5.000
15	80.000	6.000
16	86.000	6.000
17	91.000	5.000
18	97.000	6.000
19	102.000	5.000
20	109.000	7.000
21	114.000	5.000
22	119.000	5.000
23	124.000	5.000
24	130.000	6.000
25	136.000	6.000
26	142.000	6.000
27	150.000	8.000
28	154.000	4.000
29	158.000	4.000
30	163.000	5.000
31	169.000	6.000
32	174.000	5.000
33	179.000	5.000
34	183.000	4.000
35	190.000	7.000
36	195.000	5.000
37	202.000	7.000
38	207.000	5.000
39	212.000	5.000
40	218.000	6.000
41	223.000	5.000
42	227.000	4.000
43	231.000	4.000
44	235.000	4.000
45	241.000	6.000
46	246.000	5.000
47	253.000	7.000
48	258.000	5.000

49	263.000	5.000
50	268.000	5.000
51	272.000	4.000
52	278.000	6.000
53	283.000	5.000
54	287.000	4.000
55	292.000	5.000
56	296.000	4.000
57	304.000	8.000
58	307.000	3.000
59	311.000	4.000
60	315.000	4.000
61	319.000	4.000
62	324.000	5.000
63	329.000	5.000
64	334.000	5.000
65	338.000	4.000
66	343.000	5.000
67	348.000	5.000
68	353.000	5.000
69	358.000	5.000
70	363.000	5.000
71	369.000	6.000
72	374.000	5.000
73	379.000	5.000
74	384.000	5.000
75	388.000	4.000
76	393.000	5.000
77	397.000	4.000
78	402.000	5.000
79	406.000	4.000
80	412.000	6.000
81	416.000	4.000
82	419.000	3.000
83	423.000	4.000
84	426.000	3.000
85	431.000	5.000
86	436.000	5.000
87	440.000	4.000
88	444.000	4.000
89	450.000	6.000
90	456.000	6.000
91	461.000	5.000
92	466.000	5.000
93	471.000	5.000
94	475.000	4.000
95	480.000	5.000
96	485.000	5.000
97	491.000	6.000
98	498.000	7.000
99	502.000	4.000
100	510.000	8.000
101	514.000	4.000
102	520.000	6.000
103	526.000	6.000
104	530.000	4.000
105	535.000	5.000
106	539.000	4.000
107	544.000	5.000
108	549.000	5.000

109	553.000	4.000
110	558.000	5.000
111	563.000	5.000
112	567.000	4.000
113	570.000	3.000
114	574.000	4.000
115	579.000	5.000
116	584.000	5.000
117	589.000	5.000
118	594.000	5.000
119	598.000	4.000
120	602.000	4.000
121	608.000	6.000
122	613.000	5.000
123	619.000	6.000
124	624.000	5.000
125	628.000	4.000
126	632.000	4.000
127	637.000	5.000
128	641.000	4.000
129	651.000	10.000
130	658.000	7.000
131	662.000	4.000
132	670.000	8.000
133	674.000	4.000
134	678.000	4.000
135	681.000	4.000
136	685.000	4.000
137	689.000	4.000
138	693.000	4.000
139	698.000	5.000
140	706.000	8.000
141	710.000	4.000
142	714.000	4.000
143	722.000	3.000
144	727.000	5.000
145	734.000	7.000
146	738.000	4.000
147	743.000	5.000
148	747.000	4.000
149	751.000	4.000
150	757.000	6.000
151	762.000	5.000
152	767.000	5.000
153	771.000	4.000
154	775.000	4.000
155	779.000	4.000
156	784.000	5.000
157	789.000	5.000
158	800.000	11.000
159	810.000	10.000

Study P13/1: Stake Ring - Apply Silastic to Fuse  
Assembly - Load Piece into the Fixture

NO.	ELAPSED	ACTUAL
1	4.000	4.000
2	7.000	3.000
3	14.000	7.000
4	18.000	4.000
5	27.000	9.000
6	30.000	3.000
7	36.000	6.000
8	42.000	6.000
9	45.000	3.000
10	51.000	6.000
11	58.000	7.000
12	63.000	5.000
13	69.000	6.000
14	74.000	5.000
15	79.000	5.000
16	86.000	7.000
17	89.000	3.000
18	94.000	5.000
19	99.000	5.000
20	106.000	7.000
21	109.000	3.000
22	113.000	4.000
23	118.000	5.000
24	127.000	9.000
25	130.000	3.000
26	134.000	4.000
27	146.000	12.000
28	153.000	7.000
29	157.000	4.000
30	163.000	6.000
31	169.000	6.000

Study P13/3: Apply Silastic to Fuse Assembly -  
Unload Fuse from Fixture and Lay  
Aside

NO.	ELAPSED	ACTUAL
1	3.000	3.000
2	7.000	4.000
3	10.000	3.000
4	13.000	3.000
5	17.000	4.000
6	23.000	6.000
7	25.000	2.000
8	29.000	4.000
9	32.000	3.000
10	37.000	5.000
11	40.000	3.000
12	45.000	5.000
13	48.000	3.000
14	51.000	3.000
15	55.000	4.000
16	60.000	5.000
17	64.000	4.000
18	66.000	2.000
19	69.000	3.000
20	73.000	4.000
21	77.000	4.000
22	81.000	4.000
23	84.000	3.000
24	88.000	4.000
25	91.000	3.000
26	95.000	4.000
27	100.000	5.000
28	104.000	4.000
29	107.000	3.000
30	109.000	2.000
31	111.000	2.000
32	114.000	3.000

# Appendix E: Distribution of MTM-1 Categories in the Field Data

Task	Reference Number	RfA	MfA	MfB	MfC	RfA	RfC/D	MfA	MfB	MfC	R2A	M2A	M2B	M2C	R3A	R3C/D	M3A	M3C	R4C/D	M4A	M4B	M4C	R5A	R5B	M5A	M5C	R6A	R6B	R6C/D	M6A	M6C	R8A	R8C/D	M8A	M8B	M8C	RfOA	RfOB	RfOC	MfOB	MfOC						
1	P01/1		5		1				6		1			1							1										1											1					
2	P01/3		3																													1								1							
3	P06/1											1	1				1			1																			1								
4	P06/2							1				1					1																														
5	P07/1																						2			3								1													
6	P07/2																	1								1	1																				
7	P07/3																1	1	1																												
8	P07/4		2							1							1																				1										
9	P09/1																	1																	1		1										
10	P09/2																					1																									
11	P09/3																					1																									
12	P09/4		2																			2																									
13	P09/5		2																			2																									
14	P09/6		2																			2																									
15	P09/7	1	1													1		1																													
16	P09/8				1													1													1																
17	P09/9						1																											1													
18	P09/10																										1						1														
19	P09/11																																														
20	P10/1		1									1			1											1	1					1	1				1						1				
21	P10/2		2	1	1	1					2																1	1	1					1								1					
22	P11/1											2					1	1		1					1																						
23	P12/1																																														
24	P12/2				1							1								1														1										1			
25	P13/1											1																																			
26	P13/2											1		1																				1													

Continued on next page

# Appendix E: (Continued)

Task	Reference Number	R12A	M12A	M12B	M12C	R16A	R16B	M16C	M18C	M20C	M24B	R30C/D	P1SE	P1SSD	P2SE	P2SSE	P2NSE	P2SD	P2SSD	P2NSD	P3NSD	G1A	G1B	G2	G3	G4A	G4B	G4C	G5	AP2	RL1	RL2	D1E	D2E	T75	Basic	MTM-1		
1	P01/1													2						1		3		3	1						4						8.9112	6.9800	
2	P01/3													1								1			1						1						4.4832	2.5200	
3	P06/1	1									1											1							2		1	1				2.5400	3.2150		
4	P06/2	1														1						1					1			2	1	1	1			4.2290	5.8900		
5	P07/1	1		1														3							3						1					10.4548	8.2750		
6	P07/2																1							1	1	1	1					1					3.0586	3.2450	
7	P07/3																1	1	1					2	1	1					1						2.7048	3.9150	
8	P07/4					1											1							1	1	1			1	1	1	1					6.2895	6.7550	
9	P09/1																2										2					1					3.5736	4.0950	
10	P09/2																			1				3	1						1						2.7352	2.9500	
11	P09/3																1					1	1		1						1				1		2.8256	3.1250	
12	P09/4														1				1																		3.5720	3.0950	
13	P09/5															1																						4.7224	3.0950
14	P09/6															1				1																	2.6440	3.2300	
15	P09/7																			1			1		2							1					2.5680	3.0650	
16	P09/8																			1				3	2			1		1	1						4.7872	4.9450	
17	P09/9														1										1			1				1					3.3008	3.1350	
18	P09/10																				1			2	3			1		1	1	1	1		2		5.8160	6.1450	
19	P09/11																2					1										1					2.2160	3.5500	
20	P10/1	1																				3			1					3	4				2		8.3412	6.6450	
21	P10/2	1		1													2					4		1				1	3	6	2					10.2360	10.1650		
22	P11/1							1									1					1									2			1			4.7136	4.7100	
23	P12/1						1	1					1				1					1							1	1			1				4.1976	4.4700	
24	P12/2									1						1						1										2					4.0752	3.9250	
25	P13/1								1			1	2									1										1					4.3616	3.2700	
26	P13/2								1				2									1										1					2.9224	2.6150	

# Appendix F: Distribution of MTM-2 Categories in the Field Data

Task	Reference Number	MTM-2 MOTION CATEGORY																								BASIC		MTM-2			
		GA5	GB5	GC5	PA5	PB5	PC5	GA15	GB15	GC15	PA15	PB15	PC15	GA30	GB30	GC30	PA30	PC30	GA45	GB45	GC45	PA45	PB45	PC45	GB80	PA80	PC80		GB5	A	R
1	P01/1				8						3				2														2	8.9112	7.8000
2	P01/3				2								1		1		1													4.4832	2.7500
3	P06/1				2			1			1			1	1											1				2.5400	3.0500
4	P06/2				2						1				1						1			1						4.2290	6.1000
5	P07/1															1			1					3				1	2	10.4548	10.5050
6	P07/2	1								1	1		1								1									3.0586	3.5000
7	P07/3	1								1	1		1																2	2.7048	3.5000
8	P07/4	2			2								2				1		1									1	1	6.2895	6.8500
9	P09/1		1				1									1			1											3.5736	3.7000
10	P09/2		1				1						1																1	2.7352	2.9000
11	P09/3	2			1					1			1																	2.8256	3.1000
12	P09/4				2								2																	3.5720	2.9000
13	P09/5				2								2																	4.7224	2.9000
14	P09/6				2								2																	2.6440	2.9000
15	P09/7	3			1								1																	2.5680	2.5000
16	P09/8		2				1			1			1															1	3	4.7872	6.3000
17	P09/9		1							1			1																	3.3008	2.9500
18	P09/10	2			1			1					1															1	2	5.8160	4.000
19	P09/11	1					1											1												2.2160	3.2500
20	P10/1	2			2			1			2	1			1			4									2	3	8.3412	7.3000	
21	P10/2	2			3	1	1		2		1				1			1		1	1	1						4	10.2360	11.4500	
22	P11/1	1			2						2	1						1					1				1			4.7136	4.4500
23	P12/1						1								1					1				1				1		4.1976	4.9000
24	P12/2				1	1					1		1		1							1								4.0752	4.1500
25	P13/1				1		1								1											1				4.3616	4.4000
26	P13/3				1		1								1									1						2.9224	3.4000

# Appendix G: Distribution of MTM-3 Categories in the Field Data

JOB	STUDY	TE80	TA80	HE80	HA80	TE15	TA15	HE15	HA15	BASIC	MTM3
1	P01/1	0	1	0	0	3	9	0	3	8.9112	9.80
2	P01/3	0	1	0	0	1	2	0	1	4.4832	3.45
3	P06/1	0	1	0	0	0	0	0	3	2.5400	3.50
4	P06/2	0	0	1	0	0	2	0	1	4.2290	4.00
5	P07/1	0	0	3	1	0	0	0	0	10.4548	8.90
6	P07/2	0	0	0	0	0	1	1	2	3.0586	3.85
7	P07/3	0	0	0	0	0	1	1	2	2.7048	3.85
8	P07/4	0	0	0	1	2	3	1	1	6.2895	7.45
9	P09/1	0	0	1	0	1	0	0	0	3.5736	3.45
10	P09/2	0	0	0	0	0	3	1	0	2.3752	2.75
11	P09/3	0	0	0	0	0	0	1	1	2.8256	2.60
12	P09/4	0	0	0	0	2	2	0	0	3.5720	2.80
13	P09/5	0	0	0	0	2	2	0	0	4.7224	2.80
14	P09/6	0	0	0	0	2	2	0	0	2.6440	2.80
15	P09/7	0	0	0	0	0	1	1	1	2.5680	2.95
16	P09/8	0	0	0	0	1	1	1	2	4.7872	4.90
17	P09/9	0	0	0	0	0	0	2	0	3.3008	3.40
18	P09/10	0	0	1	0	0	3	0	3	5.8160	6.15
19	P09/11	0	0	1	0	1	0	0	0	2.2160	3.45
20	P10/1	0	2	0	0	0	6	1	3	8.3412	8.10
21	P10/2	1	0	1	1	2	5	0	1	10.2360	10.30
22	P11/1	2	0	0	0	1	4	0	1	4.7136	6.25
23	P12/1	1	0	1	0	0	1	0	0	4.1976	4.20
24	P12/2	1	0	0	0	2	1	0	1	4.0752	4.80
25	P13/1	0	0	1	0	1	1	0	0	4.3616	3.80
26	P13/3	0	0	1	0	1	1	0	0	2.9224	3.80

## APPENDIX H - HISTOGRAMS OF ACTUAL TIMES OF FIELD DATA JOBS

The actual times required by the operators to perform work tasks classified as field data were collected using the methods described in Chapter 3.0.0. The histograms for these times are shown in the diagrams which follow.

Figure H-1: Histogram of Work-Times: Study P01/1

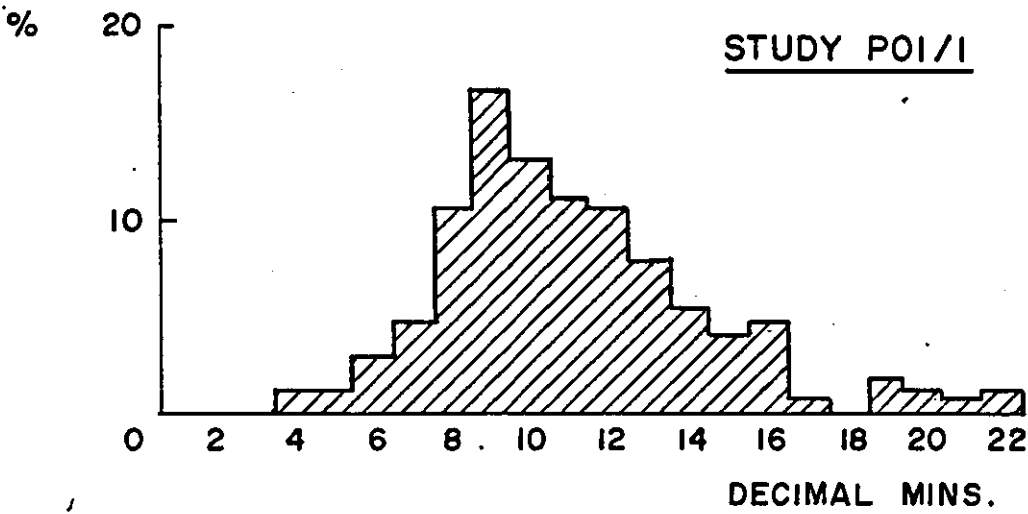


Figure H-2: Histogram of Work-Times: Study P01/3

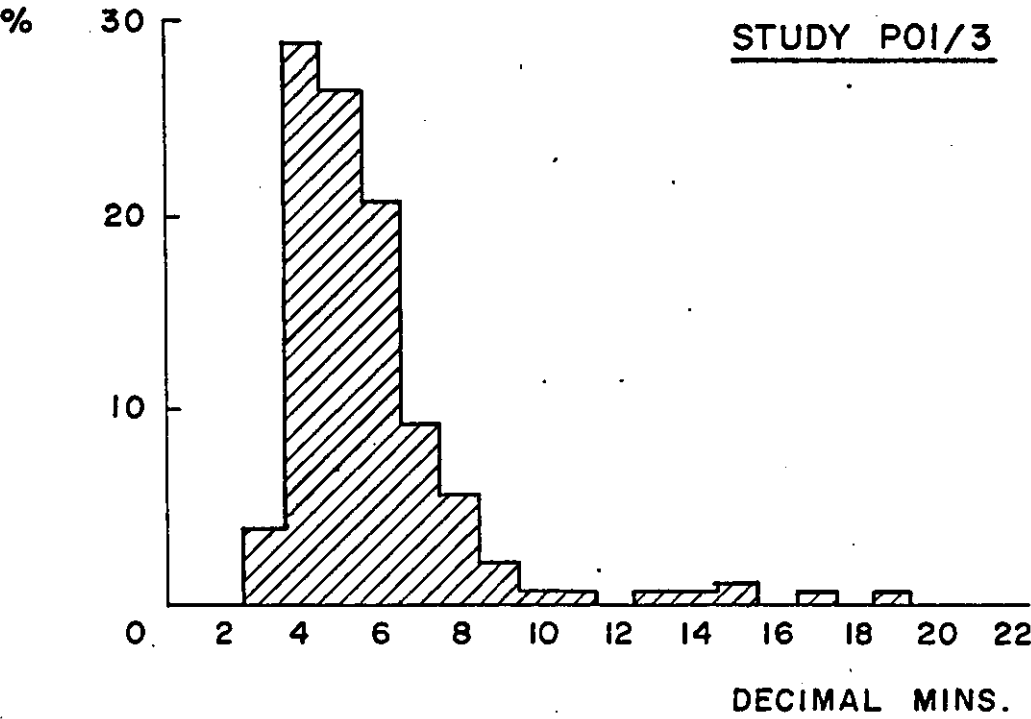


Figure H-3: Histogram of Work-Times: Study P06/1

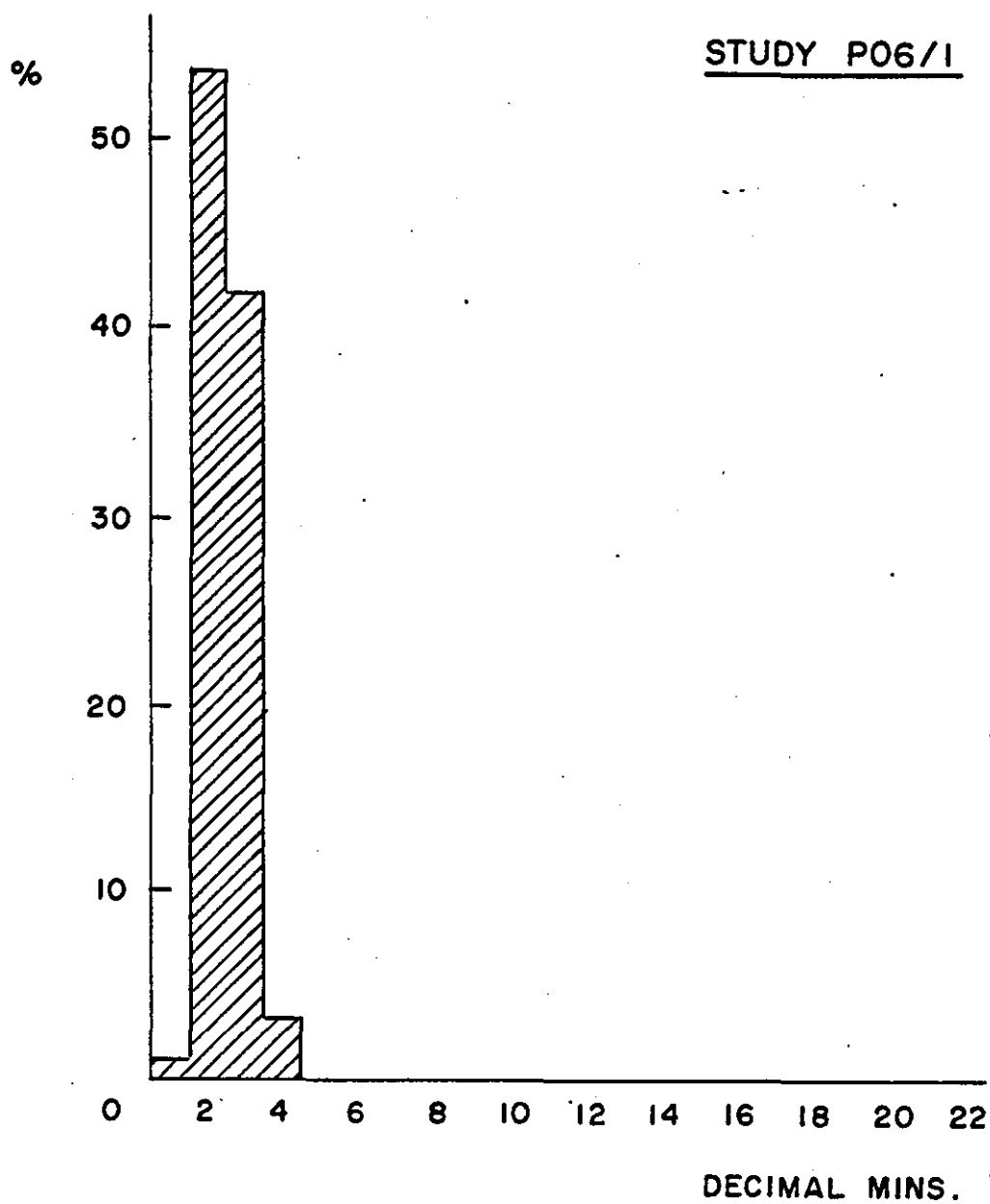


Figure H-4: Histogram of Work-Times: Study P06/2

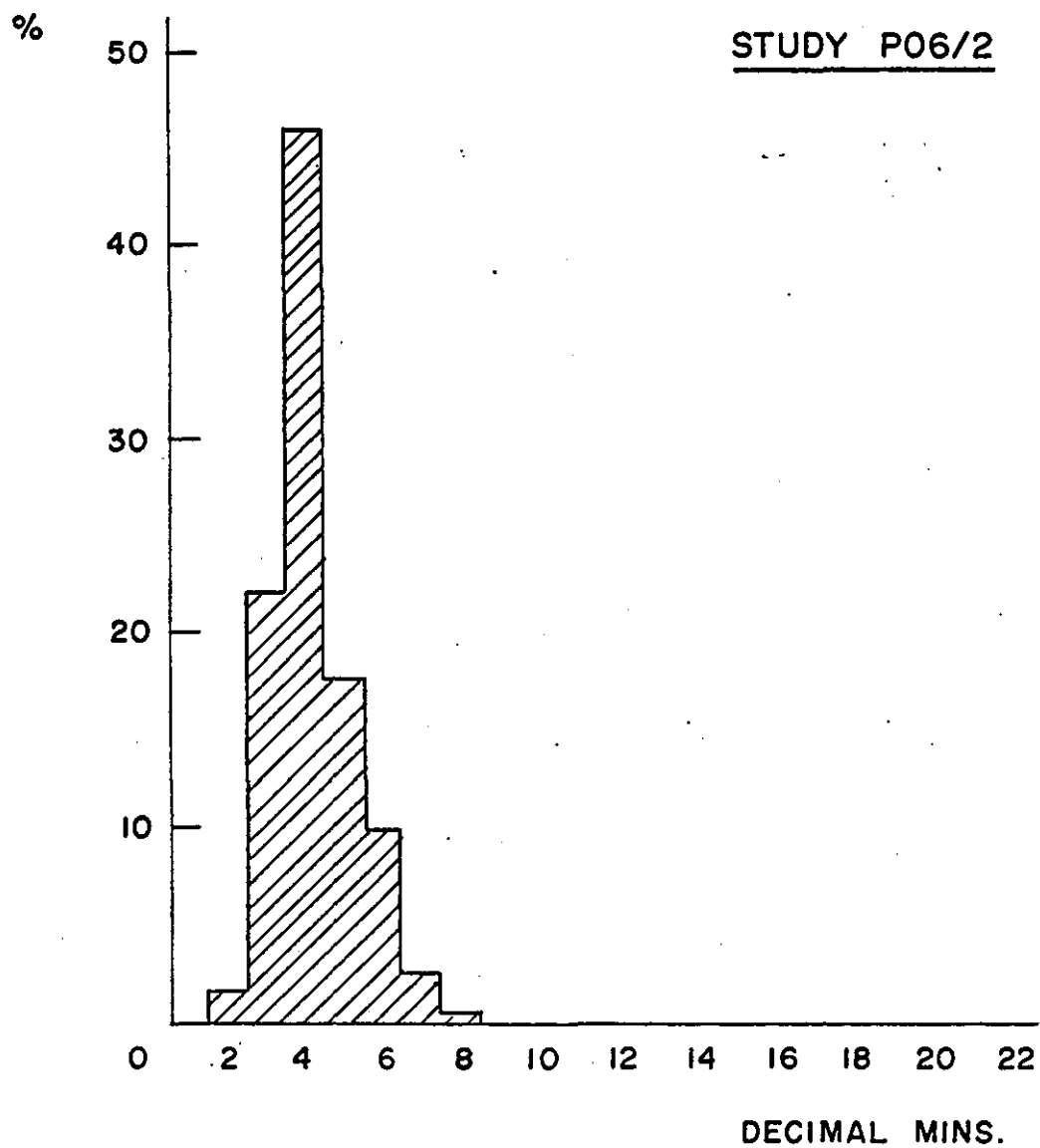


Figure H-5: Histogram of Work-Times: Study P07/1

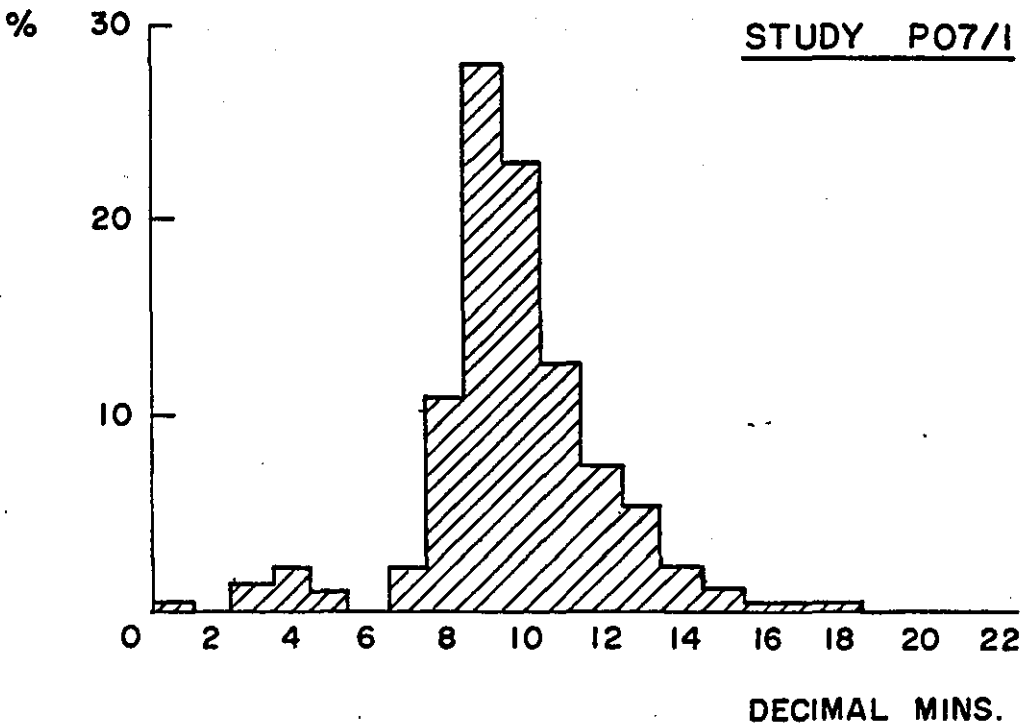


Figure H-6: Histogram of Work-Times: Study P07/2

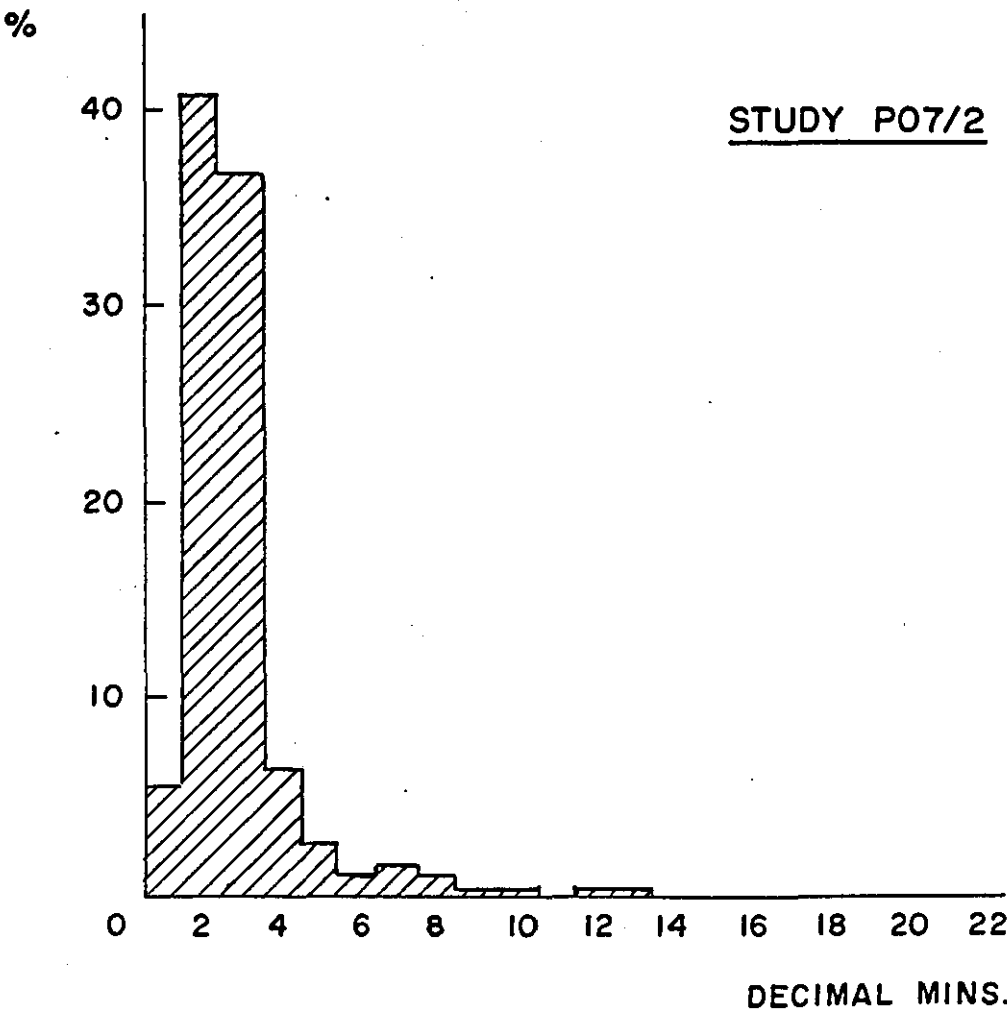


Figure H-7: Histogram of Work-Times: Study P07/3

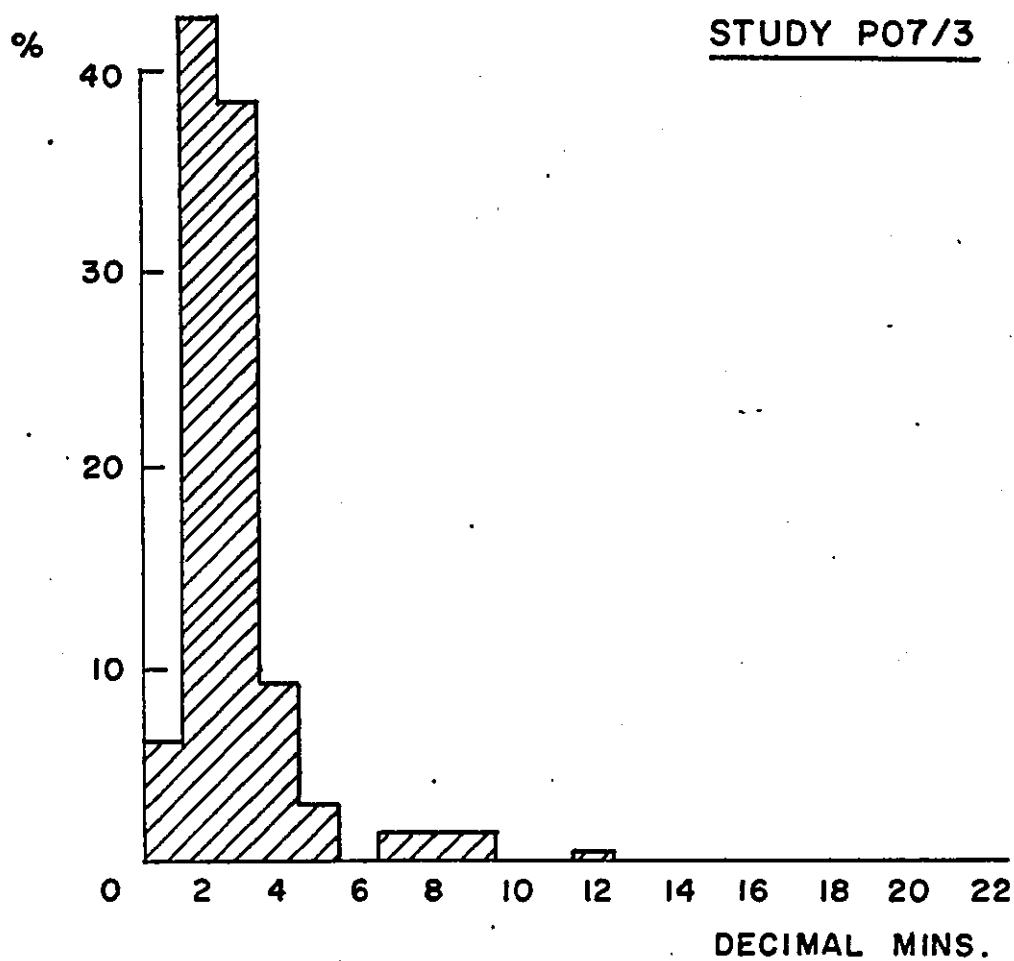


Figure H-8: Histogram of Work-Times: Study P07/4

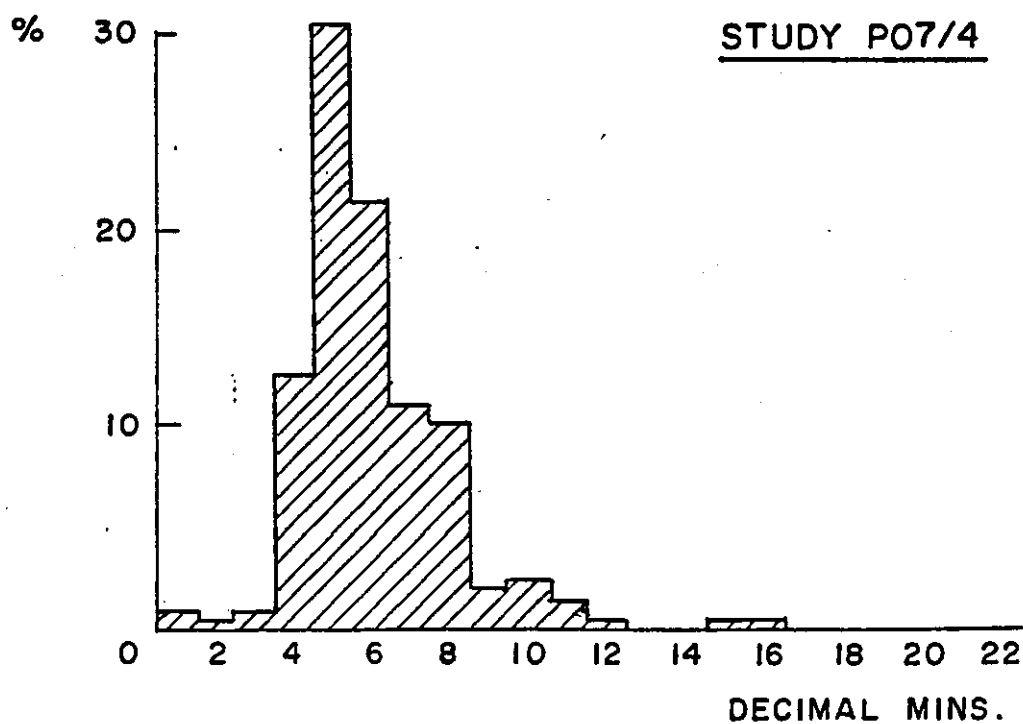


Figure H-9: Histogram of Work-Times: Study P09/1

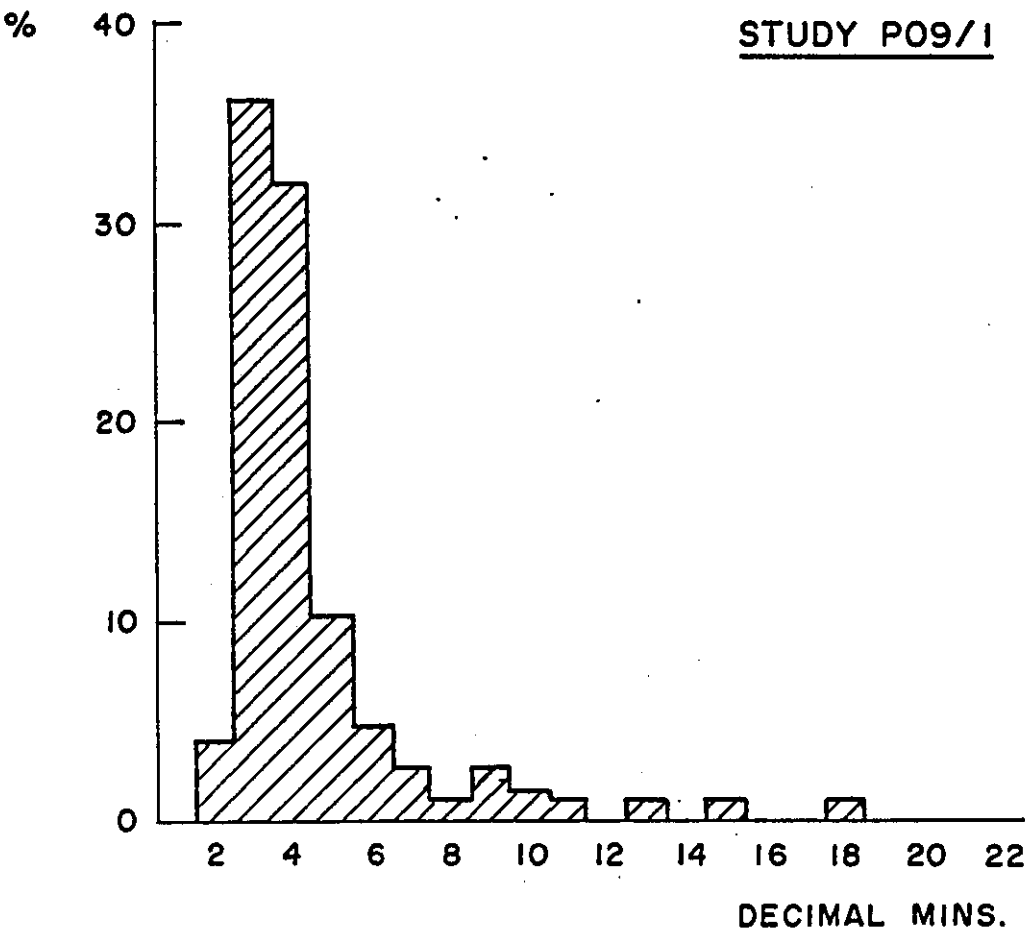


Figure H-10: Histogram of Work-Times: Study P09/2

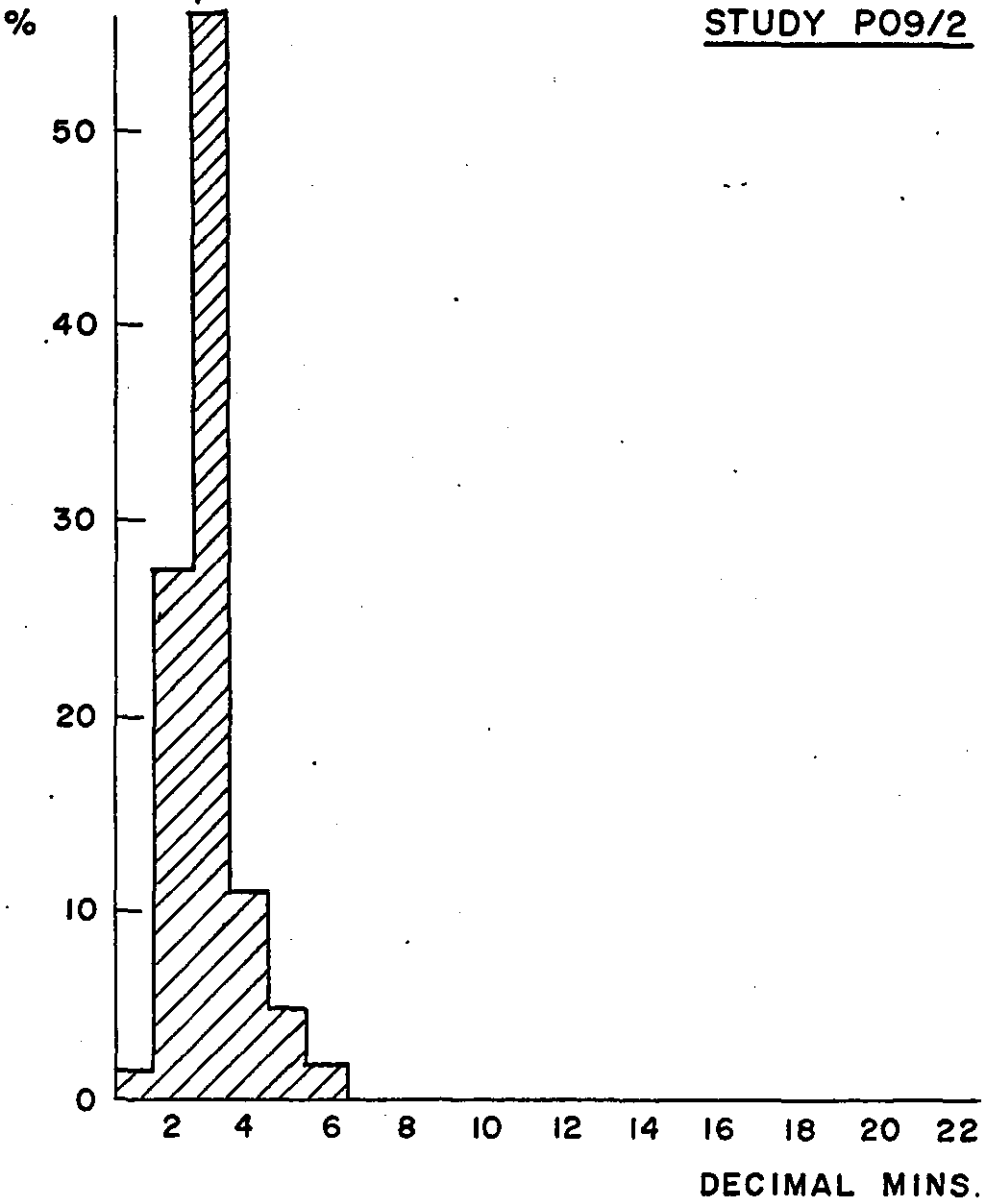


Figure H-11: Histogram of Work-Times: Study P09/3

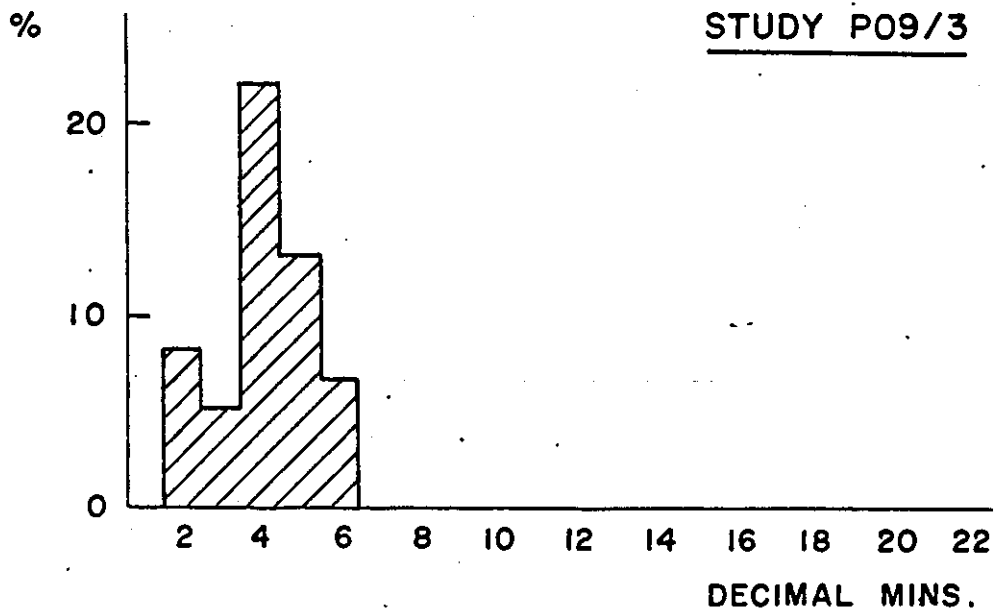
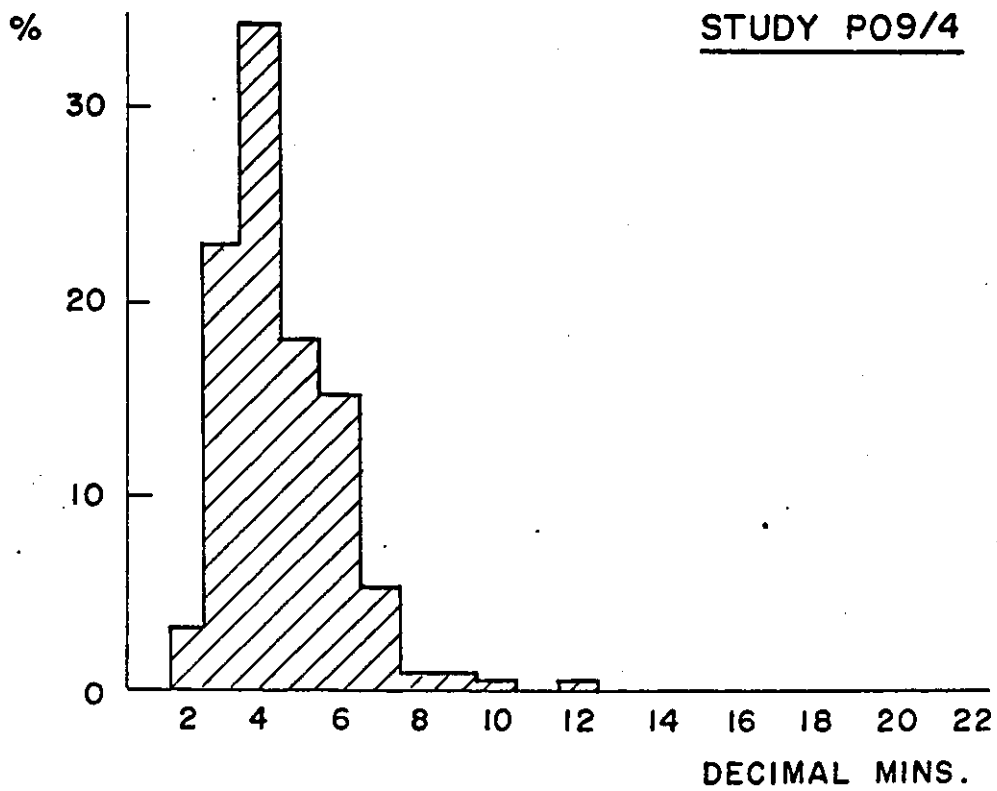


Figure H-12: Histogram of Work-Times: Study P09/4



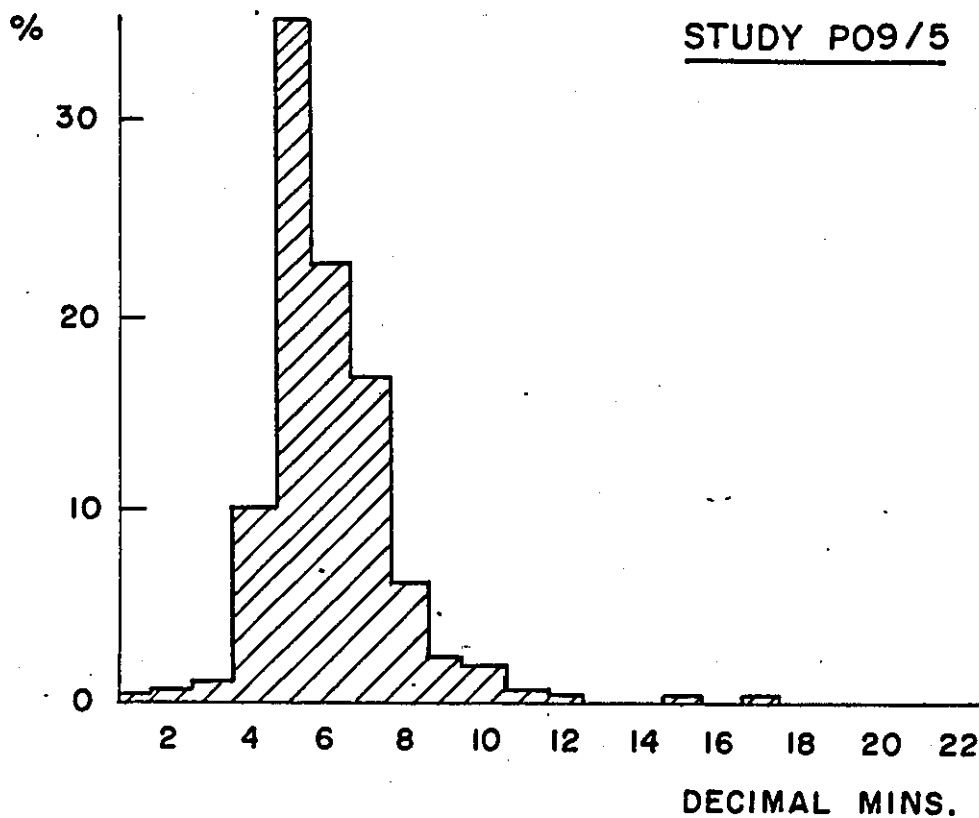


Figure H-14: Histogram of Work-Times: Study P09/6

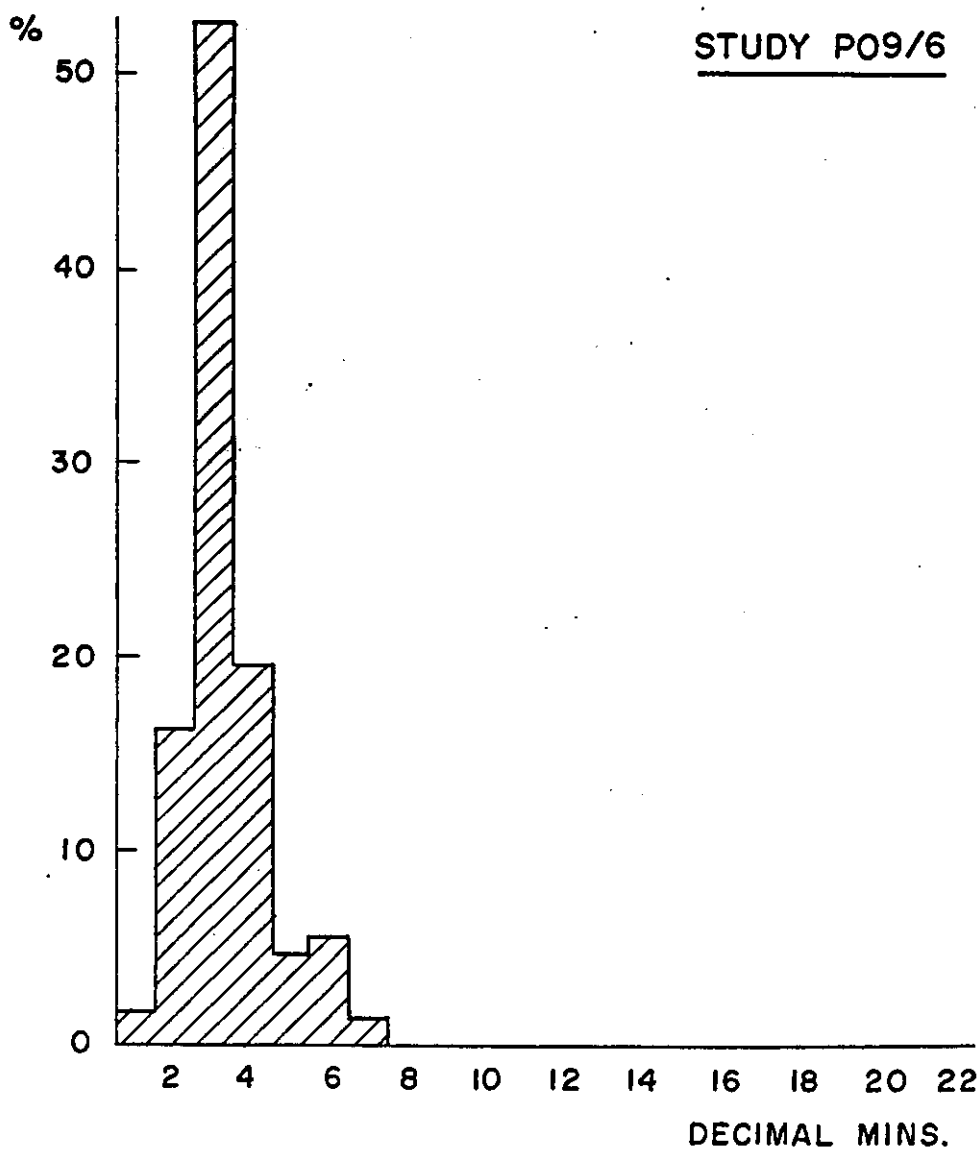


Figure H-15: Histogram of Work-Times: Study P09/7

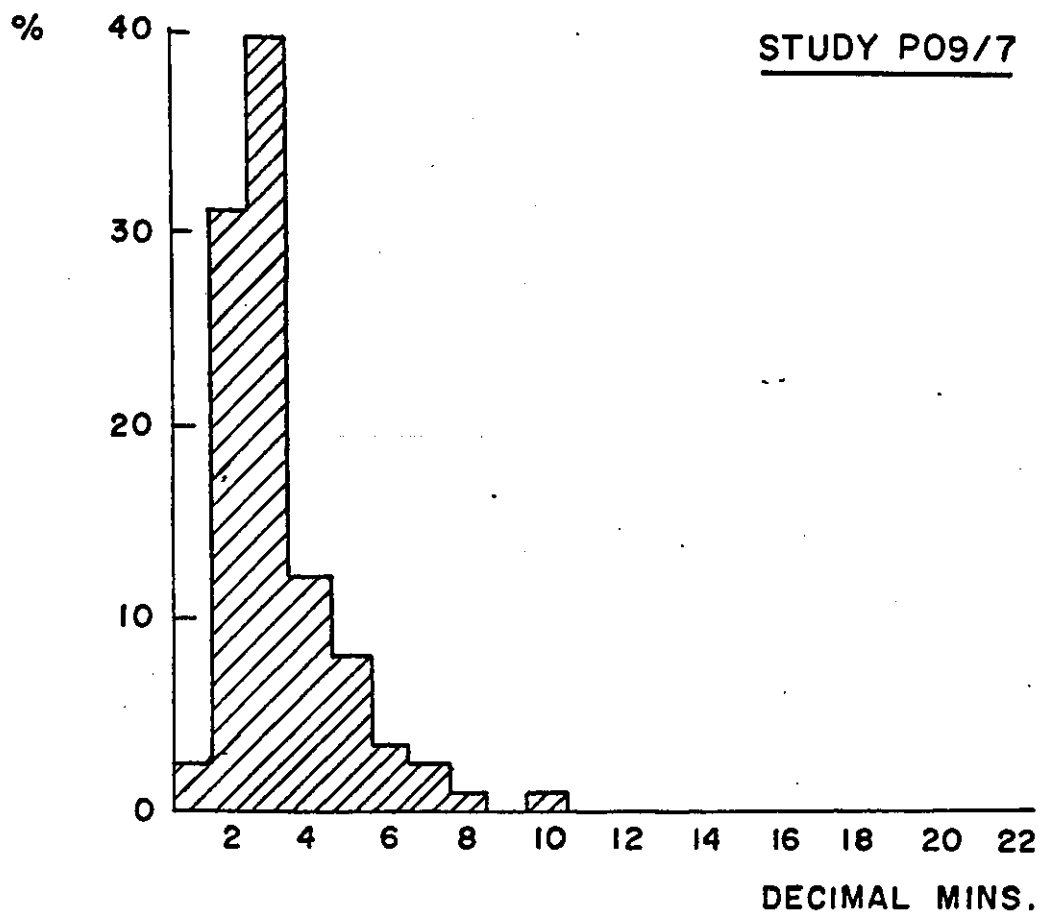


Figure H-16: Histogram of Work-Times: Study P09/8

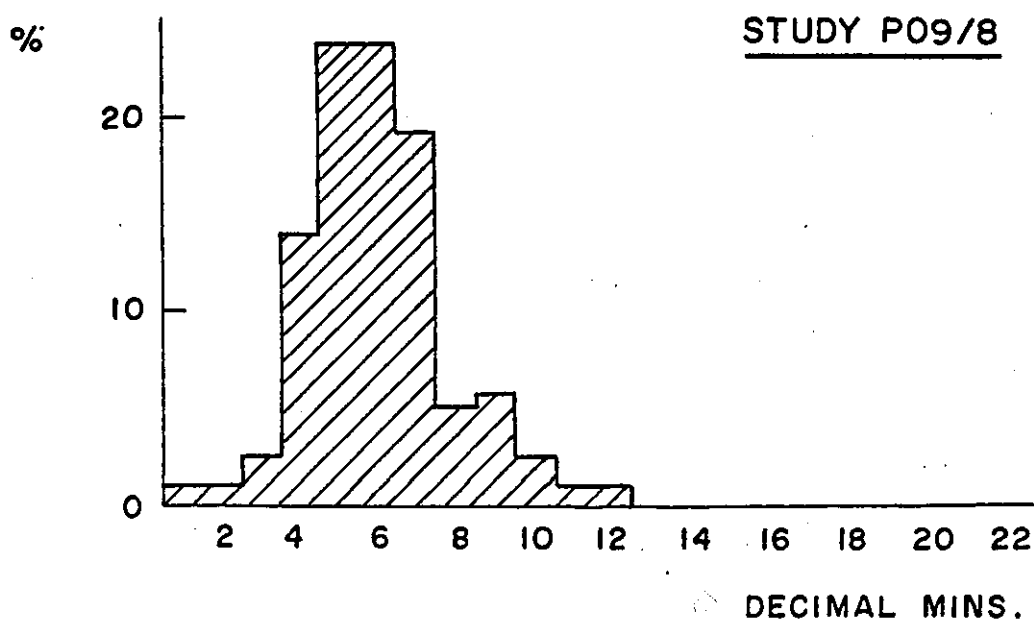


Figure H-17: Histogram of Work-Times: Study P09/9

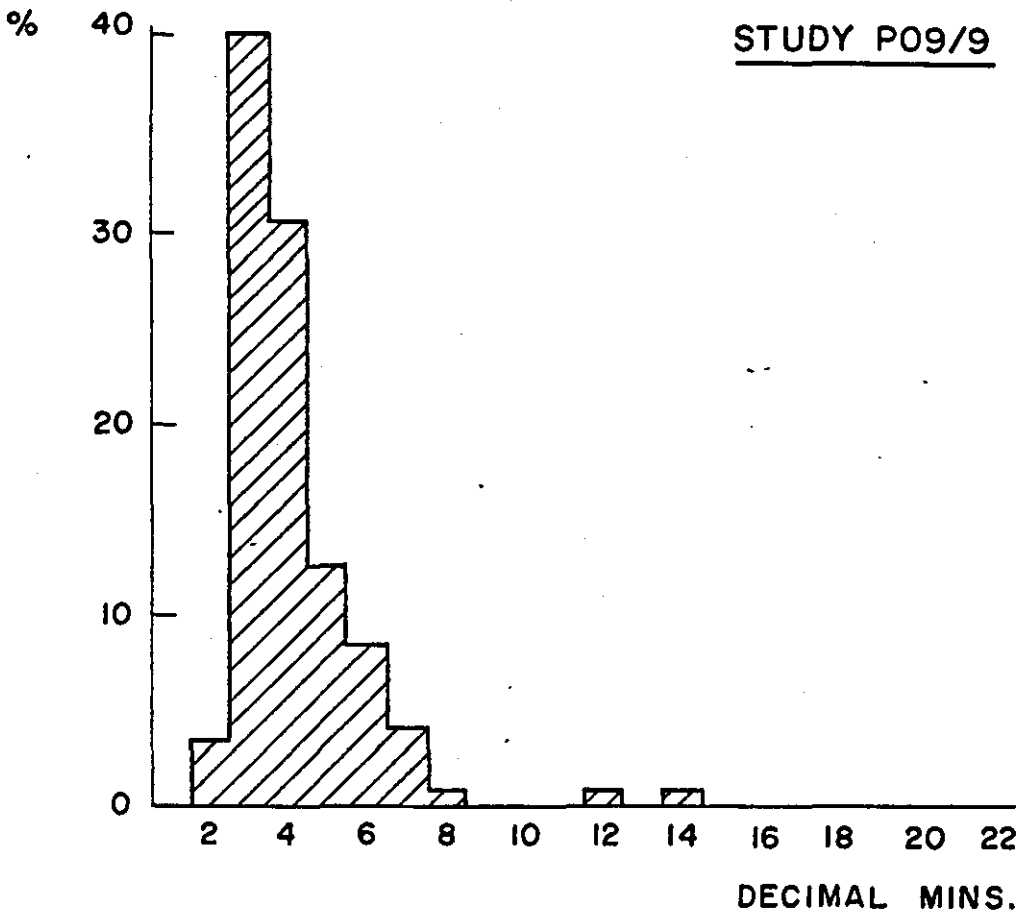


Figure H-18: Histogram of Work-Times: Study P09/10

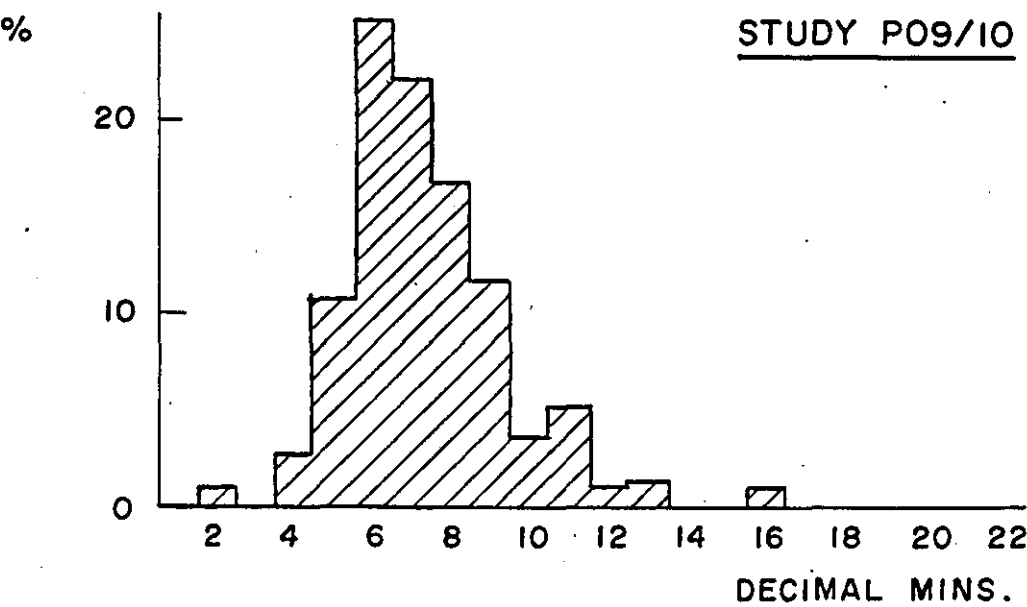


Figure H-19: Histogram of Work-Times: Study P09/11

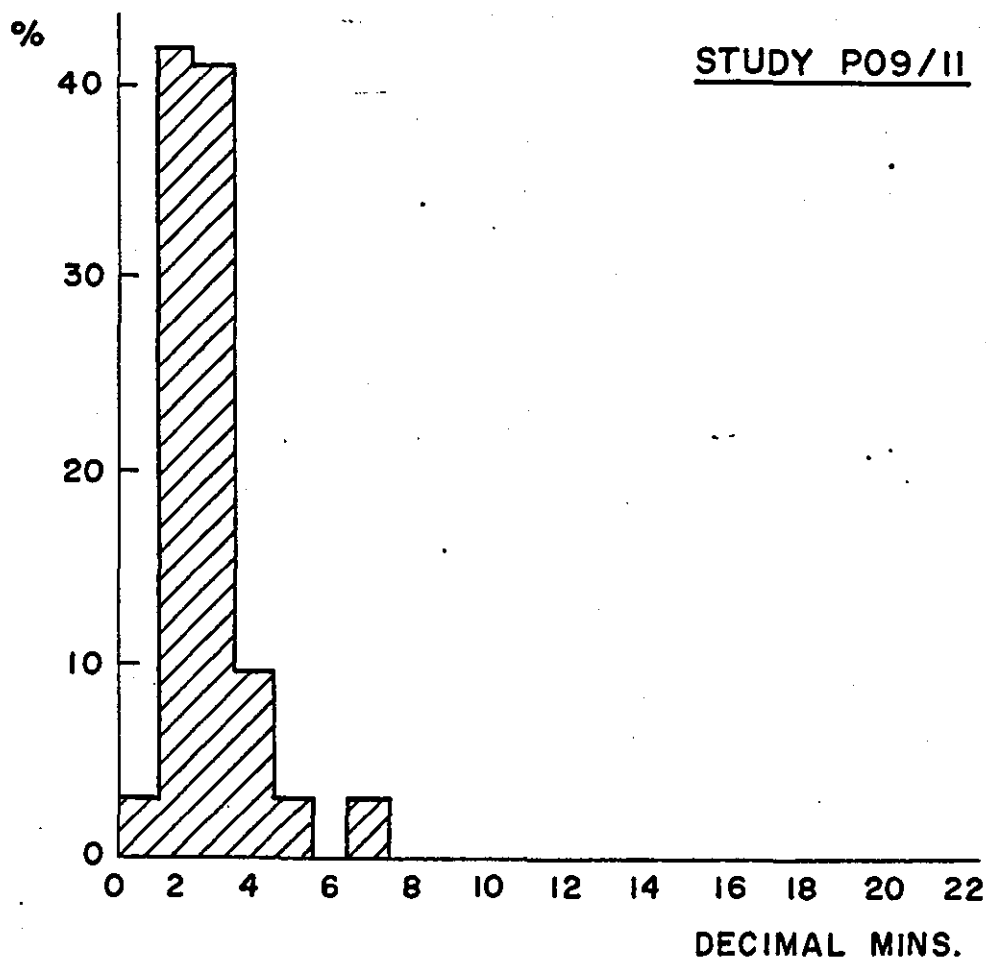


Figure H-20: Histogram of Work-Times: Study P10/1

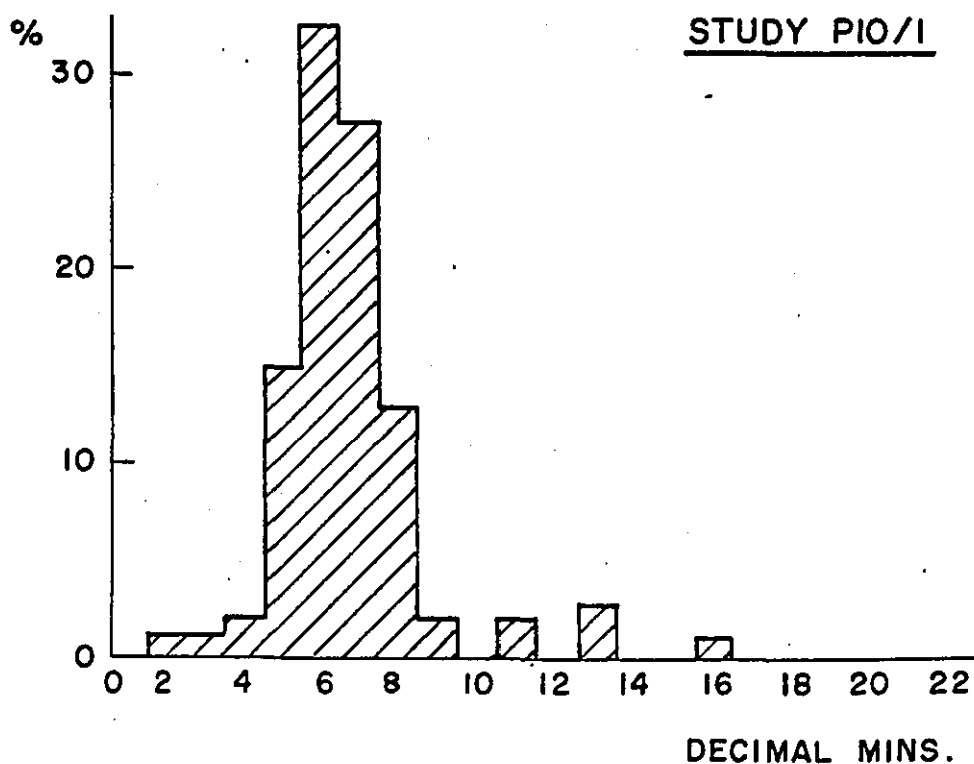


Figure H-21: Histogram of Work-Times: Study P10/2

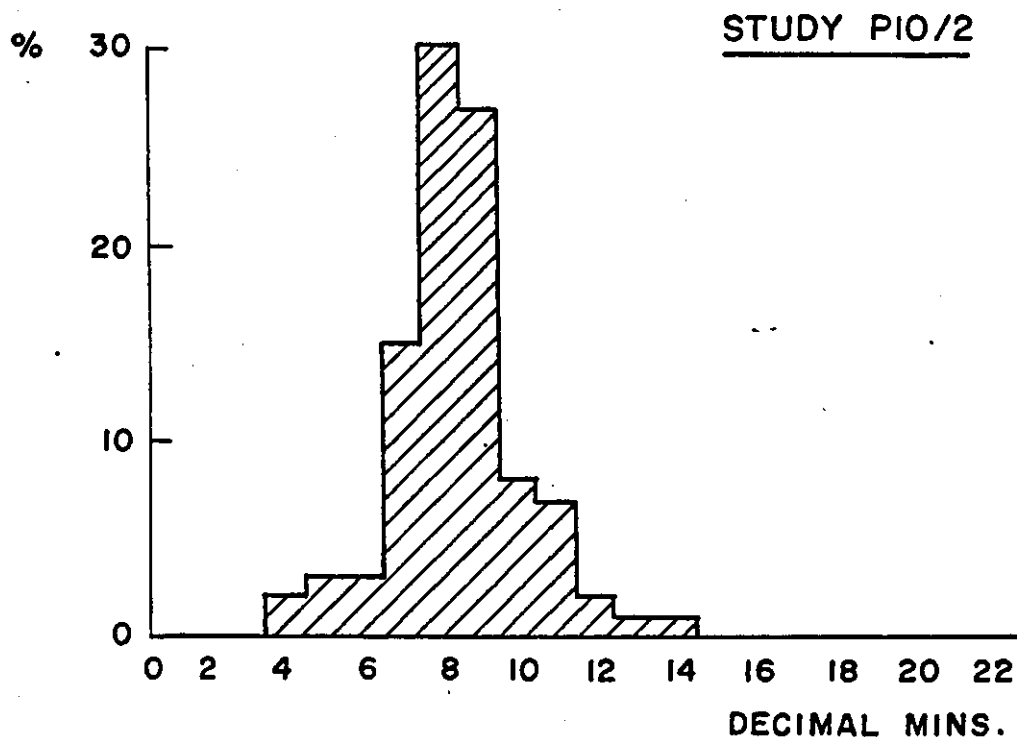


Figure H-22: Histogram of Work-Times: Study P11/1

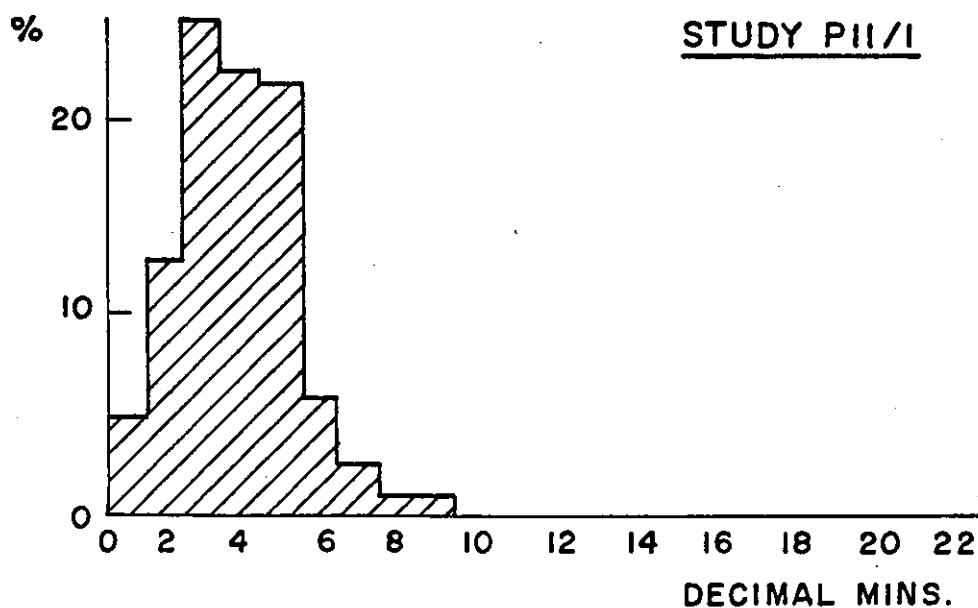


Figure H-23: Histogram of Work-Times: Study P12/1

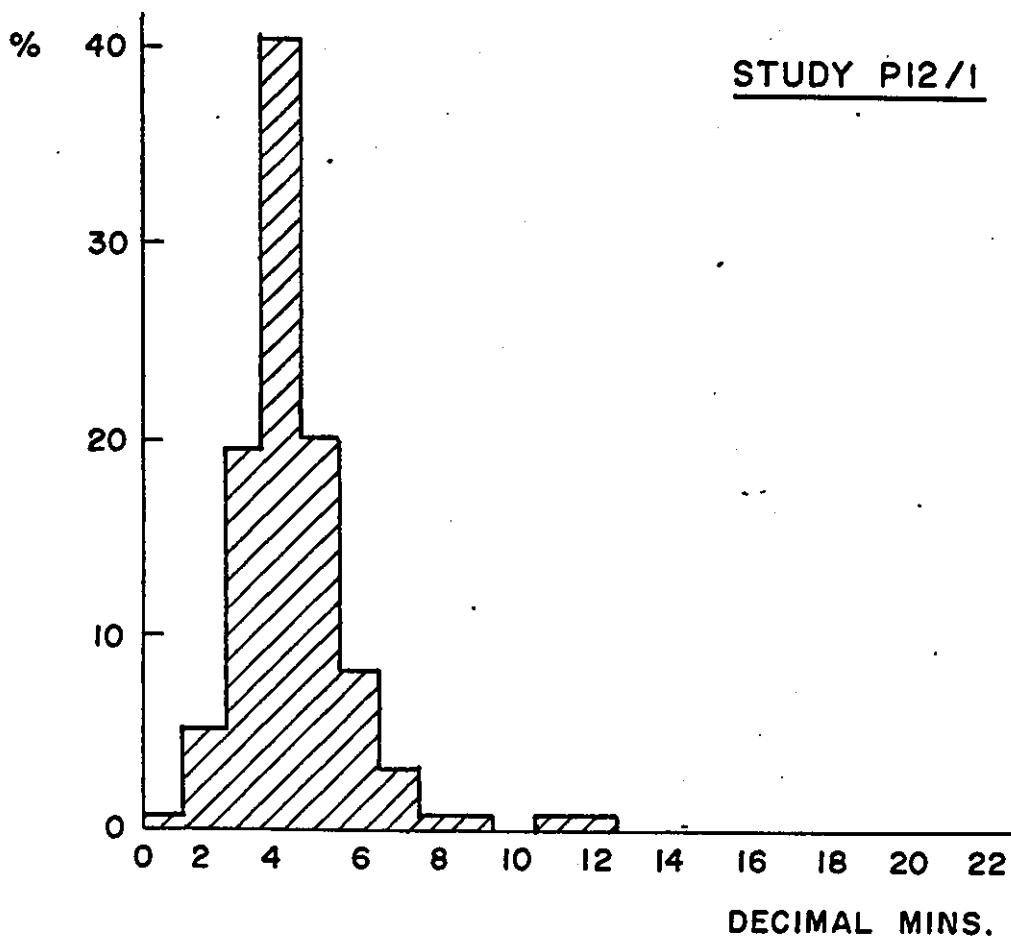


Figure H-24: Histogram of Work-Times: Study P12/2

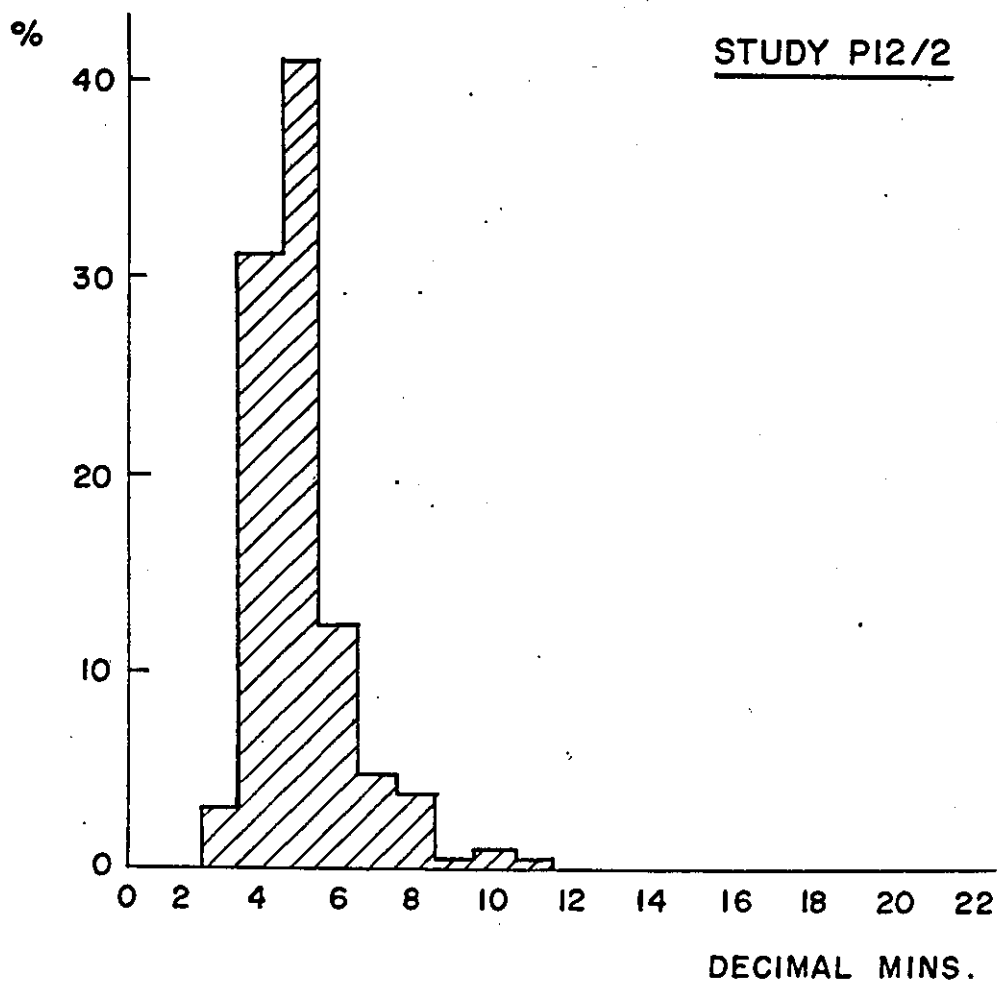


Figure H-25: Histogram of Work-Times: Study P13/1

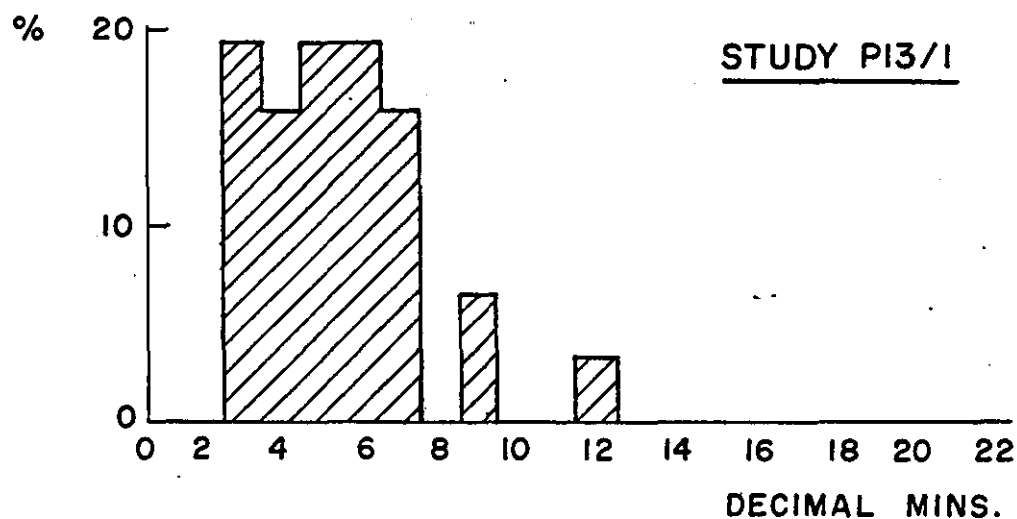
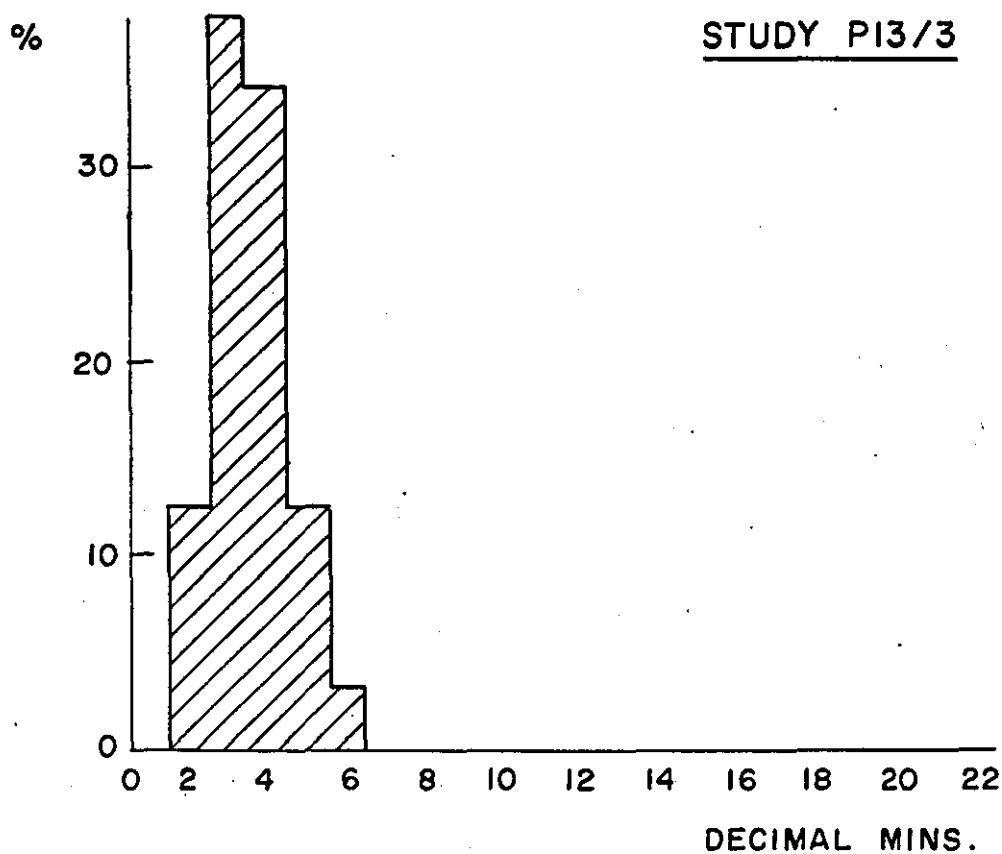


Figure H-26: Histogram of Work-Times: Study P13/3



APPENDIX J: CUMULATIVE FREQUENCY DISTRIBUTION OF  
OBSERVED TIMES FOR FIELD DATA

Figure J1: Cumulative Frequency Distribution: P01/1

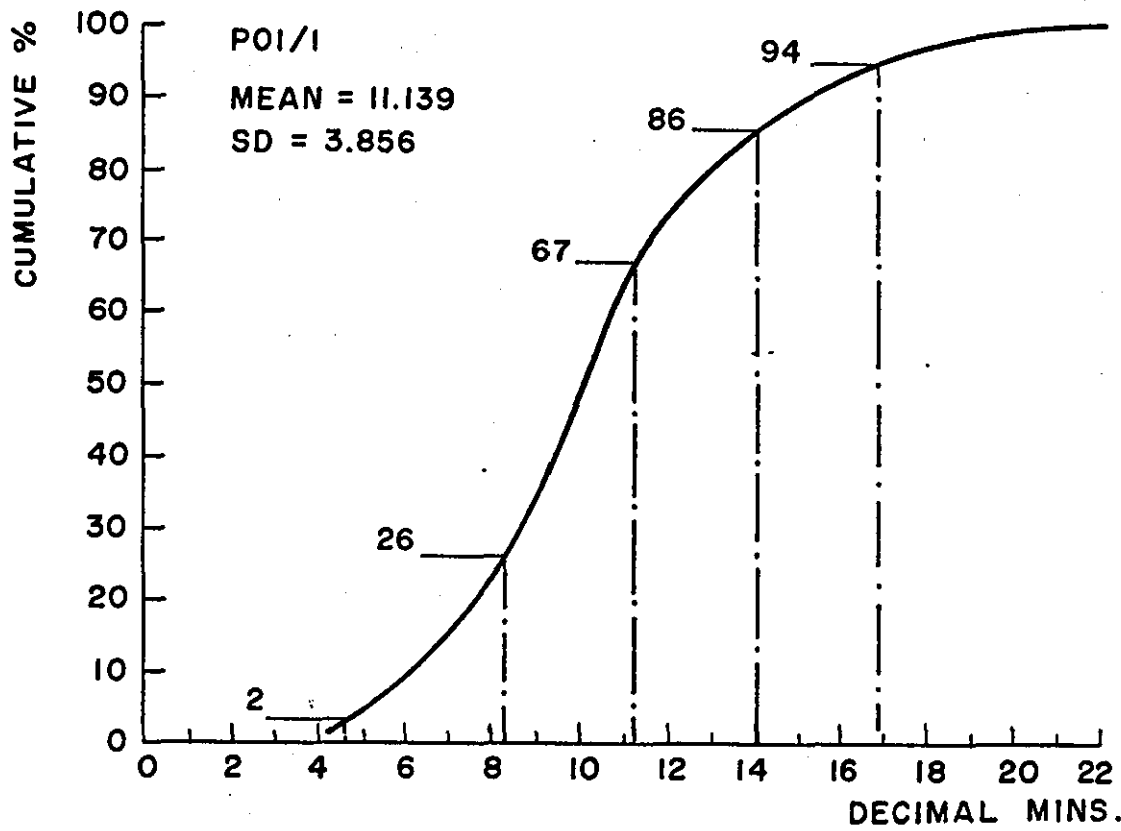


Figure J2: Cumulative Frequency Distribution: P01/3

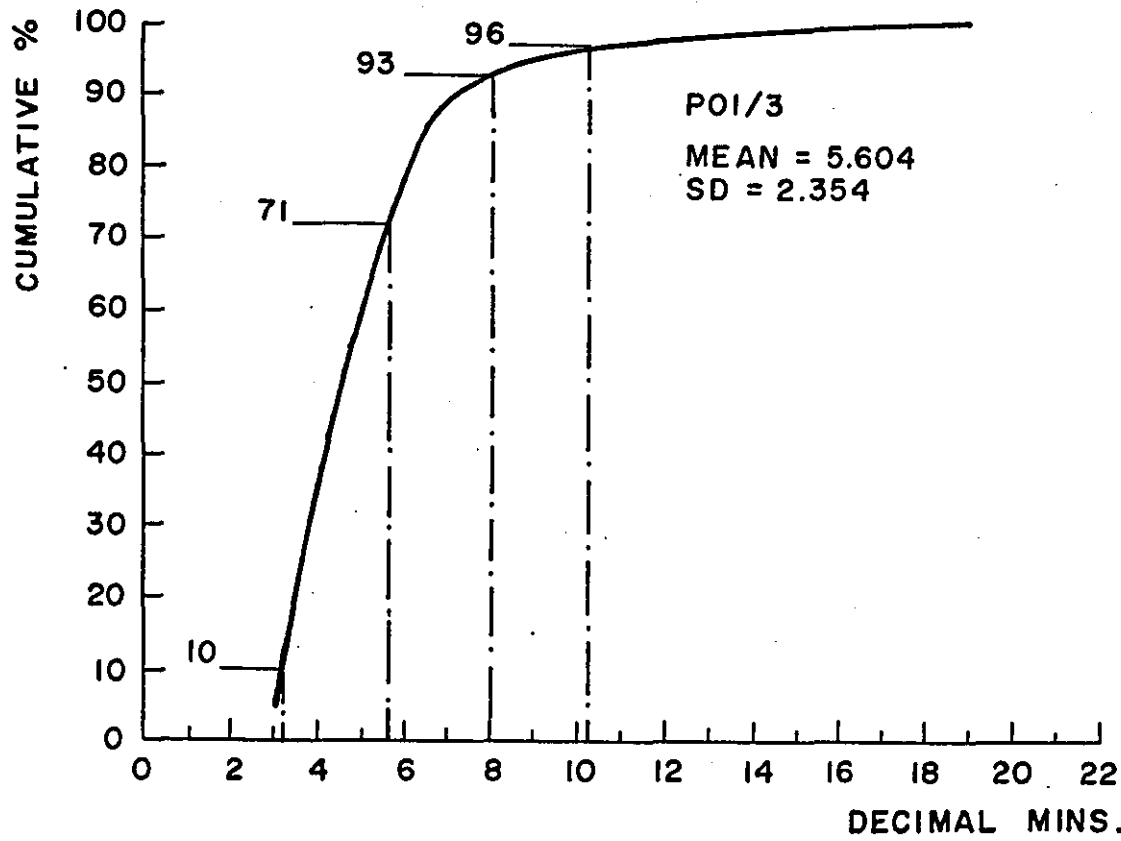


Figure J3: Cumulative Frequency Distribution: P06/1

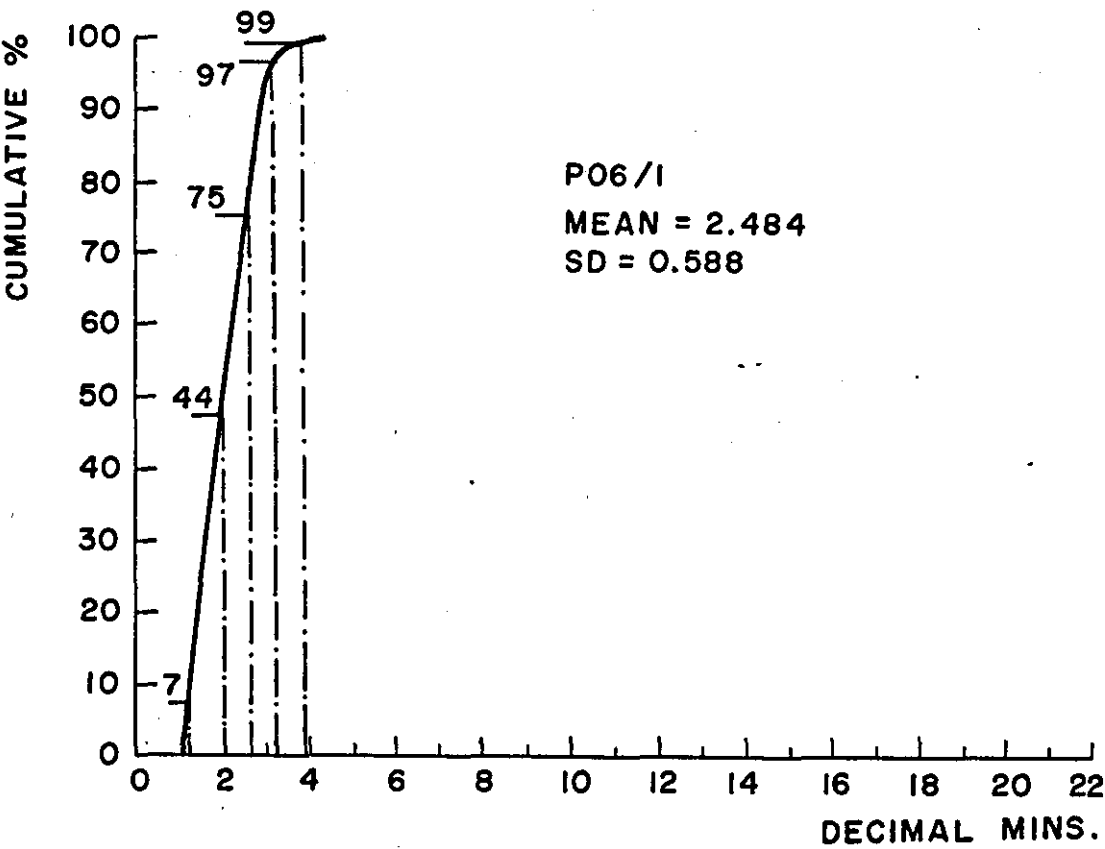


Figure J4: Cumulative Frequency Distribution: P06/2

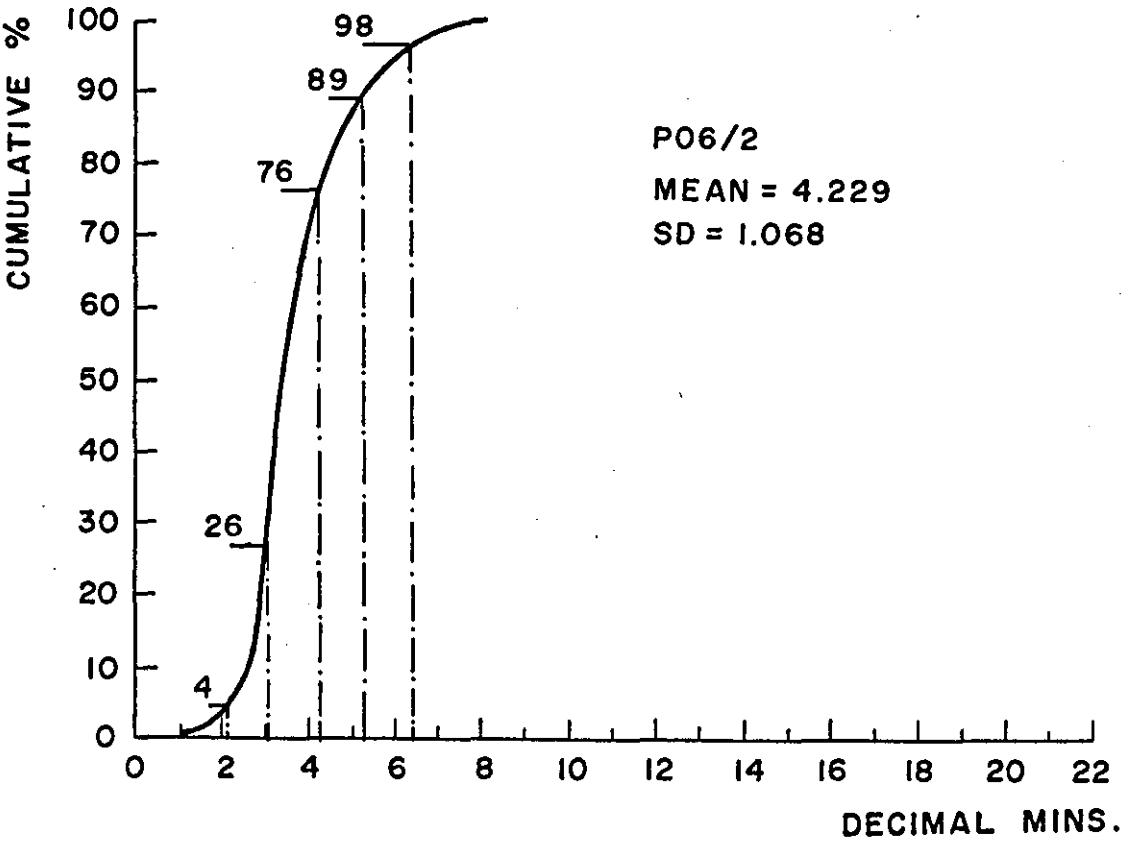


Figure J5: Cumulative Frequency Distribution: P07/1

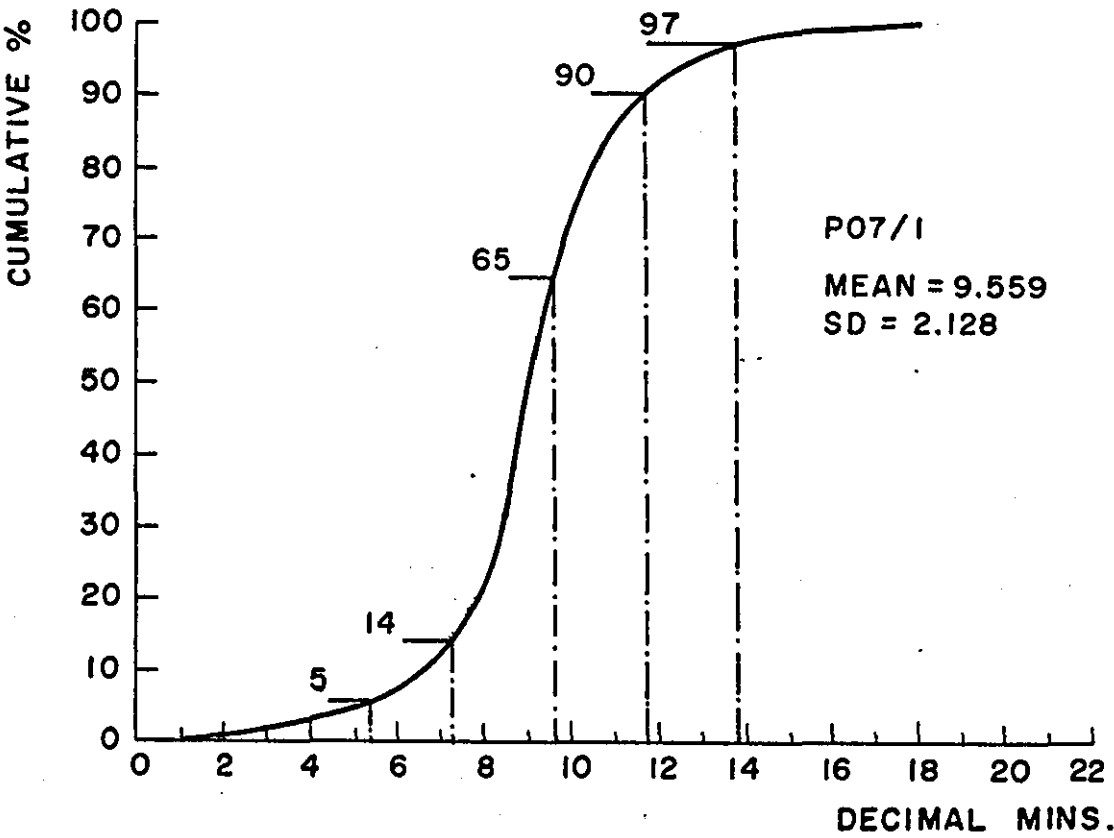


Figure J6: Cumulative Frequency Distribution: P07/2

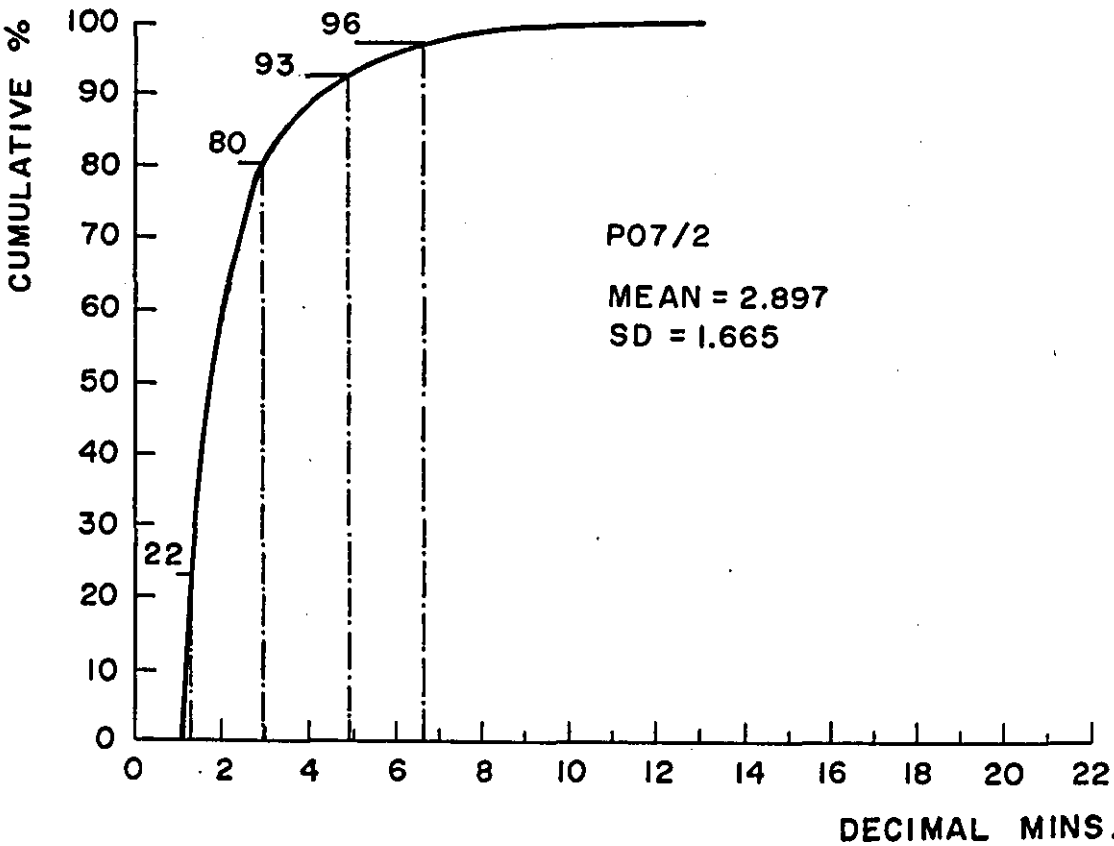


Figure J7: Cumulative Frequency Distribution: P07/3

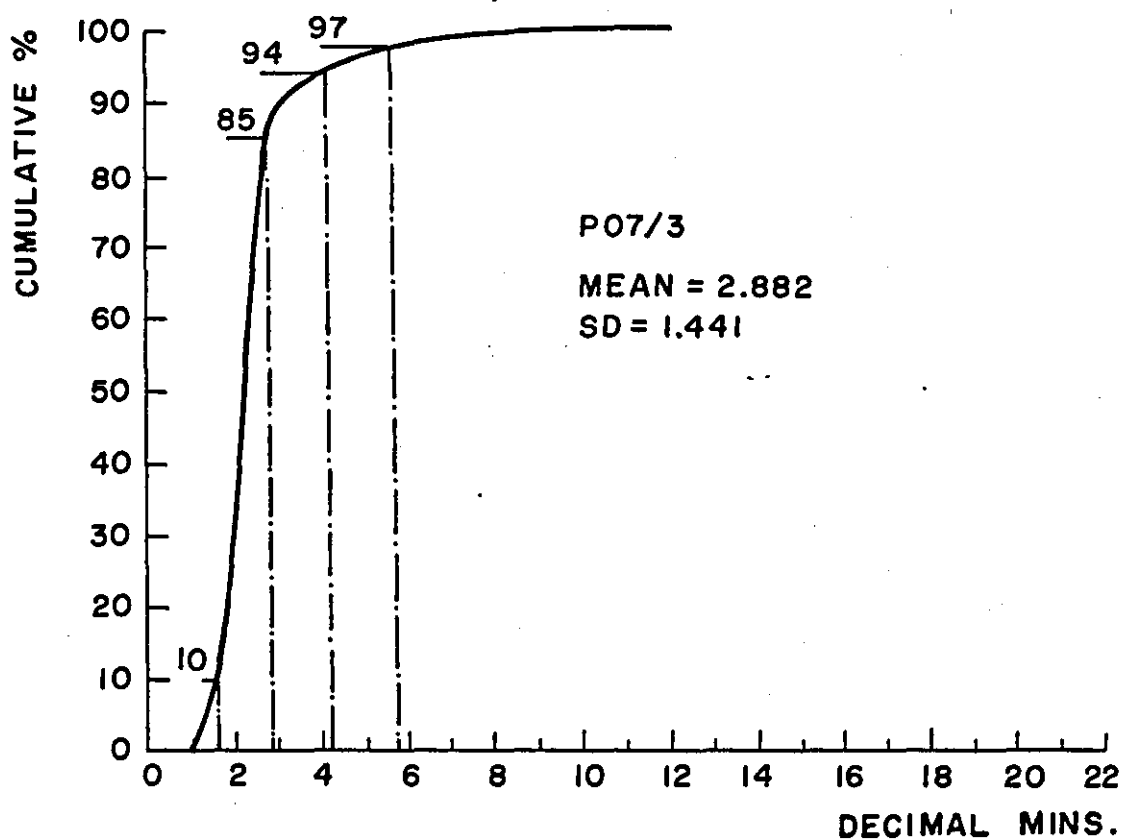


Figure J8: Cumulative Frequency Distributions: P07/4

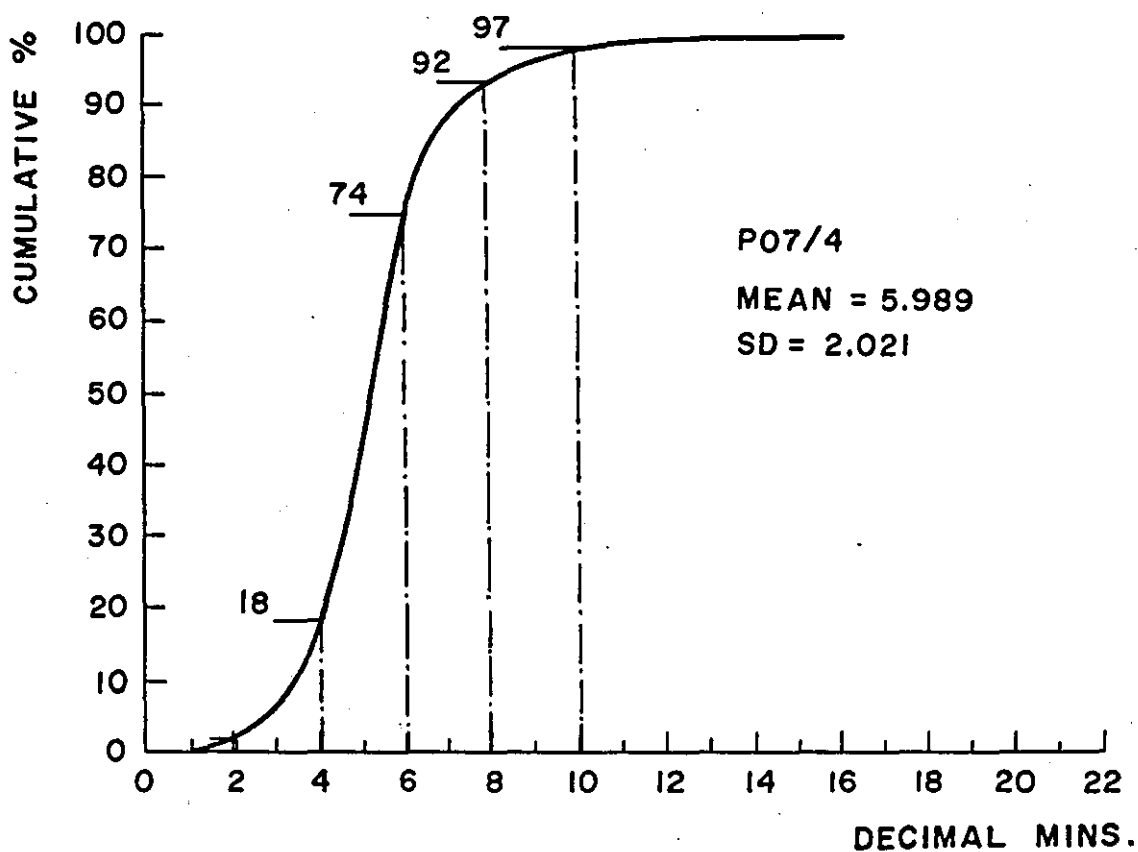


Figure J9: Cumulative Frequency Distribution: P09/1

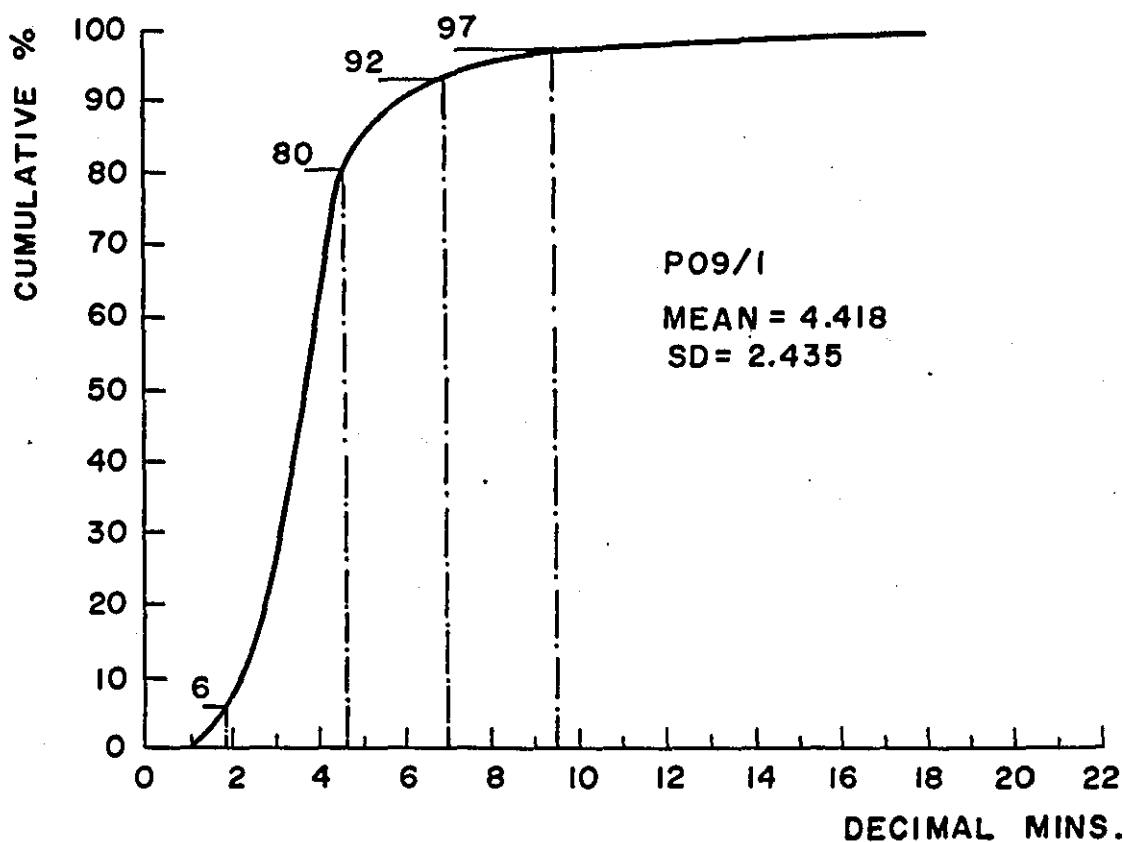


Figure J10: Cumulative Frequency Distribution: P09/2

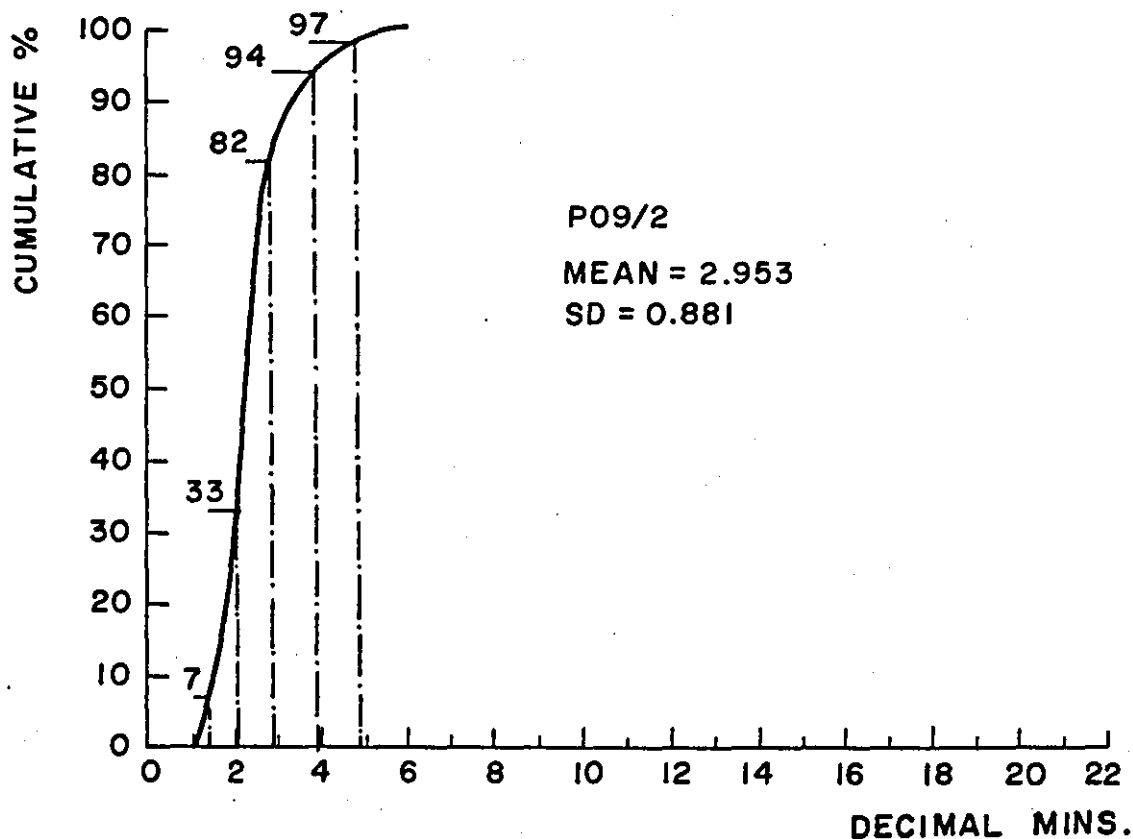


Figure J11: Cumulative Frequency Distribution: P09/3

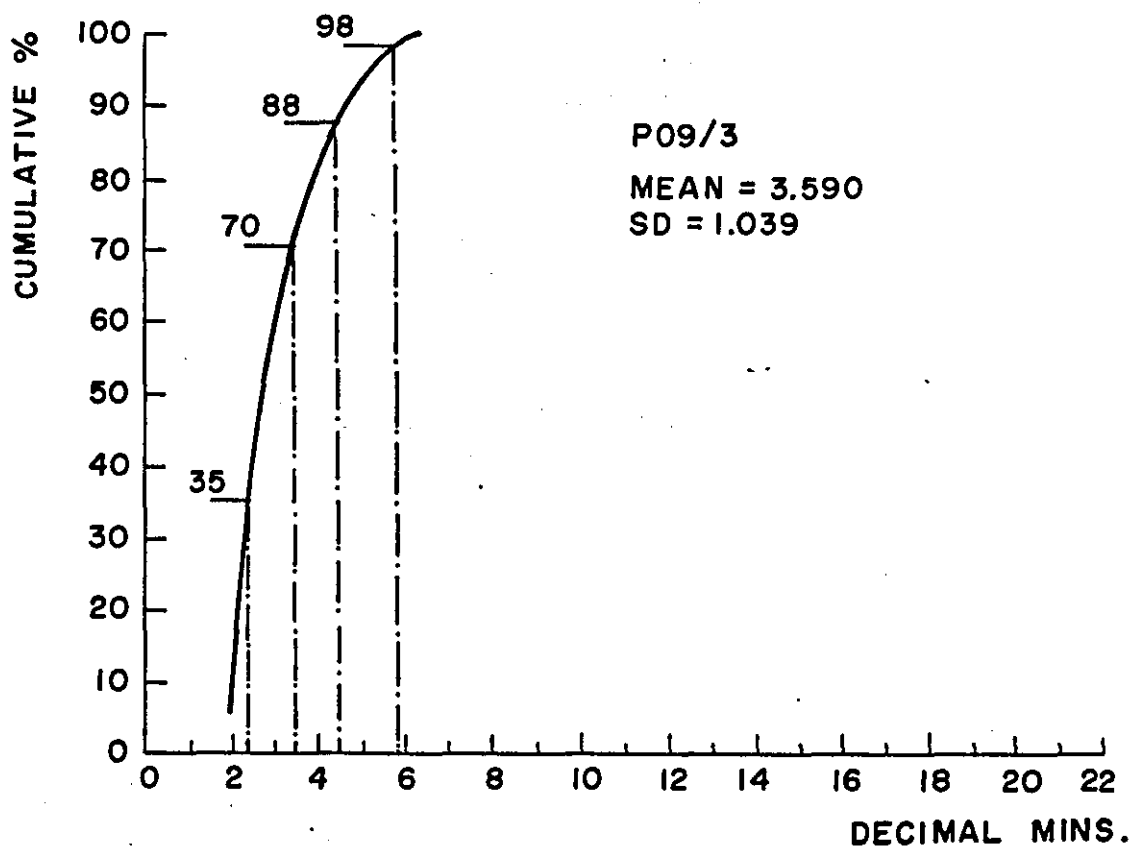


Figure J12: Cumulative Frequency Distribution: P09/4

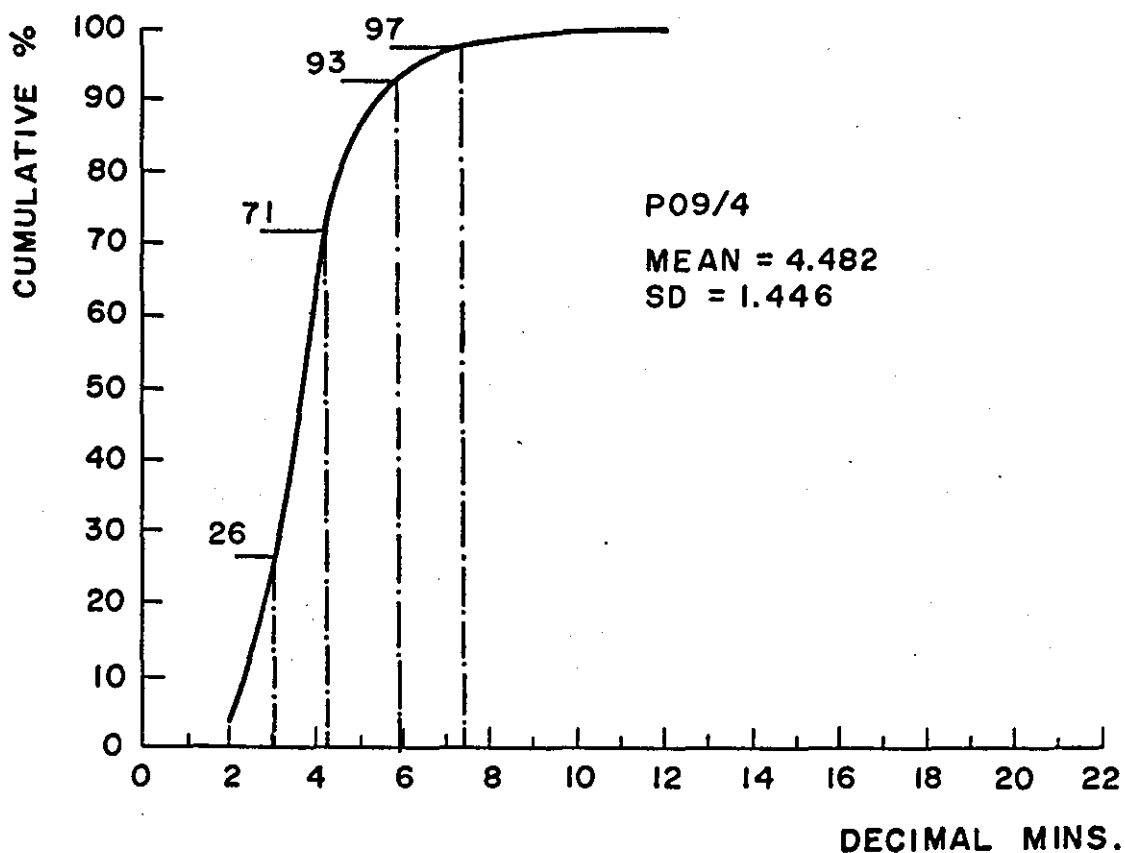


Figure J13: Cumulative Frequency Distribution: P09/5

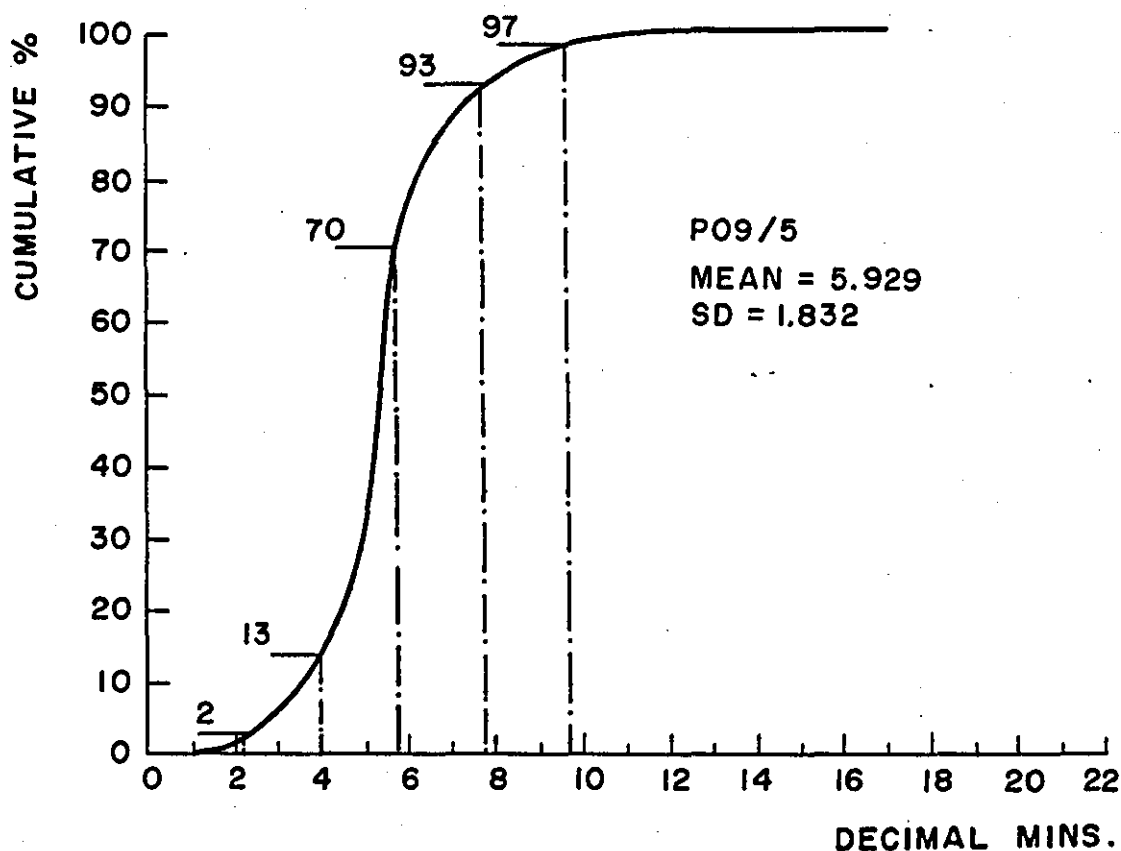


Figure J14: Cumulative Frequency Distribution: P09/6

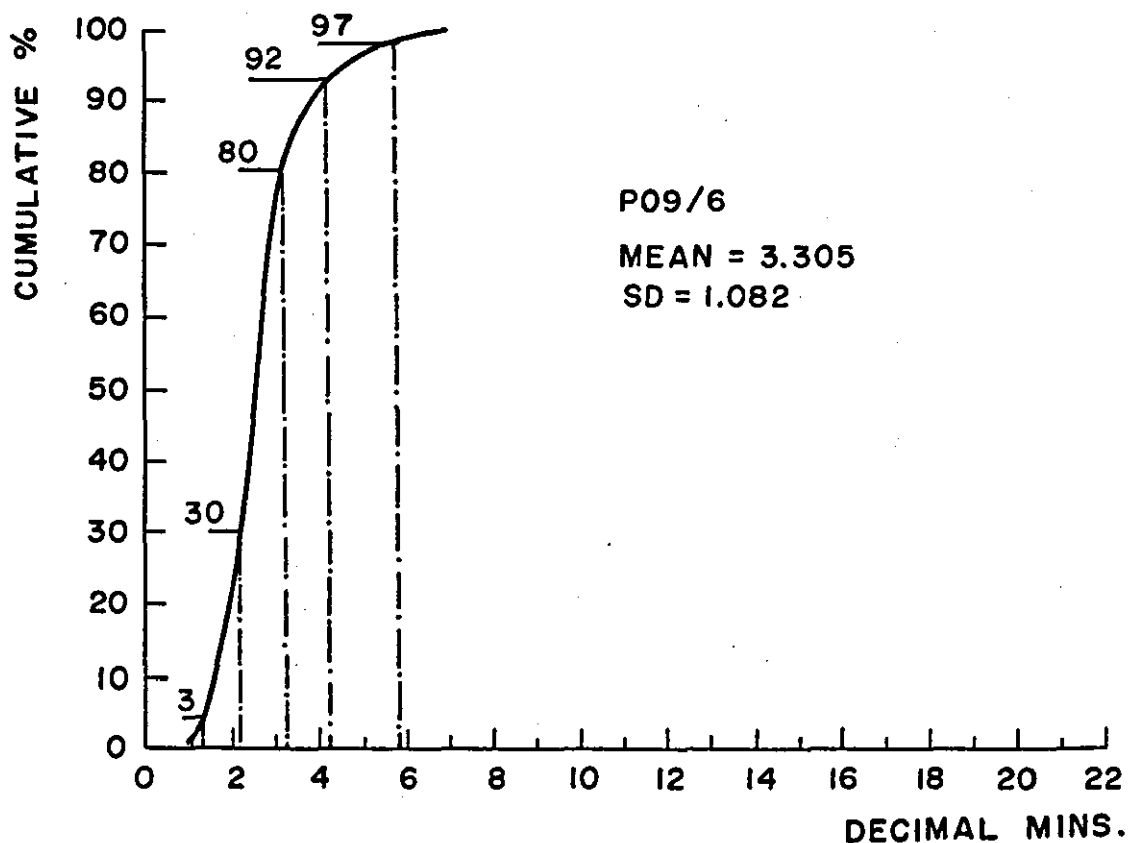


Figure J15: Cumulative Frequency Distribution P09/7

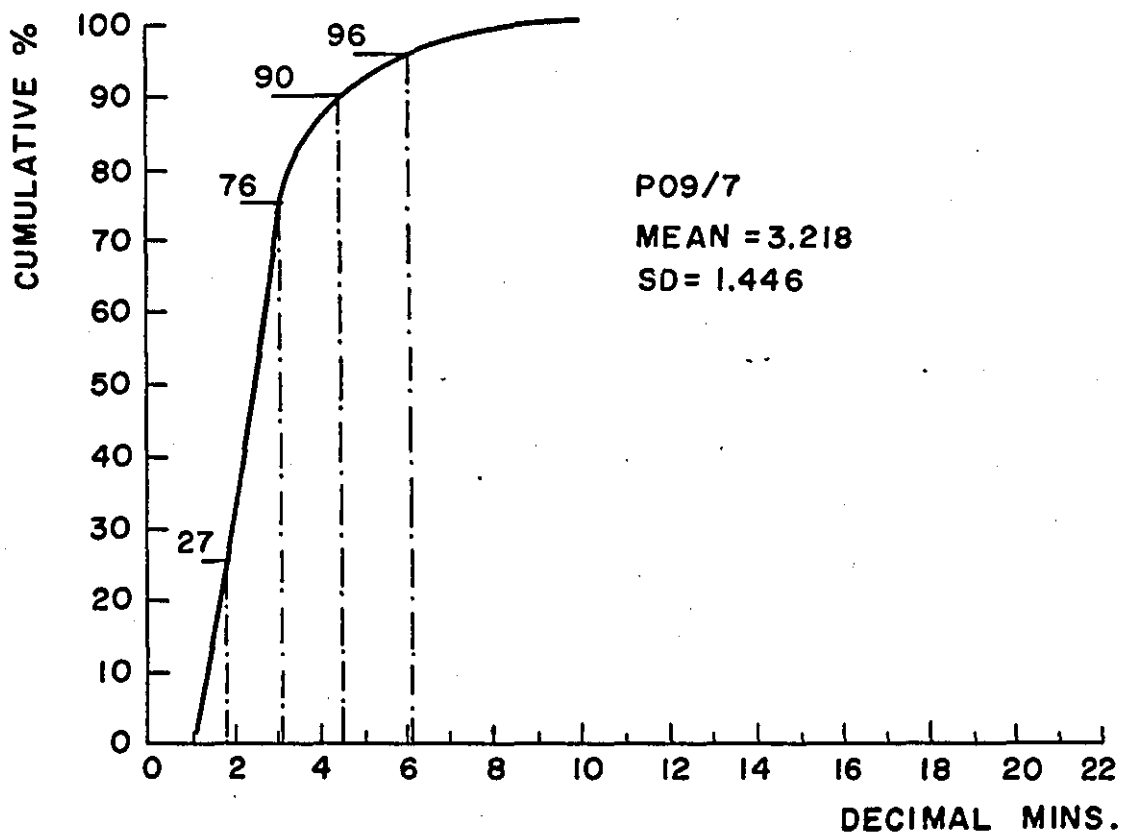


Figure J16; Cumulative Frequency Distribution: P09/8

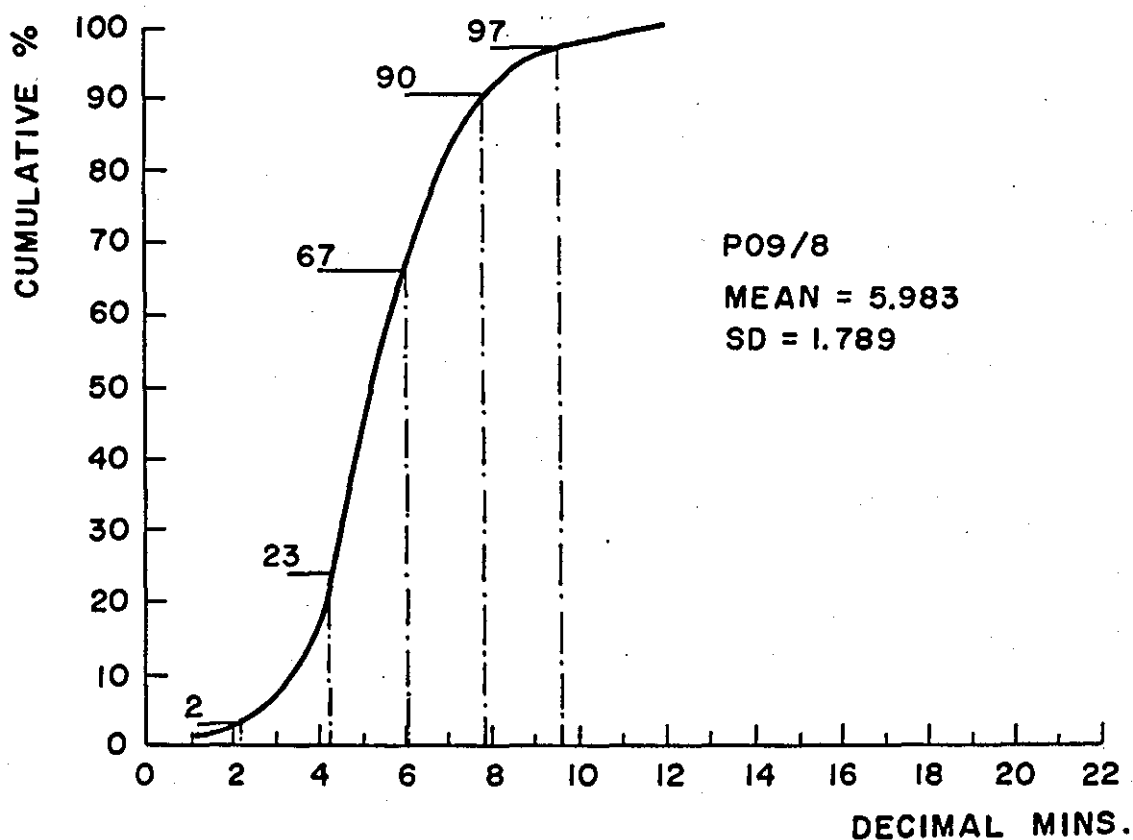


Figure J17: Cumulative Frequency Distribution: P09/9

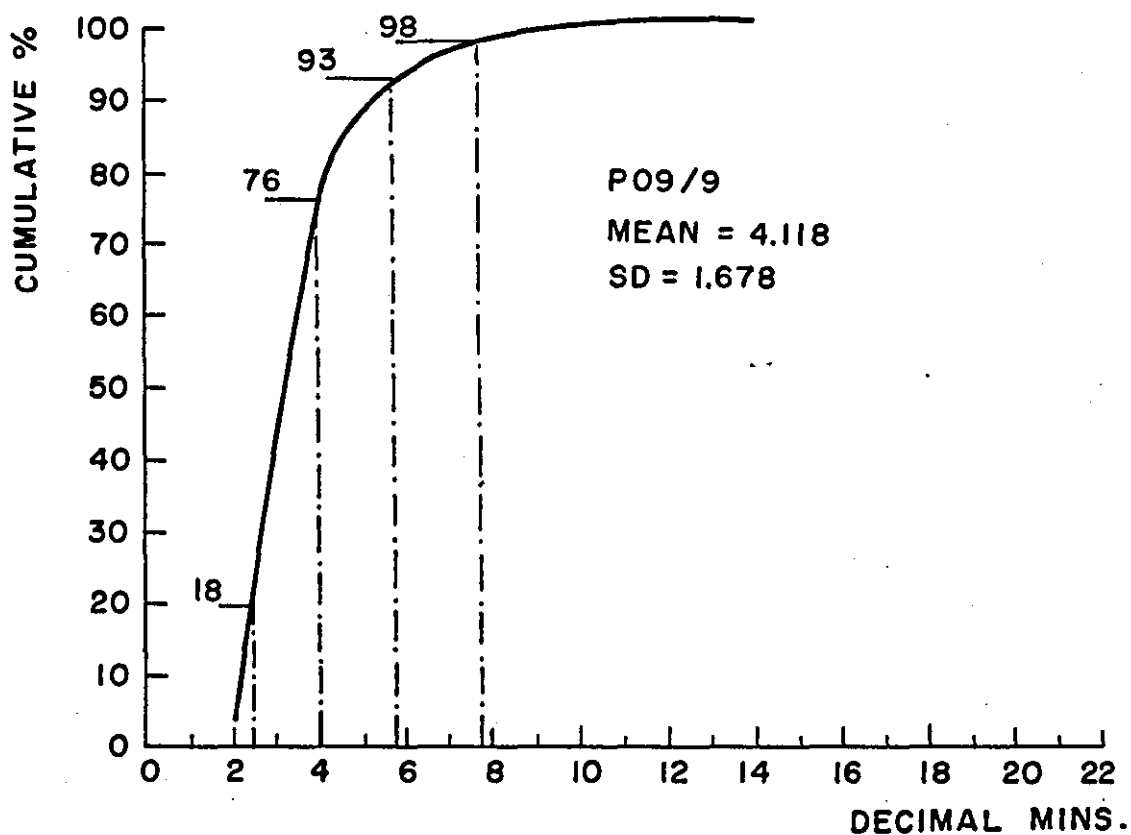


Figure J18: Cumulative Frequency Distribution: P09/10

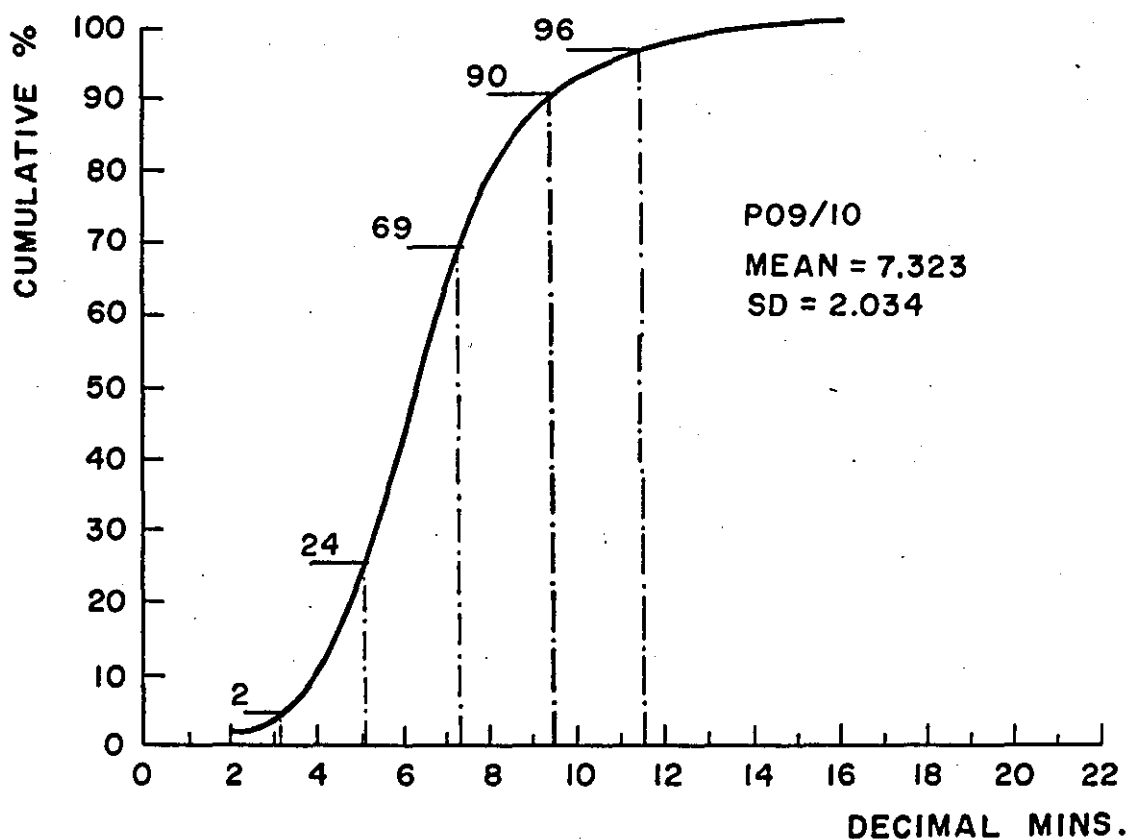


Figure J19: Cumulative Frequency Distribution: P09/11

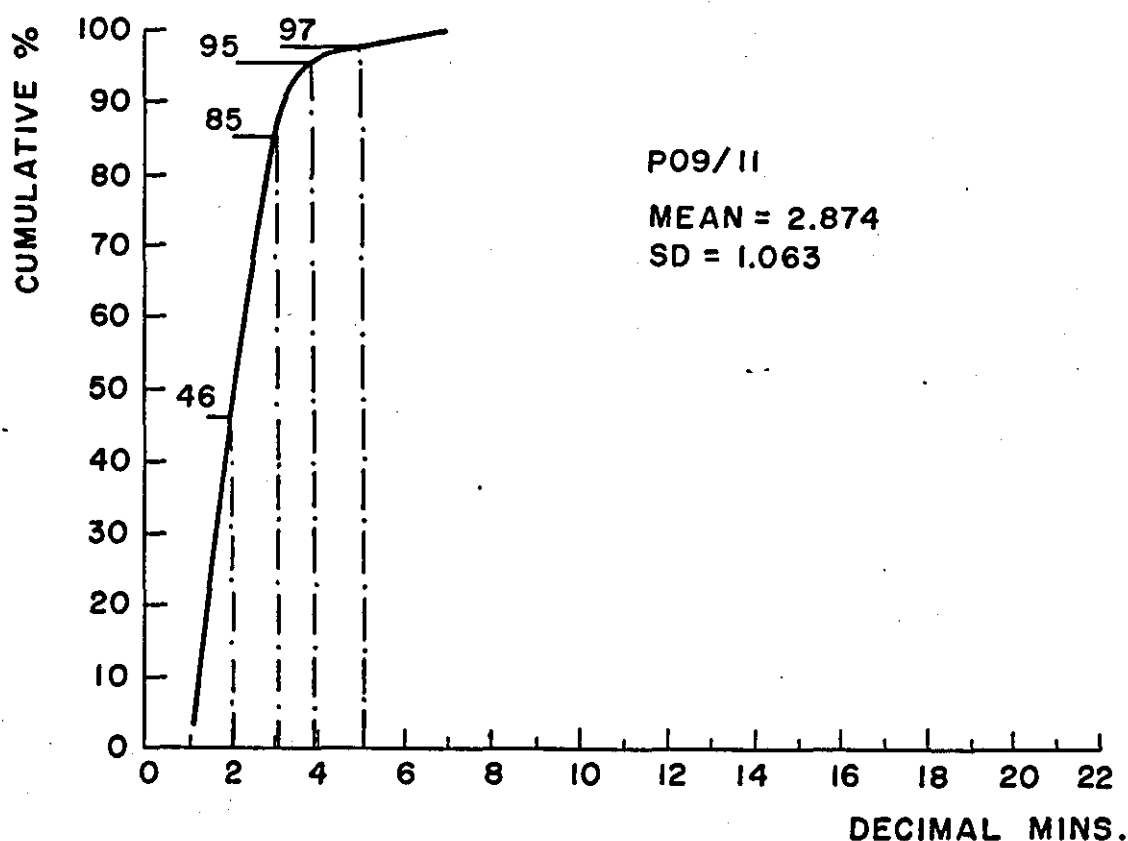


Figure J20: Cumulative Frequency Distribution: P10/1

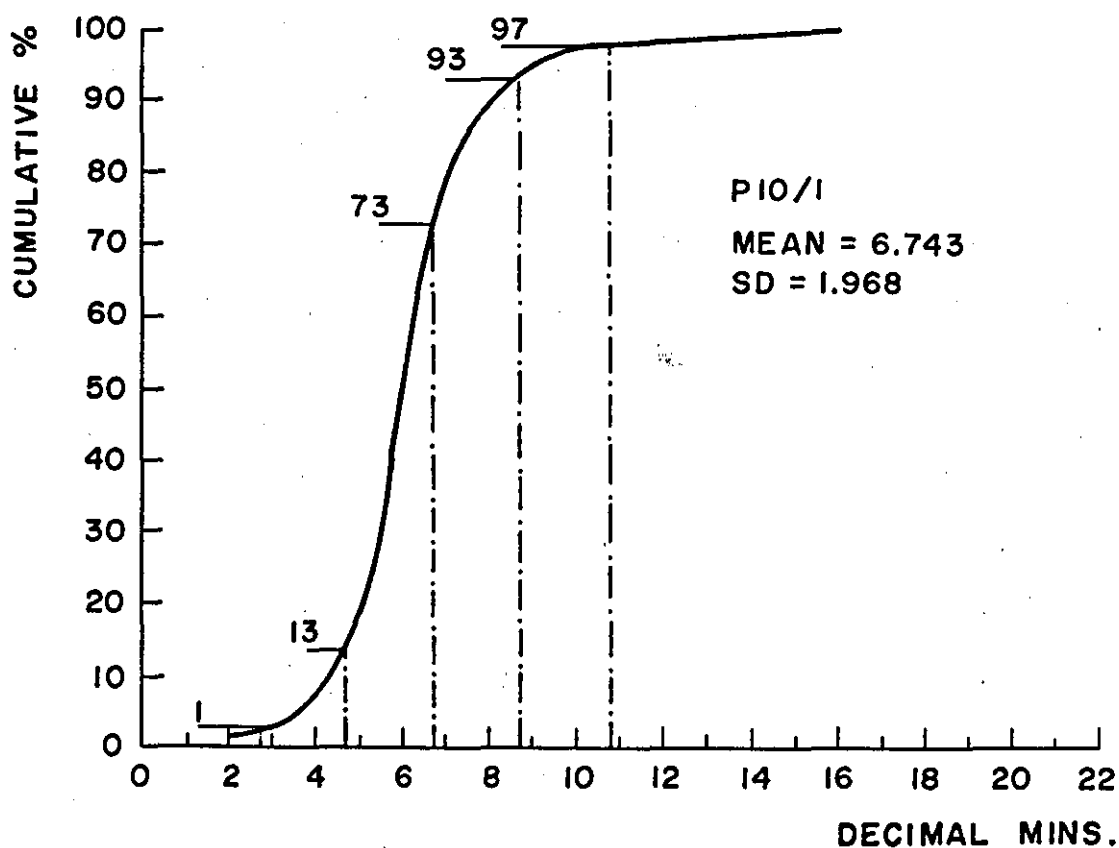


Figure J21: Cumulative Frequency Distribution: P10/2

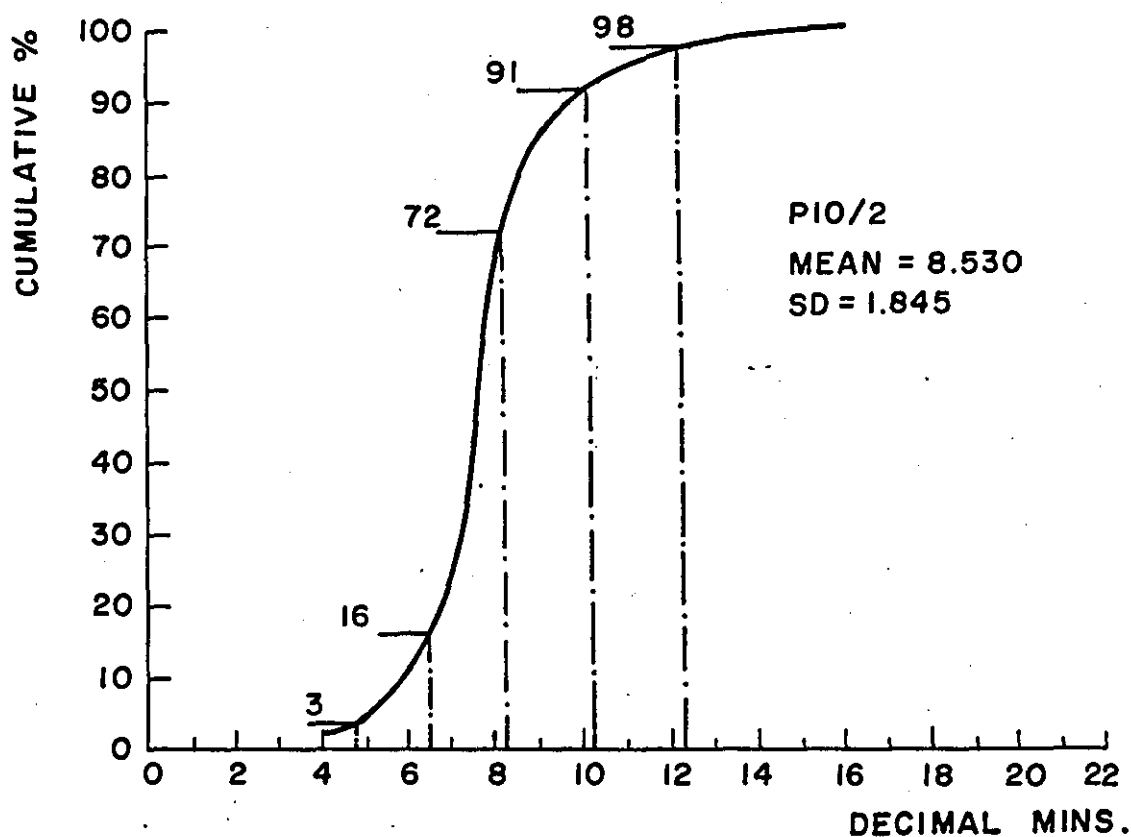


Figure J22: Cumulative Frequency Distribution: P11/1

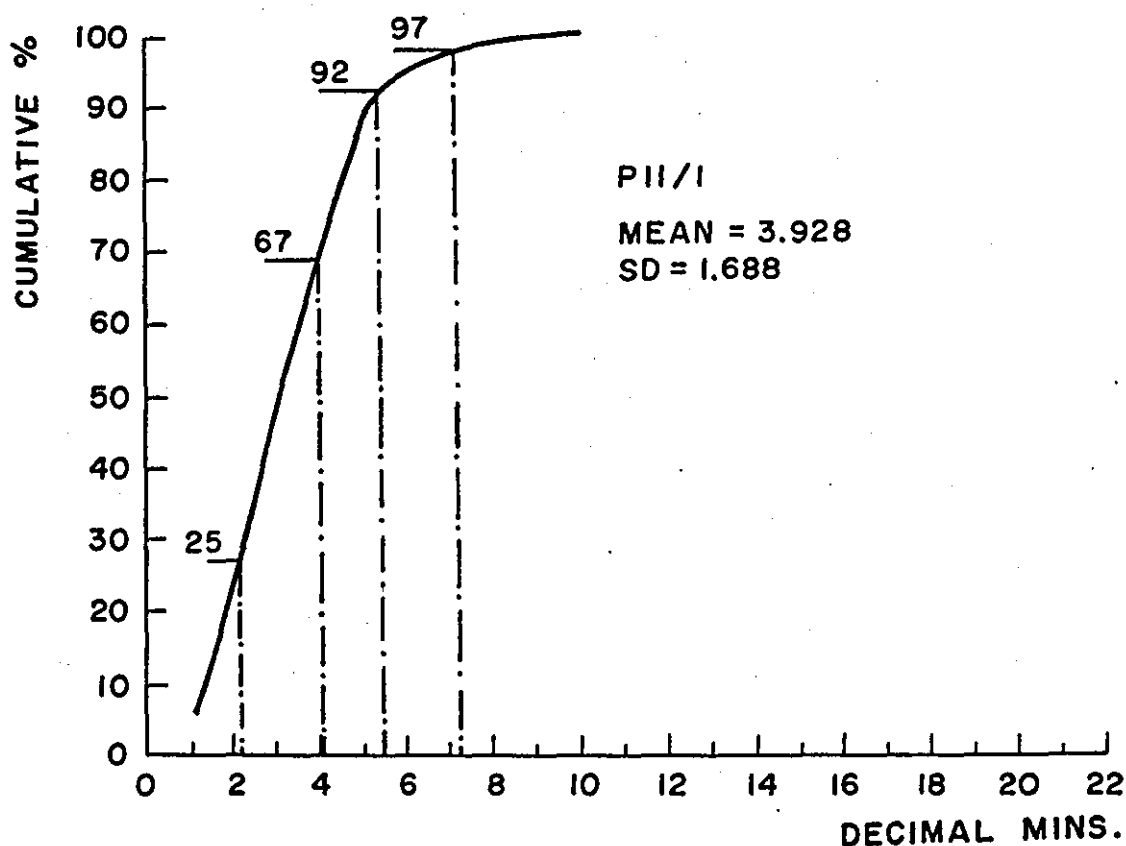


Figure J23: Cumulative Frequency Distribution: P12/1

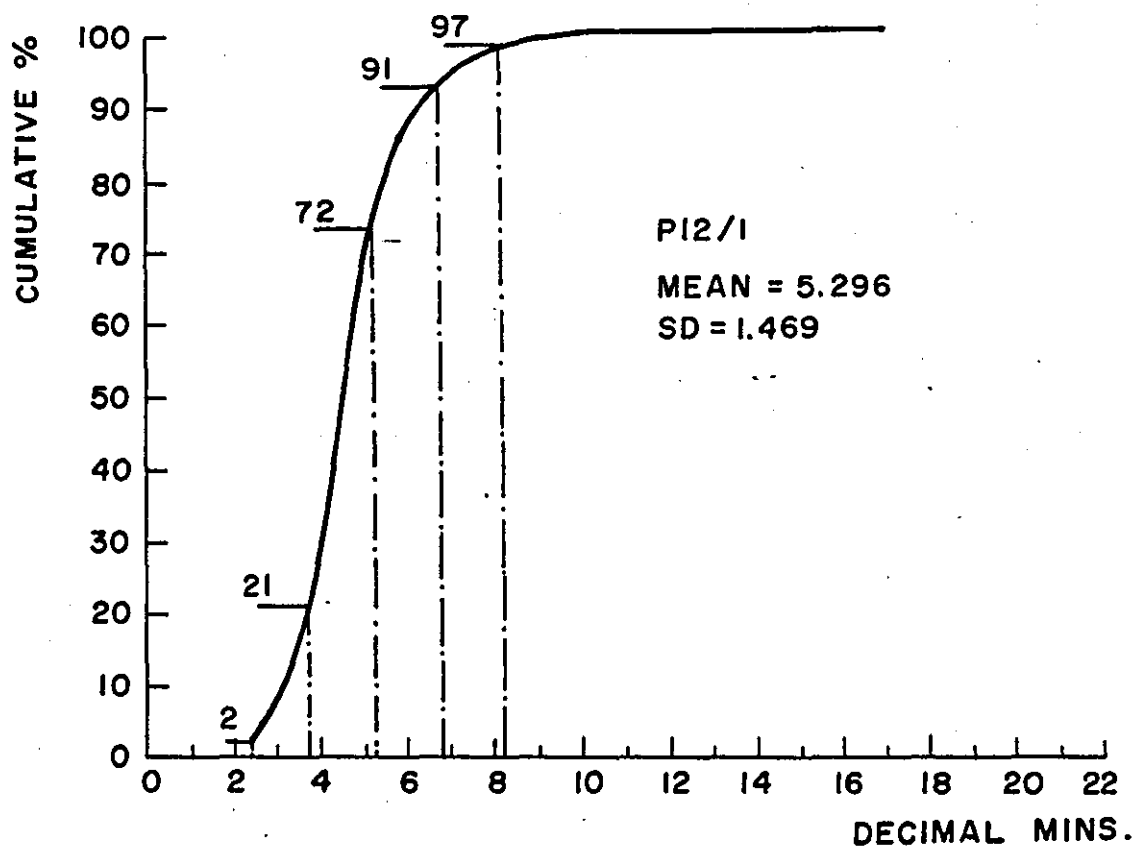


Figure J24: Cumulative Frequency Distribution: P12/2

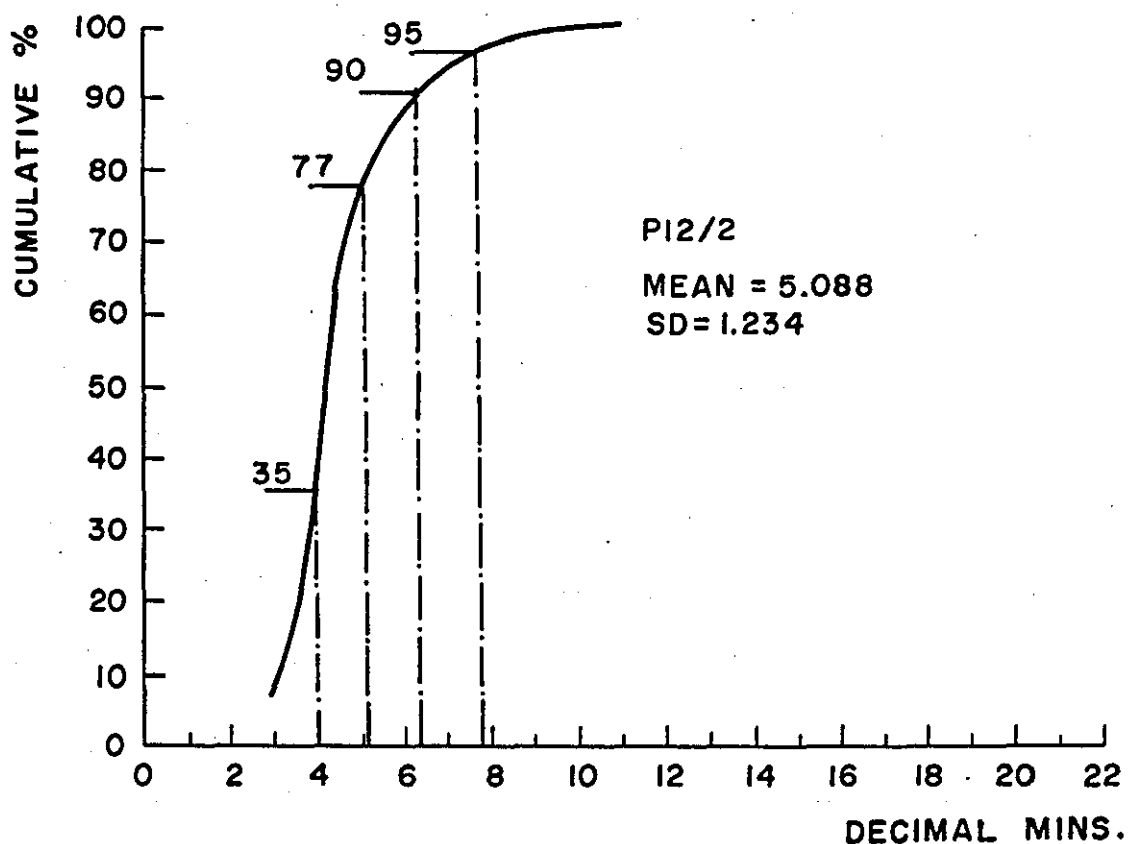


Figure J25: Cumulative Frequency Distribution: P13/1

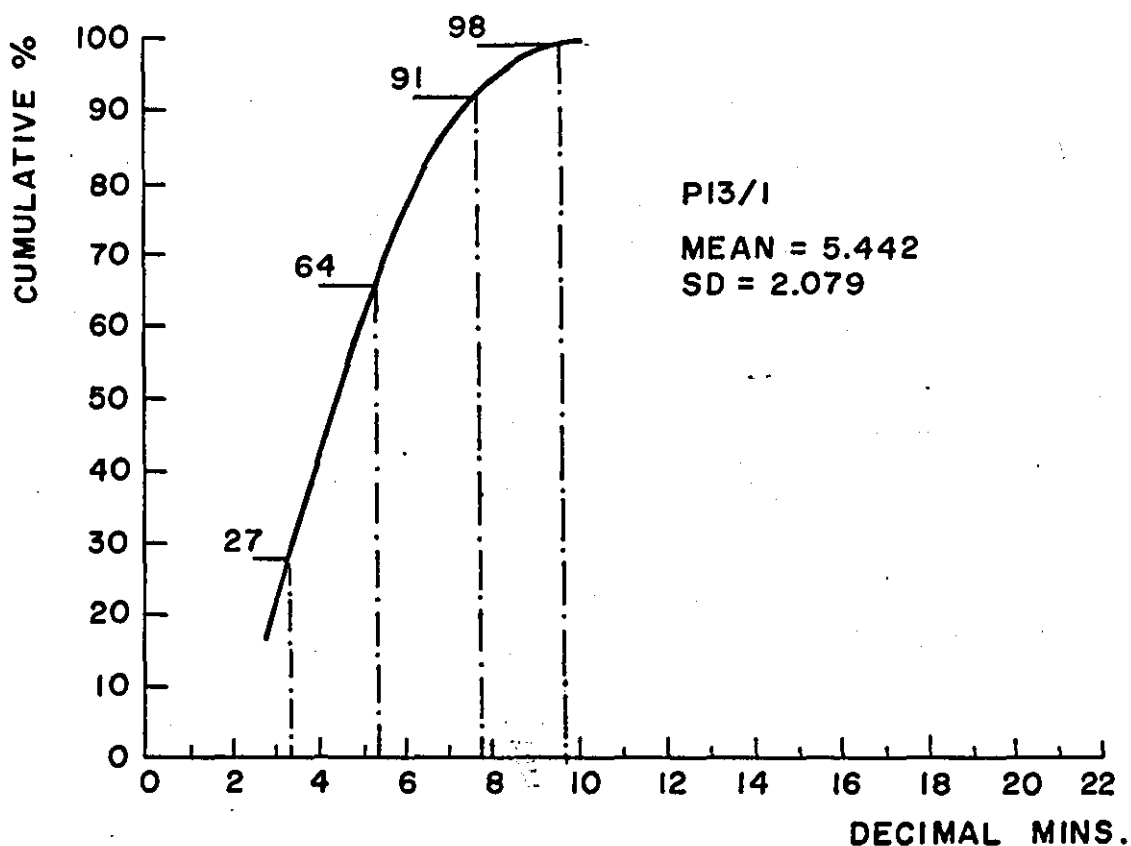
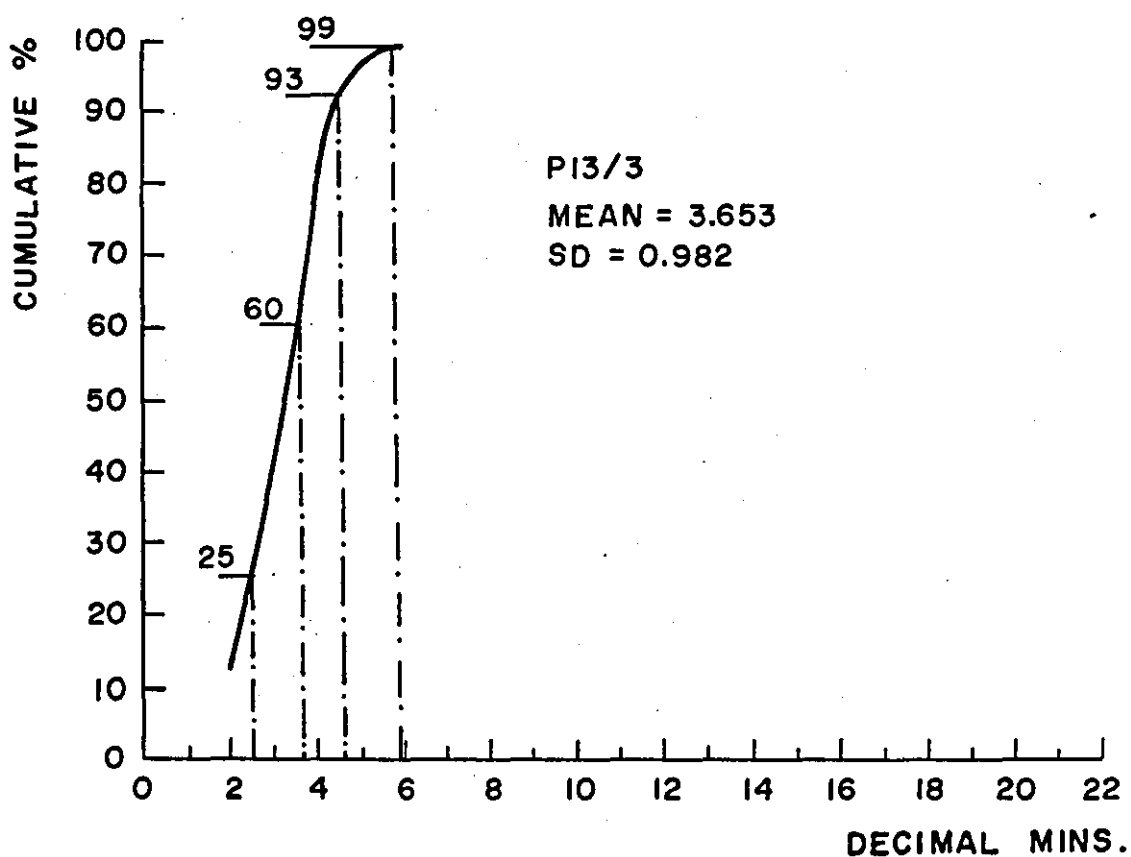


Figure J26: Cumulative Frequency Distribution: P13/3



## APPENDIX K: A REVIEW OF MTM-1, MTM-2 AND MTM-3

The development of a family of PMTS under the general heading of Methods - Time Measurement (MTM) began in 1940 due to the efforts of a consulting company, the Methods Engineering Council, which was located in Pennsylvania, USA. Details of the original system were published in a textbook by Maynard, Stegemerton and Schwab (1948) and the system entered the public domain. The originators of the system trained both their competitors and the general public in the use of the system, insisting, however, that a practitioner qualification procedure should be adhered to by those receiving training. Eventually, a user's association was set up in the USA and Canada, known as the MTM Association for Standards and Research. National MTM Associations have now been developed in twenty seven other countries, all of which subscribe to the development and control of the MTM group of PMTS.

In the late 1960's, efforts were being made by many groups to develop simplified PMTS. The MTM Associations produced two simplified, or higher level, data systems which became known as MTM-2 and MTM-3. The original system at that time became identified as MTM-1.

For a full description of the MTM-1 system, the reader is referred to Antis, et al (1963) and for a description of MTM-2 and MTM-3, to Knott and Goodall (1970, 1970). This appendix summarizes some of the characteristics of MTM-1, MTM-2 and MTM-3.

### K.0.1 Definition of Methods-Time Measurement

The definition of MTM by the originators of the system, Maynard et al (1949) is equally applicable to MTM-1, MTM-2 and MTM-3. It is as follows:

"A procedure which analyses any manual motion or method into the basic motions required to perform it, and assigns to each motion a predetermined time standard which is determined by the nature of the motion and the conditions under which it is made."

All elements in an operation are either manually or process controlled. Examples of process controlled elements are painting a surface which has to be covered completely, drinking a glass of water, the time involved in cutting in a machinery operation. This type of element cannot be measured with MTM. It is the only manually controlled motions with which MTM is concerned. These are called Basic Manual Motions.

#### K.1.0 THE TIME UNITS AND PERFORMANCE LEVEL

##### K.1.1 The Time Units

The original MTM data is based upon a frame by frame film analysis of a motion film photographed at 16 frames per second, thus the times between frames was 0.00001736 hours. Using a decision model for selecting breakpoints and rounding off times, a more practical time unit of 0.00001 hours was chosen. This unit of time in MTM became known as the "Time Measurement Unit" and was abbreviated to TMU.

##### K.1.2 The Performance Level

All of the films used for analysis in developing the MTM system, and the subsequent research carried out by the MTM Association were "levelled" according to the LMS performance rating system. Thus, the times are expressed at a level which represents the time to be expected from an average operator who, when suitably motivated, could work at a performance of 120. Thus, one TMU is 0.00001 hour at a performance level of 100 on the LMS rating scale.

##### K.1.3 Conversion to BSI

It has been shown by several authors, including Knott and Goodall (1970), that TMU values can be converted to minutes on the BSI scale as follows:

$$\text{Minutes at 100 BSI} = \frac{\text{TMU}}{2000} \quad (\text{Eq. K-1})$$

## K.2.0 A BRIEF DESCRIPTION OF THE MTM-1 SYSTEM

The MTM-1 data card consists of ten separate tables. This data card is shown as Figures K-1 and K-2.

### K.2.1 The Basic Manual Motions

The Basic Manual Motions used in MTM-1, together with their respective code letters are listed below:

Basic Manual Motions	Code Letter
REACH	R
MOVE	M
GRASP	G
RELEASE	RL
TURN	T
APPLY PRESSURE	AP
POSITION	P
DISENGAGE	D

### K.2.2 The Basic Manual Motion Reach

The Basic Manual Motion Reach is defined as

"The manual basic motion performed with the predominant purpose of transporting the hand or fingers to a destination."

This Basic Manual Motion is subject to three variables as follows:

1. Distance moved in inches. (Actual path of travel of hand or fingers is measured in inches.)
2. Type of Motion. Whether the hand is at rest or in motion at beginning and/or end of movement.
3. "Case of Reach". There are five cases of Reach, which are described on the MTM-1 data card.

The symbol used to describe a Reach Motion is shown in Figure K-3.

Figure K-1: Table 1 to 5 of the MTM-1 Data Card

TABLE I-REACH-R

Distance Moved Inches	Time TMU				Hand In Motion	
	A	B	C or D	E	A	B
1/2 or less	2.0	2.0	2.0	2.0	1.6	1.6
1	2.6	2.6	3.6	2.4	2.3	2.3
2	4.0	4.0	6.9	3.6	3.5	2.7
3	6.3	6.3	7.3	5.3	4.5	3.6
4	6.1	6.4	8.4	6.8	4.9	4.3
5	6.5	7.8	9.4	7.4	6.3	6.0
6	7.0	8.6	10.1	8.0	6.7	6.7
7	7.4	9.3	10.8	8.7	6.1	6.6
8	7.9	10.1	11.5	9.3	6.6	7.2
9	8.3	10.8	12.2	9.9	6.9	7.9
10	8.7	11.5	12.9	10.5	7.3	8.6
12	9.6	12.9	14.2	11.8	8.1	10.1
14	10.5	14.4	15.6	13.0	8.9	11.6
16	11.4	15.8	17.0	14.2	9.7	12.9
18	12.3	17.2	18.4	15.5	10.6	14.4
20	13.1	18.6	19.8	16.7	11.3	15.8
22	14.0	20.1	21.2	18.0	12.1	17.3
24	14.9	21.5	22.5	19.2	12.9	18.8
26	15.8	22.9	23.9	20.4	13.7	20.2
28	16.7	24.4	25.3	21.7	14.5	21.7
30	17.6	25.8	26.7	22.9	15.3	23.2

TABLE II-MOVE-M

Distance Moved Inches	Time TMU				Wt. Allowance		
	A	B	C	Hand In Motion B	Wt. (lb.) Up to	Fac-tor	Con-stant TMU
1/2 or less	2.0	2.0	2.0	1.7	2.5	1.00	0
1	2.6	2.9	3.4	2.3	7.5	1.06	2.2
2	3.6	4.6	5.2	2.9			
3	4.9	6.7	6.7	3.6			
4	6.1	6.9	8.0	4.3	12.5	1.11	3.9
5	7.3	8.0	9.2	5.0			
6	8.1	8.9	10.3	5.7			
7	8.9	9.7	11.1	6.6	17.5	1.17	5.8
8	9.7	10.6	11.8	7.2			
9	10.5	11.5	12.7	7.9			
10	11.3	12.2	13.5	8.6	22.5	1.22	7.4
12	12.9	13.4	16.2	10.0			
14	14.4	14.6	16.9	11.4			
16	15.0	15.8	18.7	12.8	32.5	1.33	10.8
18	17.6	17.0	20.4	14.2			
20	19.2	18.2	22.1	15.6			
22	20.8	19.4	23.8	17.0	37.5	1.39	12.5
24	22.4	20.6	25.5	18.4			
26	24.0	21.8	27.3	19.8			
28	25.5	23.1	29.0	21.2	42.5	1.44	14.3
30	27.1	24.3	30.7	22.7			

TABLE IV-GRASP-G

Case	Time TMU	DESCRIPTION
1A	2.8	Pick Up Grasp—Small, medium or large object by itself, easily grasped.
1B	3.6	Very small object or object lying close against a flat surface.
1C1	7.3	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter larger than 1/4".
1C2	8.7	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter 1/4" to 1/2".
1C3	10.8	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter less than 1/4".
2	5.6	Regrasp.
3	6.6	Transfer Grasp.
4A	7.3	Object jumbled with other objects so search and select occur. Larger than 1" x 1" x 1".
4B	9.1	Object jumbled with other objects so search and select occur. 1/2" x 1/2" x 1/2" to 1" x 1" x 1".
4C	12.9	Object jumbled with other objects so search and select occur. Smaller than 1/2" x 1/2" x 1/2".
5	0	Contact, sliding or hook grasp.

TABLE V-POSITION\*-P

CLASS OF FIT		Symmetry	Easy To Handle	Difficult To Handle
1—Loose	No pressure required	S	6.6	11.2
		SS	9.1	14.7
		NS	10.4	16.0
2—Close	Light pressure required	S	16.2	21.8
		SS	19.7	25.3
		NS	21.0	26.8
3—Exact	Heavy pressure required.	S	43.0	48.6
		SS	46.5	52.1
		NS	47.8	53.4

\*Distance moved to engage—1" or less.

TABLE III TURN AND APPLY PRESSURE-T AND AP

Weight	Time TMU for Degrees Turned										
	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
Small— 0 to 2 Pounds	2.8	3.5	4.1	4.8	5.4	6.1	6.8	7.4	8.1	8.7	9.4
Medium— 2.1 to 10 Pounds	4.4	5.5	6.5	7.5	8.5	9.6	10.6	11.6	12.7	13.7	14.8
Large— 10.1 to 35 Pounds	8.4	10.5	12.3	14.4	16.2	18.3	20.4	22.2	24.3	26.1	28.2
APPLY PRESSURE CASE 1—18.2 TMU. APPLY PRESSURE CASE 2—10.6 TMU											

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Figure K-2: Tables 6 to 10 of the MTM-1 Data Card

TABLE VI-RELEASE-RL

Case	Time TMU	DESCRIPTION
1	2.0	Normal release performed by opening fingers as independent motion.
2	0	Contact Release.

**TABLE VII-DISENGAGE-D**

CLASS OF FIT	Easy to Handle	Difficult to Handle
1—Loose—Very slight effort, blande with subsequent move.	4.0	5.7
2—Close — Normal effort, slight recoil.	7.5	11.8
3—Tight — Considerable effort, hand recoils markedly.	22.9	34.7

### TABLE VIII-EYE TRAVEL TIME AND EYE FOCUS-ET AND EF

**Eye Travel Time =  $18.2 \pm \frac{T}{D}$  TMU, with a maximum value of 20 TMU.**

where T—the distance between points from and to which the eye travels.  
D—the perpendicular distance from the eye to the line of travel T.

**Eye Focus Time = 7.3 TMU.**

### TABLE X-SIMULTANEOUS MOTIONS

REACH				MOVE			GRASP			POSITION			DISENGAGE		CASE	MOTION	
A, E	B	C, D	A, B, C	B	C	G1A G2 G3	G1B G1C	G4	P1B	P15B P7B	P15B P15C P15D	D1E D1D	D2				
		W	O	W	O		W	O	I	B	I	B		I	B	A, E	REACH
																C, D	MOVE
																G1A, G2, G3	GRASP
																G4	POSITION
																P15B, P7B	DISENGAGE
																D1E, D1D	

□ = EASY to perform simultaneously.

✕ = CAN be performed simultaneously with PRACTICE.

■ = DIFFICULT to perform simultaneously even after long practice. Allow both times.

MOTIONS NOT INCLUDED IN ABOVE TABLE

TURN—Normally EASY with all motions except when TURN is controlled or with DISENGAGE.

APPLY PRESSURE—May be EASY, PRACTICE, or DIFFICULT. Each case must be analyzed.

POSITION—Class 3—Always DIFFICULT.

DISENGAGE—Class 3—Normally DIFFICULT.

RELEASE—Always EASY.

DISENGAGE—Any class may be DIFFICULT if care must be exercised to avoid injury or damage to object.

• W = Within the area of normal vision.

O = Outside the area of normal vision.

••• = EASY to handle.

D = DIFFICULT to handle.

### TABLE IX-BODY, LEG AND FOOT MOTIONS

DESCRIPTION	SYMBOL	DISTANCE	TIME TMU
Foot Motion—Hinged at Ankle. With heavy pressure. Leg or Foreleg Motion.	FM FMP LM —	Up to 4"  Up to 8" Each add'l. inch	8.6 19.1 7.1 1.2
Sidestep—Case 1—Complete when leading leg contacts floor.  Case 2—Lagging leg must contact floor before next motion can be made.	SS-C1  SS-C2	Less than 12" 12" Each add'l. inch  12" Each add'l. inch	Use REACH or MOVE Time 17.0 .6 34.1 1.1
Bend, Stoop, or Kneel on One Knee. Arise. Kneel on Floor—Both Knees. Arise.	B.S.KOK AB, AS, AKOK KBK AKBK'		29.0 31.9 69.4 76.7
Sit. Stand from Sitting Position. Turn Body 45 to 90 degrees— Case 1—Complete when leading leg contacts floor. Case 2—Lagging leg must contact floor before next motion can be made.	SIT STD  TBC1  TBC2		34.7 43.4  19.6  37.2
Walk. Walk. Walk.	W-FT. W-P W-PO.	Per Foot Per Pace Per Pace	5.3 15.0 17.0

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Figure K-3: MTM-1 Symbol for Reach 12" to an Object  
the location of which may vary slightly  
from cycle to cycle

Description	Symbol
Symbol for Reach	<div>R12B</div>
Distance	
Case of Reach	

K.2.3 The Basic Manual Motion Move

The Basic Manual Motion Move is defined as:

"The manual basic motion performed with the predominant purpose of transporting an object to a destination."

This Basic Manual Motion has had its variables delineated as follows:

- 1. Distance Moved. (Actual path of travel of hand or fingers is measured in inches.)
- 2. Type of Motion. Whether the hand is at rest or in motion at the beginning and/or end of movement.
- 3. Weight of Object. Measured as its resistance to movement per hand.
- 4. "Case of Move". There are three cases of Move as defined on the data card.

When making the appropriate allowance to the time for handling a weight, or overcoming a resistance to motion, the time for the motion, neglecting the weight, is multiplied by a factor and then a constant time is added. This multiplication factor and constant time is dependent upon the resistance to motion per hand.

The symbol used to describe a Move is given in Figure K-4.

Figure K-4: MTM-1 Symbol for Moving an Object  
12" to an Approximate Location,  
against a Resistance of 20 lb.  
Per Hand.

Description	Symbol
	M 12 B 20
Move	
Distance	
Case	
Weight or resistance in lbs.	

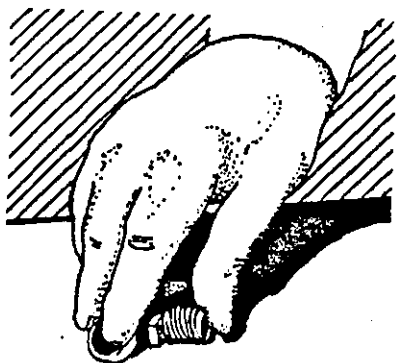
K.2.4 The Basic Manual Motion Grasp

The Basic Manual Motion Grasp is defined as:

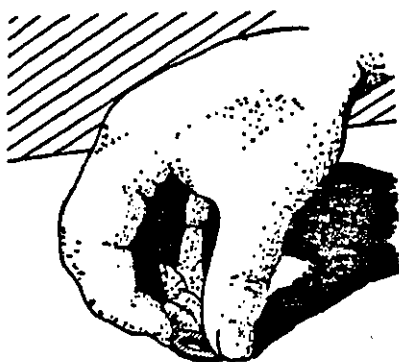
"The manual basic motion performed to gain control of an object."

There are eleven different types of Grasp recognized in the MTM-1 system. These Grasps can be further classified in five groups, which are illustrated in Figures K-5 to K-9, inclusive.

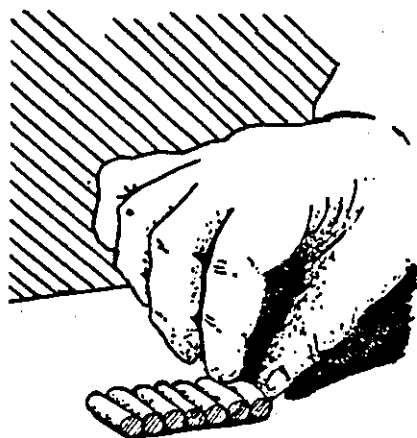
Figure K-5: MTM-1 "Pick-Up" Grasps



G1A: Small medium or large object, by itself, easily grasped.



G1B: Very small object or object lying close against a flat surface.



G1C: Interference with grasp on bottom and one side of a nearly cylindrical object.

G1C1: Diameter larger than  $\frac{1}{2}$ ".

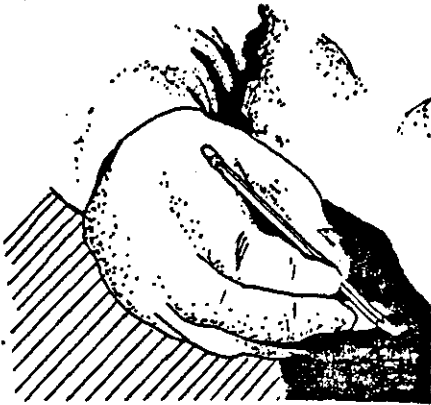
G1C2: Diameter  $\frac{1}{4}$  to  $\frac{1}{2}$ ".

G1C3: Diameter less than  $\frac{1}{4}$ ".

Figure K-6: The MTM-1 "Regrasp"



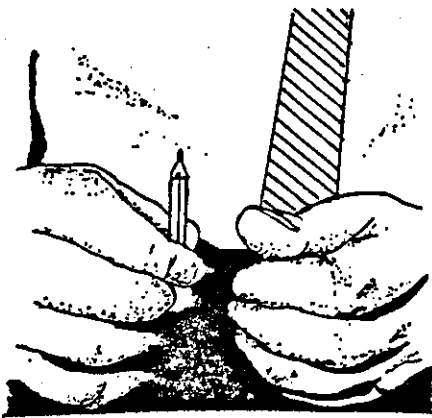
Start



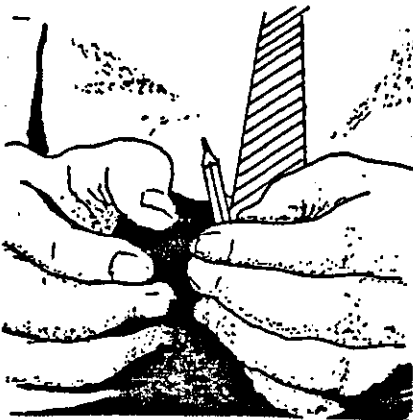
Finish

G2

Figure K-7: The MTM-1 "Transfer Grasp"



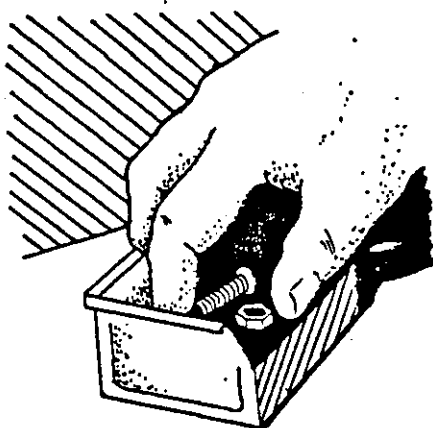
Start



Finish

G3

Figure K-8: The MTM-1 "Jumbled Grasp"



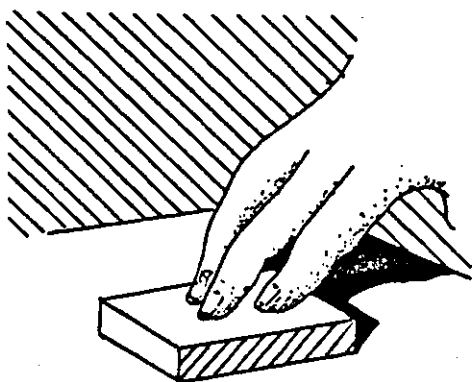
G4:

G4A: Larger than 1" x 1" x 1"

G4B:  $\frac{1}{4}$ " x  $\frac{1}{4}$ " x  $\frac{1}{8}$ " to 1" x 1" x 1"

G4C: Smaller than  $\frac{1}{4}$ " x  $\frac{1}{4}$ " x  $\frac{1}{8}$ "

Figure K-9: The MTM-1 "Contact, Sliding or Hood Grasp"



G5

### K.2.5 The Basic Manual Motion "Release"

The Basic Manual Motion Release is defined as:

"The manual basic motion performed to relinquish control of an object."

There are only two cases of Release:

RL1 - where the fingers open. This case of release is associated with all types of Grasp except G5.

RL2 - the release where contact is broken and is usually associated with G5.

### K.2.6 The Basic Manual Motion "Turn"

This is defined as follows:

"The manual basic motion performed when rotating the empty or loaded hand about the long axis of the forearm."

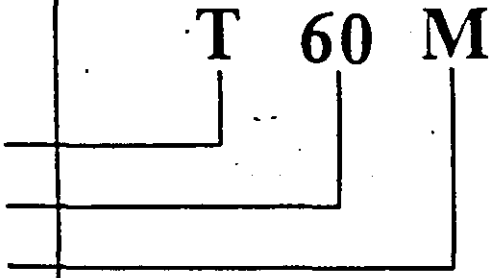
There are two variables recognised in this Basic Manual Motion, namely

1. Angle of turn measured in degrees. This is in the range 30° to 180° in Steps of 15°.
2. Weight or Resistance to Motion. This is categorised as Small ( $>0 \leq 2$  lbs), Medium ( $>2.1 \leq 10$  lbs), Large ( $>10.1$  to 35 lbs)

When the weight variable exceeds 35 lbs motions other than a Turn occur.

The symbol used to describe a turn is shown in Figure K-10.

Figure K-10: A Turn Through 60° While Carrying an Object of Medium Weight

Description	Symbol
Turn 60 degrees medium 2.1 to 10 lbs. weight	

#### K.2.7 The Basic Manual Motion "Apply Pressure"

This Basic Manual Motion is defined as

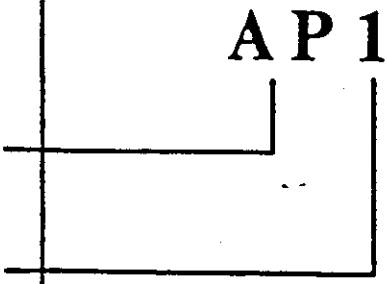
"An application of Muscular force to overcome resistance accompanied by or no resistance."

There is a limitation of  $\leq \frac{1}{4}$ " on the movement which can occur in an Apply Pressure. It is recognised by three force components as it is being performed. These are

1. Increase of muscular force.
2. Reaction time for the reversal of muscular force.
3. Reversal of muscular force.

Apart from the distance limitation noted above, the reaction time in (2) is limited to minimum reaction time for an Apply Pressure to occur. When this reaction time is exceeded, the motion is classified as a process time.

Figure K-11: Symbol for the MTM-1 "Apply Pressure"

Description	Symbol
Apply Pressure  Case	

The MTM-1 Basic Manual Motion "Apply Pressure" has only one variable, the Case, resulting in

- AP1 - when it is necessary to re-orient the hand to avoid loss of grip, or injury, or discomfort during force application.
- AP2 - when the body member is in position and requires no resetting before force application.

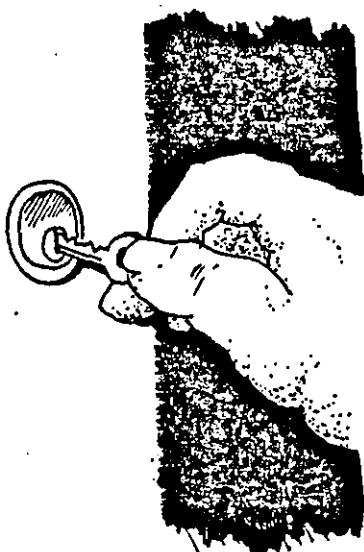
K.2.8 The Basic Manual Motion "Position"

The definition of this Basic Manual Motion is:

"The manual basic motion performed to bring an object into an exact, predetermined relationship with another object."

It is the most complex of all of the MTM-1 motions and can be partially explained in terms of the other motions. A position would typically occur when bringing a key to a lock, as shown in Figure K-12, and if preceded by a move, the case of move would be case C.

Figure K-12: An Example of "Position"



The symbol used to identify the MTM-1 Basic Manual Motion Position is shown in Figure K-13.

Figure K-13: The Symbol for "Position"

Description	Symbol
Position Class of Fit Symmetry Easy to Handle	<div style="text-align: center; font-size: 2em; font-weight: bold;">P 1 S E</div> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="width: 20%; border-left: 1px solid black; border-right: 1px solid black; height: 100px; margin: 0 auto;"></div> <div style="width: 20%; border-left: 1px solid black; border-right: 1px solid black; height: 100px; margin: 0 auto;"></div> <div style="width: 20%; border-left: 1px solid black; border-right: 1px solid black; height: 100px; margin: 0 auto;"></div> <div style="width: 20%; border-left: 1px solid black; border-right: 1px solid black; height: 100px; margin: 0 auto;"></div> </div>

There are three cases of the variable class of Fit. These are described on the data card; however, they are somewhat unclear and misleading. To use these descriptions correctly requires careful training. The cases are

- Class 1 - loose or no pressure required
- Class 2 - close or light pressure required
- Class 3 - exact or heavy pressure required

There are three types of the variable referred to as Symmetry.  
They are:

- Symmetrical - the objects can be mated in an infinite number of ways about the axis of engagement.
- Semi-Symmetrical - the objects can be mated in any one of several ways about the axis of engagement.
- Non-Symmetrical - the objects can be positioned in only one way about the axis of engagement.

K.2.9 The Basic Manual Motion "Disengage"

This Basic Manual Motion is defined as

"The manual basic motion performed to separate objects, characterised by an involuntary movement occasioned by a sudden ending of resistance."

The two variables recognised for this Basic Manual Motion are

- 1. Class of Fit
- 2. Ease or Difficulty of Handling

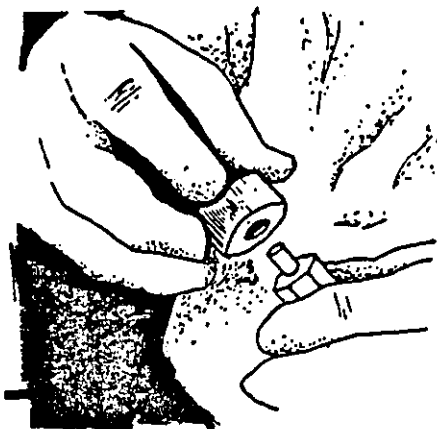
These are combined as illustrated in Figure K-14 to specify a particular Disengage.

Figure K-14: Symbol for Disengage

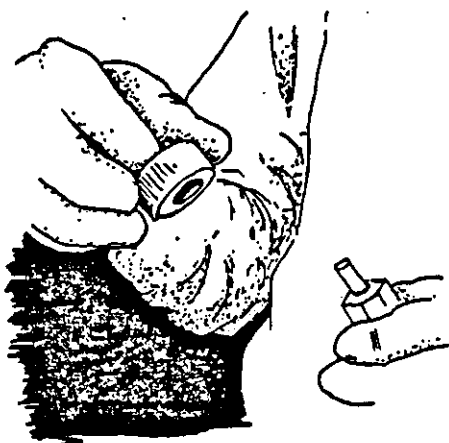
Description	Symbol
Symbol for Disengage	<div>D 2 E</div>
Class of Fit	
Ease of Handling	

The class of fit in Disengage is judged on the length of recoil which denotes the sudden ending of resistance. This is demonstrated for the three classes in Figure K-15.

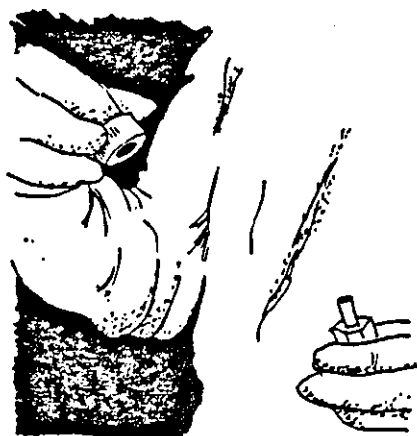
Figure K-15: Recognising the Class of "Disengage"



Case 1 - Loose - very light effort - blends with subsequent Move (0" - 2" recoil)



Case 2 - Close - normal effort - slight recoil (2" - 5" recoil)



Case 3 - Tight - considerable effort - hand recoils markedly (5" 0 12" recoil)

### K.2.10 Other MTM-1 Motions

The other MTM-1 motions are used to a much lesser extent than those outlined above. Therefore, it is proposed not to discuss these, but to refer the interested reader to Antis et al (1963).

### K.2.11 The Principle of Limiting Motion

Correct application of the Principle of Limiting Motions is the key to correct application of MTM. While the Principle is quite simple, its correct application calls for careful guidance and will only be outlined here. It is stated as follows:

"When two motions are performed at the same time the time required is the time consumed by the longer of the two motions."

When two motions are performed at the same time by the body member they are called combined motions. When the two motions are performed by different body members they are called simultaneous motions.

A combined motion can be illustrated by considering a Reach and a Turn being performed at the same time. When the object is reached for, the hand is often turned during the Reach to bring the fingers into position for grasping. This turning has sometimes been called prepositioning. Actually, it often is a Turn combined with a Reach. Usually the Turn is limited out because the Reach is the longer motion.

### K.3.0 A BRIEF DESCRIPTION OF THE MTM-2 SYSTEM

The data card for MTM-2 is given in Figure K-16. The time values, as for the MTM-1 data card, are expressed in TMU and are exclusive of any allowances. The MTM-2 data card here is the metric version, so that distances and weights are expressed in centimetres and kilogrammes, respectively.

Figure K-16: The MTM-2 Data Card

MTM-2						
CODE	G A	G B	G C	P A	P B	P C
-5	3	7	14	3	10	21
-15	6	10	19	6	15	26
-30	9	14	23	11	19	30
-45	13	18	27	15	24	36
-80	17	23	32	20	30	41
GW 1-1 Kg. PW 1-5 Kg.						
A	R	E	C	S	F	B
14	6	7	15	18	9	61

WARNING: Do not attempt to use this data unless you have been trained and qualified under a scheme approved by the International MTM Directorate.

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In an attempt to extend the utility of MTM to areas where the sheer bulk of work involved in application tended to restrict its use, several MTM based systems were developed. In October 1964, the International Directorate of the MTM Association initiated a research project to develop a second general level of MTM which would be the official second generation system of the MTM Association and was to be known as MTM-2.

The definition of MTM-2 given in the MTM-2 Student Manual by Evans and Magnusson is:

"MTM-2 is a system of synthesised MTM data and is the second general level of MTM data. It is based exclusively on MTM and consists of:

- 1. Single basic MTM motions.
- 2. Combinations of basic MTM motions."

This is the official definition which has been adopted by the MTMA.

K.3.1 Construction of MTM-2

MTM-2 was constructed from MTM-1 motion patterns using an extensive computer analysis. This analysis identified the following:

1. That certain motions such as Reach, Move and Grasp were predominant in Industrial operations while other motions such as Turn and Disengage appeared with far less frequency.
2. That certain motion sequences such as Reach, Grasp, Move, Position and Release seem to be "preferred" in a motion pattern.

The clear simplification of MTM-2 over MTM-1 was achieved by the following to produce categories rather than Basic Manual Motions.

1. Technical Simplification - in that easy decision models were produced so that where identification is difficult, it is achieved by exception.
2. Statistical Simplification - motions from basic MTM are combined, averaged, eliminated or substituted. In addition to this, distances are estimated by classes rather than actual measurements. The constructions are shown under the discussion on the various categories.

The motion categories obtained by these simplifications were summarised by Knott and Goodall (1970) as shown in Figure K-17.

### K.3.2 The Categories Get and Put

The model used for the categories Get and Put is based upon the motion sequence and breakdown shown in Figure K-18. The variables to these categories are obtained by means of a statistical weighting.

The symbols used to designate Get and Put are shown in Figures K-19 and K-20, respectively. The variables for both of these motion categories are Distance and Case. This distance variable for both Get and Put is established in the same way. The cases of Get and Put are determined differently.

Figure K-17: The MTM-2 Motion Categories

NAME OF CATEGORY	SYMBOL	DESCRIPTION
GET	GA GB GC	An action of the hand or fingers. The hand reaches to the object, grasps and subsequently releases it. There are three "cases" of GET, A, B and C.
PUT	PA PB PC	An action of the hand or fingers. The hand moves, or moves and positions, the object. There are three "cases" of PUT, A, B and C.
GET WEIGHT	GW	The finite time necessary for the muscles of the hand and arm to take up the weight of an object prior to it being moved.
PUT WEIGHT	PW	The weight of an object affects the time necessary to perform a PUT. PW is the adjustment for this difference.
APPLY PRESSURE	A	Muscular force applied to an object to overcome a resistance, accompanied by little or no motion.
REGRASP	R	The position of an object in the hand is changed, without releasing control.
EYE ACTION	E	E may occur in either of two ways. (1) Recognising a readily distinguishable characteristic of an object. (2) Shifting the aim of the axis of vision to a new viewing area.
CRANK	C	An action of the hand or fingers where an object is rotated more than one half revolution.
FOOT MOTION	F	A motion of the leg, 12" or less, or one in which the trunk is not intentionally moved.
STEP	S	A motion of the leg, greater than 12", or one in which the trunk is intentionally moved.
BEND AND ARISE	B	Lowering of the trunk, and subsequently arising.

Figure K-18: The Basic Construction of GET and PUT

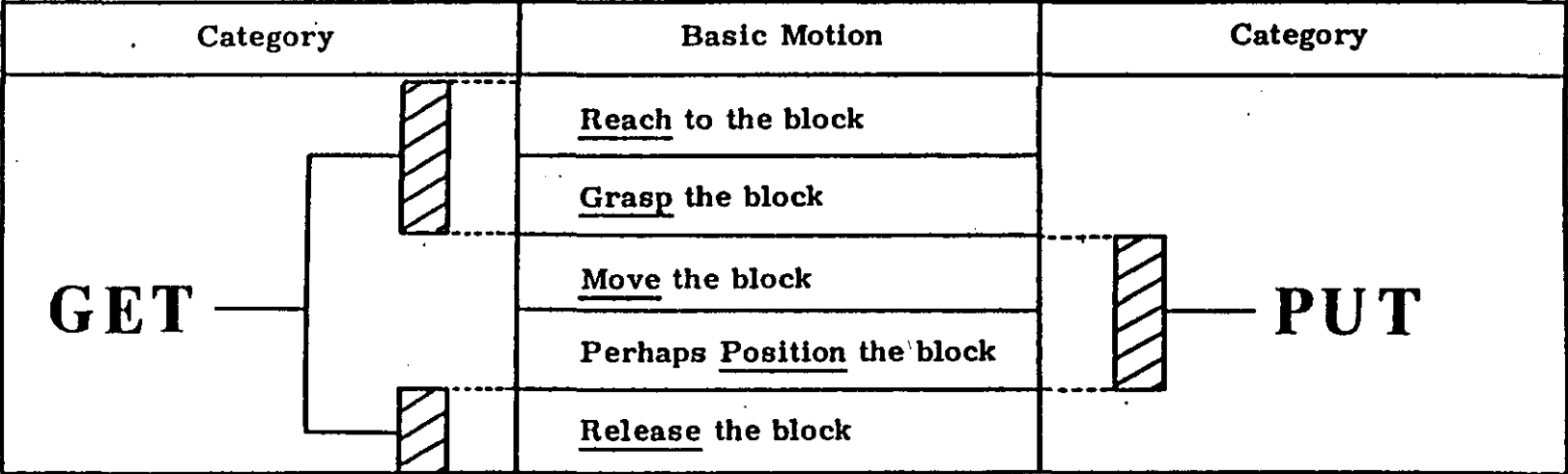


Figure K-19: The Symbol to Designate a Get

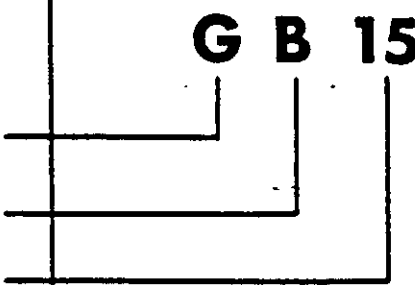
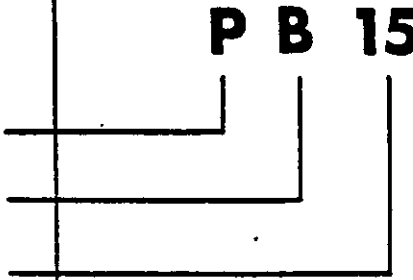
Description	Symbol
	<b>G B 15</b>
General symbol for GET	
Case of Get	
Distance Code	
Meaning: Case B GET with the length of the path of the motion over 5 cms. (2 inches) up to 15 cms. (6 inches)	

Figure K-20: The Symbol to Designate a Put

Description	Symbol
	<b>P B 15</b>
General symbol for PUT	
Case of Put	
Distance Code	
Meaning: Case B PUT with the length of the path of the motion over 5 cms. (2 inches) up to 15 cms. (6 inches)	

The distance variables for these two motion categories are estimated, locating the length of the path of motion into one of five distance ranges indicated in Figure K-21.

Figure K-21: The MTM-2 Distance Codes

Code	Distance Class	
	Distance measured in centimetres	Distance measured in inches
5	over 0 to 5	over 0 to 2
15	over 5 to 15	over 2 to 6
30	over 15 to 30	over 6 to 12
45	over 30 to 45	over 12 to 18
80	over 45	over 18
The conversion from centimetres to inches 2.5 centimetres = 1 inch		

There are three cases of Get and three cases of Put. Experience has shown that these are best recognised by simple decision models. These decision models have been extended slightly in Figures K-22 and K-23 to include illustrations of actual observations. These are due to Knott and Goodall (1970).

### K.3.3 The Categories Get Weight and Put Weight

The variable of Get Weight and Put Weight is the effective New Weight (ENW). This ENW is the resistance to motion per hand referred to in the discussion on MTM-1.

The concept of GW is that it is the Static Component that occurs prior to the move. It is the time necessary for the muscles of the hand and arms to build up sufficient tension to get the component fully under control, ready to accelerate. The data card TMU is 1 per kilogramme, excepting the first 2 kilogrammes. Fractional values are raised to the next highest whole number, up to a maximum of 20 kilogrammes ENW. The symbol used for GW is shown in Figure K-24.

Figure K-22: The Decision Model for Get

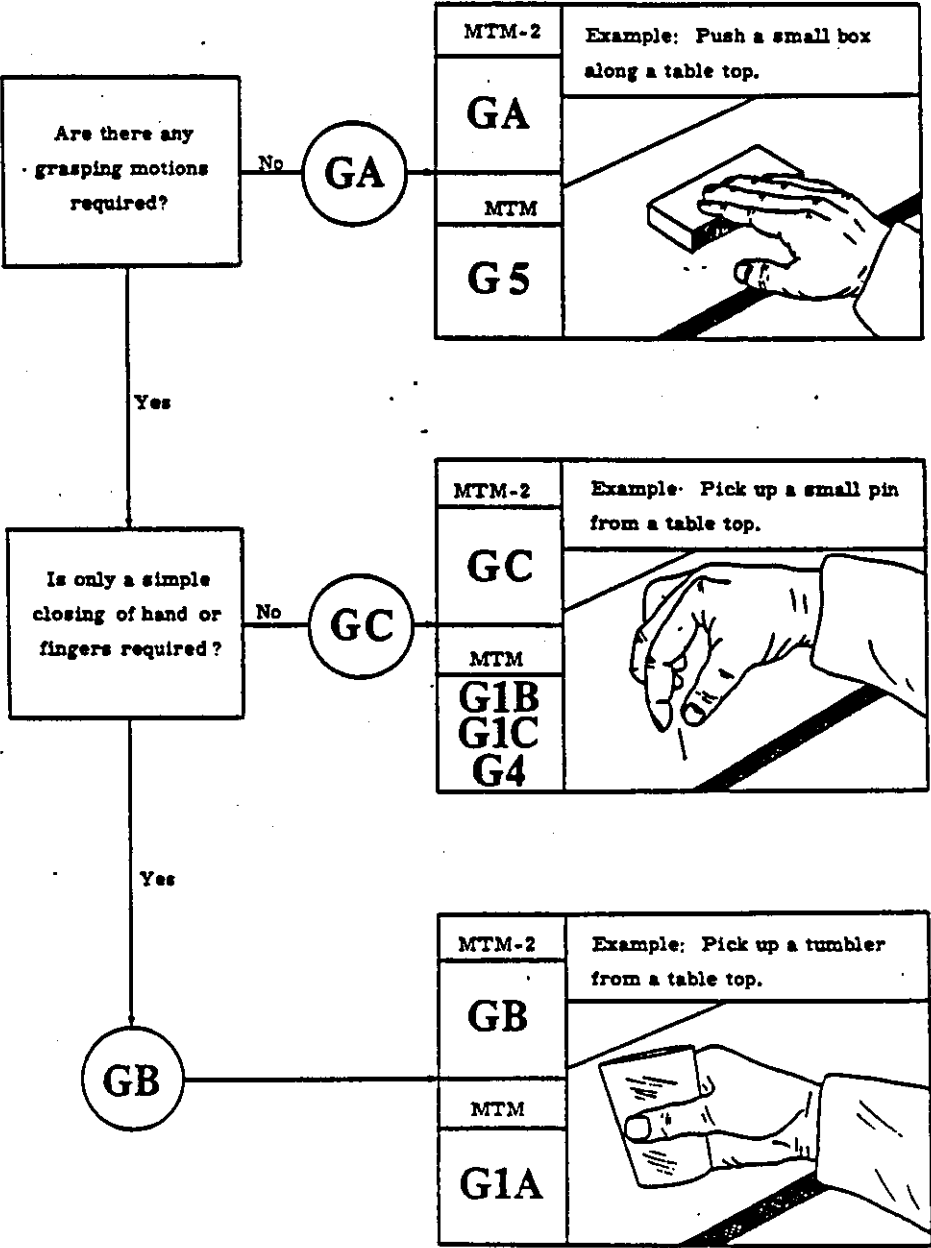


Figure K-23: The Decision Model for Put

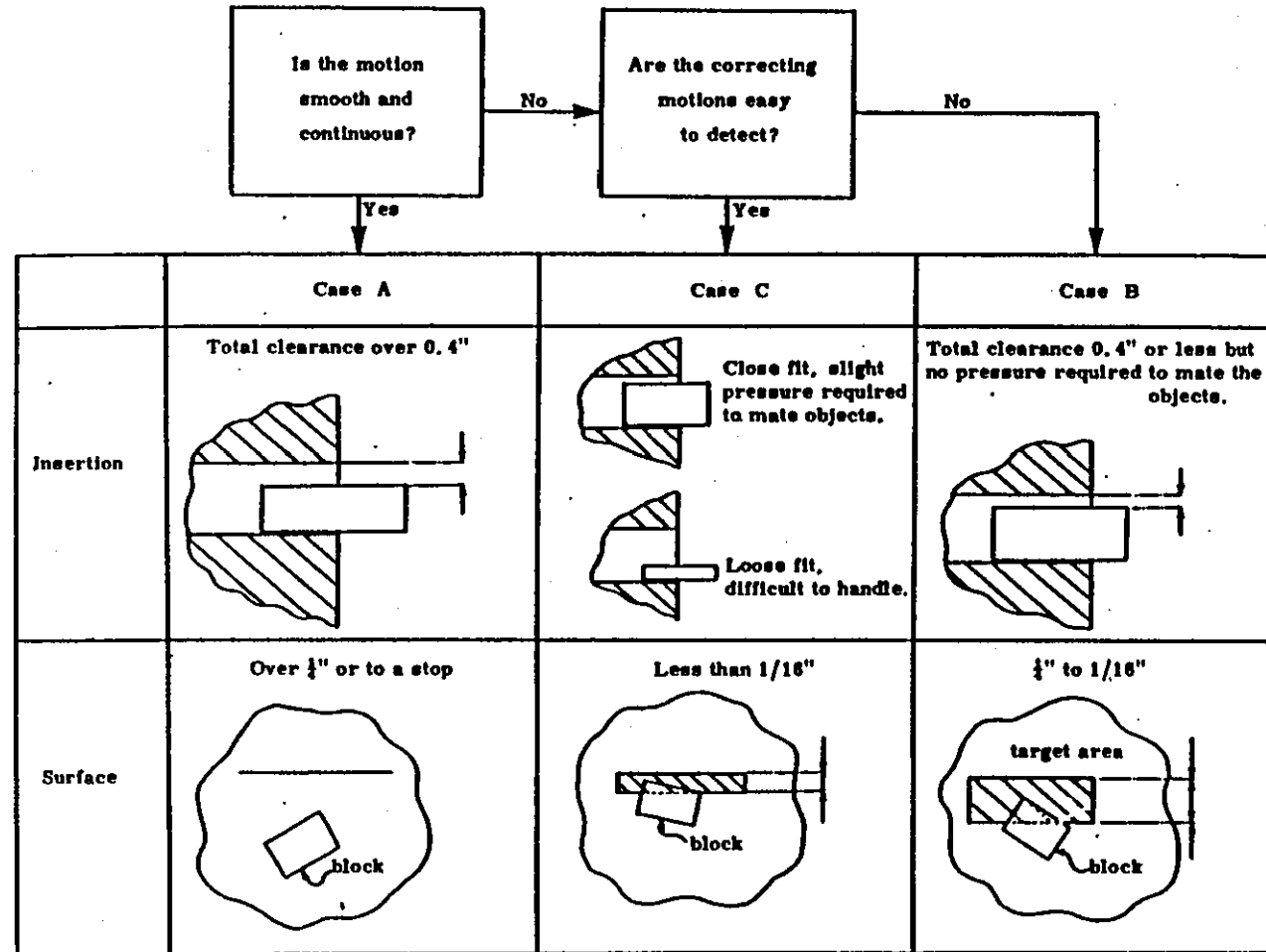


Figure K-24: The Symbol for Get Weight

Description	Symbol
GET WEIGHT symbol	<div>GW 15</div>
Effective Net Weight	
Meaning: GET WEIGHT with Effective Net Weight of 15 kilogrammes	

The difference in data card time for moving a heavy and light weight, i.e. the Dynamic Component, is allowed for by the addition of PW. The time value for PW is 1 TMU per 5 kilogrammes, up to a maximum of 20 kilogrammes. The rounding off for fractional values of ENW is the same as for GW. However, in this case, the symbolism is slightly different. The actual ENW is not shown, but the value is rounded off in steps of 5 kilogrammes. The symbol used to designate Put Weight is shown in Figure K-25.

Figure K-25: The Symbol for Put Weight

Description	Symbol
PUT WEIGHT symbol	PW 15
Effective Net Weight	
Meaning: PUT WEIGHT with Effective Net Weight over 10 and up to 15 kilogrammes	

For ENW of less than 3kg the resistance to motion is considered to be not significant and the way in which this is handled in MTM-2 is summarised in Figure K-26.

Figure K-26: The Get Weight and Put Weight Values in MTM-2

ENW	GET WEIGHT		PUT WEIGHT	
Kgs.	SYMBOL	TMU	SYMBOL	TMU
1				
2				
3	GW3	3	PW5	1
4	GW4	4		
5	GW5	5		
6	GW6	6	PW10	2
7	GW7	7		
8	GW8	8		
9	GW9	9		
10	GW10	10		
11	GW11	11	PW15	3
12	GW12	12		
13	GW13	13		
14	GW14	14		
15	GW15	15		
16	GW16	16	PW20	4
17	GW17	17		
18	GW18	18		
19	GW19	19		
20 max.	GW20	20		

#### K.3.4 The Categories Regrasp and Apply Pressure

The category Regrasp in MTM-2 is similar to the G2 found in MTM-1, and all of the rules applying to G2 apply to Regrasp, R.

The category Apply Pressure is designated by A. It is a weighted average of the MTM-1 motions AP1 and AP2. The same rules governing AP1 and AP2 govern A, with the addition that A cannot be preceded by R in MTM-2. This is so that the introduction of AP1 and AP2 into MTM-2 is avoided.

#### K.3.5 The Category Eye Action

When all other motions cease while the eyes perform some task the category Eye Action (E) is allowed. All other motions must cease. Category Eye Action (E) is allowed in the following instances:

1. When the aim of the axis of vision of the eye moves from one viewing area to another.
2. When the eye has to recognise an easily distinguishable characteristic of an object.

The normal area of vision, associated with E, is a 10 centimetres (4 inches) diameter circle at 40 centimetres (16 inches) distance from the eye. As the distance from the eye increases, the increase in circle diameter is proportional.

#### K.3.6 The Category Crank

The category Crank (C), occurs when the hands or fingers are used to move an object in a circular path of more than  $\frac{1}{2}$  revolution. If the motion is less than  $\frac{1}{2}$  revolution, the action is considered to be P-.

The variables of C used in the MTM-2 system are

1. Number of Revolutions
2. Weight or Resistance to Movement

The diameter of the crank is ignored, together with any consideration of whether the crank is continuous or intermittent, a practice has

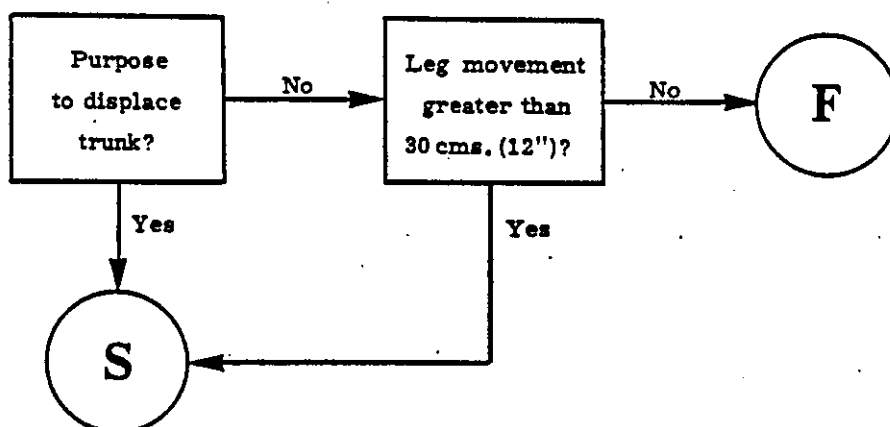
been justified by an analysis of the various basic motions over the whole of the industry.

Where weight or resistance is significant, PW is applied to each revolution, and where the motion is intermittent then GW is added to each revolution. If the motion is continuous, only one GW is necessary.

### K.3.7 The Categories Foot Motion and Step

Since these two categories have to be differentiated from each other by a decision model, in some cases it is appropriate to consider them together. This decision model is shown in Figure K-27.

Figure K-27: The Decision Model for Step and Foot Motion



The action S is the basis of walking. When considering walking, the number of times the foot strikes the floor is the governing factor. This time is based upon a 85cms. (34") pace, which is shortened when significant weight is being handled.

### K.3.8 The Category Bend and Arise

Both Bend and Arise are included in this Category. It is recognised by the body being changed in its vertical position so



Figure K-29: The MTM-3 Data Card

MTM-3				
CODE	HA	HB	TA	TB
-15	18	34	7	21
-80	34	48	16	29
	SF	18	B	61

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The four elements recognised in MTM-3 and their codes are

- Step-Foot Motion: SF
- Bend and Arise : B
- Handle : H
- Transport : T

- K.4.2 Identifying the Element STEP

When there is a purposeful action of the leg or foot in one direction then the action would be analysed as SF. Several simple examples will illustrate this.

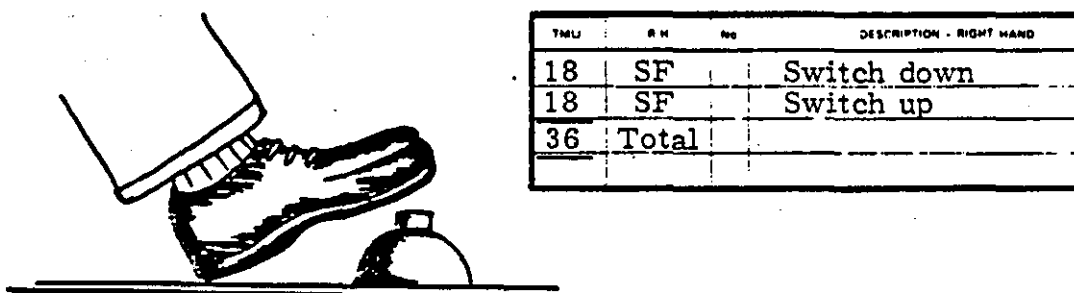
As a first example, consider a person walking across a room. Assume that his foot strikes the floor six times, then the analysis would be as shown in Figure K-30.

Figure K-30: MTM-3 Analysis of Walking

DESCRIPTION - LEFT HAND	No	L H	TMU	R H	No	DESCRIPTION - RIGHT HAND
			108	6SF		Walk

In this example the leg movement was pivoted at the hip; however, providing the motion is purposeful it may also be pivoted at the knee or heel. It should be noted that an SF covers the motion in one direction only, where for example, an operator presses and releases a foot switch. The action and the associated analysis is shown in Figure K-31.

Figure K-31: MTM-3 Analysis of "Operate Foot Switch"



#### K.4.3 Identifying the Element "Bend and Arise"

In this MTM-3 element both Bend and the subsequent Arise are included. The element Bend and Arise is identified by a change in the vertical position of the body so that the hands can, not necessarily do, reach below the knees. Typical actions which would be classified as B would be:

- Sit in a chair and Stand at some later time.
- Kneel on One Knee and Stand at some later time.
- Stoop and Arise from Stoop at some later time.

A special case of B occurs when the action involves Kneeling on Both Knees and Arising from this position at some later time. This action is analysed as 2B.

#### K.4.4 The MTM-3 Hand Actions

All hand actions are grouped into one of the two MTM-3 elements:

- Handle
- Transport

Perhaps the most convenient way of depicting these two elements is pictorially and by reference to the MTM-2 categories.

Figure K-32: Illustration of the Element HANDLE

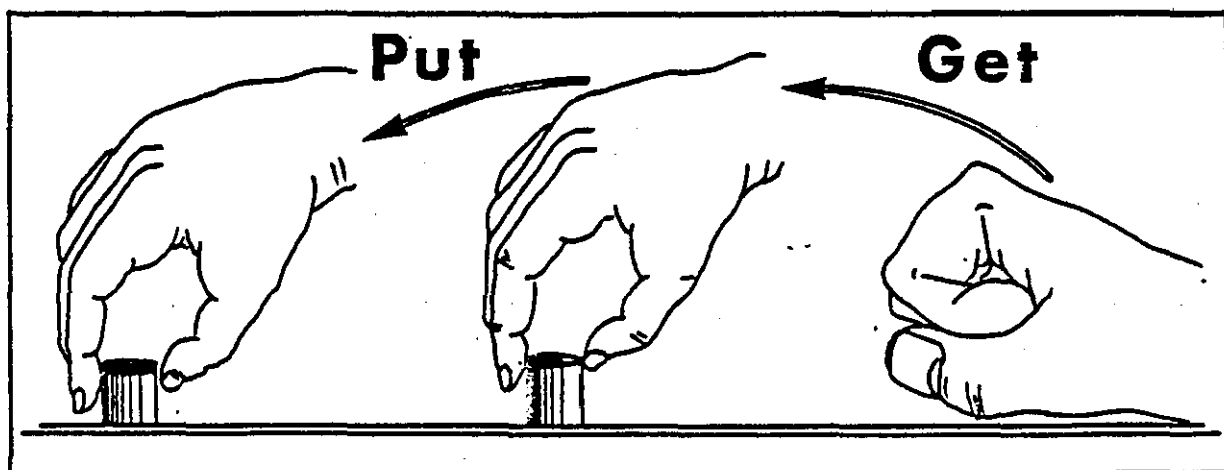
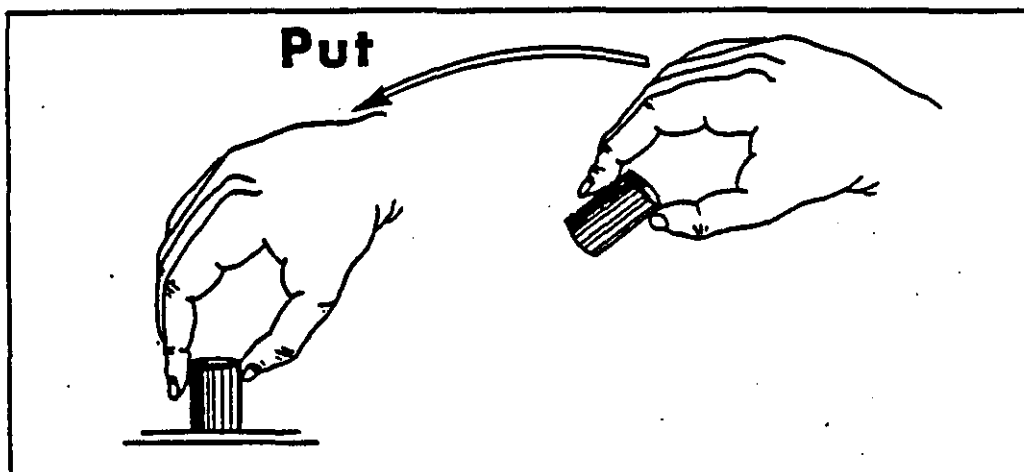


Figure K-33: Illustration of the Element TRANSPORT



Comparing the actions illustrated in Figures K-32 and K-33, it will be seen that differentiation between the two MTM-3 Hand Actions is:

- Handle: The hand must gain control of the object to be moved.
- Transport: The hand already has control of the object to be moved.

These MTM-3 Hand Actions, Handle and Transport, are affected by two variables:

- The Case
- The Distance

The two cases of Handle and Transport are both judged by the correcting actions required at the termination of the movement of the object. Recognition of the two cases is relatively simple.

- Case A: a smooth continuous action with no correcting motions.
- Case B: an action involving any correcting motions at the terminal.

There are two distance codes in the actions Handle and Transport. These are shown in Figure K-34. This distance code is judged from the distance moved by the object, not by the hand, as illustrated in Figures K-35 and K-36.

Figure K-34: The MTM-3 Distance Codes

Distance Code	Distance Range
15	Over 0 to 15 cms.
80	Over 15 cms.

The symbols used to designate Handle and Transport are shown in Figures K-37 and K-38, respectively.

Figure K-35: The Distance Variable in HANDLE

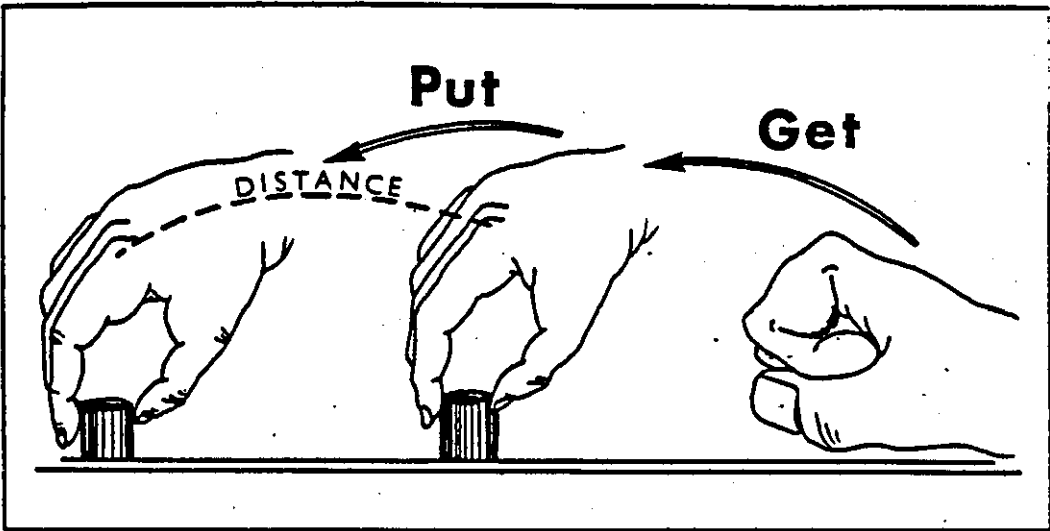


Figure K-36: The Distance Variable in TRANSPORT

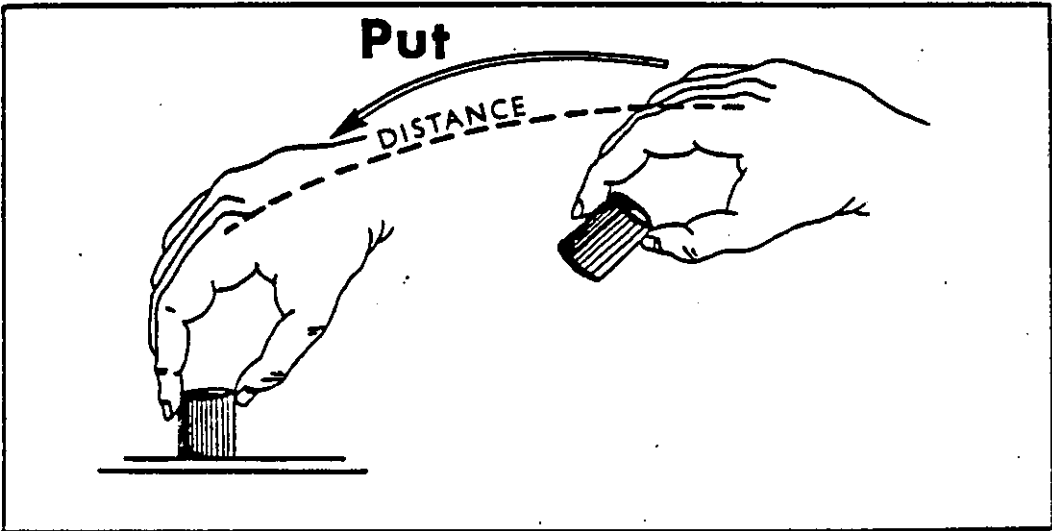


Figure K-37: Symbol for Handle

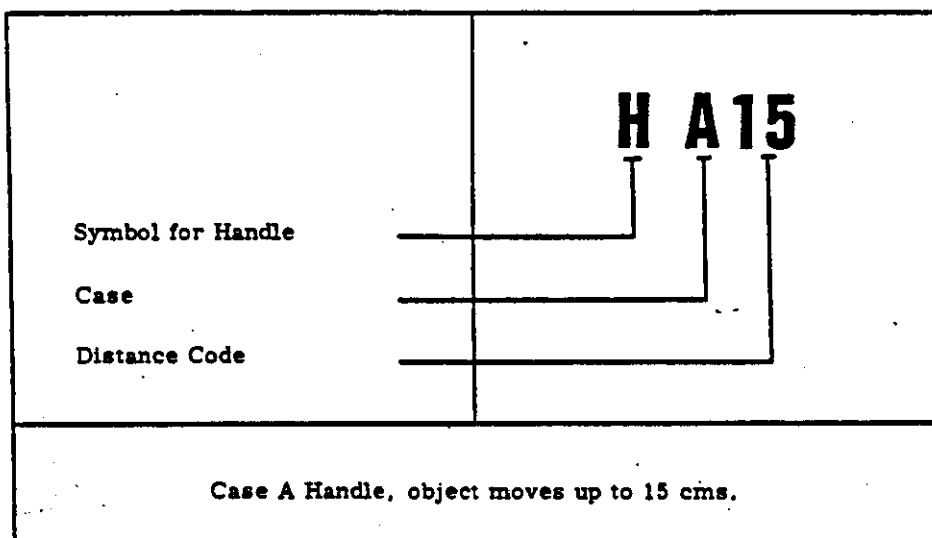
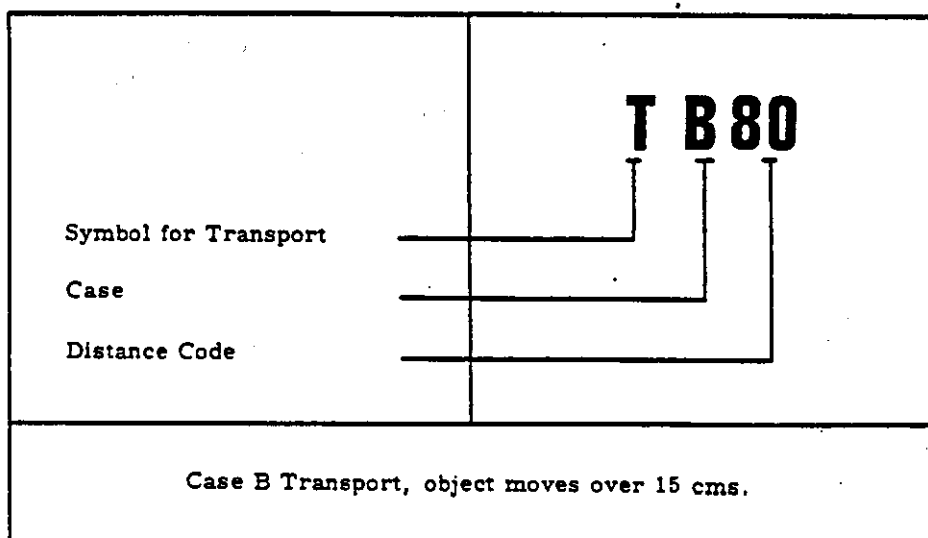


Figure K-38: Symbol for Transport



K.4.5 Important Application Rules

Four important application rules relative to MTM-3 which must be noted at this point.

The first is with respect to Application of Force. Where the MTM-3 element Handle, or Transport is performed and is terminated by one or more applications of force, the first application of force is included in the MTM-3 element. The subsequent force applications are analysed as HA15 or TA15, dependent upon whether it is necessary to gain control of the object during each force application. As an example, consider an operator seating a screw cap on a bottle, in which at the end of the final of six turns there is an application of force. The analysis would be as shown in Figure K-39.

Figure K-39: MTM-3 Analysis of "Tighten Screw Cap"

TMU	R H	No	DESCRIPTION - RIGHT HAND
108	6	HA15	Screw down and seat
108	Total		

If the operation is changed slightly, so that the operator now applies force a total of three times at the end of the screwing action, without relinquishing control of the cap, the analysis becomes that shown in Figure K-40.

Figure K-40: MTM-3 Analysis of "Tighten Screw Cap Firmly"

TMU	R H	No	DESCRIPTION - RIGHT HAND
108	6	HA15	Screw down and seat
14	2	TA15	Final seating of cap
122	Total		

The second application rule which we should consider is where there is a high repetition of an MTM-3 element. If, for example, an operator makes an action of turning down a nut on a bolt by a series of Handles, providing the frequency does not exceed 10, then MTM-3 can be used. When this frequency exceeds 10, the the

analyst must revert to using MTM-2 or MTM-1. Failure to follow this application rule can have considerable effects on the consistency of time standards established by MTM-3.

The third application rule is with respect to analysis of Eye Action. MTM-3 is not sufficiently sensitive to detect Eye Action and in fact they are not recognised in the MTM-3 system. Where Eye Actions are significant then a lower level of MTM data is necessary.

The fourth application rule is with respect to handling objects which have significant weight. The theoretical construction of the MTM-3 system is such that the weights of objects can be ignored in MTM-3 analyses.

APPENDIX L: REGRESSION ANALYSES APPERTAINING TO THE  
THREE GENERAL LEVELS OF MTM

Figure L-1: Regression Analysis Data of MTM-1 on MTM-2

Source	d.f.	Sum of Squares	Mean Squares	F	PR > F
MTM-1	1	610.304	610.304	1361.07	0.0001
Error	25	11.210			
Total	26				

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.9423	36.89	0.000.	0.0251

$R^2 = 0.9819$       Std. Dev. = 0.6696      c.v. = 14.8774

Independent Variable = MTM-2      Mean MTM-1 = 4.501

Figure L-2: Regression Analysis Data of MTM-2 on MTM-1

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-2	1	701.437	701.437	1361.07	0.0001
Error	25	12.884	0.515		
Total	26	714.321			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	1.0624	36.89	0.0001	0.0288

$R^2 = 0.9819$       Std. Dev. =      c.v. = 15.234

Independent Variable - MTM-1      Mean MTM-2 = 4.713

Figure L-3: Regression Analysis Data of MTM-1 on MTM-3

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-1	1	604.977	604.977	914.55	0.0001
Error	25	16.538	0.661		
Total	26				

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.9137	30.24	0.0001	0.0303

$R^2 = 0.9734$       Std. Dev. = 0.8133      c.v. = 18.0701

Independent Variable - MTM-3      Mean MTM-1 =

Figure L-4: Regression Analysis Data of MTM-3 on MTM-1

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-3	1	705.334	705.334	914.55	0.0001
Error	25	19.281	0.771		
Total	26	724.615			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	1.0653	30.24	0.0001	0.0352

$R^2 = 0.9734$       Std. Dev. = 0.8782      c.v. = 18.3991

Independent Variable = MTM-1      Mean MTM-3 = 4.7731

Figure L-5: Regression Analysis Data of MTM-2 on MTM-3

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-2	1	691.109	691.109	744.36	0.0001
Error	25	23.212	0.928		
Total	26	714.321			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.9766	27.28	0.0001	0.0358

$R^2 = 0.9675$       Std. Dev. = 0.9636      c.v. = 20.4471

Independent Variable = MTM-3      Mean MTM-2 = 4.7125

Figure L-6: Regression Analysis Data of MTM-3 on MTM-2

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-3	1	701.069	701.069	744.36	0.0001
Error	25	23.546	0.9418		
Total	26	724.615			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.9907	27.28	0.0001	0.0363

$R^2 = 0.9675$       Std. Dev. = 0.9705      c.v. = 20.3325

Independent Variable = MTM-2      Mean MTM-3 = 4.7731

Figure L-7: Regression Analysis Data of Basic Time on MTM-1

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
Basic	1	668.558	668.588	624.32	0.0001
Error	25	26.772			
Total	26	695.330			

Parameters	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	1.0372	24.99	0.0001	0.0415

$R^2 = 0.961$       Std. Dev. = 1.035      c.v. = 22.436

Independent Variable = MTM-1      Mean Basic = 4.6123

Figure L-8: Regression Analysis Data of MTM-1 on Basic Time

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-1	1	597.585	597.585	624.32	0.0001
Error	25	23.930	0.957		
Total	26	621.515			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope		24.99	0.0001	0.0415

$R^2 = 0.9615$       Std. Dev. = 0.9784      c.v. = 21.7366

Independent Variable = Basic Time      Mean MTM-1 = 4.5010

Figure L-9: Regression Analysis Data of MTM-2 on Basic Time

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-2	1	690.675	690.675	730.23	0.0001
Error	25	23.646	0.946		
Total	26	714.321			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.9966	27.02	0.0001	0.0369

$R^2 = 0.9669$       Std. Dev. = 0.9725      c.v. = 20.6374

Independent Variable = Basic      Mean MTM-2 = 4,730

Figure L-10: Regression Analysis Data of Basic Time on MTM-2

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
Basic Time	1	672.313	672.313	730.23	0.0001
Error	25	23.017	0.9207		
Total	26	695.330			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of
Slope	0.9702	27.02	0.0001	0.0359

$R^2 = 0.9669$       Std. Dev. = 0.9595      c.v. = 2018036

Independent Variable = MTM-2      Mean Basic = 4.613

Figure L-11: Regression Analysis Data of Basic Time on MTM-3

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
Basic Time	1	677.238	677.238	935.83	0.0001
Error	25	18.092	0.7234		
Total	26	695.330			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.9668	30.59	0.0001	0.0316

$R^2 = 0.9740$       Std. Dev. = 0.8507      c.v. = 18.4440

Independent Variable = MTM-3      Mean Basic Time = 4.6123

Figure L-12: Regression Analysis of MTM-3 on Basic Time

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-3	1	705.761	705.761	935.83	0.0001
Error	25	18.854	0.754		
Total	26	724.615			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	1.0075	30.59	0.0001	0.0329

$R^2 = 0.9740$       Std. Dev. = 0.8684      c.v. = 18.1491

Independent Variable = Basic Time      Mean MTM-3 = 4.7731

Figure L-13: Regression Analysis Data of MTM-1 on Average Observed Time

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-1	1	577.619	577.619	328.98	0.0001
Error	25	43.895	1.756		
Total	26	621.514			

Parameter	Estimate	T for H1: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.8552	18.14	0.0001	0.0471

$R^2 = 0.9294$       Std. Dev. = 1.3251      c.v. = 29.4397

Independent Variable = Average Observed Time      Mean MTM-1 = 4.5010

Figure L-14: Regression Analysis of Average Observed Time  
on MTM-1

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
Average	1	734.057	734.651	328.98	0.0001
Error	25	55.783	2.231		
Total	26	789.840			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	1.0868	18.14	0.0001	0.0471

$R^2 = 0.9294$       Std. Dev. = 1.4938      c.v. = 29.5287

Independent Variable = MTM-1      Mean Average Observed Time = 5.0587

Figure L-15: Regression Analysis Data of Average Observed  
Time on MTM-2

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-2	1	659.369	659.367	299.96	0.000.
Error	25	54.954	2.198		
Total	26	714.321			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.9138	17.32	0.0001	0.0528

$R^2 = 0.9231$       Std. Dev. = 1.4826      c.v. = 31.4614

Independent Variable: Average Observed Time      Mean MTM-2 = 4.7125

Figure L-16: Regression Analysis Data of MTM-2 on Average Observed Time

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
Average	1	729.076	729.076	299.96	0.0001
Error	25	60.764	2.431		
Total	26	789.840			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	1.0103	17.32	0.0001	0.0583

$R^2 = 0.9231$       Std. Dev. = 1.5590      c.v. = 30.8187

Independent Variable = MTM-2      Mean Average Observed Time = 5.0587

Figure L-17: Regression Analysis of MTM-3 on Average Observed Time

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
Average	1	744.227	744.227	407.90	0.0001
Error	25	45.613	1.825		
Total	26	789.840			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	1.0134	20.20	0.0001	0.0502

$R^2 = 0.9423$       Std. Dev. = 1.3508      c.v. = 26.7016

Independent Variable = MTM-3      Mean Average Observed Time = 5.0587

Figure L-18: Regression Analysis Data of Average  
Observed Time on MTM-3

Source	d.f.	Sum of Squares	Mean Square	F	PR > F
MTM-3	1	782.769	782.769	407.90	0.0001
Error	25	41.864	1.674		
Total	26	724.615			

Parameter	Estimate	T for Ho: Parameter=0	PR >  T	Std. Error of Estimate
Slope	0.9298	20.20	0.0001	0.0460

$R^2 = 0.9423$       Std. Dev. = 1.2938      c.v. = 27.106

Independent Variable = Average Observed Time      Mean MTM-3 = 4.7731

APPENDIX M: MTM-1 ANALYSIS OF PROVING DATA  
FROM TEST SITE

The following is a summary of the times of the tasks used for proving the simplified data systems. These time values have been developed using MTM-1, and then transformed to 0.01 minutes at 100 B. S. I. performance level.

Task	Description	0.01 Minutes
T1-1	Load Springs into Magazines	6.740
T2-1	Hand Load Detonators to Magazine	5.465
T3-1	Insert S-A Retainer into Fuse Body	13.895
T4-1	Handle Fuses	4.450
T5-1	Assemble and Stamp Torque Module	4.145
T6-1	Apply Tape Seal to S-A	8.400
T7-1	Assemble Body and Washer to Fuse	12.640
T8-1	Assemble and Crimp Detonator Support	8.655
T9-1	Assemble Timer, Spacers and Retainer	19.315
T10-1	Assemble and Stake Trigger Assembly	63.005
T11-1	Torque (3) Posts	16.050
T12-1	Assemble Starting Spring Pin	25.025
T13-1	Burnish Slot	9.770
T14-1	Assemble Option Pin Arm	38.030
T15-1	Assemble and Form Key Assembly	8.780

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T1-1	<u>LOAD SPRINGS INTO MAGAZINES (MTM-1)</u>				
	A	Obtain and Place Magazines	70.3	1	70.3
	B	Load Springs and Aside Work	64.5	1	64.5
				Total	134.8
T2-1	<u>HAND LOAD DETONATOR TO MAGAZINE (MTM-1)</u>				
	D	Detonator Boxes to Dog House	646.1	1/500	1.3
	E	Magazine Tray to Work Fixture	77.2	1/100	0.8
	F	Detonator Box to Work Fixture	184.3	1/10	18.4
	G	Empty Magazines onto Platform	50.3	1/5	10.1
	H	Detonator in Magazine	38.7	1	38.7
	J	Expose Detonator Rim	13.6	1	13.6
	L	Full Magazine in Work Fixture	33.8	1/5	6.8
	M	Completed Magazine to Locker	98.1	1/5	19.6
				Total	109.3
T3-1	<u>INSERT S-A RETAINER INTO FUSE BODY (MTM-1)</u>				
	P	Assemble, Press and Gauge	176.1	1	176.1
	R	Obtain Tray of Fuses: 100% Inspection Closing Screws	104.2	1/8	13.0
	S	Aside Tray of Modules	57.0	1/20	2.9
	T	Start Module Threads	84.4	1	84.4
	U	Obtain Tray of Modules	30.6	1/20	1.5
				Total	277.9
T4-1	<u>HANDLE FUSES (MTM-1)</u>				
	V	Obtain and Aside Fuses	65.4	1	65.4
	W	Aside Completed Tray	48.5	1/4	12.1
	X	Obtain New Tray	45.8	1/4	11.5
				Total	89.0

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T5-1	<u>ASSEMBLE AND STAMP TORQUE MODULE (MTM-1)</u>				
	AA	Insert Fuse Into Train	41.2	1	41.2
	AB	Aside Completed Fuse to Tray	41.7	1	41.7
				Total	82.9
T6-1	<u>APPLY TAPE SEAL TO S-A (MTM-1)</u>				
	AD	Apply Seal	96.5	1	96.5
	AE	Actuate Press	10.4	1	10.4
	AF	Remove Fuse from Press and Check Seal	56.6	1	56.6
	AG	Obtain Tray of Fuses	21.8	1/8	2.7
	AH	Tray of Fuses Aside	14.2	1/8	1.8
				Total	168.0
T7-1	<u>ASSEMBLE BODY AND WASHER TO FUSE (MTM-1)</u>				
	AJ	Finished Unit from Fixture	42.9	1	42.9
	AL	Assemble Body, Washer and Fuse	196.8	1	196.8
	AM	Assemble Body to Limit	13.1	1	13.1
				Total	252.8
T8-1	<u>ASSEMBLE AND CRIMP DETONATOR SUPPORT (MTM-1)</u>				
	AP	Aside Finished Unit, Assemble Spring to Detonator Fuse	154.2	1	154.2
	AR	Heat Stake and Obtain Detonator Holder	18.5	1	18.2
	AG	Obtain Tray	21.8	1/50	0.4
	AH	Tray Aside	14.2	1/50	0.3
				Total	173.1

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T9-1	<u>ASSEMBLE TIMER, SPACERS AND RETAINER (MTM-1)</u>				
	AS	Assemble Spacer to Unit	58.3	1	58.3
	AT	Load Retainer Ring	148.2	1	148.2
	AU	Assemble Housing and Retainer to Timer	131.3	1	131.3
	AV	Press Retainer, Aside Unit	46.7	1	46.7
	AG	Obtain Tray	21.8	1/24	0.9
	AH	Aside Tray	14.2	1/24	0.6
				Total	386.3
T10-1	<u>ASSEMBLE AND STAKE TRIGGER ASSEMBLY (MTM-1)</u>				
	AW	Assemble Trigger Assembly and Top Plate	128.1	1	128.1
	AX	Assemble Rivits, Place Unit on Block, Assemble Inserts	308.2	1	308.2
	AY	Assemble Firing Pin and Spring to Unit	97.3	1	97.3
	AZ	Assemble Safety Plate, SSD Release, Firing Arm and Bottom Plate	409.7	1	409.7
	BA	Check Springs, Inspect Shaft, Stake Unit and Recycle	261.2	1	261.2
	BB	Open Clamp and Remove from Fixture	54.1	1	54.1
	AG	Aside Tray	14.2	1/24	0.6
	AH	Obtain Tray	21.8	1/24	0.9
				Total	1260.1
T11-1	<u>TORQUE (3) POSTS (MTM-1)</u>				
	BD	Unit to Fixture	49.3	1	49.3
	BE	Torque (3) Posts	164.9	1	164.9
	BF	Check Dropleaf, Dropleaf Rod, Gauge	106.8	1	106.8
				Total	321.0

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T12-1	<u>ASSEMBLE STARTING PIN SPRING (MTM-1)</u>				
	BG	Housing into Fixture	56.4	1	56.4
	BH	Assemble Washer, 'O' Ring, Start- ing Pin and Spring	304.9	1	304.9
	BJ	Assemble Retainer	113.1	1	113.1
	BL	Housing Aside: Dump Out Pin Guide	26.1	1	26.1
				Total	500.5
T13-1	<u>BURNISH SLOT (MTM-1)</u>				
	BM	Load Fixture	96.4	1	96.4
	BP	Burnish Slot	40.7	1	40.7
	BR	Unload Fixture	58.3	1	58.3
				Total	195.4
T14-1	<u>ASSEMBLE OPTION PIN (MTM-1)</u>				
	BS	Assemble Spring	152.3	1	152.3
	BT	Assemble Option Pin, Washer and 'O' Ring	193.5	1	193.5
	BU	Check Unit for End Shake	84.9	1	84.9
	BV	Assemble Large or Small 'E' Ring	127.3	2	254.6
	BW	Assemble Crank	75.3	1	75.3
				Total	760.6
T15-1	<u>ASSEMBLE AND FORM KEY ASSEMBLY (MTM-1)</u>				
	BX	Assemble and Form Elements	175.6	1	175.6
				Total	175.6

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
A - OBTAIN AND PLACE MAGAZINES (MTM-1)						
			21.2	R22C		Magazine to Work Area
			7.3	G4A		
			20.6	M24B		
			2.0	RLI		
			4.0	R2B	2	Orientate
			2.0	G1A		
			11.2	G2		
			2.0	RLI		
		Total	70.3	TMU		
B - LOAD SPRINGS TO MAGAZINE, ASIDE WORK (MTM-1)						
P.U. Springs & to Magazine	1/4	RGC	2.5			
	1/4	G4C	3.2			
	1/4	M8B	2.7			
Unpalm (1) Spring	1/2	G2	5.6	R-		
			5.6	G3		Spring from LH
			9.5	M5C		Insert
			21.8	P2SD		
			2.0	RL1		
Aside Work	1/20	R8B	0.5	R8B	1/20	Aside Work
	1/20	G5	-	G5	1/20	
	1/20	M20C	11.1	M20C	1/20	
	1/20	R12	-	RL2	1/20	
		Total	64.5	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
D - DETONATOR BOXES	TO	DOGHOUSE	(MTM-1)			
Assist R. H.			9.6	R12A		Open Locker Door
			2.0	G1A		
			3.9	SC10		
			28.3	M28A10		
			2.0	RL1		
		R32A	29.5	R34D		Open Lid
			7.3	G4A		
		G4A	7.3			
			22.9	D3E		Lid Aside
		RL1	24.3	M30B		
			2.0	RL1		
From RH Box in Work Area			147.5	R34D	5	Remove Box of Detonators and to LH
			17.5	G1B	5	
			20.0	D1E	5	
	5	R-	112.0	M24A	5	
	5	G3	28.0			
	5	M30B	121.5			Toss Empty Box Aside
	5	RL1	10.0			
			27.8	R34B		
			2.0	G1A		
			18.4	M24Bm		
			-	<del>RL1</del>		Close Locker
			17.5	R30A		
			2.0	G1A		
			3.9	SC10		
			28.3	M28B10		
			2.0	RL1		
		Total	646.1	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
E - OBTAIN AND POSITION EMPTY MAGAZINE TRAY TO WORK FIXTURE (MTM-1)						
P.U. Tray and to Fixture	{	R20B	18.6		{	Assist LH
		G1A	2.0			
		M28C	24.4	R-		
				G-		
Insert	{			M-	{	Assist LH
		P2SSE	19.7	P2SSE		
		M9A	10.5	M9A		
		RL1	2.0	RL1		
		Total	77.2	TMU		
F - OPEN DETONATOR BOX AND TRANSFER TO FIXTURE (MTM-1)						
Assist RH	{		18.6	R29B	{	Box of Detona- tors onto Platform
			2.0	G1A		
		R-	13.5	M10C		
		G-		<del>T903</del>		
Assist RH	{	M-			{	Open Lid
		<del>T903</del>				
		PISE	5.6	PISE		
		RL1	2.0	RL1		
Assist RH	{	RfB	2.0	RfB	{	Open Lid
		G5	-	G5		
		AP2	10.6	AP2		
		M3B	5.7	M3B		
Detonator Box	{	RL1	2.0	RL1	{	Detonator Box Lid
			2.0	RfA		
			2.0	G1A		
		RfD	2.0			
		G1B	3.5			
		RL1	2.0	M6B		Remove Lid
		Carry Fwd.	73.5			

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
<u>F - Continued</u>						
		Brought Fwd.	73.5			
		R-	6.1	M4A		Lid to LH
From LH		G3	5.6			
Toss Lid Aside	{	M18Bm	14.2			
		RL1	2.0			
		mR2E	2.7			
Cardboard Pad from Box and Aside	{	R18D	18.4			
		G1B	3.5			
		M10B	11.5			
		RL1	2.0			
Assist R.H.	{	R7D	10.8	R7D		
		G1B	3.5			
			3.5	G1B		
		M8C	11.8	M8C		Box of Detonators to Fixture
		PISE	5.6	PISE		
		RL1	2.0	RL1		
			2.0	RfA		
			-	G5		
			6.1	M4A		Slide into Fixture
			-	RL2		
		Total	184.3			
<u>G - OBTAIN AND PLACE EMPTY MAGAZINES ON WORK PLATFORM (MTM-1)</u>						
Magazines to Platform	{	R14C	15.6			
		G4A	7.3			
		M16B	15.8			
1st Magazine		RL1	2.0			
Orientate 2nd Magazine	{	G2	5.6			
		MfB	2.0			
		RL1	2.0			
		Total	50.3	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
H - POSITION DETONATOR IN MAGAZINE (MTM-1)						
			10.3	M6C		} Tool to P.U. Detonator
			5.6	PISE		
			15.2	M12C		} Position Detonator Seat
			5.6	PISE		
			2.0	MfA		
		Total	38.7			
J - EXPOSE DETONATOR RIM (MTM-1)						
			2.5	R1A		} Expose Rim
			-	G5		
			11.1	M7C		
			-	RL2		
			Total	13.6		
		L - POSITION FULL MAGAZINE IN WORK FIXTURE (MTM-1)				
Assist RH	}	R6D	10.1	R6D		} Work to Fixture
		G1A	2.0	G1A		
		M2C	5.2	M2C		
		PISE	5.6	PISE		
		RL1	2.0	RL1		
			2.0	RfA	} Slide into Position	
		-	G5			
		6.9	M4B			
		-	RL2			
		Total	33.8	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
M - COMPLETED MAGAZINE INTO LOCKER (MTM-1)						
Wire Guard to Work Area	{	R14B	14.4			
		G1A	2.0			
		M10B	12.2			
		G2				
			6.1	R4A		{ Wire Guard
			2.0	G1A		
Assist RH	{	M4C	8.0	M4C		{ Wire Guard into Slot in Tray
		P25SE	19.7	P25SE		
		M1A	2.5	M1A		
		RL1	2.0	RL1		
Assist RH	{	RfD	2.0	RfD		{ Magazine Tray From Fixture and Aside
		G1B	3.5			
			3.5	G1B		
		M20B	18.2	M20B		
		RL1	2.0	RL1		
		Total	98.1	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
P - ASSEMBLE, PRESS AND GAUGE:			ASIDE TO TRAY (MTM-1)			
Retainer to S-A	{	R16C	17.0	R-C	{	Assemble S-A
		G4A	7.3	G1A		
		M10A	16.9	M14C		
			21.0	P2NSE		
			2.0	RL1		
Position S-A in Fixture	{	M6C	10.3	R8A	{	Handle
		PINSE	10.4	G1A		
		RL1	2.0			
			8.7	M10A		Clamp
			16.2	AP1		
Gauge S-A	{	R-	8.7	M10A	{	Handle Up
		G1A	2.0	RL1		
		M4C	8.0			
		M2B	12.9			
		RL1	2.0			
Assemble to Fuse	{	R1B	2.5		{	
		G1A	2.0			
		M10C	13.5			
		<del>T180S</del>				
		P2SE	11.2			
		RL1	2.0			
		Total	176.6			

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>R - OBTAIN TRAY OF FUSES: 10% INSPECTION CLOSING SCREWS (MTM-1)</u>						
Assist RH		R20B	18.6	R20B		Trays to Bench
		G1A	2.0	G1A		
		SC4	2.2	SC4		
		M20B4	19.3	M20B4		
			58.4	EF	8	Inspect
			20.3	2/12ET	8	
		RL1	2.0	RL1		
		Total	104.2	TMU		
<u>S - ASIDE TRAY (MTM-1)</u>						
Tray to Conveyor		R12B	12.9	R-		Assist LH
		G1A	2.0	G-		
		SC4	2.2	SC4		
		M20B4	19.3	M-		
		RL1	2.0	RL1		
Slide Down Conveyor		R2A	4.0			
		G5	-			
		M14B	14.6			
		RL2	-			
		Total	57.0	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
T - START MODULE THREADS (MTM-1)						
Module Turner to Fuse	{	1/8 R8B	1.3			
		1/8 G1A	0.3			
		1/8 M6C	.13			
		P2SSE	19.7			
Turn Down	{	5 M2B	23.0			
		4 RL1	8.0			
		4 R2B	16.0			
		4 G1A	8.0			
Next Fuse		M2C	5.2			
Aside Tool	{	1/8 M8B	1.3			
		1/8 RL1	0.3			
		Total	84.4	TMU		
U - OBTAIN TRAY OF S-A MODULES (MTM-1)						
Assist RH	{	R14B	14.4	R14B		P.U. and Move Tray
		G1A	2.0	G1A		
		M10B	12.2	M10B		
		RL1	2.0	RL1		
		Total	30.6	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
V - ASIDE AND OBTAIN FUSES (MTM-1)						
Finished Fuse Aside	{	R6A	7.0	R6A	{	Finished Fuse Aside
		G1A	2.0	G1A		
		M18C	20.4	M18C		
		RL1	2.0	RL1		
Obtain Fuse	{	R2B	4.0	R2B	{	Obtain Fuse
		G1A	2.0	G1a		
		M18C	20.4	M18C		
		PISE	5.6	PISE		
		RL1	2.0	RL1		
		Total	65.4	TMU		
W - ASIDE COMPLETED TRAY (MTM-1)						
Tray to Conveyor	{	R18B	17.2	R18B	{	Assist RH
		G1A	2.0	G1A		
		SC4	2.2	SC4		
		M10B4	12.9	M10B4		
		RL1	2.0	RL1		
Slide Along Conveyor	{	R3A	5.3		{	
		G5	-			
		M4B	6.9			
		RL2	-			
Total		48.5	TMU			
X - OBTAIN NEW TRAY OF WORK (MTM-1)						
Tray to New Work Area	{	R26B	22.9	R26B	{	Assist LH
		G1A	2.0	G1A		
		SC4	2.2	SC4		
		M16B4	16.7	M16B4		
		RL1	2.0	RL1		
		Total	45.8	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND	
AA - INSERT FUSE INTO POSITION IN TRAIN (MTM-1)							
			12.9	R12B		} Fuse	
			2.0	G1A			
			18.7	M16C			
			5.6	PISE			
			2.0	RL1			
			Total	41.2			TMU
		AB - ASIDE COMPLETED FUSE TO TRAY (MTM-1)					
P. U. Fuse and Aside		R10A	8.7				
		G1A	2.0				
		M28C	29.0				
		RL1	2.0				
		Total	41.7				TMU
AD - APPLY SEAL (MTM-1)							
Pull Tape Out		R10B	11.5	R-		} Seal to Fixture	
		G1A	2.0				
		M2B	4.6				
		6.8	R4D				
		3.5	G1B				
		15.2	M12C				
		<del>T180S</del>					
Fuse to Fixture		16.2	P2SE				
		R12B	12.9				G2
		G1A	2.0				RL2
		M12C	14.2				
		<del>T180</del>					
		PISE	5.6				
		RL1	2.0				
Total	96.5	TMU					

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND	
<u>AE - ACTUATE PRESS (MTM-1)</u>							
Actuate Button No. (1) {		R8A	7.9	R8A	} Actuate Button No. (2)		
		G5	-	G5			
		M1A	2.5	M1A			
		Total	10.4	TMU			
Remaining motions in Element LT limited out by Process Time. Process Time not included in the study.							
<u>AF - REMOVE FUSE FROM PRESS AND CHECK SEAL (MTM-1)</u>							
Remove from Press {		R14B	14.4		}		
		G1A	2.0				
		M10B )	12.2				
		<del>T180</del>					
Check Seal		EF	7.3				
To Tray {		M16C	18.7				
		RL1	2.0				
		Total	56.6	TMU			
<u>AG - OBTAIN TRAY OF FUSES (MTM-1)</u>							
Slide From Conveyor {		R12B	12.9			}	
		G5	-				
		M6B	8.9				
		RL2	-				
		Total	21.8	TMU			
<u>AH - TRAY OF FUSES ASIDE (MTM-1)</u>							
Slide to Conveyor {		R3B	5.3		}		
		G5	-				
		M6B	8.9				
		RL2	-				
		Total	14.2	TMU			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AJ - FINISHED UNIT FROM FIXTURE AND ASIDE (MTM-1)</u>						
Fuse from Fixture and Aside		R14A	10.5	R14A	Open Clamp	
		G1A	2.0	G5		
			4.0	D1E		
			4.6	M2B		
		M2B	4.6	RL2		
		M12C	15.2			
		RL1	2.0			
		Total	42.9	TMU		
<u>AL - ASSEMBLE BODY, WASHER AND FUSE (MTM-1)</u>						
Assemble (1) Washer			17.2	R18B	Body into Fixture	
			2.0	G1A		
			20.4	M18C		
			25.3	P2SSD		
			16.2	AP1		
			2.9	M1B		
			2.0	RL1		
		R8C	15.8	R16B	Fuse Asembly into Fixture	
		G4B	9.1	G1A		
		M-	18.7	M16C		
			25.3	P2SSD		
			2.5	M1A	Clamp	
			2.0	RL1		
		M2C	5.2			
		PISE	5.6			
		RL1	6.4	R4A		
			-	G5		
			4.0	M2A		
			16.2	AP1		
			-	RL2		
		Total	196.8	TMU		



DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND	
AS - ASSEMBLE SPACER TO UNIT (MTM-1)							
P.U. Supply of Spacers	{	1/24 R16C	0.7				
		1/24 G4B	0.4				
		1/24 G2	0.5				
To Work Area	1/24	M14B	0.6				
Unpalm (1) Spacer	{	2 G2	11.2	R-		{ (1) Spacer from LH	
			5.6	G3			
			9.2	M5C		{ Spacer to Assembly	
			21.8	P2SD			
			4.6	M2B			
			2.0	RL1			
		1/24 M14B	0.6				
		1/24 RL1	1.1				
			Total	58.3	TMU		
		AT - LOAD RETAINER RING (MTM-1)					
Jig	{	R14B	15.6	R14C		{ Retainer Ring	
		G1A	9.1	C4B			
			11.6	M1B	4	{ Shake - Untangle and Orientate	
			4.7	T18)S	1/2		
			18.7	M16C		{ Retainer Ring to Jig	
			16.0	P1NSD			
			2.0	RL1		{ Weight into Jig	
			8.6	R6B			
			2.0	G1A			
			10.1	M6C			
			16.2	P2SE			
			2.5	M1A			
			10.6	AP2		{ Seat in Jig	
			5.6	G2			
Jig	{		4.0	DIE		{ Remove Weight from Jig and Aside	
		RL1	8.9	M6B			
			2.0	RL1			
		Total	148.2	TMU			

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
AU - ASSEMBLE HOUSING AND RETAINER TO TIMER (MTM-1)						
P.U Timer and to Work Area	{	R14B	22.1	R20C	{	Housing to Timer and Assemble
		G1B	3.5			
			7.3	G4A		
		M16B	22.1	M20C		
			21.0	P2NSE		
Assembly from RH	{		4.0	MfB	{	Seat
		G3	5.6			
			8.6	R6B		
			2.0	G1A		
			10.1	M6C		
Assist RH	{			<del>T180S</del>	{	Assemble Fixture with Retainer Ring to Timer Assembly
			5.6	P2SE		
		M8C	11.8	M8C		
		P2SE	5.6	P2SE		
		RL1	2.0	RL1		
		Total	131.3	TMU		Whole Assembly to Fixture
AV - PRESS RETAINER AND ASIDE FINISHED UNIT (PROCESS TIME EXCLUDED) (MTM-1)						
Operate	{	R6A	7.0	R6A	{	Operate
		G5	-	G5		
		AP2	10.6	AP2		
From Fixture	{	M2B	4.6	M2B	{	From Fixture
		M14C	16.9	M6B		
Assembly to Tray	{	P1SE	5.6	RL1	{	Top to Bench
		RL1	2.0			
		Total	46.7	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AW - ASIDE FINISHED UNIT TO TRAY, ASSEMBLE TRIGGER ASSEMBLY AND TOP PLATE (MTM-1)</u>						
Finished Unit to Tray		M20C	22.1			Trigger Assy. to Work Area
		RL1	18.6	R20B		
			2.0	G1A		
			17.0	M18B		
	Top Plate to Trigger Assy.		R10C	12.9		
			G4B	9.1		
			M8C	11.8		
			<del>G2</del>			
		1/2	T180S	4.7		
			P2NSE	21.0		
		RL1	6.9	M4B		
		2.0	RL1			
		Total	128.1	TMU		To Bench
<u>AX - ASSEMBLE RIVETS, PLACE UNIT ON BLOCK, ASSEMBLE INSERTS (MTM-1)</u>						
Rivet to Trigger Assy.		R14C	15.6	R10C		Rivet to Trigger Assy.
			9.1	G4B		
		G4B	9.1			
		M10B	15.2	M12C		
			21.8	P2SD		
		M4C	8.4	RL1		
Trigger Assembly		P2SD	21.8			
		RL1	2.0			
		R1B	8.9	R6B		
		G1A	2.0	G1A		
			4.0	D1E		
						Block
						Remove from Fixture
		Carry Fwd.	117.9			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AX - Continued</u>						
		Brought Fwd.	117.9			
		M4B	10.3	M6C		} Assemble
			21.0	P2NSE		
Change Hold.	{	G2	5.6	G2		
		T180S	9.4			
			5.6	G3		Assy. from LH
Clamp Fixture to Work Area	{	R8B	10.1			
		G1A	2.0			
		M6B	8.9			
			8.0	M4C		} Trigger to Clamp Assy.
			21.0	P2NSE		
			2.0	RL1		
			10.1	R8B		} P.U Insert with Tweezers
			2.0	G1A		
			11.8	M8C		
				<del>G2</del>	2	
			14.7	P1SSD		
			2.0	MfA		
			11.8	M8C		} Insert to Hole
			7.3	EF		
			21.8	P2SD		
			2.0	MfB		Open Tweezers
		RL1	2.9	MLB		Tweezers from Assy.
		Total	308.2			

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
<u>AY - OBTAIN FIRING PIN AND SPRING ASSEMBLE TO UNIT (MTM-1)</u>						
Spring to Trigger Assembly		R16C	17.0	R14C <del>G2</del>	2	P.U Firing Pin & Unpalm Tweezers
		G4B	9.1			
			9.1	G4B		Firing Pin to Assembly
		M16C	18.7	M10B		
		P2SE	16.2			
		RL1	8.0	M4C		
			16.2	P2SE		
			2.0	RL1		
		Total	97.3	TMU		
<u>AZ - ASSEMBLE, SAFETY PLATE, SSD RELEASE, FIRING ARM AND BOTTOM PLATE (MTM-1)</u>						
Safety Plate to Work Area		R14C	15.6	G2	2	Unpalm Tweezers
		G1B	3.5			Tweezers to Safety Plate
		M12B	13.4	M8C		
			14.7	P1SSD		Close Tweezers
			2.0	MfA		
		RL1	2.0			Safety Plate to Trigger Assembly
			8.0	M4C		
			16.2	P2SE		
SSD to Work Area			2.0	MfB		Open Tweezers
		R14C	15.6	M4C		Tweezers to SSD Release
		G4B	9.1			
		M12B	13.4			
			14.7	P1SSD		Close Tweezers
			2.0	MfA		
		RL1	8.2	M4C		
			16.2	P2SE		SSD to Trigger Assy.
			2.0	MfB		
			10.6	M8B		
			2.0	RL1		Tweezers Aside
		Carry Fwd.	171.2			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AZ - Continued</u>						
		Brought Fwd.	171.2			
Firing Arm	{	R14C	15.6	R4B	{	P.U Pliers to W. A.
Pin to W. A.		G4B	9.1	G1A		
		M12B	13.4	M12B		
		G2	5.6	G2		
			2.0	MfC	{	Grasp Firing Arm Pin with Pliers
			9.1	P1SSE		
			2.0	MfA		
Firing Pin		RL1	2.0			
Spring with Thumbs	{	R2B	4.0			
		G5				
		AP2	10.6			
Wind Spring and Hook Onto Pliers	{	M2C	5.2			
		P2SD	21.8			
		RL2	-			
			8.0	M4C	{	Firing Pin Arm in Trigger Assy.
			21.0	P2NSD		
			2.0	MfB		Open Pliers
			11.5	M10B	{	Pliers to Table
			2.0	RL1		
	{	R3A	12.9	R10C	{	Bottom Plate to Trigger Assy.
		G1A	9.1	G4B		
			13.5	M10C		
			9.4	T180S		
Clamp	{		5.6	P1SE	{	Plate onto Pins
		M3A	4.9			
		AP2	10.6			
		RL1	2.0			
			5.6	G2		
			2.0	MfC		
			21.0	P2NSE		
			10.6	AP2		
			2.0	RL1		
		Total	425.3	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
BA - CHECK SPRINGS, INSPECT SHART, STAKE UNIT AND RECYCLE (MTM-1)						
P.U Unit From Table		R4B	10.1	R8B	2	Release Contact Using Tweezers
		G1A	2.0	G1A		
		M4B	11.8	M8C		
				<del>G2</del>		
			-	G5		
			5.6	P1SE		Tweezers to Firing Pin Arm Shaft
			-	RL2		
			2.0	MfC		
			14.7	P1SSD		Close Tweezers
			2.0	MfA		Shaft to Hole
			2.0	MfC		
			5.6	P2SE		
			2.0	MfB		Open Tweezers
			4.6	M2B		Aside
Turn Unit	2	M2B	9.2			
Clamped Unit to Fixture			14.6	EF	2	Inspect
			4.0	M4C	1/2	Adjust
			2.8	P1SE	1/2	
			-	G5	1/2	
			1.0	MfC	1/2	
			-	RL2	1/2	
			16.9	M8B		Aside Tweezers
	<del>T180S</del>	RL1				
	P2SSE	19.7				
	RL1	2.0				
Operate		R14A	10.6	R14A		Operate
		G5	-	G5		
		AP2	10.6	AP2		
		RL2	-	RL2		
		Carry Fwd.	153.8			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BA - Continued</u>						
		Brought Fwd.	153.8			
		R14A	10.6	PT		Process Time
		G1A	2.0	R10A		
		D1E	4.0			
Clamp. From Press to Recycling Fixture		M14C)	16.9			
		<del>T90S</del>				
		P2SSE	19.7			
		RL1	2.0			
		R5A	6.5			
Operate 1st Lever	2	G5	-	G5	2	Operate 2nd Lever
		M2A	7.2	M2A		
		AP2	10.6	AP2		
		RL2	-	RL2		
			6.1	R4A		
			2.0	G1A		
			7.2	M2A	2	Operate 3rd Lever
			10.6	AP2		
			2.0	RL1		
		Total	261.2	TMU		
<u>BB - OPEN CLAMP AND REMOVE FROM FIXTURE (MTM-1)</u>						
		R6B	8.6			
		G1A	2.0			
Open Clamp		AP2	10.6			
		M3B	5.2			
		RL1	2.0			
		R6A	7.0			
		G1A	2.0			
Remove from Fixture		M6B)	8.9			
		<del>T180S</del>				
			7.3	EF		Inspect
		Total	54.1	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BD - OBTAIN UNIT AND PLACE IN FIXTURE (MTM-1)</u>						
Close		R-	14.4	R14B		P.U Unit
		G5	2.0	G1A		
			16.9	M14C		
				<del>T180S</del>		
				<del>G2</del>		Into Fixture
			10.4	P1NSE		
			2.0	RL1		
		M2A	3.6			
		RL2	-			
		Total	49.3	TMU		
<u>BE - TORQUE (3) POSTS (MTM-1)</u>						
			10.8	R9B		Torque defice to Unit
			2.0	G1A		
			12.7	M9C		
			59.1	P2SSE	3	Torque
			8.7	M1B	3	
			16.8	G2	3	
			31.8	AP2	3	
			10.4	M2C	2	To Next Post Device Aside
			10.6	M8B		
			2.0	RL1		
		Total	164.9	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
BF - CHECK DROPLEAF, DROPLEAF ROD, GAUGE UNIT AND ASIDE (MTM-1)						
Unit to W. A.	{	R7A	9.4	R5D	{	Gauge
		G1A	3.5	G1B		
		M6B	8.9			
		<del>T180S</del>				
To White Disc	{	<del>G2</del>			{	
		RfA	2.0			
Move Unit	{	G5	-		{	Pull Gauge Out
			4.0	D1E		
			9.7	M7B		
			2.0	RL1		
		M1B	7.4	R7A		
		G2	2.0	G1A		
Adjust Unit	{		8.0	MfA	{	Check End Shake
			2.0	RL1		
		M1B	4.0	R2A		
			-	G5		
			10.6	AP2		
			-	RL2		
Unit Aside to Tray	{		2.0	RfA	{	Check Spring
			-	G5		
			10.6	AP2		
			-	RL2		
		M16C	18.7			
		<del>G2</del>				
	{	RL1	2.0		{	Check Dropleaf
		Total	106.8	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
BG - PLACE HOUSING, INTO FIXTURE (MTM-1)						
Assist RH		R-	20.1	R22B		P.U Housing
		G-	3.5	G1B		
		M18C	20.4	M18C		Into Fixture
		<del>T180S</del>		<del>T180S</del>		
		P1NSE	10.4	P1NSE		
		RL1	2.0	RL1		
		Total	56.4	TMU		
BH - OBTAIN AND ASSEMBLE 'O' RING, WASHER STARTING PIN AND SPRING (MTM-1)						
Washer to Guide Pin			16.8	G2	3	Guide Pin (Held in Hand)
		R7C	10.8	M4B		Move to WA
		G4C	12.9			
		M7C	11.1			
		P2SE	16.2			
'O' Ring to Guide Pin		RL1	2.0			
		R8C	11.5			
		G4C	12.8			
		M8C	11.8			
		P2SE	16.2			
		RL1	2.0			
			8.0	M4C		
				<del>T180S</del>		
			16.2	P2SE		To Hole
			2.0	MfB		
			2.0	RL1		
Carry Fwd.			152.3			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BH - Continued</u>						
		Brought Fwd.	152.3			
			14.2	R12C		} Spring to Work Area
			7.3	G4A		
		R10C	12.9	M8A		
		G4A	7.3			} Assemble on Guide
			8.0	M4C		
Starting Pin to Spring			21.8	P2SD		
			13.5	RL1		
		M10C	12.9			
		P2SD	21.8			} Housing Aside
		AP2	10.6			
			6.1	R4A		
			2.0	G1A		
Housing Aside		M10B <del>T180S</del>	12.2	(M10B <del>T180S</del> )		
		RL1	2.0	RL1		
		Total	304.9	TMU		
<u>BJ - ASSEMBLE RETAINER (MTM-1)</u>						
			11.5	R10B		} Retainer Tool to Assy.
			2.0	G1A		
		8.0	8.0	M4C		
		16.2	16.2	P2SE		
		10.6	10.6	AP2		
		15.2	15.2	M12C		} Retainer to Pin
		16.2	16.2	P2SE		
		10.6	10.6	AP2		
		4.0	4.0	D1E		Disengage Tool
		13.4	13.4	M12B		} Tool Aside
Turn Housing		T90S	5.4	RL1		
		Total	113.1	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
BL - HOUSING ASIDE AND DUMP OUT PIN GUIDE (MTM-1)						
Housing		M6B	8.9	MyB		Hand to Housing
		<del>T180S</del>				
		M12C	15.2	G2		Palm Guide
		<del>T180S</del>				
		RL1	2.0			
		Total	26.1	TMU		
BM - LOAD FIXTURE (MTM-1)						
Help Orientate Lever			9.2	M5C	6	Tweezers to Lever
			12.0	MfB		} Separate and Orientate
			12.0	MfB		
			2.0	MfC		} P.U Lever with Tweezers
			25.3	P1SSD		
			2.0	MfA		
			5.3	M3C		} Lever to Fixture
		G5	26.6	P2NSD		
		FL2	2.0	MfB		
				Total		96.4
BP - BURNISH SLOT (MTM-1)						
Start Machine		R5A	6.5	(R4A		Burnish Handle
		G5		<del>G2</del>		Palm Tweezers
Hand Clear		AP2	10.2		10	} Handle to Burnisher Burnish Slot
		R-E	2.0	GLA		
			2.0	MfA		
			20.0	MfA		
		Total	40.7	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
BR - UNLOAD FIXTURE	(MTM-1)					
Stop Machine {		R5A	6.5	MfA	}	Handle from Burnisher
		G5	5.6	RL1		
		AP2	10.2	G2	}	Unpalm Tweezers
			6.7	M3C		
			14.7	PLSSD	}	P.U Lever with Tweezer
			2.0	MfA		
			10.6	M8B		To Pan
			2.0	MfA		Open Tweezers
		Total	58.3	TMU		
BS - OBTAIN HOUSING AND ASSEMBLE SPRING	(MTM-1)					
P.U Spring {			21.5	R24B	}	Housing to Table
			2.0	G1A		
			20.6	M24B <del>T</del>		
			2.0	RL1		
		R9C	12.2			
Orientate {		G4B	9.1		}	P.U Tweezers & to Spring
			9.3	R7B		
			2.0	G1A		
Spring {		M- <del>T</del>	11.8	M8C	}	Close Tweezers
			9.1	PLSSE		
			2.0	MfA		
Housing {		RL1	2.0		}	Spring to Hole Open Tweezers Tweezers Aside
		R-	8.4	M4C		
		G-	26.6	P2NSD		
			2.0	MfA		
			9.7	M7B		
			2.0	RL1		
		Total	152.3	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
BT - ASSEMBLE OPTION PIN, WASHER AND 'O' RING IN HOUSING (MTM-1)						
Ass. Washer to Option Pin		R-	14.2	R12C		Option Pin to Work Area
			7.3	G4A		
		G4A	12.9			
		M12C	15.2	M-		
		P2SE	16.2			
Assemble 'O' Ring to Option Pin		RL1	2.0			
		R6C	10.1			
		G4C	12.9			
		M6C	10.3			
		P2SD	21.8			
Housing to Work Area		RL1	2.0			
		R4B	8.0	M4C GZ		
		G1A	2.0			
		M4B	6.9			
			8.0	MfC	4	Align Pin
			26.6	P2NSD		Ass. Pin
			2.5	M1A		
			2.0	RL1		
			2.0	RfA		Seat on Spring
			-	G5		
			10.6	AP2		
			-	RL2		
		Total	193.5	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
BU - CHECK UNIT FOR	END	SHAKE (MTM-1)				
			10.1	R8B		
			2.0	G1A		
			11.8	M8C		
			25.3	P2SSD		
			8.5	T90M		
			14.6	EF	2	
			10.6	M8B		
			2.0	RL1		
		Total	84.9	TMU		
BV - ASSEMBLE LARGE	OR	SMALL 'E'	RING (MTM-1)			
Housing	2	G2	11.2			
		R-	12.9	R10C		
		G5	7.3	G4A		
			8.0	M4C		
			16.2	P2SE		
			10.6	AP2		
			15.2	M12C		
			21.8	P2SD		
			10.6	AP2		
		RL2	11.5	M10B		
Pin Housing		G2	2.0	RL1		
		Total	127.3	TMU		
BW - ASSEMBLE CRANK		(MTM-1)				
			12.9	R10C		
			9.1	G4B		
			13.5	M10C		
				G2		
			26.6	P2NSD		
			10.2	AP2		
			2.0	RL1		
		Total	75.3	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
BX - ASSEMBLE AND FORM ELEMENTS			(MTM-1)			
Finished Unit Aside	{	R8A	8.7	R10A	2	Back Unit to Fixture
		G1A	2.0	G1A		
		M10B	12.2	G2		
		RL1	2.0	<del>M2C</del>		
			21.8	P2SD		
P.U Setting Key and Lubricate	{		2.0	RL1		Ass. Unit to Setting Key
		R7C	10.8	R7C		
		G4B	9.1			
			9.1	G4B		
		M4B	6.9			
Key to Crush Elements	{	M5B	9.2	M5C		Assemble Retaining Plug
		<del>T90S</del>		<del>T90S</del>		
			5.6	P1SE		
			2.0	RL1		
			7.3	R3C		
Ass. in Die	{		9.1	G4B		
			7.3	M3C		
			11.2	P1SD		
			2.0	RL1		
		M8C	13.5			
		P2SD	21.8			
		RL1	2.0			
		Total	175.6	TMU		

APPENDIX N: MTM-2 ANALYSIS OF PROVING DATA FROM TEST SITE

The following is a summary of the times of the tasks used for proving the simplified data systems. These time values have been developed using MTM-2, and then transformed to 0.01 minutes at 100 B.S.I. performance level.

Task	Description	0.01 Minutes
T1-2	Load Springs into Magazines	6.200
T2-2	Hand Load Detonators to Magazines	7.115
T3-2	Insert S-A Retainer into Fuse Body	13.510
T4-2	Handle Fuses	5.475
T5-2	Assemble and Stamp Torque Module	5.250
T6-2	Apply Tape Seal to S-A	9.270
T7-2	Assemble Body and Washer to Fuse	12.100
T8-2	Assemble and Crimp Detonator Support	8.725
T9-2	Assemble Timer, Spacers and Retainer	21.725
T10-2	Assemble and Stake Trigger Assembly	63.760
T11-2	Torque (3) Posts	15.950
T12-2	Assemble Starting Spring Pin	25.150
T13-2	Burnish Slot	11.200
T14-2	Assemble Option Pin Arm	36.150
T15-2	Assemble and Form Key Assembly	9.950

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T1-2	<u>LOAD SPRINGS INTO MAGAZINES (MTM-2)</u>				
	A	Obtain and Place Magazine	71.0	1	71.5
	B	Load Springs and Aside Work	52.5	1	52.5
				Total	124.0
T2-2	<u>HAND LOAD DETONATOR TO MAGAZINE (MTM-2)</u>				
	D	Detonator Boxes to Dog House	657	1/500	1.3
	E	Magazine Tray to Work Fixture	75	1/100	0.8
	F	Detonator Box to Work Fixture	286	1/10	28.6
	G	Empty Magazine on Platform	51	1/5	10.2
	H	Detonator in Magazine	55	1	55.0
	J	Expose Detonator Rim	22	1	22.0
	L	Full Magazine in Work Fixture	49	1/5	9.8
	M	Completed Magazine to Locker	73	1/5	14.6
				Total	142.3
T3-2	<u>INSERT S-A RETAINER INTO FUSE BODY (MTM-2)</u>				
	P	Assemble, Press and Gauge	194.0	1	194.0
	R	Obtain Tray of Fuses: 100% Inspection Closing Screws	155.0	1/8	19.4
	S	Aside Tray of Modules	56.0	1/20	2.8
	T	Start Module Threads	70.5	1	70.5
	U	Obtain Tray of Modules	29.0	1/20	1.5
				Total	270.2
T4-2	<u>HANDLE FUSES (MTM-2)</u>				
	V	Obtain and Aside Fuses	89	1	89
	W	Aside Completed Tray	44	1/4	11
	X	Obtain New Tray	38	1/4	9.5
				Total	109.5

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T5-2	<u>ASSEMBLE AND STAMP TORQUE MODULE (MTM-2)</u>				
	AA	Insert Fuse into Train	50	1	50
	AB	Aside Completed Fuse to Tray	55	1	55
				Total	105
T6-2	<u>APPLY TAPE SEAL TO S-A (MTM-2)</u>				
	AD	Apply Seal	110	1	110.0
	AE	Actuate Press	12	1	12.0
	AF	Remove Fuse from Press and Check Seal	60	1	60.0
	AG	Obtain Tray of Fuses	15	1/8	1.9
	AH	Tray of Sues Aside	12	1/8	1.5
				Total	185.4
T7-2	<u>ASSEMBLE BODY AND WASHER TO FUSE (MTM-2)</u>				
	AJ	Finished Unit from Fixture	51	1	51
	AL	Assemble Body, Washer and Fuse	175	1	175
	AM	Assemble Body to Unit	16	1	16
				Total	242
T8-2	<u>ASSEMBLE AND CRIMP DETONATOR SUPPORT (MTM-2)</u>				
	AP	Aside Finished Unit, Assemble Spring to Detonator Fuse	151	1	151
	AR	Stake Unit and Obtain Detonator	23	1	23
	AG	Obtain Tray	15	1/50	0.3
	AH	Aside Tray	12	1/50	0.2
				Total	174.5

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T9-2	<u>ASSEMBLE TIMER, SPACERS AND RETAINER (MTM-2)</u>				
	AS	Assemble Spacer to Unit	64.8	1	64.8
	AT	Load Retainer Ring	148	1	148.0
	AU	Assemble Housing and Retainer to Timer	162	1	162.0
	AV	Press Retainer, Aside Unit	59	1	59.0
	AG	Obtain Tray	15	1/24	0.2
	AH	Aside Tray	12	1/24	0.5
				Total	434.5
T10-2	<u>ASSEMBLE AND STAKE TRIGGER ASSEMBLY (MTM-2)</u>				
	AW	Assemble Trigger Assembly and Top Plate	98.5	1	98.5
	AX	Assemble Rivets, Place Unit on Block, Assemble Insert	271	1	271
	AY	Assemble Firing Pin and Spring to Unit	98	1	98
	BA	Check Springs, Inspect Shaft, Stake Unit and Recycle	321	1	321
	AZ	Assemble Safety Plate, SSD Release, Firing Arm and Bottom Plate	446	1	446
	BB	Open Clamp and Remove from Fixture	40	1	40
	AG	Aside Tray	12	1/24	0.2
	AH	Obtain Tray	15	1/24	0.5
				Total	1275.2
T11-2	<u>TORQUE (3) POSTS (MTM-2)</u>				
	BD	Unit to Fixture	57	1	57
	BE	Torque (3) Posts	149	1	149
	BF	Check Dropleaf, Dropleaf Rod, Gauge	113	1	113
				Total	319

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T12-2	<u>ASSEMBLE STARTING PIN SPRING (MTM-2)</u>				
	BG	Housing Into Fixture	59	1	59
	BH	Assemble Washer, 'O' Ring, Starting Pin and Spring	296	1	296
	BJ	Assemble Retainer	123	1	123
	BL	Housing Aside: Dump Out Pin Guide	25	1	25
				Total	503
T13-2	<u>BURNISH SLOT (MTM-2)</u>				
	BM	Load Fixture	101	1	101
	BP	Burnish Slot	60	1	60
	BR	Unload Fixture	63	1	63
				Total	224
T14-2	<u>ASSEMBLE OPTION PIN (MTM-2)</u>				
	BS	Assemble Spring	138	1	138
	BT	Assemble Option Pin, Washer and 'O' Ring	214	1	214
	BU	Check Unit for End Shake	68	1	68
	BV	Assemble Large or Small 'E' Ring	118	2	236
	BW	Assemble Crank	67	1	67
				Total	723
T15-2	<u>ASSEMBLE AND FORM KEY ASSEMBLY (MTM-2)</u>				
	BX	Assemble and Form Elements	199	1	199
				Total	199

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<b>A - OBTAIN AND PLACE MAGAZINE (MTM-2)</b>						
			32	GC80		} Magazine to Work Area
			20	PA80		
			7	GB5		} Orientate
			12	2R		
		Total	71	TMU		
<b>B - LOAD SPRINGS TO MAGAZINE, ASIDE WORK (MTM-2)</b>						
P-U Springs	1/4	GC15	4.8			} Obtain Spring and Assemble
	1/4	PA30	2.8			
Unpalm (1) Spring	1/2	R	2.8	G-		
			14.0	GC5		
			26.6	PC15		
Aside Work	1/20	GA30	0.5	GA30	1/20	} Aside Work
	1/20	PB80	1.0	PB8	1/20	
		Total	52.5	TMU		
<b>D - DETONATOR BOXES TO DOGHOUSE (MTM-2)</b>						
			18	GB45		} Open Locker Door
			5	GW5		
			20	PA80		
			1	PW5		
		G-	32	GC80		} Open Lid and Aside
			5	GW5		
			3	PA5		
			20	PA80		
			160	GC80	5	} Remove Box of Detonators and to LH
			25	GW5	5	
			15	PA5	5	
		G-	100	PA80	5	
From RH	5	GB5	35			
Box in Work Area	5	PA80	100			
		Carry Fwd.	559			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>D - Continued</u>						
		Brought Fwd.	559			
			23	GB80		} Toss Empty Box Aside
			20	PA80		
			23	GB80		} Close Locker
			10	GW10		
			20	PA80		
			2	PW10		
		Total	657	TMU		
<u>E - OBTAIN AND POSITION EMPTY MAGAZINE</u>						
Tray to Fixture {		GB80	23	G-		} Assist RH
		PC80	41	P-		
		PA30	11	P-		
		Total	75	TMU		
<u>F - OPEN DETONATOR BOX AND TRANSFER TO FIXTURE (MTM-2)</u>						
Assist RH {		G	23	GB80		} Box of Detonators to Platform
		P	41	PC80		
		G-	3	GA5		} Open Lid
		A	14	A		
		P-	11	PA15		} Lid
Box {			7	GB5		
		GC5	14			} Remove Lid To LH
			6	PA15		
		G-	6	PA15		
		GB5	7			
Lid from LH		PA45	15			
Toss Lid Aside		GC45	27			
Cardboard Pad From Box		PA30	11			
		Carry Fwd.	195			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>F - Continued</u>						
		Brought Fwd.	195			
Detonators		GC30	23			Box of Detonators to Fixture
			14	GC5		
Assist RH		PC30	30	PC30		Slide into Fixture
			3	GA5		
			6	PA15		
		Total	286	TMU		
<u>G - OBTAIN AND PLACE EMPTY MAGAZINES ON WORK PLATFORM (MTM-2)</u>						
Magazines to Platform	{	GC45	27			
		PA45	15			
Orientate 2nd Magazine	{	R	6			
		PA5	3			
		Total	51	TMU		
<u>H - POSITION DETONATOR IN MAGAZINE (MTM-2)</u>						
			26	GC15		P-U Detonator Locate Insert
			26	PC15		
			3	PA5		
		Total	55	TMU		
<u>J - EXPOSE DETONATOR RIM (MTM-2)</u>						
			3	GA5		Expose Rim
			19	PB30		
		Total	22	TMU		
<u>L - POSITION FULL MAGAZINE IN WORK FIXTURE (MTM-2)</u>						
Assist RH	{	G-	19	GC15		Work in Fixture
		P-	21	PC5		
		G-	3	GA5		Insert
		P-	6	PA15		
		Total	49	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
<u>M - COMPLETED MAGAZINE INTO LOCKER (MTM-2)</u>						
Wire Guard to Work Area	{	GB45				
		PA30				
Assist RH	{	G	10	GB15		{ Wire Guard into Slot in Tray
		D	26	PC15		
Assist RH	{	P	3	PA5		{ Tray from Fixture and Aside
		G-	14	GC5		
		P-	20	PA80		
		Total	73	TMU		
<u>P - ASSEMBLE, PRESS AND GAGE: ASIDE TO TRAY (MTM-2)</u>						
Retainer to S-A	{	GC45	27	G-		{ Assemble S-A
		P-	36	PC45		
S-A in Fixture	{	PC15	26	G-		{ Clamp
			11	PA30		
			14	A		
Gauge S-A	{	G-	11	PA30		{ Release
		PC15	26			
Assemble to Fuse	{	PA15	6			
		GB5	7			
		PC30	30			
		Total	194	TMU		
<u>R - OBTAIN TRAY OF FUSES: 100% INSPECTION CLOSING SCREWS (MTM-2)</u>						
Assist RH	{	GB80	23	GB80		{ Tray to Bench
		PA80	20	PA80		
			56	E	8	{ Inspect
			56	E	8	
		Total	155	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>S - ASIDE TRAY (MTM-2)</u>						
Tray to Conveyor	{	GB30	14	G-		
		PA80	20	P-		
Slide on Conveyor	{	GA5	7			
		PA45	15			
		Total	56	TMU		
<u>T - START MODULE THREADS (MTM-2)</u>						
Module Turner to Fuse	{	1/8 GB30	1.8			
		1/8 PC15	3.3			
Turn Down	{	5 PA5	15.0			
		4 GB5	28.0			
Next Fuse		PC5	21.0			
Aside Tool	1/8	PA30	1.4			
		Total	70.5	TMU		
<u>U - OBTAIN TRAY OF MODULES (MTM-2)</u>						
Assist RH	{	GB45	18	GB45		} PU and Move Tray
		PA30	11	PA30		
		Total	29	TMU		
<u>V - ASIDE AND OBTAIN FUSES (MTM-2)</u>						
Finished Fuse Aside	{	GB15	10	GB15		} Finished Fuse Aside
		PC45	36	PC45		
Obtain Fuse	{	GB5	7	GB5		} Obtain Fuse
		PC45	36	PC45		
		Total	89	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>W - ASIDE COMPLETED TRAY (MTM-2)</u>						
Tray to Conveyor {		GB45	18	GB45		Assist LH
		PA30	11	PA30		
Slide Along Conveyor {		GA15	9			Obtain Fuse
		PA15	6			
		Total	44	TMU		
<u>X - OBTAIN NEW TRAY OF WORK (MTM-2)</u>						
To work Area		GB80	23	GB80		Assist LH
		PA45	15	PA45		
		Total	38	TMU		
<u>AA - INSERT FUSE INTO POSITION IN TRAIN (MTM-2)</u>						
			14	GB30		Assemble
			36	PC45		
		Total	50	TMU		
<u>AB - ASIDE COMPLETED FUSE TO TRAY (MTM-2)</u>						
Aside {		GB30	14			
		PC80	41			
		Total	55	TMU		
<u>AD - APPLY SEAL (MTM-2)</u>						
Pull Tape Out {		GB30	14			
		PA5	3			
			19	GC15		Seal to Fixture
			30	PC30		
Seal to Fixture {		GB30	14			
		PC30	30			
		Total	110	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AE - ACTUATE PRESS (MTM-2)</u>						
Actuate Button No. (1)	{	GA30	9	GA30	{	Actuate Button No. (2)
		PA5	3	PA5		
		Total	12	TMU		
Remaining motions in element limited out by Process Time. Process Time not included in the study.						
<u>AF - REMOVE FUSE FROM PRESS AND CHECK SEAL (MTM-2)</u>						
Remove from Press	{	GB45	18			
		PA30	11			
Inspect		E	7			
To Tray		PB45	24			
		Total	60	TMU		
<u>AG - OBTAIN TRAY OF FUSES (MTM-2)</u>						
Slide from Conveyor	{	GA30	9			
		PA15	16			
		Total	25			
<u>AH - TRAY OF FUSES ASIDE (MTM-2)</u>						
Slide to Conveyor	{	GA15	6			
		PA15	6			
		Total	12			
<u>AJ - FINISHED UNIT FROM FIXTURE AND ASIDE (MTM-2)</u>						
{ Clamp from Fuse and Aside		GB45	18	GA45	{	Clamp
			5	GW5		Release
			3	PA5		
			3	PA5		Open
		PA5	3			
		PB30	19			
		Total	51	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AL - ASSEMBLE BODY, WASHER AND FUSE (MTM-2)</u>						
Assemble (1) Washer			18	GB45		Body into Fixture
			36	PC45		
			14	A		
			3	PA5		
		G-	18	GB45		Fuse Assembly into Fixture
		P-	36	PC45		
			3	PA5		
		PC5	21			Clamp
			6	GA15		
			6	PA15		
			14	A		
		Total	175	TMU		
<u>AM - ASSEMBLE BODY TO UNIT (MTM-2)</u>						
Button (1)		GA45	13	GA45		Button (2)
		PA5	3	PA5		
		Total	16	TMU		
<u>AP - ASIDE FINISHED UNIT, ASSEMBLE SPRING TO DETONATOR HOLDER (MTM-2)</u>						
Finished Unit From Fixture: Aside to Tray		GC15	19	G-		Detonator Holder to Fixture
		GW5	5			
		PA5	3			
		PB45	24			
Spring to Detonator Holder	3		26	PC15		
		GC30	23			
		R	21			
		PC30	30			
		Total	151	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AR - HEAT STAKE UNIT AND OBTAIN DETONATOR (MTM-2)</u>						
Operator		GA30	9	GA30		Operator
		A	14	A		
		Total	23	TMU		
Detonator holder is obtained during Process Time. Process Time is not shown in the study.						
<u>AS - ASSEMBLE SPACER TO UNIT (MTM-2)</u>						
P-U Supply of Spacers	1/24	GB45	0.8			
	1/24	R	0.3			
	1/24	PA45	0.7			
Unpalm (1) Spacer	2	R	12.0	G-		Spacer from LH
			7.0	GB5		
			26.0	PC15		
			3.0	PA5		Spacer to Assembly
Extra Spacers Aside	1/24	PA45	15.0			
		Total	64.8	TMU		
<u>AT - LOAD RETAINER RING (MTM-2)</u>						
Jig		GB-	27	GC45		Retainer Ring
			12	PA5	4	Shake Out
			36	PC45		To Jig
			10	GB15		Weight to Jig
			26	PC15		
			3	PA5		Seat
			14	A		
			6	R		Remove Weight From Jig
			5	GW5		
			3	PA5		
			6	PA15		
		Total	148	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
AU - ASSEMBLE HOUSING AND RETAINER TO TIMER (MTM-2)						
Assembly from RH		GC	32	GC80	2	Assemble Timer to Housing
		GC5	14			
		P=	41	PC80		
			6	PA5		Seal
		GB5	7			Assemble Fixture With Retainer Ring to Timer Assembly
			10	GB15		
Assist RH			26	PC15		Whole Assembly to Fixture
		PC15	26	PC15		
		Total	162	TMU		
AV - PRESS RETAINER AND ASIDE FINISHED UNIT (PROCESS TIME EXCLUDED) (MTM-2)						
Operate  From Fixture Assembly to Tray	{	GA15	6	GA15	{	Operate  From Fixture Top to Bench
		A	14	A		
		PA5	3	PA5		
		PC45	36	PA45		
		Total	59	TMU		
AW - ASIDE FINISHED UNIT TO TRAY, ASSEMBLE TRIGGER ASSEMBLY AND TOP PLATE (MTM-2)						
Top Plate to Trigger Assembly	{	1/2		23.0	GB80	Trigger Assembly to WA
				15.0	PA45	
				GC30	23.0	To Bench
				PC30	30.0	
				PA5	1.5	
					6.0	
				Total	98.5	TMU

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND		
AX - ASSEMBLE RIVETS, PLACE UNIT ON BLOCK, ASSEMBLE INSERTS (MTM-2)								
Rivet to Trigger Assembly	{	GC45	27	G-	{	Rivet to Trigger Assembly		
			14	GC5				
			36	PC45				
Trigger Assembly	{	PC5	21	GB15	{	Remove Block From Fixture		
			G-				10	GB15
			P-				5	GW5
Change Hold	{	R	6	R	{	Assembly to Fixture		
			PA15	6				
			7	GB5				
Clamp Fixture to W. A	{	GB30	10	PC15	{	Trigger to Clamp Assembly		
			PA15				6	
			21				PC15	
	{		14	GB30	{	Tweezers to Insert		
			30	PC30				
			3	PA5				
	{		11	PA30	{	Close Tweezers		
			7	E				
			21	PC5				
	{		3	PA5	{	Insert to Hole		
			3	PA5				
			3	PA5				
	{	Total	271	TMU	{	Open Tweezers Tweezers Away from Assembly		
AY - OBTAIN FIRING PIN AND SPRING ASSEMBLY TO UNIT (MTM-2)								
Spring to Trigger Assembly	{	GC45	27	G-	{	Firing Pin to Assembly		
			14	GC5				
			36	P-				
	{	PC45	21	PC5	{			
	{	Total	98	TMU	{			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
AZ - ASSEMBLE SAFETY PLATE, SSD RELEASE, FIRING ARM AND BOTTOM PLATE (MTM-2)						
Safety Plate to Work Area	{	GC45	27	R	2	Unpalm Tweezers
		P-	30	PC30		Tweezers to Plate
			3	PA5		Close Tweezers
			26	PC15		Plate to Assembly
			3	PA5		Open Tweezers
SSD Release to Work Area	{	GC45	27	P-	{	Tweezers to SSD Release Plate
		PA30	11			
			21	PC5		
			3	PA5		
			26	PC15		
Firing Arm Pin to Work Area	{		3	PA5	{	SSD to Trigger Open Tweezers and Away
			11	PA30		
		GC45	27	GB45		
		PA30	11	PA30		
			21	PC5		
Spring With Thumb	{		3	PA5	{	Grasp Firing Arm Pin with Pliers
		GA5	3			
		A	14			
			21	PC5		
			21	PC5		
Spring Onto Pliers	{				{	Firing Pin Arm to Trigger Assy.
Clamp	{	G-	3	PA5	{	Pliers to Table
			11	PA30		
			23	GC30		
			30	PC30		
		PA15	6			
		A	14			
			6	R		
			21	PC5		
			14	A		
Total		446	TMU			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND			
BA - CHECK SPRINGS, INSPECT SHAFT, STAKE UNIT AND RECYCLE (MTM-2)									
P-U Unit From Table		GB15	14	GB30	2	Release Contact with Tweezers			
		P-	30	PC30					
			21	PC5		Tweezer to Pin			
			3	PA5			Close Tweezers		
			21	PC5				Shaft to Hole	
			3	PA5		Open & Aside			
			3	PA5					
		Turn Unit	2	PA5		6			
						14	E	2	Inspect
						13	PC15	1/2	Adjust
	10			PC5	1/2				
Clamp Unit		PC45	36	PA30		Tweezers Aside			
Operate		GA45	13	GA45		Operate			
		A	14	A					
Clamp - From Press to Recycling Fixture		GB45	18	G-		Operate 2nd Lever			
		GW5	5						
		PA5	3						
		PC45	36						
Operate 1st Lever	2	GA15	9		2	Operate 2nd Lever			
		PA5	6	PA5					
		A	14	A					
			9	GA15					
			6	PA5			2		
			14	A					
		Total	321	TMU					

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND		
BB - OPEN CLAMP AND REMOVE FROM FIXTURE (MTM-2)								
Open Clamp		GB15	10	E TMU		Inspect		
		A	14					
Remove from Fixture		PA5	3					
		GB15	10					
		PA5	3					
Total		40						
BD - OBTAIN UNIT AND PLACE IN FIXTURE (MTM-2)								
Close		PA5	18	GB45		Unit into Fixture		
			36	PC45 X				
			3					
			Total	57				
BE - TORQUE (3) POSTS (MTM-2)								
			14	GB30		Torque Device		
			30	PC30				
			18	R	3		Torque	
			42	A	3			
			42	PC5	2	Aside Device		
			3	PA5				
Total		149	TMU					

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BF - CHECK DROPLEAF, DROPLEAF ROD, GAUGE UNIT AND ASIDE (MTM-2)</u>						
Unit to Work Area {		GB15	19	GC15		Gauge
		PA15	6			
		R				
		GA5	3			
			5	GW5		} Pull Gauge Out
			3	PA5		
			6	PA15		Gauge Aside
			10	GB15		} Check End Shake
			12	PA5	4	
			3	GA5		} Check Spring
			14	A		
			3	GA5		} Check Dropleaf
			14	A		
		PA45	15			
Unit Aside		Total	113	TMU		
<u>BG - PLACE HOUSING INTO FIXTURE (MTM-2)</u>						
Assist RH {		G-	23	GB80		} To Fixture
		PC45	36	RC45		
		Total	59	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
BH - OBTAIN AND ASSEMBLE 'O' RING, WASHER, STARTING PIN AND SPRING						
(MTM-2)						
			18	R	3	} Guide Pin to Work Area
Washer to Guide Pin	{	GC30	23	PA15		
		PC30	30			
'O' Ring to Guard Pin	{	GC30	23			} To hole
		PC30	30			
			26	PC15		} Spring to Work Area
			3	PA5		
			23	GC30		} Assemble to Guide
			6	PA15		
Starting Pin to Guide	{	GC30	23			
			26	PC15		
		PC30	30			
		A	14			} Housing Aside
			10	GB15		
Housing Aside		PA30	11	PA30		
		Total	296	TMU		
BJ - ASSEMBLE RETAINER (MTM-2)						
			14	GB30		} Retainer Tool to Assembly
			26	PC15		
			14	A		} Retainer to Pin
			30	PC30		
			14	A		} Disengage Tool
			5	GW5		
			3	PA5		
			11	PA30		} Tool Aside
Turn Housing		PA15	6			
		Total	123	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BL - HOUSING ASIDE AND DUMP OUT PIN GUIDE (MTM-2)</u>						
Housing {		PA15	6	PA15		Hand to Housing
		PB30	19	R		Palm Guide
		Total	25	TMU		
<u>BM - LOAD FIXTURE (MTM-2)</u>						
			15	PB15		Tweezers to Levers
			18	PA5	6	Separate and
			18	PA5	6	Orientate
Assist RH		GA5	21	PC5		P. U. Lever
			3	PA5		Lever to Fixture
			26	PC15		
		Total	101	TMU		
<u>BP - BURNISH SLOT (MTM-2)</u>						
Start Machine {		GA15	6	R		Palm Tweezers
		A	14			
			7	GB5		Handle to
			3	PA5		Burnisher
			30	PA5	10	Burnish Lever
		Total	60	TMU		
<u>BR - UNLOAD FIXTURE (MTM-2)</u>						
Stop Machine {		GA15	6	P-		Handle from
		A	14	R		Burnisher
			26	PC15		Unpalm Tweezers
			3	PA5		P.U. Lever
			11	PA30		with Tweezers
			3	PA5		To Pan
		Total	63	TMU		Open Tweezers

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND	
BS - OBTAIN HOUSING AND ASSEMBLE SPRING (MTM-2)							
Orientate Spring {		GC30 PA-	18	GB45		Housing to Table	
			15	PA45			
			23			Tweezers to Spring	
			14	GB30			
			30	PC30			
			3	PA5		Close Tweezers	
			26	PC15	Spring to Hole		
			3	PA5	Open Tweezers		
			6	PA30	Tweezers Aside		
		Total	138	TMU			
BT - ASSEMBLE OPTION PIN, WASHER AND 'O' RING IN HOUSING (MTM-2)							
Assemble Washer to Option Pin {		GC5 PC30	23	GC30		Option Pin	
			14				
			30				
			GC15 PC15	19			
				26			
Assemble 'O' Ring to Option Pin {		PC15	15	PB15	4	Pin to Housing	
			6				
Housing to Work Area		PA15	40	PB5		Assemble Pin	
			21	PC5			
			3	PA5			
			3	GA5			
			14	A			
			Total	214	TMU		Seat on Spring
			BU - CHECK UNIT FOR END SHAKE (MTM-2)				
			14	GB30		Driver to Slot	
			30	PC30			
			6	PA15			Turn
			12	E			Check Holes
			6	PA30			Driver Aside
Total	68	TMU					

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BV - ASSEMBLE LARGE OR SMALL 'E' RING (MTM-2)</u>						
			23	GC30		} E Ring Tool to Fixture
			26	PC15		
			14	A		} Tool on E Ring Assemble E Ring
			30	PC30		
			14	A		} Tool Aside
			11	PA30		
		Total	118	TMU		
<u>BW - ASSEMBLE CRANK (MTM-2)</u>						
			23	GC30		} Crank to Option Pin Unit
			30	PC30		
			14	A		} Seat
		Total	67	TMU		
<u>BX - ASSEMBLE AND FORM ELEMENTS (MTM-2)</u>						
		GB-	14	GB30		} Back Unit to Fixture
		PA-	12	R	2	
			21	PC5		} Assembly Unit to Setting Key
		GC30	23	G-		
P.U. Setting Key and Lubricate			14	GC5		} Assemble Retaining Plug
		PA5	3			
Key to Crush Element		P-	26	PC15		} Assemble Retaining Plug
			10	GB15		
			26	PC15		} Assemble Retaining Plug
		PC30	30			
Assembly in Die		Total	199	TMU		

## APPENDIX O: MTM-3 ANALYSIS OF PROVING DATA FROM TEST SITE

The following is a summary of the times of the tasks used for proving the simplified data systems. These time values have been developed using MTM-3, and then transformed to 0.01 minutes at 100 B.S.I. performance.

Task	Description	0.01 Minutes
T1-3	Load Springs into Magazine	5.370
T2-3	Hand Load Detonators to Magazine	8.760
T3-3	Insert S-A Retainer into Fuse Body	17.490
T4-3	Handle Fuses	6.050
T5-3	Assemble and Stamp Torque Module	4.800
T6-3	Apply Tape Seal to S-A	9.530
T7-3	Assemble Body and Washer to Fuse	12.250
T8-3	Assemble and Crimp Detonator Support	7.420
T9-3	Assemble Timer, Spacers and Retainer	17.015
T10-3	Assemble and Stake Trigger Assembly	64.590
T11-3	Torque (3) Posts	13.900
T12-3	Assemble Starting Spring Pin	20.000
T13-3	Burnish Slot	16.650
T14-3	Assemble Option Pin Arm	30.050
T15-3	Assemble and Form Key Assembly	9.300

# SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T1-3	<u>LOAD SPRINGS INTO MAGAZINE (MTM-3)</u>				
	A	Obtain and Place Magazines	59.0	1	59.0
	B	Load Springs and Aside Work	48.4	1	48.4
				Total	107.4
T2-3	<u>HAND LOAD DETONATOR TO MAGAZINE (MTM-3)</u>				
	D	Detonator Boxes to Doghouse	476	1/500	1.0
	E	Magazine Work Tray to Fixture	64	1/100	.6
	F	Detonator Box to Work Fixture	236	1/10	23.6
	G	Empty Magazine on Platform	41	1/5	8.2
	H	Detonator on Magazine	57	1	57.0
	J	Expose Detonator Rim	48	1	48.0
	L	Full Magazine in Work Fixture	52	1/5	10.4
	M	Completed Magazine to Locker	132	1/5	26.4
				Total	175.2
T3-3	<u>INSERT S-A RETAINER INTO FUSE BODY (MTM-3)</u>				
	P	Assemble, Press and Gauge	230	1	230.1
	R	Obtain Tray of Fuses: 100% Inspection, Closing Screws	146	1/8	18.3
	S	Aside Tray of Modules	68	1/20	3.4
	T	Start Module Threads	96.3	1/20	96.3
	U	Obtain Tray of Modules	34	1/20	1.7
				Total	349.8
T4-3	<u>HANDLE FUSES (MTM-3)</u>				
	V	Obtain and Aside Fuses	96	1	96
	W	Aside Completed Tray	52	1/4	13
	X	Obtain New Tray	48	1/4	12
				Total	121

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T5-3	<u>ASSEMBLE AND STAMP TORQUE MODULE (MTM-3)</u>				
	AA	Insert Fuse into Train	48	1	48
	AB	Aside Completed Fuse in Tray	48	1	48
				Total	96
T6-3	<u>APPLY TAPE SEAL TO S-A (MTM-3)</u>				
	AD	Apply Seal	114	1	114.0
	AE	Actuate Press	18	1	18.0
	AF	Remove Fuse from Press and Check Seal	50	1	50.0
	AG	Obtain Tray of Fuses	34	1/8	4.3
	AH	Tray of Fuses Aside	34	1/8	4.3
				Total	190.6
T7-3	<u>ASSEMBLE BODY AND WASHER TO FUSE (MTM-3)</u>				
	AJ	Finished Unit from Fixture	65	1	65
	AL	Assemble Body, Washer and Fuse	162	1	162
	AM	Assemble Body to Unit	18	1	18
				Total	245
T8-3	<u>ASSEMBLE AND CRIMP DETONATOR SUPPORT (MTM-3)</u>				
	AP	Aside Finished Unit, Assemble Spring to Deontator Fuse	129	1	129
	AR	Stake Unit and Obtain Detonators	18	1	18
	AG	Obtain Tray	34	1/50	0.7
	AH	Aside Tray	34	1/50	0.7
				Total	148.4

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T9-3	<u>ASSEMBLE TIMER, SPACERS AND RETAINER (MTM-3)</u>				
	AS	Assemble Spacer to Unit	57.0	1	57.0
	AG	Load Retainer Ring	126.5	1	126.5
	AU	Assemble Housing and Retainer to Timer	100	1	100.0
	AV	Press Retainer, Aside Unit	54	1	54.0
	AG	Obtain Tray	34	1/24	1.4
	AH	Aside Tray	34	1/24	1.4
				Total	340.3
T10-3	<u>ASSEMBLE AND STAKE TRIGGER ASSEMBLY (MTM-3)</u>				
	AW	Assemble Trigger Assembly and Top Plate	75	1	75
	AX	Assemble Rivets. Place Unit on Block. Assemble Inserts	304	1	304
	AY	Assemble Firing Pin and Spring to Unit	69	1	69
	AZ	Assemble Safety Plate SSD Release, Firing Pin and Bottom Plate	556	1	556
	BA	Check Springs, Inspect Shaft, Stake Unit and Recycle	242	1	242
	BB	Open Clamp and Remove from Fixture	43	1	43
	AG	Obtain Tray	34	1/24	1.4
	AH	Aside Tray	34	1/24	1.4
				Total	1291.8
T11-3	<u>TORQUE (3) POSTS (MTM-3)</u>				
	BD	Unit to Fixture	55	1	55
	BE	Torque (3) Posts	85	1	85
	BF	Check Dropleaf, Dropleaf Rod, Gauge	138	1	138
				Total	278

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T12-3	<u>ASSEMBLE STARTING PIN SPRING (MTM-3)</u>				
	BG	Housing into Fixture	48	1	48
	BH	Assemble Washer, 'O' Ring, Starting Pin and Spring	243	1	243
	BJ	Assemble Retainer	86	1	86
	BL	Housing Aside: Dump Out Pin Guide	23	1	23
				Total	400
T13-3	<u>BURNISH SLOT</u>				
	BM	Load Fixture	160	1	160
	BP	Burnish Slot	106	1	106
	BR	Unload Fixture	69	1	69
				Total	333
T14-3	<u>ASSEMBLE OPTION PIN (MTM-3)</u>				
	BS	Assemble Spring	120	1	120
	BT	Assemble Washer, Option Pin and 'O' Ring	190	1	190
	BU	Check Unit for End Shake	71	1	71
	BV	Assemble Large or Small 'E' Ring	86	2	172
	BW	Assemble Crank	48	1	48
				Total	601
T15-3	<u>ASSEMBLE AND FORM KEY ASSEMBLY (MTM-3)</u>				
	BX	Assemble and Form Elements	186	1	186
				Total	186

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>A - OBTAIN AND PLACE MAGAZINES (MTM-3)</u>						
			34	HB80		To Work Area
			18	HA15		} Orientate
			7	TA15		
		Total	59	TMU		
<u>B - LOAD SPRINGS TO MAGAZINE, ASIDE WORK</u>						
P. U. Springs	1/4	HA80	8.5			
Unpalm (1) Spring	1/2	TA15	3.5			
			34.0	HB15		Assemble (1) Spring
Aside Work	1/20	HB80	2.4	HB80	1/20	Aside Work
		Total	48.4	TMU		
<u>D - DETONATOR BOXES TO DOGHOUSE (MTM-3)</u>						
			34	HA80		Open Locker
			18	HA15		} Open Lid & Aside
			16	TA80		
			90	HA15	5	
			80	TA80	5	} Remove Box & To LH
Box in Work Area	5	HA80	170			
			34	HA80		Empty Box Aside
			34	HA80		Close Locker
		Total	476	TMU		
<u>E - OBTAIN AND POSITION EMPTY WORK TRAY TO WORK FIXTURE (MTM-3)</u>						
Tray to Fixture		HB80	48	H-		Assist LH
Insert		TA80	16	T-		
		Total	64	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND	
<u>F - OPEN DETONATOR BOX AND TRANSFER TO FIXTURE (MTM-3)</u>							
Toss Lid Aside Cardboard Pad		H-	48	HB80		Box to Platform	
			18	HA15		Open Lid	
			18	HA15		Remove Lid	
			7	TA15		To LH	
		HA80	34				
		HA80	34				
			48	HB80		Slide into	
			29	TA80		Fixture	
		Total	236	TMU			
<u>G - OBTAIN AND PLACE EMPTY MAGAZINES ON WORK PLATFORM (MTM-3)</u>							
To Platform Orientate		HA80	34	TMU			
		TA15	7				
		Total	41				
<u>H - POSITION DETONATOR IN MAGAZINE (MTM-3)</u>							
			21	TB15		Tool to Part	
			29	TB80		Move Part	
			7	TA15		Insert	
			Total	57		TMU	
<u>J - EXPOSE DETONATOR RIM (MTM-3)</u>							
			48	HB80			
			Total	48			TMU
<u>L - POSITION FULL MAGAZINE IN WORK FIXTURE (MTM-2)</u>							
Assist RH		H-	34	HB15		Work to Fixture	
			18	HA15		Locate	
		Total	52	TMU			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
M - COMPLETE MAGAZINE INTO LOCKER (MTM-3)						
Wireguard to W.A.	{	HA80	34	HB15 HA80 TMU		Guard to Slot Tray Aside
Assist RH		T-	34			
		H-	34			
		Total	132			
P - ASSEMBLE, PRESS AND GAUGE: ASIDE TO TRAY (MTM-3)						
Retainer to S-A	{	H-	48	HB80		Assemble S-A
S-A to Fixture		HB15	34	TA80 TA80		} Clamp & Release
			16			
			16			
Gauge S-A		HB15	34			
		HA15	34			
Assemble Fuse		HB80	48			
	Total	230	TMU			
R - OBTAIN TRAY OF FUSES: 100% INSPECTION CLOSING SCREWS (MTM-3)						
Assist RH		HA80	34	HA80	16	Tray to Bench Inspect
			112	E		
		Total	146	TMU		
S - ASIDE TRAY (MTM-3)						
To Conveyor		HA80	34			
Slide		HA80	34			
		Total	68			
T - START MODULE THREADS (MTM-3)						
Tool to Fuse	1/8	HB15	4.3	TMU		
Screw Down	5	HA15	90.0			
Aside Tool	1/8	TA80	2.0			
	Total	96.3				

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>U - OBTAIN TRAY OF S-A MODULES (MTM-3)</u>						
Assist RH		HA80	34	HA80		Obtain Tray
		Total	34	TMU		
<u>V - OBTAIN AND ASIDE FUSES (MTM-3)</u>						
Part Aside		HB80	48	HB80		Part Aside
Obtain Fuse		HB80	48	HB80		Obtain Fuse
		Total	96	TMU		
<u>W - ASIDE COMPLETED TRAY (MTM-3)</u>						
To Conveyor		HA80	34	HA80		To Conveyor
Slide		HA15	18	HA15		Slide
		Total	52	TMU		
<u>X - OBTAIN NEW TRAY OF WORK (MTM-3)</u>						
Tray to Work Area		HB80	48	HB80		Assist LH
		Total	48	TMU		
<u>AA - INSERT FUSE INTO POSITION IN TRAIN (MTM-3)</u>						
			48	HB80		Insert
		Total	48	TMU		
<u>AB - ASIDE COMPLETED FUSE TO TRAY (MTM-3)</u>						
Aside		HB80	48			
		Total	48	TMU		
<u>AD - APPLY SEAL (MTM-3)</u>						
Pull Tape Out		HA15	18			
			48	HB80		Seal to Fixture
Fuse to Fixture		HB80	48			
		Total	114	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AE - ACTUATE PRESS (MTM-3)</u>						
Button (1)		HA15	18	HA15		Button (2)
		Total	18	TMU		
Remaining motions in element AE limited out by Process Time. Process Time not included in the study.						
<u>AF - REMOVE FUSE FROM PRESS AND CHECK SEAL (MTM-3)</u>						
Remove & Check		HA80	34			
To Tray		TA80	16			
		Total	50	TMU		
<u>AG - OBTAIN TRAY OF FUSES (MTM-3)</u>						
Obtain		HA80	34			
		Total	34	TMU		
<u>AH - ASIDE TRAY OF FUSES (MTM-3)</u>						
Aside		HA80	34			
		Total	34	TMU		
<u>AJ - FINISHED UNIT FROM FIXTURE AND ASIDE (MTM-3)</u>						
Fuse From Fixture and Aside			18	HA15		Open Clamp
		HA15	18			
		TB80	29			
		Total	65	TMU		
<u>AL - ASSEMBLE BODY WASHER &amp; FUSE (MTM-3)</u>						
Assemble Washer			48	HB80		Body into Fixture
			7	TA15		
			48	HB80		Fuse Assembly into Fixture
			7	TA15		
		HB15	34			Clamp
			18	HA15		
		Total	162	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AM - ASSEMBLE BODY TO UNIT (MTM-3)</u>						
Button (1)		HA15	18	HA15		Button (2)
		Total	18	TMU		
<u>AP - ASIDE FINISHED UNIT, ASSEMBLE SPRING TO DETONATOR HOLDER (MTM-3)</u>						
Unit From Fixture to Tray		HA15	18			
		TB80	29			
			21	TB15		Detonator Holder to Fixture
Spring to Detonator Holder	2	HA15	18			
		TA15	14			
		TB80	29			
		Total	129	TMU		
<u>AR - HEAT STAKE UNIT AND OBTAIN DETONATOR HOLDER (MTM-3)</u>						
Operate		HA15	18	HA15		Operate
		Total	18	TMU		
<u>AS - ASSEMBLE SPACER TO UNIT (MTM-3)</u>						
P.U. Spacers	1/24	HA80	1.4			
Unpalm (1)	2	TA5	14.0			
			34.0	HB15		Spacer to Assembly
			7.0	TA15		
Extra Spacers Aside	1/24	TA80	0.6			
		Total	57.0			
<u>AT - LOAD RETAINER RING (MTM-3)</u>						
			18.0	HA15		Untangle Retainer Ring
			21.0	TA15	3	
			3.5	TA15	1/2	Orientate
			29.0	TB80		Ring to Jig
			34.0	HB90		Weight to Jig
			7.0	TA15		Seat
			7.0	TA15		Remove Weight From Jig
			7.0	HA15		
Total			126.5	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
AU - ASSEMBLE HOUSING AND RETAINER TO TIMER (MTM-3)						
Timer to Work Area		H-	34	HB80	2	Housing to Timer
			14	TA15		Seat
			18	HB15		Assemble Fixture
Whole Assembly to Fixture		HB80	34	T-		to Timer Assembly
		Total	100	TMU		
AV - PRESS RETAINER AND ASIDE FINISHED UNIT (PROCESS TIME EXCLUDED) (MTM-3)						
Operate		HA15	18	HA15		Operate
From Fixture		TA15	7	TA15		From Fixture
Assembly to Tray		TB80	29	T-		Top to Bench
		Total	54	TMU		
AW - ASIDE FINISHED UNIT TO TRAY, ASSEMBLE TRIGGER ASSEMBLY AND TOP PLATE (MTM-3)						
Plate to Assembly		HB80	34	HA80		Trigger to W.A.
			34			
			7	TA15		To Bench
		Total	75	TMU		
AX - ASSEMBLE RIVETS, PLACE UNIT ON BLOCK, ASSEMBLE INSERTS (MTM-3)						
Rivet to Assembly		HB80	48			
			29	TB80		Rivet to Assy.
			18	HA15		Block from Fixt.
			21	TB15		Assemble
Change Hold	2	TA15	14			
			18	HA15		From LH
Clamp Fixture		HA15	18			
			21	TB15		Trigger to Clamp
			48	HB80		Assembly
			7	TA15		P.U. Insert
						With Tweezers
	Carry Fwd.		242			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AX - Continued</u>						
		Brought Fwd	242			
			48	HB80		Insert
			7	TA15		} Open Tweezers and Aside
			7	TA15		
		Total	304	TMU		
<u>AY - OBTAIN FIRING PIN AND SPRING, ASSEMBLE TO UNIT (MTM-3)</u>						
Spring to Trigger Assembly		HB80	48	HA80		} Firing Pin to Assembly
			21	TB15		
		Total	69	TMU		
<u>AZ - ASSEMBLE SAFETY PLATE, SSD RELEASE, FIRING PIN AND BOTTOM PLATE (MTM-3)</u>						
Safety Pl. to W.A.		HA80	48	HB80		Tweezers to Pl.
			7	TA15		Close Tweezers
			21	TB15		To Trigger Assy.
			7	TA15		Open Tweezers
SSD to Work Area		HA80	34			
			21	TB15		} P. U. SSD Release With Tweezers
			7	TA15		
			21	TB15		} SSD to Trigger Assy. & Release
			7	TA15		
Firing Arm Pin to Work Area and Regrasp		HA80	34	HA80		} Pliers to Work Area & Regrasp
		TA15	7	TA15		
			21	TB15		} P.U. Firing Pin With Pliers
			7	TA15		
Spring onto Pliers Using Thumb		TB15	21			
			21	TB15		} Firing Pin Arm into Trigger Assy. and Release
			7	TA15		
			16	TA80		Aside Pliers
			48	HB80		Rim Pl. to Assy.
		Carried Fwd	373			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AZ - Continued</u>						
		Brought Fwd.	373			
Clamp		TA15	7			
			7	TA15		} Plate onto Pins
			21	TB15		
			21	TB15		Pin to Trigger Arm
			7	TA15		Open Pliers
			16	TA80		Pliers Aside
			48	HB80		} Bottom Plate to Trigger Assembly
Clamp		TA15	7			
			7	TA15		} Plate Onto Pins
			21	TB15		
		Total	556	TMU		
<u>BA - CHECK SPRINGS. INSPECT SHAFT, STAKE UNIT AND RECYCLE (MTM-1)</u>						
P. U. Unit		HA15	48	HB80		Release Contact
			21	TB15		Tweezers to Pin and P. U.
			7	TA15		
			21	TB15		To Hole
			7	TA15		} Open Tweezers and Aside
			7	TA15		
Turn Unit	2	TA15	14			
			10.5	TB15	1/2	} Adjust
			10.5	TB15	1/2	
Clamp Unit to Fixture		TB80	29	T-		Aside Tweezers
Operate		HA15	18	HA15		Operate
Clamp From Press	{	HA15	18			
		TB80	29			
Operate 1st Lever	{	HA15	18	TA15		} Operate 2nd Lever
		TA15	7	TA15		
			18	HA15		} Operate 3rd Lever
			7	TA15		
		Total	242	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
BB - OPEN CLAMP AND REMOVE FROM FIXTURE (MTM-3)						
Open Clamp		HA15	18			
		TA15	7			
Remove from Fixture		HA15	18			
		Total	43	TMU		
BD - OBTAIN UNIT AND PLACE IN FIXTURE (MTM-3)						
			48	HB80		Unit to Fixture
Close		TA15	7			
		Total	55	TMU		
BE - TORQUE (3) POSTS (MTM-3)						
			48	HB80		Torque Device to Unit
			21	TB15	3	Torque
			16	TA80		Aside Device
		Total	85	TMU		
BF - CHECK DROPLEAF, DROPLEAF ROD, GAUGE UNIT AND ASIDE (MTM-3)						
Unit to Work Area		HA80	34			
			7	TA15		Pull Gauge Out
			7	TA15		Gauge Aside
			18	HA15		
			7	HA15	3	Check End Shake
			18	HA15		Check Spring
			18	HA15		Check Dropleaf
Unit Aside		TB80	29			
		Total	138	TMU		
GB - PLACE HOUSING INTO FIXTURE (MTM-3)						
Assist RH		H-	48	HB80		Assemble
		Total	48	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BH - OBTAIN AND ASSEMBLE 'O' RING, WASHER, STARTING PIN AND SPRING (MTM-3)</u>						
Washer to Guide Pin 'O' Ring to Guide Pin  Starting Pin to Spring Assist RH		HB80	21	TA15	3	} Guide Pin to
			48	T-		
			48			
			21	TB15		
			7	TA15		
			48	HB80		
			16			
			34	HA80		
Total	243	TMU				
<u>BJ - ASSEMBLE RETAINER (MTM-3)</u>						
Turn Housing		TA-	34	HB15		Retainer Tool to Assembly Retainer to Pin Disengage Tool Tool Aside
			29	TB80		
			7	TA15		
			16	TA80		
			Total	86		
<u>BL - HOUSING ASIDE AND DUMP-OUT PIN</u>						
Housing Aside		TA15 TA80	7	TA15		Hand to Housing Palm Guide
			16	TA15		
			Total	23		
<u>BM - LOAD FIXTURE (MTM-3)</u>						
			21	TB15	6 6	} Tweezers to Lever Separate Out P.U. with Tweez. Lever to Fixture
			42	TA15		
			42	TA15		
			21	TB15		
			7	TA15		
			21	TB15		
			7	TA15		
			Total	160		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BP - BURNISH SLOT (MTM-3)</u>						
Start Machine		HA15	18			
			18	HA15		Handle to
			70	TA15	10	Burnisher
		Total	106	TMU		Burnish
<u>BR - UNLOAD FIXTURE (MTM-3)</u>						
Stop Machine		HA15	18			
			21	TB15		} P.U. Lever with Tweezers
			7	TA15		
			16	TA80		
			7	TA15		
		Total	69	TMU		To Pan
						Open Tweezers
<u>BS - OBTAIN HOUSING AND ASSEMBLE SPRING (MTM-3)</u>						
			34	HA80		Housing to Table
			34	HB80		PU Spring-Tweez.
			29	TB80		Spring to Hole
			7	TA15		Close Tweezers
			16	TA80		Tweezers Aside
		Total	120	TMU		
<u>BT - ASSEMBLE OPTION PIN, WASHER AND 'O' RING IN HOUSING (MTM-3)</u>						
Ass. Washer to Pin		HB80	48			
'O' Ring to Pin		HB80	48			
			34	HB15		Pin to Housing
Housing to W.A.		TA15	7			
			7	TA15	4	Align Pin
			21	TB15		} Assemble Pin
			7	TA15		
			18	HA15		Seat on Spring
		Total	190	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>BU - CHECK UNIT FOR END SHAKE (MTM-3)</u>						
			48	HB80		Driver to Slot
			7	TA15		Turn
			16	TA80		Driver Aside
		Total	71	TMU		
<u>BV - ASSEMBLE LARGE OR SMALL 'E' RING (MTM-3)</u>						
Regrasp Housing		TA15	7			
			34	HB15		Tool onto 'E' Ring
			29	TB80		Assemble Ring
			16	TA80		Tool Aside
		Total	86	TMU		
<u>BW - ASSEMBLE CRANK (MTM-3)</u>						
			48	HB80		
		Total	48	TMU		
<u>BX - ASSEMBLE AND FORM ELEMENTS (MTM-3)</u>						
Aside Finished Unit		HA80	34			
			21	TB15		Back Unit to Fixture
Lub. Setting Key		HA80	34			
			34	HB15		Assembly to Setting Key
			34	HB15		Assemble Retaining Plut
Assembly in Die		TB80	29			
		Total	186	TMU		

APPENDIX P: ANALYSIS OF PROVING DATA FROM TEST  
SITE USING SYSTEM II

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T1-II	<u>LOAD SPRINGS INTO MAGAZINES</u>				
	A	Obtain and Place Magazine	1.5943	1	1.5943
	B	Load Springs and Aside Work	1.0313	1	1.0313
				Total	2.6256
T2-II	<u>HAND LOAD DETONATOR TO MAGAZINE</u>				
	D	Detonator Boxes to Doghouse	15.0265	1/500	.0300
	E	Magazine Tray to Wire Fixture	2.8703	1/100	.0287
	F	Detonator Box to Work Fixture	7.6622	1/10	.7622
	G	Empty Magazines onto Platform	1.9439	1/5	.3888
	H	Detonator in Magazine	2.6073	1	2.6073
	J	Expose Detonator Rim	2.4116	1	2.4116
	L	Full Magazine into Work Fixture	2.9794	1/5	.5959
	M	Completed Magazine to Locker	3.5472	1/5	.7094
				Total	7.5339
T3-II	<u>INSERT S-A RETAINER INTO FUSE BODY</u>				
	P	Assemble, Press and Gauge	10.9164	1	10.9164
	R	Obtain Tray of Fuses. 100% Inspection Closing Screws	.5768	1/8	.0721
	S	Aside Tray of Modules	1.1356	1/20	.0568
	T	Start Module Threads	3.2747	1	3.2747
	U	Obtain Tray of Modules	.5768	1/20	.0288
				Total	14.3488
T4-II	<u>HANDLE FUSES</u>				
	V	Obtain New Tray of Work	.5678	1/4	.1420
	W	Obtain and Aside Fuses	4.8232	1	4.8232
	X	Aside Completed Tray	1.1356	1/4	.2839
				Total	5.2491

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T5-II	<u>ASSEMBLE AND STAMP TORQUE MODULE</u>				
	AA	Insert Fuse into Train	2.4116	1	2.4116
	AB	Aside Completed Fuse Tray	2.4116	1	2.4116
				Total	4.2823
T6-II	<u>APPLY TAPE SEAL TO S-A</u>				
	AD	Apply Seal	5.3910	1	5.3910
	AE	Actuate Press	.5678	1	.5768
	AF	Remove Fuse from Press	1.0265	1	1.0265
	AG	Obtain Tray of Fuses	.5678	1/8	.0721
	AH	Aside Tray of Fuses	.5678	1/8	.0721
				Total	7.1385
T7-II	<u>ASSEMBLE BODY AND WASHER TO FUSE</u>				
	AJ	Finished Unit from Fixture	2.2099	1	2.2099
	AL	Assemble Body; Washer and Fuse	8.7209	1	8.7029
	AM	Assemble Body to Unit and Operate the Press	.5678	1	.5678
				Total	11.4806
T8-II	<u>ASSEMBLE AND CRIMP DETONATOR SUPPORT</u>				
	AP	Aside Finished Unit, Assemble Spring and Detonator Fuse	5.2759	1	5.2769
	AR	Stake Unit and Obtain Detonator	.5768	1	.5768
	AG	Obtain Tray	.5678	1/50	.0115
	AH	Aside Tray	.5678	1/50	.0115
				Total	5.8767

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T9-II	<u>ASSEMBLE TIMER, SPACERS AND RETAINER</u>				
	AS	Assemble Spacer to Unit	5.6756	1	5.6756
	AT	Load Retainer Ring	6.9609	1	6.9609
	AU	Assemble Housing and Retainer to Unit	9.3834	1	9.3834
	AV	Press Retainer, Aside Unit	2.1008	1	2.1008
	AG	Obtain Tray	.5768	1/24	.0240
	AH	Aside Tray	.5768	1/24	.0240
				Total	24.1687
T10-II	<u>ASSEMBLE AND STAKE TRIGGER ASSEMBLY</u>				
	AW	Assemble Trigger Assembly and Top Plate	3.4381	1	3.4381
	AX	Assemble Rivets, Place Unit on Block, Assemble Inserts	14.4546	1	14.4546
	AY	Assemble Firing Pin and Spring to Unit	3.4859	1	3.4859
	AZ	Assemble Safety Plate, SSD Release, Firing Arm and Bottom Plate	25.6443	1	25.6443
	BA	Check Springs, Inspect Shaft, Stake Unit and Recycle	12.6974	1	12.6974
	BB	Open Clamp and Remove from Fixture	1.1356	1	1.1356
	AG	Aside Tray	.5768	1/24	.0240
	AH	Obtain Tray	.5768	1/24	.0240
				Total	60.9039
T11-II	<u>TORQUE (3) POSTS</u>				
	BD	Unit to Fixture	2.8708	1	2.8073
	BE	Torque (3) Posts	6.0932	1	6.0932
	BF	Check Dropleaf, Dropleaf Rod, Gauge	3.3455	1	3.3455
				Total	12.2460

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T12-II	<u>ASSEMBLE STARTING PIN SPRING</u>				
	BG	Housing into Fixture	2.4116	1	2.4116
	BH	Assemble Washer, 'O' Ring, Start- ing Pin and Spring	3.3455	1	3.3455
	BJ	Assemble Retainer	4.4033	1	4.4033
	BL	Housing Aside, Dump Out Pin Guide	.9174	1	.9174
				Total	11.0778
T13-II	<u>BURNISH SLOT</u>				
	BM	Load Fixture	9.6447	1	9.6447
	BP	Burnish Slot	5.7226	1	5.7226
	BR	Unload Fixture	3.0182	1	3.0182
				Total	18.3855
T14-II	<u>ASSEMBLE OPTION ARM</u>				
	BS	Assemble Spring	4.9711	1	4.9711
	BT	Assemble Option Pin, Washer and 'O' Ring	11.6291	1	11.6291
	BU	Check Unit for End Shake	3.3290	1	3.3290
	BV	Assemble Large or Small 'E' Ring	4.4033	2	8.8066
	BW	Assemble Crank	2.4116	1	2.4116
				Total	31.1474
T15-II	<u>ASSEMBLE AND FORM KEY ASSEMBLY</u>				
	BX	Assemble and Form	2.4116	1	2.4116
				Total	2.4116

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
A	<u>OBTAIN AND PLACE MAGAZINE</u>				
	Magazine to Work Area			1	
	Orientate			1	
		1			
	Freq.	1		2	
	Time =	1.5943			
B	<u>LOAD SPRINGS TO MAGAZINE AND ASIDE WORK</u>				
	Springs to Magazine			.25	
		.5			
	Change Hands			1	
	Insert		1		
	Aside Work				.05
	Freq.	.5	1	1.2	.05
	Time =	1.0313			
D	<u>DETONATOR BOXES TO DOGHOUSE</u>				
	Open Locker Door			1	
	Open Lid and Aside			1	
		1			
	Remove Detonators and to LH			5	
				5	
	Empty Box Aside			1	
	Close Locker			1	
	Freq.	1		14	
	Time	15.0265			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
E	<u>POSITION EMPTY MAGAZINE TRAY TO FIXTURE</u>				
	Tray to Fixture				1
	Insert	1			
	Freq.	1			1
	Time	2.8703			
F	<u>OPEN DETONATOR BOX AND TRANSFER TO FIXTURE</u>				
	Detonators to Platform				1
	Open Lid			1	
	Remove Box Lid			1	
	Lid Change Hands			1	
	Cardboard Pack from Box			1	
	Box of Detonators to Fixture				1
	Slide into Fixture			1	
	Freq.			5	2
	Time	7.6622			
G	<u>OBTAIN AND PLACE EMPTY MAGAZINES ON WORK PLATFORM</u>				
	Magazines to Platform			1	
	Orientate	3			
	Freq.	3		1	
	Time	1.9439			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
H	<u>POSITION DETONATOR IN MAGAZINE</u>				
	Tool to Part		1		
	Move Part		1		
	Insert	1			
	Freq.	1	2		
	Time	2.6073			
J	<u>EXPOSE DETONATOR RIM</u>				
	Expose Rim				1
	Freq.				1
	Time	2.4116			
L	<u>POSITION FULL MAGAZINE IN WORK FIXTURE</u>				
	Work to Fixture				1
	Locate			1	
	Freq.			1	1
	Time	2.9794			
M	<u>COMPLETE MAGAZINE INTO LOCKER</u>				
	Wire Guard to Work Area			1	
	Guard to Slot				1
	Tray Aside			1	
	Freq.			2	1
	Time	3.5472			

# ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
P	<u>ASSEMBLE PRESS AND GAUGE</u>				
	Retainer to SA				1
	Position on Fixture				1
	Clamp and Unclamp Fixture		2		
	Gauge S-A		1		
	Assemble Fuse	1			1
	Freq.	1	3		3
	Time	10.9164			
R	<u>OBTAIN FUSES: 100% INSPECTION CLOSING SCREWS</u>				
	Obtain and Inspect			1	
	Freq.			1	
	Time	0.5678			
S	<u>ASIDE TRAY</u>				
	To Conveyor			1	
	Slide			1	
	Freq.			2	
	Time	1.1356			
T	<u>START MODULE THREADS</u>				
	Tool to Fuse				.125
	Screw Down			5	
	Aside Tool		.125		
	Freq.		.125	5	.125
	Time	3.2747			

# ANALYSIS SHEET: SYSTEM II

	BLOCK TIME 0.01 MINS	0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
U	<u>OBTAIN TRAY OF S-A MODULES</u>				
	Obtain Tray			1	
	Freq.			1	
	<u>Time</u>	<u>0.5678</u>			
V	<u>OBTAIN NEW TRAY OF WORK</u>				
	Tray			1	
	Freq.			1	
	<u>Time</u>	<u>0.5678</u>			
W	<u>OBTAIN AND ASIDE FUSES</u>				
	Part Aside				1
	Obtain Fuse				1
	Freq.				2
X	<u>ASIDE COMPLETED TRAY</u>				
	To Conveyor			1	
	Slide			1	
	Freq.			2	
AA	<u>INSERT FUSE INTO POSITION IN TRAIN</u>				
	Insert				1
	Freq.				1
	<u>Time</u>	<u>2.4116</u>			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
AB	<u>ASIDE COMPLETED FUSE TRAY</u>				
	Aside				1
	Freq.				1
	<u>Time</u>	2.4116			
AD	<u>APPLY SEAL</u>				
	Pull Tape Out			1	
	Seal to Fixture				1
	Fuse to Fixture				1
	Freq.			1	2
AE	<u>ACTUATE PRESS</u>				
	Actuate			1	
	Freq.			1	
	<u>Time</u>	0.5678			
AF	<u>REMOVE FUSE FROM PRESS</u>				
	Remove and Check			1	
	To Tray	1			
	Freq.	1		1	
AG	<u>OBTAIN TRAY OF FUSES</u>				
	Obtain			1	
	Freq.			1	
	<u>Time</u>	.5678			

# ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
AH	<u>ASIDE TRAY OF FUSES</u>				
	Aside			1	
	Freq.			1	
	Time	.5678			
AJ	<u>FINISHED UNIT FROM FIXTURE AND ASIDE</u>				
	Open Clamp			1	
	Fuse From Fixture			1	
	Aside		1		
	Freq.		1	2	
AL	<u>ASSEMBLE BODY, WASHER AND FUSE</u>				
	Body into Fixture				1
		1			
	Fuse Assembly to Fixture				1
		1			
	Assemble Washer				1
	Clamp			1	
AM					
	Freq.	2		1	3
	Time	8.7209			
AM	<u>ASSEMBLE BODY TO UNIT</u>				
	Operate Press			1	
	Freq.			1	
	Time	.5678			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
AP	<u>ASIDE FINISHED UNIT, ASSEMBLE SPRING TO DETONATOR HOLDER</u>				
	Unit from Fixture to Tray			1	
			1		
	Detonator Holder to Fixture		1		
	Spring to Detonator Holder			1	
		2	1		
	Freq.	2	3	2	
	Time	5.2759			
AR	<u>HEAT STAKE UNIT AND OBTAIN DETONATOR HOLDER</u>				
	Operate Machine			1	
	Freq.			1	
	Time	.5678			
AS	<u>ASSEMBLE SPACER TO UNIT</u>				
	P.U. Spacers			.04	
	Unpalm		2		
	Spacers to Assembly		1		1
	Extra Spacers Aside	.04			
	Freq..	.04	3	.04	1
	Time	5.6756			

# ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
AT	<u>LOAD RETAINER RING</u>				
	Untangle Retainer Ring			1	
		3			
	Orientate	.5			
	Ring to Jig		1		
	Weight to Jig				1
	Seat	1			
AU	Remove Weight from Jig	1			
				1	
	Freq.	5.5	1	2	1
	Time	6.9609			
	<u>ASSEMBLE HOUSING AND RETAINER TO UNIT</u>				
	Assemble Timer and Housing				1
	Seat		2		
AV	Assemble Fixture to Timer				1
	Whole Assembly to Fixture				1
	Freq.		2		3
	Time	9.3834			
	<u>PRESS RETAINER AND ASIDE FINISHED UNIT</u>				
	Operate Press			1	
	Part from Fixture	1			
	Assembly to Tray		1		
	Freq.	1	1	1	
	Time	2.1008			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
AW	<u>ASIDE FINISHED UNIT TO TRAY, ASSEMBLE TRIGGER ASSEMBLY AND TOP PLATE</u>				
	Trigger to Work Area			1	
	Plate to Assembly				1
	To Bench	1			
	Freq.	1		1	1
	Time	3.4381			
AX	<u>ASSEMBLE RIVETS, PLACE UNIT ON BLOCK, ASSEMBLE INSERTS</u>				
	Rivet to Assembly				1
	Rivet to Assembly		1		
	Block From Fixture			1	
	Assemble		1		
	Change Hold	2			
	Change Hands			1	
	Clamp Fixture			1	
	Trigger to Clamp Assembly		1		
	P.U. Insert With Tweezers				1
		1			
	Insert				1
	Open Tweezers and Aside	2			
	Freq.	5	3	3	3
	Time	14.4546			
AY	<u>OBTAIN FIRING PIN AND SPRING ASSEMBLE TO UNIT</u>				
	Assemble				1
			1		
	Freq.		1		1
	Time	3.4859			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
AZ	ASSEMBLE SAFETY PLATE, SSD RELEASE, FIRING PIN AND BOTTOM PLATE				
	P.U. Safety Plate with Tweezers	1			1
	Safety Plate to Trigger Assembly	1	1		
	SSD to Work Area			1	
	P.U. SSD With Tweezers	1	1		
	SSD to Trigger Assembly	1	1		
	Firing Arm Pin, Hold with Pliers	1		1	
	Spring onto Pliers, Using Thumb		1	1	
	Firing Pin onto Trigger Arm	1	1		
	Aside Pliers	1			
	Bottom Plate to Assembly				1
	Clamp	1			
	Plate onto Pins	1			
	Pin to Trigger Arm		1		
	Pliers Aside	1			
	Bottom Plate to Trigger Assembly				1
	Clamp	1	1		
	Plate onto Pins	1	1		
Freq.		13	10	3	3

Time 25.6443

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
BA	<u>CHECK SPRINGS, INSPECT SHAFT, STAKE UNIT AND RECYCLE</u>				
	P.U. Pin with Tweezers and to Hole				1
			1		
		1	1		
	Open Tweezers and Aside.	1			
		1			
	Turn Unit	2			
	Adjust		1		
	Clamp Unit to Fixture		1		
	Operate			1	
	Clamp From Press			1	
			1		
	Operate Levers			1	
		1			
		1			
	Freq.	7	5	3	1
	<u>Time</u>	<u>12.6974</u>			
BB	<u>OPEN CLAMP AND REMOVE FROM FIXTURE</u>				
	Open Clamp			1	
		1			
	Remove from Fixture			1	
	Freq.	1		2	
	<u>Time</u>	<u>1.1356</u>			
BD	<u>OBTAIN UNIT AND PLACE IN FIXTURE</u>				
	Unit to Fixture				1
	Close	1			
	Freq.	1			1
	<u>Time</u>	<u>2.8703</u>			

# ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
BE	<u>TORQUE (3) POSTS</u>				
	Torque Device to Unit				1
	Torque (3) Posts		3		
	Aside Device	1			
	Freq.	1	3		1
	<u>Time</u>	<u>6.0932</u>			
BF	<u>CHECK DROPLEAF, DROPLEAF ROD, GAUGE UNIT AND ASIDE</u>				
	Unit to Work Area			1	
	Pull Out Gauge	1			
	Gauge Aside	1			
	Check End Shake			1	
		3			
	Check Spring			1	
	Check Dropleaf			1	
	Nut Aside		1		
	Freq.	5	1	4	
	<u>Time</u>	<u>3.3455</u>			
BG	<u>PLACE HOUSING INTO FIXTURE</u>				
	Assemble				1
	Freq.				1
	<u>Time</u>	<u>2.4116</u>			

ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
BH	<u>OBTAIN AND ASSEMBLE 'O' RING, WASHER, STARTING PIN AND SPRING</u>				
	Assemble Washer and Guide Pin	3			1
	'O' Ring to Guide Pin				1
	Assemble to Hole and onto Guide		1		
			1		
	Starting Pin to Spring	1			1
				1	
	Freq.	4	2	1	3
	Time	11.786			
BJ	<u>ASSEMBLE RETAINER</u>				
	Retainer Tool to Pin				1
			1		
	Disengage Tool and Aside	1			
		1			
	Freq.	2	1		1
	Time	4.4033			
BL	<u>HOUSING ASIDE AND DUMP OUT PIN GUIDE</u>				
	Housing Aside and Palm Guide	1			
		1			
	Freq.	2			
	Time	0.9174			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
BM	<u>LOAD FIXTURE</u>				
	Tweezers to Lever		1		
	Separate Out	6 6			
	P. U. with Tweezers	1	1		
	Lever to Fixture	1	1		
	Freq.	14	3		
	Time	9.6447			
BP	<u>BURNISH SLOT</u>				
	Start Machine			1	
	Handle to Burnisher			1	
	Burnish	10			
	Freq.	10		2	
BR	<u>UNLOAD FIXTURE</u>				
	Stop Machine			1	
	P. U. Lever with Tweezers		1		
	To Pan	1			
	Open Tweezers	1			
	Freq.	3	1	1	
	Time	3.0182			

# ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
BS	<u>OBTAIN HOUSING AND ASSEMBLE SPRING</u>				
	Housing to Table			1	
	P. U. Spring with Tweezers				1
	Spring to Hole		1		
	Close Tweezers	1			
	Tweezers Aside	1			
	Freq.	2	1	1	1
	<u>Time</u>	<u>4.9711</u>			
BT	<u>ASSEMBLE OPTION PIN, WASHER AND 'O' RING IN HOUSING</u>				
	Assemble Washer to Pin				1
	'O' Ring to Pin				1
	Pin to Housing				1
	Housing to Work Area	1			
	Align Pin	4			
	Assemble Pin	1	1		
	Seat on Spring			1	
	Freq.	6	1	1	3
	<u>Time</u>	<u>11.6291</u>			
BU	<u>CHECK UNIT FOR END SHAKE</u>				
	Driver to Slot				1
	Turn and Set	1			
	Aside Driver	1			
	Freq.	2			1
	<u>Time</u>	<u>3.3290</u>			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
BV	<u>ASSEMBLE LARGE OR SMALL 'E' RING</u>				
	Regrasp Housing	1			
	Tool Onto 'E' Ring				1
	Assemble Ring		1		
	Tool Aside	1			
	Freq.	2	1		1
	Time	4.4083			
BW	<u>ASSEMBLE CRANK</u>				
	Assemble				1
	Freq.				1
	Time	2.4116			
BX	<u>ASSEMBLE AND FORM ELEMENTS</u>				
	Aside Finished Unit			1	
	Back Unit to Fixture		1		
	Lubricate Setting Key			1	
	Assemble Unit to Setting Key				1
	Assemble Retaining Plut				1
	Assemble in Die		1		
	Freq.		2	2	2
	Time	8.1074			

APPENDIX Q: ANALYSIS OF PROVING DATA FROM TEST  
SITE USING SYSTEM IV

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T1-IV	<u>LOAD</u>	<u>SPRINGS INTO MAGAZINES</u>			
	A	Obtain and Place Magazines	1.8951	1	1.8951
	B	Load Springs and Aside Work	2.3588	1	2.3588
		Total			4.2539
T2-IV	<u>HAND</u>	<u>LOAD DETONATOR TO MAGAZINE</u>			
	D	Detonator Boxes to Doghouse	12.5431	1/500	.0251
	E	Magazine Tray to Work Fixture	2.2268	1/100	.0223
	F	Detonator Box to Work Fixture	9.4545	1/10	.9455
	G	Empty Magazines Onto Platform	1.4714	1/5	.2943
	H	Detonator in Magazine	2.2992	1	2.2992
	J	Expose Detonator Rim	.6539	1	.6539
	L	Full Magazine into Work Fixture	2.5574	1/5	.5115
	M	Completed Magazine to Locker	3.7988	1/5	.7598
		Total			5.5116
T3-IV	<u>INSERT S-A RETAINER INTO FUSE BODY</u>				
	P	Assemble Press and Gauge	8.5831	1	8.5831
	R	Obtain Tray of Fuses: 100% Inspection Closing Screws	.7488	1/8	.0936
	S	Aside Tray of Modules	1.0070	1/20	.0504
	T	Start Module Threads	5.0767	1	5.0767
	U	Obtain Tray of Modules	.7488	1/20	.0374
		Total			13.8413
T4-IV	<u>HANDLE FUSES</u>				
	V	Obtain New Tray of Work	.8195	1/4	.2049
	W	Obtain and Aside Fuses	3.0834	1	3.0834
	X	Aside Completed Tray	1.3321	1/4	.3330
		Total			3.6213

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T5-IV	<u>ASSEMBLE AND STAMP TORQUE MODULE</u>				
	AA	Insert Fuse into Train	1.9017	1	1.9017
	AB	Aside Completed Fuse Tray	1.9017	1	1.9017
		Total			3.8034
T6-IV	<u>APPLY TAPE SEAL TO S-A</u>				
	AD	Apply Seal	4.6245	1	4.6245
	AE	Actuate Press	.5833	1	.5833
	AF	Remove Fuse From Press	1.1445	1	1.1445
	AG	Obtain Tray of Fuses	.5833	1/8	.0729
	AH	Aside Tray of Fuses	.5833	1/8	.0729
		Total			6.4981
T7-IV	<u>ASSEMBLE BODY AND WASHER TO FILE</u>				
	AJ	Finished Unit from Fixture	1.4696	1	1.4697
	AL	Assemble Body, Washer and Fuse	6.9658	1	6.9658
	AM	Assemble Body to Unit and Operate the Press	.5833	1	.5833
		Total			9.0188
T8-IV	<u>ASSEMBLE AND CRIMP DETONATOR SUPPORT</u>				
	AP	Aside Fi-ished Unit, Assemble Spring and Detonator Fuse	5.6448	1	5.6443
	AR	Stake Unit and Obtain Detonator	1.0342	1	1.0342
	AG	Obtain Tray	.5833	1/50	.0117
	AH	Aside Tray	.5833	1/50	.0117
		Total			6.7019

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T9-IV	<u>ASSEMBLE TIMER, SPACERS AND RETAINER</u>				
	AS	Assemble Spacer to Unit	2.9200	1	2.9200
	AT	Load Retainer Ring	6.9275	1	6.9275
	AU	Assemble Housing and Retainer to Unit	6.4277	1	6.4277
	AV	Press Retainer, Aside Unit	2.8373	1	2.8373
	AG	Obtain Tray	.5833	1/24	.0243
	AH	Aside Tray	.5833	1/24	.0243
		Total			19.1611
T10-IV	<u>ASSEMBLE AND STAKE TRIGGER ASSEMBLY</u>				
	AW	Assemble Trigger Assembly and Top Plate	2.9208	1	2.9208
	AX	Assemble Rivets, Place Unit on Blcok Assemble Inserts	14.5533	1	14.5533
	AY	Assemble Firing Pin and Spring to Unit	3.4521	1	3.4521
	BA	Assemble Safety Plate, SSD Release, Firing Arm and Bottom Plate	20.1823	1	20.1823
	AZ	Check Springs, Inspect Shaft, Stake Unit and Recycle	14.0666	1	14.0666
	BB	Open Clamp and Remove from Fixture	2.2736	1	2.2736
	AG	Obtain Tray	.5678	1/24	.0243
	AH	Aside Tray	.5678	1/24	.0243
		Total			57.4973
T11-IV	<u>TORQUE (3) POSTS</u>				
	BD	Unit to Fixture	2.2268	1	2.2268
	BE	Torque (3) Posts	8.4861	1	8.4861
	BF	Check Dropleaf, Dropleaf Rod, Gauge	5.5890	1	5.5890
		Total			16.3019

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T12-IV	<u>ASSEMBLE STARGING SPRING PIN</u>				
	BG	Housing into Fixture	1.9017	1	1.9017
	BH	Assemble Washer, 'O'-Ring, Start-Starting Pin and Spring	11.7035	1	11.7035
	BJ	Assemble Retainer	6.6830	1	6.6830
	BL	Housing Aside, Dump Out Pin Guide	.6502	1	.6502
		Total			20.9384
T13-IV	<u>BURNISH SLOT</u>				
	BM	Load Fixture	7.5780	1	7.5780
	BP	Burnish Slot	5.0340	1	5.0340
	BR	Unload Fixture	3.4875	1	3.4875
		Total			16.0995
T14-IV	<u>ASSEMBLE OPTION ARM</u>				
	BS	Assemble Spring	5.9999	1	5.9999
	BT	Assemble Option Pin, Washer and 'O' Ring	8.1812	1	8.1812
	BU	Check Unit for End Shake	2.5519	1	2.5519
	BV	Assemble Large or Small 'E' Ring	5.3292	2	10.6584
	BW	Assemble Crank	2.7501	1	2.7501
		Total			30.1415
T15-IV	<u>ASSEMBLE AND FORM KEY ASSEMBLY</u>				
	BX	Assemble and Form	8.2769	1	8.2769
		Total			8.2769

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
A	<u>OBTAIN AND PLACE MAGAZINES</u>							
	Magazine to Work Area			1				
	Orientate		1		1			
					2			
	Freq.		1	1	3			
	Time	1.8951						
B	<u>LOAD SPRINGS TO MAGAZINE AND ASIDE WORK</u>							
	P. U. Springs and Palm			.25				
					.25			
					.5			
	Obtain Spring and Assemble			1				
	Aside Work	.05					1	
						.05		
	Freq.	.05		1.25	.75	.01	1	
	Time	2.3588						

ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
D	<u>DETONATOR BOXES TO DOGHOUSE</u>							
	Open Locker Door		1		1			
	Open Lid and Aside			1	1			
	Remove Box of Detonators			5	5			
					5			
	Change Hands		5					
	Box to Work Area				5			
	Empty Box Aside		1		1			
	Close Locker		1		1			
	Freq.		8	6	19			
	Time	12.5431						
E	<u>OBTAIN AND POSITION EMPTY MAGAZINE TRAY TO FIXTURE</u>							
	Tray to Fixture		1				1	
	Insert				1			
	Freq.		1		1		1	
	Time	2.2268						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
F	<u>OPEN DETONATOR BOX AND TRANSFER TO FIXTURE</u>							
	Box of Detonators to Platform		1				1	
	Open Lid	1			1			1
	Lid		1					
	Box			1				
	Remove Lid				1			
	To Other Hand				1			
	Lid From Other Hand		1					
	Toss Aside				1			
	Cardboard Pad From Box			1	1			
	Box of Detonators to Fixture			1				
				1				
	Slide into Fixture	1			1		1	
	Freq.	2	3	4	6		2	1
	Time	9.4545						
G	<u>OBTAIN AND PLACE EMPTY MAGAZINES ONTO PLATFORM</u>							
	Magazines to Platform			1	1			
	Orientate 2nd Magazine				2			
	Freq.			1	3			
	Time	1.4714						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
H	<u>POSITION DETONATOR IN MAGAZINE</u>							
	Pick Up Detonator			1				
	Locate						1	
	Insert				1			
	Freq.			1	1		1	
	Time	2.2992						
J	<u>EXPOSE DETONATOR RIM</u>							
	Expose Rim	1				1		
	Freq.	1				1		
	Time	.6539						
L	<u>POSITION FULL MAGAZINE IN WORK FIXTURE</u>							
	Work to Fixture			1				
	Insert	1			1		1	
	Freq.	1		1	1		1	
	Time	2.5574						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
M	<u>COMPLETED MAGAZINE INTO LOCKER</u>							
	Wire Guard to Work Area		1		1			
	Wire Guard with Slot in Tray		1				1	
	Tray from Fixture and Aside			1	1			
	Freq.		2	1	3		1	
	Time	3.7988						
P	<u>ASSEMBLE, PRESS AND GAUGE: ASIDE TO TRAY</u>							
	Assemble S-A			1			1	
	S-A into Fixture						1	
	Clamp				1			1
	Release Clamp				1			
	Gauge S-A				1		1	
	Assemble to Fuse		1				1	
	Freq.		1	1	3		4	1
R	<u>OBTAIN TRAY OF FUSES: 100% INSPECTION CLOSING SCREWS</u>							
	Tray to Bench and Inspect		1		1			
	Freq.		1		1			
	Time	.7488						

ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
S	<u>ASIDE TRAY</u>							
	Tray to Conveyor		1					
					1			
	Slide Tray onto Conveyor	1			1			
	Freq.	1	1		2			
	Time	1.007						
T	<u>START THREAD MODULES</u>							
	Module Turner to Fuse		.125				.125	
	Turn Down				5			
			4					
	Next Fuse						1	
	Aside Tool				.125			
	Freq.		4.125		5.125		1.125	
	Time		5.0767					
U	<u>OBTAIN TRAY OF MODULES</u>							
	Pick Up Tray and Move		1		1			
	Freq.		1		1			
	Time		.7488					
V	<u>OBTAIN NEW TRAY OF WORK</u>							
	Obtain		1			1		
	Freq.		1			1		
	Time		.8135					

# ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
W	<u>ASIDE AND OBTAIN FUSES</u>							
	Finished Fuse Aside		1				1	
	Obtain Next Fuse		1				1	
	Freq.		2				2	
	Time	3.0834						
X	<u>ASIDE COMPLETED TRAY</u>							
	Tray to Conveyor		1		1			
	Slide Along Conveyor	1			1			
	Freq.	1	1		2			
	Time	1.8321						
AA	<u>INSERT FUSE INTO POSITION IN TRAIN</u>							
	Assemble		1				1	
	Freq.		1				1	
	Time	1.9017						
AB	<u>ASIDE COMPLETED FUSE TO TRAY</u>							
	Aside		1				1	
	Freq.		1				1	
	Time	1.9017						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AD	<u>APPLY SEAL</u>							
	Pull Out Tape		1		1			
	Seal to Fixture			1			1	
	Fuse to Fixture		1				1	
	Freq.		2	1	1		2	
AE	<u>ACTUATE PRESS</u>							
	Press Button	1			1			
	Freq.	1			1			
	Time	4.6245						
AF	<u>REMOVE FUSE FROM PRESS AND CHECK</u>							
	Remove and Inspect		1		1			
	Aside					1		
	Freq.		1		1	1		
	Time	1.1445						
AG	<u>OBTAIN TRAY OF FUSES, SLIDE FROM CONVEYOR</u>							
	Obtain	1			1			
	Freq.	1			1			
	Time	.5833						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AH	<u>TRAY OF FUSES ASIDE</u>							
	Slide to Conveyor	1			1			
	Freq.	1			1			
	Time	.5833						
AJ	<u>FINISHED UNIT FROM FIXTURE AND ASIDE</u>							
	Clamp from Fuse and Aside		1		1			
	Freq.		1		2	1		
	Time	1.4696						
AL	<u>ASSEMBLE BODY, WASHER AND FUSE</u>							
	Body into Fixture		1				1	1
	Fuse Assembly into Fixture		1				1	
	Assemble (1) Washer				1		1	
	Clamp	1			1			1
	Freq.	1	2		2		3	1
	Time	6.9658						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AM	<u>ASSEMBLE BODY TO UNIT</u>							
	Assemble	1			1			
	Freq.	1			1			
	Time	.5833						
AP	<u>ASIDE FINISHED UNIT, ASSEMBLE SPRING TO DETONATOR HOLDER</u>							
	Finished Unit from Fixture and Aside to Tray			1	1	1	1	
	Detonator Holder to Fixture							
	Spring to Detonator Holder			1	3		1	
	Freq.			2	4	1	2	
	Time	5.6443						
AR	<u>HEAT STAKE UNIT AND OBTAIN DETONATOR</u>							
	Operate	1						1
	Freq.	1						1
	Time	1.0342						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AS	<u>ASSEMBLE SPACER TO UNIT</u>							
	Pick up Supply of Spacers		.04					
	Unpalm				.04			
	Spacer from Other Hand		1		2			
	Assemble				1		1	
	Extra Spacers Aside				.04			
	Freq.		1.04		3.08		1	
	Time	2.9200						
AT	<u>LOAD RETAINER RING</u>							
	Retainer Ring - Shake Out and to Jig			1	4		1	
	Weight to Jig		1				1	
					1			1
	Remove Weight From Jig				1			
	Freq.		1	1	7		2	1
	Time	6.9275						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AU	<u>ASSEMBLE HOUSING AND RETAINER TO TIMER</u>							
	Assemble Housing to Timer			1			1	
	Seat				2			
	Change Hands		1					
	Assemble Retainer Ring to Timer Assembly		1				1	
	Assembly to Fixture						1	
	Freq.		2	1	2		3	
	Time	6.4277						
AV	<u>PRESS RETAINER AND ASIDE FINISHED UNIT</u>							
	Operate Press	1						1
	Remove from Fixture				1		1	
	Freq.	1			1		1	1
	Time	2.8373						
AW	<u>ASIDE FINISHED UNIT TO TRAY, ASSEMBLE TRIGGER ASSEMBLY AND TOP PLATE</u>							
	Trigger Assembly to Work Area		1		1			
	Top Plate to Trigger Assembly			1			1	
	To Bench				1	.5		
	Freq.		1	1	1	.5	1	
	Time	2.9208						

# ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	.S
AX	<u>ASSEMBLE RIVETS, PLACE UNIT ON BLOCK, ASSEMBLE INSERTS</u>							
	Rivets to Trigger Assembly			1				
				1			1	
							1	
	Block and Fixture			1				
					1			
	Change Hold				2		1	
					1			
	Change Hands		1					
	Clamp Fixture to Work Area		1					
					1			
	Trigger to Clamp Assembly						1	
	Tweezers to Insert		1					
							1	
	Insert into Hole				1			
					1		1	
	Open and Aside Tweezers				1			
					1			
Freq.			3	3	9		6	
Time			14.5533					
AY	<u>OBTIAN FIRING PIN AND SPRING ASSEMBLE TO UNIT</u>							
	Spring to Trigger Assembly			1				
							1	
	Firing Pin to Assembly						1	
Freq.				1			2	
Time			3.4521					

ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AZ	CHECK SPRING, INSPECT SHAFT, STAKE UNIT AND RECYCLE							
	Release Contact with Tweezers		1				1	
	Shaft to Hole with Tweezers						1	
	Tweezers Aside				1		1	
	Turn Unit Over				1			
	Adjust Unit				2		.5	
	Clamp Unit						.5	
	Operate	1					1	
	Clamp From Press to Recycling Fixture		1					
	Operate 1st & 2nd Levers	1			1			1
	Operate 3rd Lever	1						1
					1			
								1
Freq.			2		8		5	4
Time		14.0666						



ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
BB	<u>OPEN CLAMP AND REMOVE FROM FIXTURE</u>							
	Open Clamp		1					1
	Remove from Fixture		1		1			
	Freq.		2		2			1
	Time	2.2736						
BD	<u>OBTAIN UNIT AND PLACE IN FIXTURE</u>							
	Open Clamp		1					1
	Remove from Fixture		1		1			
	Freq.		2		2			1
	Time	2.2736						
BD	<u>OBTAIN UNIT AND PLACE IN FIXTURE</u>							
	Unit to Fixture		1				1	
	Close				1			
	Freq.		1		1		1	
	Time	2.2268						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
BE	<u>TORQUE (3) POSTS</u>							
	Torque Device		1					
	Torque				3		1	
								3
	Aside Device				1		2	
	Freq.		1		4		3	3
	Time	8.4861						
BF	<u>CHECK DROPLEAF, DROPLEAF ROD, GAUGE UNIT AND ASIDE</u>							
	Gauge			1				
	Unit to Work Area				1			
	Pull Out Gauge				1			
	Gauge Aside				1			
	Check End Shake		1					
					4			
	Check Spring	1						1
	Check Dropleaf	1						1
	Aside Unit				1			
	Freq.	2	1	1	8			2
	Time	1.9017						
BG	<u>HOUSING INTO FIXTURE</u>							
	Into Fixture		1					
							1	
	Freq.		1				1	
	Time	1.9017						

ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
BH	OBTAIN AND ASSEMBLE 'O' RING , WASHER, STARTING PIN AND SPRING							
	Guide Pin to Work Area				3			
	Washer to Guide Pin			1			1	
	'O' Ring to Guide Pin			1			1	
	Assembly to Hole						1	
	Starting Pin to Guide			1	1		1	
							1	
	Housing Aside		1					1
					1			
	Freq.		1	3	5		5	1
Time		11.7035						
BJ	ASSEMBLE RETAINER							
	Retainer Tool to Assembly		1				1	
								1
	Retianer to Pin						1	
								1
	Disengage Tool				1			
	Tool Aside				1			
	Turn Housing				1			
	Freq.		1		3		2	3
	Time	6.6830						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
BL	HOUSING ASIDE AND DUMP OUT PIN GUIDE							
	Housing Over and Guide to Hand				1			
	Housing Aside				1			
	Freq.				2			
	Time	.6502						
BM	<u>LOAD FIXTURE</u>							
	Tweezers to Lever					1		
	Separate and Orientate				6			
	P. U. Lever				6		1	
	Lever to Fixture				1		1	
	Freq.				13	1	2	
	Time	7.5780						
BP	<u>BURNISH SLOT</u>							
	Start Machine	1						1
	Handle to Burnisher		1		1			
	Burnish Lever				10			
	Freq.	1	1		11			1
	Time	5.0340						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
BR	<u>UNLOAD FIXTURE</u>							
	Stop Machine	1						1
	Pick Up Lever with Tweezers				1		1	
	To Pan				1			
	Open Tweezers				1			
	Freq.	1			3		1	1
	Time	3.4875						
BS	<u>OBTAIN HOUSING AND ASSEMBLE SPRING</u>							
	Housing to Table		1		1			
	Orientate Spring			1				
	Tweezers to Spring		1				1	
	Close Tweezers				1			
	Spring to Hole						1	
	Open Tweezers and Aside				1			
					1			
	Freq.		2	1	4		2	
	Time	5.5999						

# ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
BT	ASSEMBLE OPTION PIN, 'O' RING AND WASHER IN HOUSING							
	Assemble Washer and Option Pin			1				1
				1				
	Assemble 'O' Ring			1				1
	Pin to Housing					1		
	Housing to Work Area				1			
	Assemble Pin					4		
							1	
	Seat on Spring	1			1			1
	Freq.	1		3	2	5	1	3
BU	Time	8.1812						
	CHECK UNIT FOR END SHAKE							
	Driver to Slot		1				1	
	Turn				1			
	Driver Aside				1			
	Freq.		1		2		1	
	Time	2.5519						

ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
BV	<u>ASSEMBLE LARGE OR SMALL 'E' RING</u>							
	'E' Ring Tool to Fixture			1			1	
								1
	Assemble 'E' Ring						1	
	Tool Aside				1			1
	Freq.			1	1		2	2
BW	<u>ASSEMBLE CRANK</u>							
	Crank to Option Pin Unit			1			1	
								1
	Seat							
	Freq.			1			1	1
	Time	5.3292						
BX	<u>ASSEMBLE AND FORM ELEMENTS</u>							
	Back Unit to Fixture		1					
					2			
							1	
	Lubricate Setting Key and Assemble to Unit			1				
				1				
					1			
	Assemble Retaining Plug		1				1	
							1	
	Assemble in Die						1	
	Freq.		2	2	3		4	
	Time	8.2769						

APPENDIX R: MTM-1 ANALYSIS OF PROVING TASKS  
FROM OUTSIDE OF TEST SITE

There follows the development of standard data, based upon MTM-1, of work tasks which were obtained away from the test site. The times were initially established in TMU and then converted to 0.01 minutes at 100 B.S.I. performance level.

TOOL	OPERATION AND DESCRIPTION		SYMBOL	0.01 Min.	
Vice (Bench, Pipe and Wood)	Assemble	Small Easy to Handle Part or Pipe ≤ 6'-0" long	T16-1	20.630	
	Remove	Large or Heavy Part or Part > 6'-0" long	T17-1	25.000	
SPRING CLAMP ASSEMBLE AND REMOVE			T1801	3.540	
VICE GRIP PLIER	ASSEMBLE AND REMOVE		T19-1	18.315	
C-Clamp	Assemble	≤ 6"	Easy to Place, Little or no Align- ment	T20-1	24.880
		> 6"	Difficult to Place, More Exact- ing Align.	T21-1	31.960
			Easy to Place, Little or no Align- ment	T22-1	30.715
			Difficult to Place, More Exact- ing Align.	T23-1	39.335
	Remove	All Classifica- tions		T24-1	9.020
	Wood Hand- Screw Clamp	Assemble		T25-1	22.525
Remove		T26-1	8.815		

TOOL	OPERATION AND DESCRIPTION		SYMBOL	TMU	
Vice (Bench, Pipe and Wood)	Assemble	Small Easy to Handle Part or Pipe ≤ 6'-0" long	T16-1	412.6	
	Remove	Large or Heavy Part or Part > 6'-0" long	T17-1	500.0	
SPRING CLAMP ASSEMBLE AND REMOVE			T18-1	70.8	
VICE GRIP PLIER	ASSEMBLE AND REMOVE		T19-1	366.3	
C-Clamp	Assemble	≤ 6"	Easy to Place, Little or no Align- ment	T20-1	497.6
		≤ 6"	Difficult to Place, More Exact- ing Align.	T21-1	639.2
			> 6"	Easy to Place, Little or no Align- ment	T22-1
		> 6"		Difficult to Place, More Exact- ing Align.	T23-1
	Remove	All Classifica- tions		T24-1	180.4
	Wood Hand- Screw Clamp	Assemble		T25-1	450.5
Remove		T26-1	176.3		

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T16-1		<u>VICE AND REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE, OR PIPE &lt; 6'-0" LONG</u>			
	K1	Vice and Remove Small Easy to Handle Part	470.2	1/2	235.1
	K3	Vice and Remove Small Section of Pipe (< 6'-0" long)	354.9	1/2	177.5
				Total	412.6
T17-1		<u>VICE AND REMOVE LARGE OR HEAVY PART FROM BENCH VICE, OR PIPE &gt; 6'-0" LONG</u>			
	K2	Vice and Remove Large or Heavy Part from Vice	625.8	1/2	312.9
	K4	Vice and Remove Large Section of Pipe (> 6'-0" long)	374.1	1/2	187.1
				Total	500.0
T18-1		<u>ASSEMBLE AND REMOVE SPRING CLAMP</u>			
	AF	Assemble Spring Clamp			36.5
	AG	Remove Spring Clamp			34.3
				Total	70.8
T19-1		<u>ASSEMBLE AND REMOVE VICE-GRIP PLIERS</u>			
	AH	Close Pliers for Gauging			66.7
	AJ	Adjust Screw: (2) Revolutions	52.8	2	105.6
	AL	Try Vice-Pliers Over Part			50.3
	AJ	Additional Adjustment			52.8
	AL	Move and Close Pliers			50.3
	AM	Remove Pliers			40.6
				Total	366.3

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T20-1	<u>ASSEMBLE EASY TO PLACE C-CLAMP WITH SOME ALIGNMENT (2" - 6" CLAMP)</u>				
	T	Adjust Clamp 1"			128.3
	V	Place Clamp and Align			54.8
	T	Take Up Slack in Clamp			128.3
	B	Tighten Clamp			82.2
				Total	497.6
T21-1	<u>ASSEMBLE DIFFICULT TO PLACE C-CLAMP WITH MORE EXACTING ALIGNMENT (2" - 6" CLAMP)</u>				
	T	Adjust Clamp			128.3
	W	Place Clamp and Align			94.0
	T	Take up Slack in Clamp			128.3
	B	Tighten Clamp	86.2	3	258.6
				Total	639.2
T22-1	<u>ASSEMBLE EASY TO PLACE CLAMP WITH SOME ALIGNMENT (8" AND OVER CLAMP)</u>				
	U	Adjust C-Clamp 3"			321.5
	V	Place C-Clamp and Align			99.4
	U	Take up Slack	321.5	1/3	105.2
	B	Tighten			86.2
				Total	614.3
T23-1	<u>ASSEMBLE DIFFICULT TO PLACE C-CLAMP WITH MORE EXACTING ALIGNMENT (8" AND OVER CLAMP)</u>				
	U	Adjust C-Clamp			321.5
	V	Place C-Clamp and Align			99.4
	U	Take Up Slack	321.5	1/3	107.2
	B	Tighten Clamp and Loosen Once to Complete Alignment	86.2	3	258.6
				Total	786.7

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T24-1	<u>REMOVE C-CLAMP</u>				
	B	Loosen Clamp			86.2
	T	Run Screw Out 1/2" Approx.	128.3	1/2	64.2
	R	Remove Clamp			30.0
				Total	180.4
T25-1	<u>ASSEMBLE WOOD HAND-SCREW CLAMP (TWIN SCREWDRIVER TYPE HANDLES)</u>				
	AA	Adjust Wood Hand Screw Jack			123.0
	AB	Place Clamp to Part			50.9
	AD	Adjust (2) Hand Screws (3) Revs. Each	25.2	6	151.2
	AD	Adjust (2) Hand Screws Approx. (1) Rev. Each for Jaw Alignment	25.2	2	50.4
	AE	Tighten Each Hand Screw	37.5	2	75.0
				Total	450.5
T26-1	<u>REMOVE WOOD HAND-SCREW CLAMP</u>				
	AE	Loosen Each Hand Screw	37.5	2	75.0
	AD	Open Each Hand Screw Approx. 1½ Revs.	25.2	3	75.6
	F	Remove Clamp from Part			25.7
				Total	176.3

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
K1	<u>VICE</u>	<u>AND REMOVE SMALL EASY TO HANDLE PART FROM</u>		<u>BENCH VICE</u>	
	A	Adjust Opening			181.4
	D	Place Small Part into Vice			
	B	Tighten and Loosen Vice	86.2	2	172.4
	A	Adjust Vice Opening Before Tightening and After Loosening	181.4	1/2	90.7
	F	Remove Small Part from Vice			25.7
				Total	470.2
K2	<u>VICE</u>	<u>AND REMOVE LARGE OR HEAVY PART FROM</u>		<u>BENCH VICE</u>	
	A	Adjust Vice Open			181.4
	E	Place Part into Vice			87.4
	B	Tighten and Later Loosen	86.2	2	172.4
	A	Adjust Vice Opening Before Tightening and After Loosening	181.4	1/2	90.7
	G	Remove Large Part from Vice			93.9
				Total	625.9
K3	<u>VICE</u>	<u>AND REMOVE SMALL SECTION OF PIPE (&lt; 6'-0" LONG)</u>			
		<u>FROM PIPE VICE</u>			
	M	Pipe into Vice			25.3
	L	Close Pipe Vice			31.4
	H	Adjust Jaws, Close and Later Open			133.8
	B	Tighten and Later Loosen Vice			86.2
	J	Open Pipe Vice			48.2
	R	Remove Pipe			30.0
				Total	354.9

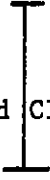
## SYNTHESIS

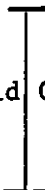
Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
K4		<u>VICE AND REMOVE LARGE SECTION OF PIPE (&gt; 6'-0" LONG) FROM</u> <u>PIPE VICE</u>			
	P	Large Section of Pipe into Vice			41.6
	L	Close Pipe Vice			31.4
	H	Adjust Jaws, Close, Open Later			133.8
	B	Tighten and Loosen Later			86.2
	J	Open Pipe Vice			48.2
	S	Remove Pipe from Vice			32.9
				Total	374.1

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>A - ADJUST BENCH VICE OPENING: 2" APPROX. (3/16" PER REVOLUTION)</u>						
			15.8	R16B		} Handle
			2.0	G1A		
			163.6	11C10		} Open
				<del>G2</del>		
			1	RL2		
		Total	181.4	TMU		
<u>B - TIGHTEN OR LOOSEN VICE</u>						
			15.8	R16B		} First Tighten
			2.0	G1A		
			3.9	SC10		
			13.5	M10B10		
			5.6	G2		Change Hold
			32.4	AP1	2	} Final Tighten
			7.4	SC20		
			5.6	M2B20		
		Total	86.2	TMU		
<u>D - EASY TO HANDLE PART INTO BENCH VICE</u>						
Move into Jaws		M16C	18.7			
		P2SSE	19.7			
		MfC	2.0			
		P2SE	16.2			
		RL1	2.0			
		Total	58.6	TMU .		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
E - PLACE LARGE OR HEAVY PART INTO BENCH VICE						
Assist RH		SC10	8.6	SC10		Part into Vice
		M16C10	20.8	M16C10		
		P2SSD	19.7	P2SSD		
		G2	5.6	G2		
		M4C10	8.9	M4C10		Align
		P2SD	21.8	P2SD		
			2.0	RL1		
		Total	87.4	TMU		
F - REMOVE SMALL EASY TO HANDLE PART FROM THE BENCH VICE						
Clear Vice		R10B	11.5	TMU		
		G1A	2.0			
		M10B	12.2			
		Total	25.7			
G - REMOVE LARGE OR HEAVY PART FROM THE BENCH VICE						
For Part After Loosen		R18B	17.2	R16B		Large Part
		G1A	2.0			
			15.8			
			5.6			
New Hold		R10B	11.5	G2		
		G1A	2.0			
		G2	5.6			
Assist RH		AP2	10.6	AP2		Remove From
		SC10	8.6	SC10		
		M10C10	15.0	M10C10		
		Total	93.9	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>H - ADJUST PIPE VICE, OPENING APPROXIMATELY 1" (1/8" PER REVOLUTION)</u>						
			15.8	R16B		} Handle
			2.0	G1A		
			114.0	8C8		} Open
			2.0	RL1		
		Total	133.8	TMU		
<u>J - OPEN PIPE VICE FRAME</u>						
			15.8	R16B		} Obtain Dog
			2.0	G1A		
			6.9	M14B		
			5.6	G2		
			2.2	SC5		} Release Dog
			13.7	M12A5		
			2.0	RL1		
		Total	48.2	TMU		
<u>L - CLOSE PIPE VICE FRAME</u>						
			11.5	R10B		} Vice Frame
			2.0	G1A		
			2.2	SC5		} Close
			13.7	M12A5		
			2.0	RL1		
		Total	31.4	TMU		
<u>M - PLACE SMALL SECTION OF PIPE (<math>\leq 6'-0"</math> LONG) INTO PIPE VICE</u>						
To Vice		M16C	18.7			
Into Vice		M2B	4.6			
		RL1	2.0			
		Total	25.3	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>P - PLACE LARGE SECTION OF PIPE (&gt; 6'-0" LONG) INTO PIPE VICE</u>						
		SC3	2.2	SC3		} Into Vice
		M16C3	19.8	M16C3		
		RL1	2.0	RL1		} New Hold
		R4B	6.4	R4B		
		G1A	2.0	G1A		} Slide In
	2	M2B	9.2	M2B	2	
		Total	41.6	TMU		
<u>R - REMOVE SMALL SECTION OF PIPE (<math>\leq</math> 6'-0" LONG) FROM PIPE VICE</u>						
Remove		R16B	15.8			
		G1A	2.0			
		M10B	12.2			
		Total	30.0	TMU		
<u>S - REMOVE LARGE SECTION OF PIPE (&gt; 6'-0" LONG) FROM PIPE VICE</u>						
Assist RH		R16B	15.8	R16B		} Pipe
		G1A	2.0	G1A		
		SC3	2.2	SC3		} Clear Vice
		M10B3	12.9	M10B3		
		Total	32.9	TMU		
<u>T - ADJUST C-CLAMP 1" (2" TO 6" CLAMP - AVERAGE 4")</u>						
Hold Clamp 			11.5	R10B		} Form Crank
			-	G5		
			106.8	8C6		} Adjust
				RL2		
		Total	128.3	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
U - ADJUST C-CLAMP 3" (8" CLAMP AND OVER - 12" AVERAGE)						
 Hold Clamp			11.5	R10B		Adjust
			-	G5		
			310.0	24C6		
			-	RL2		
		Total	321.5			
V - PLACE C-CLAMP AND ALIGN (2" - 6" CLAMP EASY TO PLACE)						
			18.7	M16C		1st End of Clamp
			9.1	P1SSE		
			3.4	M1C		2nd End of Clamp
			5.6	P1SE		
			6.4	R4B		Clamp Frame
			2.0	G1A		
			2.0	MfC		Relocate or Align 2nd End
			5.6	P1SE		
			2.0	RL1		
		Total	54.8	TMU		
W - PLACE C-CLAMP AND ALIGN (2" to 6" CLAMP) DIFFICULT TO PLACE						
			18.7	M16C		Initial Clamp (2) Ends
			9.1	P1SSE		
			3.4	M1C		
			5.6	P1SE		
			12.8	R4B	2	Align Clamp Frame
			4.0	G1A	2	
			4.0	MfC	2	
			32.4	P2SE	2	
			4.0	RL1	2	
	Total	94.0	TMU			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
X - REMOVE 2" - 6" CLAMP FROM PART						
			11.5	R10B	}	Clamp
			2.0	G1A		
			11.8	D2D	}	Remove
			12.2	M10B		
			Total	37.5		
		Y - PLACE C-CLAMP AND ALIGN (8" CLAMP AND OVER) EASY TO PLACE				
Assist RH		SC5	11.5	R10B	}	Place 1st End of Clamp
			2.0	G1A		
			2.2	SC5		
			19.8	M16C5		
			9.1	P1SSE		
		M4C5	8.5	M4C5	}	2nd End of Clamp
			5.6	P1SE		
			11.5	R10B	}	Frame
		2.0	G1A			
		5.6	G2			
		10.6	AP2			
		10.6	3.4	M1C	}	Align and Locate 2nd End
			5.6	P1SE		
			2.0	RL1		
		Total	99.4	TMU		
Z - PLACE C-CLAMP AND ALIGN (8" CLAMP AND OVER) DIFFICULT TO PLACE						
		SC5	11.5	R10B	}	Initial Place (2) Ends
			2.0	G1A		
			2.2	SC5		
			19.8	M16C5		
			9.1	P1SSE		
		M4C5	8.5	M4C5		
		Carry Fwd.	53.1			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>Z - Continued</u>						
		Brought Fwd.	53.1			} Align and Locate
			5.6	P1SE		
			23.0	R10B	2	
			4.0	G1A	2	
			11.2	G2	2	
			21.2	AP2	2	
			6.8	M1C	2	
			32.4	P2SE	2	
			4.0	RL1	2	
		Total	163.5	TMU		
<u>AA - ADJUST WOOD HAND-SCREW CLAMP, APPROXIMATELY 1" (1/16" PER REVOLUTION)</u>						
Driver Handle	{	R-	12.2	M10B		} Clamp
		G1A	2.0			
		8C6	106.8	8C6		
		RL1	2.0			
		Total	123.0	TMU		
<u>AB - PLACE WOOD HAND-SCREW CLAMP</u>						
Assist RH	{	M16C	18.7	M16C		} Clamp to Part Into Clamp
			35.3	P2SSD		
		M4B	6.9	M4B		
		Total	50.9	TMU		
<u>AD - ADJUST ONE SIDE OF WOOD HAND-SCREW CLAMP (ONE REVOLUTION)</u>						
			9.2	M2B	2	} Turn Screw Driver Handle.
			4.0	RL1	2	
			8.0	R2A	2	
			4.0	G1A	2	
		Total	25.2	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
AE - LOOSEN OR TIGHTEN ONE HAND-SCREW						
		Total	5.6	G2		} Initial Tighten  Set
			10.2	AP2		
			5.5	T45M		
			16.2	AP1		
			37.5	TMU		
AF - ATTACH SPRING CLAMP						
		Total	15.8	M16B		} To Part and Open Clamp
			2.2	SC5		
			2.1	MfA5		
			5.2	M2C		} Locate on Part
			9.1	P1SSE		
			2.1	MfA5		
			36.5			
AG - REMOVE SPRING CLAMP						
		Total	15.8	R16B		} Clamp
			2.0	G1A		
			2.2	SC5		} Open
			2.1	MfA5		
			12.2	M10B		Remove
			34.3	TMU		
AH - CLOSE VICE-GRIP PLIER FOR GAUGING OPENING						
Pliers to RH		M10B	12.2	R-		} Handle
			2.0	G1A		
			2.0	MfA		
		M18C	10.6	AP2		} Close Pliers
			20.4	M18C		
			9.1	P1SSE		
			2.0	RL1		
Carry Fwd.			58.3			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AH - Continued</u>						
		Brought Fwd.	58.3			} Adjusting Screw
			6.4	R4B		
			2.0	G1A		
		Total	66.7	TMU		
<u>AJ - TURN ADJUSTING SCREW ONE REVOLUTION</u>						
			20.4	T1205	3	} Move Screw
			6.0	RL1	3	
			20.4	T120	3	} Reach Screw
			6.0	G1A	3	
		Total	52.8	TMU		
<u>AL - PLACE VICE GRIP PLIER TO PART AND CLOSE</u>						
			6.4	R4B		} Handle
			2.0	G1A		
		AP2	10.2	AP2		Open Pliers
			8.0	M4C		} Pliers to Part
			9.1	PLSSE		
			2.0	MfA		} Close Pliers
			10.6	AP2		
			2.0	RL1		
		Total	50.3	TMU		
<u>AM - OPEN AND REMOVE VICE GRIP PLIERS</u>						
Assist RH	{	R16B	15.8	R16B	}	Open
		G1A	2.0	G1A		
		AP2	10.6	AP2		Tool Away
			12.2	M10B		
		Total	40.6	TMU		

APPENDIX S: MTM-2 ANALYSIS OF PROVING TASKS  
FROM OUTSIDE OF TEST SITE

There follows the development of standard data, based upon MTM-2, of work tasks where obtained away from the test site. The times were initially established in T.M.UM and then converted to 0.01 minutes at 100 B.S.I. performance level.

Tool	Operation and Description		Symbol	0.01 Min.	
Vice (Bench, Pipe and Wood)	Assemble	Small Easy to Handle Part or Pipe ≤ 6'-0" Long	T16-2	21.165	
	Remove	Large or Heavy Part or Part > 6'-0" Long	T17-2	23.515	
SPRING CLAMP ASSEMBLE AND REMOVE			T18-2	4.150	
VICE GRIP PLIER	ASSEMBLE AND REMOVE		T19-2	23.800	
C-Clamp	Assemble	≤ 6"	Easy to Place Little or no Align.	T20-2	21.500
			Difficult to Place, More Exact- ing Align.	T21-2	31.450
		> 6"	Easy to Place Little or no Align.	T22-2	35.600
			Difficult to Place, More Exact- ing Align.	T22-2	44.000
	Remove	All Classifica- tions		T24-2	8.875
	Wood Hand- Screw Clamp	Assemble		T25-2	20.600
Remove		T26-2	8.250		

Tool	Operation and Description		Symbol	TMU	
Vice (Bench, Pipe and Wood)	Assemble	Small Easy to Handle Part or Pipe ≤ 6'-0" Long	T16-2	423.3	
	Remove	Large or Heavy Part or Part > 6'-0" Long	T17-2	470.3	
SPRING CLAMP ASSEMBLE AND REMOVE			T18-2	83.0	
VICE GRIP PLIER	ASSEMBLE AND REMOVE		T19-2	476.0	
C-Clamp	Assemble	≤ 6"	Easy to Place Little or No Align.	T20-2	430.0
		> 6"	Difficult to Place, More Exact- ing Align.	T21-2	629.0
			Easy to Place Little or No Align.	T22-2	712.0
		Difficult to Place, More Exact- ing Align.	T23-2	880.0	
	Remove	All Classifica- tion		T24-2	177.5
	Wood Hand- Screw Clamp	Assemble		T25-2	413.0
Remove		T26-2	165.0		

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T16-2	<u>VICE AND REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE, OR PIPE <math>\leq 6'-0''</math> LONG</u>				
	K1	Vice and Remove Small Easy to Handle Part	524.5	1/2	262.3
	K3	Vice and Remove Small Section of Pipe ( $\leq 6'-0''$ Long)	322.0	1/2	161.0
				Total	423.3
T17-2	<u>VICE AND REMOVE LARGE OR HEAVY PART FROM BENCH VICE, OR PIPE <math>&gt; 6'-0''</math> LONG</u>				
	K2	Vice and Remove Large or Heavy Part from Vice	608.5	1/2	304.3
	K4	Vice and Remove Large Section of Pipe ( $> 6'-0''$ Long)	332.0	1/2	166.0
				Total	470.3
T18-2	<u>ASSEMBLE AND REMOVE SPRING CLAMP</u>				
	AF	Assemble Spring Clamp			47
	AG	Remove Spring Clamp			36
				Total	83
T19-2	<u>ASSEMBLE AND REMOVE VICE-GRIP PLIERS</u>				
	AH	Close Pliers for Gauging			74.0
	AJ	Adjust Screw: (2) Revolutions	75.0	2	150.0
	AL	Try Vice-Pliers Over Part			67.0
	AJ	Additional Adjustment			75.0
	AL	Move and Close Pliers			67.0
	AM	Remove Pliers			43.0
				Total	476.0

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T20-2	<u>ASSEMBLE EASY TO PLACE C-CLAMP WITH SOME ALIGNMENT (2" - 6" CLAMP)</u>				
	T	Adjust Clamp 1"			129.0
	V	Place Clamp and Align			88.0
	T	Take Up Slack in Clamp			129.0
	B	Tighten Clamp			84.0
				Total	430.0
T21-2	<u>ASSEMBLE DIFFICULT TO PLACE C-CLAMP WITH MORE EXACTING ALIGNMENT (2" - 6" CLAMP)</u>				
	T	Adjust Clamp			129.0
	W	Place Clamp and Align			119.0
	T	Take Up Slack in Clamp			129.0
	B	Tighten Clamp	84.0	3	252.0
				Total	629.0
T22-2	<u>ASSEMBLE EASY TO PLACE CLAMP WITH SOME ALIGNMENT (8" AND OVER CLAMP)</u>				
	U	Adjust C-Clamp 3"			369.0
	Y	Place C-Clamp and Align			136.0
	U	Take up Slack	369.0	1/3	123.0
	B	Tighten			84.0
				Total	712.0
T23-2	<u>ASSEMBLE DIFFICULT TO PLACE C-CLAMP WITH MORE EXACTING ALIGNMENT (8" AND OVER CLAMP)</u>				
	U	Adjust C-Clamp			369.0
	Y	Place C-Clamp and Align			136.0
	U	Take Up Slack	369.0	1/3	123.0
	B	Tighten Clamp and Loosen Once to Complete Alignment	84.0	3	252.0
				Total	880.0

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T24-2	<u>REMOVE C-CLAMP</u>				
	B	Loosen Clamp			84.0
	T	Run Screw Out 1/2" Approx.	129.0	1/2	64.5
	R	Remove Clamp			29.0
				Total	177.5
T25-2	<u>ASSEMBLE WOOD HAND-SCREW CLAMP (TWIN SCREWDRIVER TYPE HANDLES)</u>				
	AA	Adjust Wood Hand Screw Jack			131.0
	AB	Place Clamp to Part			42.0
	AD	Adjust (2) Hand Screws (3) Revs. Each	20.0	6	120.0
	AD	Adjust (2) Hand Screw Approx. (1) Rev. Each for Jaw Alignment	20.0	2	40.0
	AE	Tighten Each Hand Screw	40.0	2	80.0
				Total	413.0
T26-2	<u>REMOVE WOOD HAND-SCREW CLAMP</u>				
	AE	Loosen Each Hand Screw	40.0	2	80.0
	AD	Open Each Hand Screw Approx. 1-1/2 Revs.	20.0	3	60.0
	F	Remove Clamp from Part			25.0
				Total	165.0
K1	<u>VICE AND REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE</u>				
	A	Adjust Opening			183.0
	D	Place Small Part into Vice			57.0
	B	Tighten and Loosen Vice	84	2	168.0
	A	Adjust Vice Opening Before Tightening and AFTER Loosening	183	1/2	91.5
	F	Remove Small Part from Vice			25.0
				Total	524.5

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
K2	<u>VICE AND REMOVE LARGE OR HEAVY PART FROM BENCH VICE</u>				
	A	Adjust Vice OPeN			183.0
	E	Place Part into Vice			75.0
	B	Tighten and Later Loosen	84.0	2	168.0
	A	Adjust Vice Opening Before Tightening and AFTER Loosening	183.0	1/2	91.5
	G	Remove Large Part from Vice		"	91.0
				Total	608.5
K3	<u>VICE AND REMOVE SMALL SECTION OF PIPE (<math>\leq</math> 6'-0" LONG) FROM PIPE VICE</u>				
	M	Pipe into Vice			18.0
	L	Close Pipe Vice			29.0
	H	Adjust Jaws, Close and Later Open			108.0
	B	Tighten and Later Loosen			84.0
	J	Open Pipe Vice			54.0
	R	Remove Pipe			29.0
				Total	322.0
K4	<u>VICE AND REMOVE LARGE SECTION OF PIPE (<math>&gt;</math> 6'-0" LONG) FROM PIPE VICE</u>				
	P	Large Section of Pipe into Vice			28.0
	L	Close Pipe Vice			29.0
	H	Adjust Jaws, Close, Open Later			108.0
	B	Tighten and Loosen Later			84.0
	J	Open Pipe Vice			54.0
	S	Remove Pipe from Vice			29.0
				Total	332.0

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
A - ADJUST BENCH VICE OPENING:			2" APPROX. (3/16" PER REVOLUTION)			
			18	GB45		Handle
			165	(11C X		} Open
		Total	183	TMU		
B - TIGHTEN AND LOOSEN VICE						
			18	GB45		} First Tighten
			5	GW5		
			11	PA30		
			1	PW5		} Change Hold
			6	R		
			28	A	2	} Final Tighten
			10	GW10		
			3	PA5		
			2	PW10		
		Total	84	TMU		
D - EASY TO HANDLE PART INTO BENCH VICE						
Part to Jaws		PC45	36			
Into Jaws		PC5	21			
		Total	57	TMU		
E - PLACE LARGE OR HEAVY PART INTO BENCH VICE						
Assist RH		GW5	5	GW5		} Part into Vice
		PC45	36	PC45		
		PW5	1	PW5		
		R	6	R		} Align
		PC15	26	PC15		
		PW5	1	PW5		
		Total	75	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>F - REMOVE SMALL EASY TO HANDLE PART FROM THE BENCH VICE</u>						
Obtain		GB30	14			
Aside		PA30	11			
		Total	25	TMU		
<u>G - REMOVE LARGE OR HEAVY PART FROM THE BENCH VICE</u>						
Part After Loosen		GB45	18			
			18	GB45		Large Part
New Hold		GB30	14			
		R	6	R		
		A	14	A		
Assist RH		GW5	5	GW5		Remove
		PB30	15	PB30		
		PW5	1	PW5		
		Total	91	TMU		
<u>H - ADJUST PIPE VICE OPENING APPROXIMATELY 1" (1/8" PER REVOLUTION)</u>						
			18	GB45		Handle
			90	8C		Open
		Total	108	TMU		
<u>J - OPEN PIPE VICE FRAME</u>						
			18	GB45		Obtain Dog
			15	PA45		
			6	R		
			3	GW3		
			11	PA30		Release Dog
			1	PW5		
		Total	54	TMU		

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND
L - CLOSE PIPE VICE	FRAME					
			14	GB30		Vice Frame
			3	GW3		} Close
			11	PA30		
			1	PW5		
		Total	29	TMU		
M - PLACE SMALL SECTION	OF PIPE	( $\leq 6'-0''$ LONG)	INTO	PIPE VICE		
To Vice		PA45	15			
Into Vice		PA5	3			
		Total	18	TMU		
P - PLACE LARGE SECTION	OF PIPE	( $> 6'-0''$ LONG)	INTO	PIPE VICE		
Assist RH	{	PA45	15	PA45	2	Into Vice
		GB15	10	GB15		New Hole
		PA5	3	PA5		Slide In
		Total	28	TMU		
R - REMOVE SMALL SECTION	OF PIPE	( $\leq 6'-0''$ LONG)	FROM	PIPE		
Remove Pipe	{	GB45	18			
		PA30	11			
		Total	29	TMU		
S - REMOVE LARGE SECTION	OF PIPE	( $> 6'-0''$ LONG)	FROM	PIPE		
Assist RH	{	GB45	18	GB45		} Remove
		PA30	11	PA30		
		Total	29	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
T - ADJUST C-CLAMP 1" (2" to 6" CLAMP - AVERAGE 4")						
			9	GA30		
			120	8C		
		Total	129	TMU		
U - ADJUST C-CLAMP 3" (8" CLAMP AND OVER - 12" AVERAGE)						
			9	GA30		} Adjust
			360	24C		
		Total	369	TMU		
V - PLACE C-CLAMP AND ALIGN (2" - 6" CLAMP) EASY TO PLACE						
			36	PC45		1st Clamp
			21	PC5		2nd Clamp
			10	GB15		Clamp Frame
			21	PC5		Set 2nd Clamp
		Total	88	TMU		
W - PLACE C-CLAMP AND ALIGN (2" to 6" CLAMP) DIFFICULT TO PLACE						
			36	PC45		} Initial Clamp (2) Ends
			21	PC5		
			20	GB15	2	} Align Clamp Frame
			42	PC5	2	
		Total	119	TMU		
X - REMOVE 2" to 6" CLAMP FROM PART						
			14	GB30		} Remove
			5	GW5		
			11	PA30		
		Total	30	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
Y - PLACE C-CLAMP AND ALIGN (8" CLAMP AND OVER) EASY TO PLACE						
Assist RH			14	GB30		} Place 1st End of Clamp
		GW3	3	GW3		
		PC45	36	PC45		
		PW5	1	PW5		} 2nd End of Clamp
		PC15	26	PC15		
		PW5	1	PW5		
			14	GB30		} Frame
			6	R		
			14	A		
			21	PC5		} Align and Locate 2nd End
		Total	136	TMU		
Z - PLACE C-CLAMP AND ALIGN (8" CLAMP AND OVER) DIFFICULT TO PLACE						
			14	GB30		} Initial Place (2) Ends
		GW3	3	GW3		
		PC45	36	PC45		
		PW5	1	PW5		
		PC15	21	PC15		
		PW5	1	PW5		} Align and Locate
			28	GB30	2	
			12	R	2	
			28	A	2	
			42	PC5	2	
		Total	186	TMU		
AA - ADJUST WOOD HAND-SCREW CLAMP APPROX. 1" (1/16" PER REVOLUTION)						
Driver Handle Clamp		GB-	11	PA30		Clamp
		8C	120	8C		
		Total	131	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AB - PLACE WOOD HAND-SCREW CLAMP</u>						
Assist RH {		P-	36	PC45		Clamp to Part Into Clamp
		P-	6	PA15		
		Total	42	TMU		
<u>AD - ADJUST ONE SIDE OF WOOD HAND SCREW CLAMP (ONE REVOLUTION)</u>						
		Total	6	PA5	2	
			14	GB5	2	
			20	TMU		
<u>AE - LOOSEN OR TIGHTEN ONE HAND SCREW</u>						
		Total	6	R		Initial Tighten  Set
			14	A		
			6	PA15		
			14	A		
			40	TMU		
<u>AF - ATTACH SPRING CLAMP</u>						
		Total	15	PA45		To Part and Open Clamp
			3	GW3		
			3	PA5		
			1	PW5		
			21	PC5		On Part
			3	PA5		
			1	PW5		
			47	TMU		Close

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AG - REMOVE SPRING CLAMP</u>						
			18	GB45		Clamp
			3	GW3		} Open
			3	PA5		
			1	PW5		
			11	PA30		Remove
		Total	36	TMU		
<u>AH - CLOSE VICE GRIP PLIERS FOR GAUGING OPENING</u>						
Pliers to RH		PA30	11	GB-		Handle
			3	PA5		} Close Pliers
			14	A		
		P-	36	PC45		To Part for Gauging
			10	GB15		Adjusting Screw
		Total	74	TMU		
<u>AJ - TURN ADJUSTING SCREW ONE REVOLUTION</u>						
			33	PA20	3	
			42	GB30	3	
		Total	75	TMU		
<u>AL - PLACE VICE GRIP PLIERS TO PART AND CLOSE</u>						
			10	GB15		Handle
			14	A		Open Pliers
			26	PC15		To Part
			3	PA5		} Close Pliers
			14	A		
		Total	67	TMU		
<u>AM - OPEN AND REMOVE VICE GRIP PLIERS</u>						
			18	GB45		} Open
			14	A		
			11	PA30		Tool Away
		Total	43	TMU		

APPENDIX T: MTM-3 ANALYSIS OF PROVING TASKS FROM  
OUTSIDE OF WORK SITE

There follows the development of standard data, based upon MTM-3, of work tasks which were obtained away from the test site. The times were initially established in T.M.U. and then converted to 0.01 minutes at 100 B.S.I. performance level.

Tool	Operation and Description		Symbol	0.01 Min.	
Vice (Bench, Pipe and Wood)	Assemble  and  Remove	Small Easy to Handle Part or Pipe ≤ 6'-0" Long	T16-3	21.250	
		Large or Heavy Part or Part > 6'-0" Long	T17-3	22.075	
SPRING CLAMP ASSEMBLE AND REMOVE			T18-3	5.150	
VICE GRIP PLIER ASSEMBLE AND REMOVE			T19-3	23.950	
C-Clamp	Assemble	≤ 6"	Easy to Place Little or No Align.	T20-3	20.900
			Difficult to Place, More Exact- ing Align.		30.150
		> 6"	Easy to Place Little or No Align.	T21-3	
			Difficult to Place, More Exact- ing Align.	T22-3	33.915
	Remove	All Classifica- tion		T24-3	8.100
	Wood Hand- Screw Clamp	Assemble		T25-3	26.000
Remove		26-3	9.600		

Tool	Operation and Description		Symbol	TMU	
Vice (Bench, Pipe and Wood)	Assemble	Small Easy to Handle Part or Pipe ≤ 6'-0" Long	T16-3	425.0	
	Remove	Large or Heavy Part or Part > 6'-0" Long	T17-3	441.5	
SPRING CLAMP ASSEMBLE AND REMOVE			T18-3	103.0	
VICE GRIP PLIER ASSEMBLE AND REMOVE			T19-3	479.0	
C-Clamp	Assemble	≤ 6"	Easy to Place Little or No Align.	T20-3	418.0
		> 6"	Difficult to Place, More Exact- ing Align.	T21-3	603.0
			Easy to Place Little or No Align.	T22-3	678.3
		Difficult to Place, More Exact- ing Align.	T23-3	788.3	
	Remove	All Classifica- tions		T24-3	162.0
	Wood Hand- Screw Clamp	Assemble		T25-3	520.0
Remove		T26-3	192.0		

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T16-3		<u>VICE AND REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE, OR PIPE &lt; 6'-0" LONG</u>			
	K1	Vice and Remove Small Easy to Handle Part	485.0	1/2	242.5
	K3	Vice and Remove Small Section of PIPE (< 6'-0" Long)	365.0	1/2	182.5
				Total	425.0
T17-3		<u>VICE AND REMOVE LARGE OR HEAVY PART FROM BENCH VICE, OR PIPE &gt; 6'-0" LONG</u>			
	K2	Vice and Remove Large or Heavy Part from Vice	537.0	1/2	268.5
	K4	Vice and Remove Large Section of Pipe (> 6'-0" Long)	346.0	1/2	173.0
				Total	441.5
T18-3		<u>ASSEMBLE AND REMOVE SPRING CLAMP</u>			
	AF	Assemble Spring Clamp			51.0
	AG	Remove Spring Clamp			52.0
				Total	103.0
T19-3		<u>ASSEMBLE AND REMOVE VICE-GRIP PLIERS</u>			
	AH	Close Pliers for Gauging			47.0
	AJ	Adjust Screw: (2) Revolutions	102.0	2	204.0
	AL	Try Vice-Pliers Over Part			46.0
	AJ	Additional Adjustment			102.0
	AL	Move and Close Pleirs			46.0
	AM	Remove Pliers			34.0
				Total	479.0

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T20-3	<u>ASSEMBLE EASY TO PLACE C-CLAMP WITH SOME ALIGNMENT (2" - 6" CLAMP)</u>				
	T	Adjust Clamp 1"			146.0
	V	Place Clamp and Align			71.0
	T	Take up Slack in Clamp			146.0
	B	Tighten Clamp			55.0
				Total	418.0
T21-3	<u>ASSEMBLE DIFFICULT TO PLACE C-CLAMP WITH MORE EXACTING ALIGNMENT (2" - 6" CLAMP)</u>				
	T	Adjust Clamp			146.0
	W	Place Clamp and Align			146.0
	T	Take up Slack in Clamp			146.0
	B	Tighten Clamp	55.0	3	165.0
				Total	603.0
T22-3	<u>ASSEMBLE EASY TO PLACE CLAMP WITH SOME ALIGNMENT (8" AND OVER CLAMP)</u>				
	U	Adjust C-Clamp 3"			379.0
	Y	Place C-Clamp and Align			118.0
	U	Take Up Slack	379.0	1/3	126.3
	B	Tighten			55.0
				Total	678.3
T23-3	<u>ASSEMBLE DIFFICULT TO PLACE C-CLAMP WITH MORE EXACTING ALIGNMENT (8" AND OVER CLAMP)</u>				
	U	Adjust C-Clamp			379.0
	Y	Place C-Clamp and Align			118.0
	U	Take Up Slack	379.0	1/3	126.3
	B	Tighten Clamp and Loosen Once to Complete Alignment	55.0	3	165.0
				Total	788.3

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T24-3	<u>REMOVE C-CLAMP</u>				
	B	Loosen Clamp			55.0
	T	Run Screw Out 1/2" Approx.	146.0	1/2	73.0
	R	Remove Clamp			34.0
				Total	162.0
T25-3	<u>ASSEMBLE WOOD HAND-SCREW CLAMP (TWIN SCREWDRIVER TYPE HANDLES)</u>				
	AA	Adjust Wood Hand Screw Jack			146.0
	AB	Place Clamp to Part			36.0
	AD	Adjust (2) Hand Screws (3) Revs. Each	36.0	6	216.0
	AD	Adjust (2) Hand Screws Approx. (1) Rev. Each for Jaw Alignment	36.0	2	72.0
	AE	Tighten Each Hand Screw	25.0	2	50.0
				Total	520.0
T26-3	<u>REMOVE WOOD HAND-SCREW CLAMP</u>				
	AE	Loosen Each Hand Screw	25.0	2	50.0
	AD	Open Each Hand Screw Approx. 1-1/2 Revs.	36.0	3	108.0
	F	Remove Clamp From Part			34.0
				Total	192.0
K1	<u>VICE AND REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE</u>				
	A	Adjust Opening			194.0
	D	Place Small Part into Vice			50.0
	B	Tighten and Loosen Vice	55.0	2	110.0
	A	Adjust Vice Opening Before Tightening and After Loosening	194.0	1/2	97.0
	F	Remove Small Part from Vice			34.0
				Total	485.0

# SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
K2		<u>VICE AND REMOVE LARGE OR HEAVY PART FROM BENCH VICE</u>			
	A	Adjust Vice Open			194.0
	E	Place Part into Vice			89.0
	B	Tighten and Later Loosen	55.0	2	110.0
	A	Adjust Vice Opening Before Tightening and After Loosening	194.0	1/2	97.0
	G	Remove Large Part from Vice			47.0
				Total	537.0
K3		<u>VICE AND REMOVE SMALL SECTION OF PIPE (≤ 6'-0" LONG) FROM PIPE VICE</u>			
	M	Pipe into Vice			23.0
	L	Close Pipe Vice			34.0
	H	Adjust Jaws, Close and Later Open			162.0
	B	Tighten and Later Loosen Vice			55.0
	J	Open Pipe Vice			57.0
	R	Remove Pipe			34.0
				Total	365.0
K4		<u>VICE AND REMOVE LARGE SECTION OF PIPE (&gt; 6'-0" LONG) FROM PIPE VICE</u>			
	P	Large Section of Pipe into Vice			59.0
	L	Close Pipe Vice			34.0
	H	Adjust Jaws, Close, Open Later			162.0
	B	Tighten and Loosen Later			55.0
	J	Open Pipe Vice			57.0
	S	Remove Pipe from Vice			34.0
				Total	401.0

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
A - ADJUST BENCH VICE OPENING:			2" APPROXIMATELY (3/16" PER REVOLUTION)			
			34	HA80		Handle
			160	10TA80		Open
		Total	194	TMU		
B - TIGHTEN AND LOOSEN VICE						
			34	HA80		First Tighten
			7	TA15		Change Hold
			7	TA15		
			7	TA15		
		Total	55	TMU		
D - EASY TO HANDLE PART INTO VICE						
To Jaws		TB80	29			
Into Jaws		TB15	21			
		Total	50	TMU		
E - PLACE LARGE OR HEAVY PART INTO BENCH VICE						
Assist RH	{	HB80	48	HB80		Part into Vice
		TA15	7	TA15		Change Hold
		HB15	34	HB15		Align
		Total	89	TMU		
F - REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE						
Clear Vice		HA80	34			
		Total	34	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>G - REMOVE LARGE OR HEAVY PART FROM THE BENCH VICE</u>						
			18	HA15	}	Into Vice
			29	TB80		
		Total	47	TMU		
<u>H - ADJUST PIPE VICE OPENING APPROXIMATELY 1" (1/8" PER REVOLUTION)</u>						
			34	HA80		Handle
			128	8TA80		Open
		Total	162	TMU		
<u>J - OPEN PIPE VICE FRAME</u>						
			34	HA80		Obtain Dog
			7	TA15		
			16	TA80		Release Dog
		Total	57	TMU		
<u>L - CLOSE PIPE VICE FRAME</u>						
			34	HA80		Close
		Total	34	TMU		
<u>M - PLACE SMALL SECTION OF PIPE (<math>\leq 6'-0"</math> LONG) INTO PIPE VICE</u>						
To Vice		TA80	16			
Into Vice		TA15	7			
		Total	23	TMU		
<u>P - PLACE LARGE SECTION OF PIPE (<math>&gt; 6'-0"</math> LONG) INTO PIPE VICE</u>						
Assist RH	{	HA80	34	HA80	}	Into Vice
		HA15	18	HA15		
		TA15	7	TA15		
		Total	59	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND	
<u>R - REMOVE SMALL SECTION OF PIPE (<math>\leq 6'-0''</math> LONG) FROM PIPE VICE</u>							
Remove		HA80	34	TMU			
		Total	34				
<u>S - REMOVE LARGE SECTION OF PIPE (<math>&gt; 6'-0''</math> LONG) FROM PIPE VICE</u>							
Assist RH		HA80	34	HA80		Remove	
		Total	34	TMU			
<u>T - ADJUST C-CLAMP 1" (2" TO 6" CLAMP - AVERAGE 4")</u>							
			34	HA80			
			112	TTA80			
			Total	146			TMU
<u>U - ADJUST C-CLAMP 3" (8" CLAMP AND OVER - 12" AVERAGE)</u>							
			34	HA80		} Adjust	
			345	23C			
			Total	379			TMU
<u>V - PLACE C-CLAMP AND ALIGN (2" - 6" CLAMP EASY TO PLACE)</u>							
			29	TB80		1st Clamp	
			21	TB15		2nd Clamp	
			21	TB15		Realign & Clamp	
			Total	71		TMU	
<u>W - PLACE C-CLAMP AND ALIGN (2" TO 6" CLAMP, DIFFICULT TO PLACE)</u>							
			29	TB80	2	} Initial Clamp (2) Ends	
			21	TB15			
			96	HB15		Align	
			Total	146		TMU	

DESCRIPTION -LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION -RIGHT HAND	
<u>X - REMOVE 2" TO 6" CLAMP FROM PART</u>							
			18	HA80	}	Remove	
			7	TA80			
		Total	25	TMU			
<u>Y - PLACE C-CLAMP AND ALIGN (8" CLAMP AND OVER) EASY TO PLACE</u>							
			48	HB80		1st Clamp	
			21	TB15		2nd Clamp	
			18	HA15	}	Locate 2nd End	
			34	HB15			
		Total	118	TMU			
<u>Z - PLACE C-CLAMP AND ALIGN (8" CLAMP AND OVER) DIFFICULT TO PLACE</u>							
			48	HB80		1st Clamp	
			21	TB15		2nd Clamp	
			36	HB15	2	}	Locate 2nd End
			68	HB15	2		
		Total	173	TMU			
<u>AA - ADJUST WOOD HAND-SCREW CLAMP APPROXIMATELY L" (1/16" PER REVOLUTION)</u>							
		HA80	34				
		7TA80	112				
		Total	146	TMU			
<u>AB - PLACE WOOD HAND-SCREW CLAMP</u>							
Assist RH		T-	29	TB80		Clamp to Part Into Clamp	
		T-	7	TA15			
		Total	36	TMU			

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
<u>AD - ADJUST ONE SIDE OF WOOD HAND-SCREW</u>			<u>(ONE REVOLUTION)</u>			
			36	2HA15		
		Total	36	TMU		
<u>AE - LOOSEN AND TIGHTEN ONE HAND SCREW</u>						
			18	HA15		Initial Tighten Set
			7	TA15		
		Total	25	TMU		
<u>AF - ATTACH SPRING CLAMP</u>						
			16	TA80		} To Part and Open Clamp
			7	TA15		
			21	TB15		
			7	TA15		
		Total	51	TMU		Locate Close
<u>AG - REMOVE SPRING CLAMP</u>						
			18	HA15		Open Remove
			34	HA80		
		Total	52	TMU		
<u>AH - CLOSE VICE GRIP PLIERS FOR GAUGING OPENING</u>						
			18	HA15		Close Pliers To Part
			29	TB80		
		Total	47	TMU		
<u>AJ - TURN ADJUSTING SCREW ONE REVOLUTION</u>						
			102	HA80	3	
		Total	102	TMU		

DESCRIPTION - LEFT HAND	No.	LH	TMU	RH	No.	DESCRIPTION - RIGHT HAND
AL - PLACE VICE GRIP PLIER TO PART AND CLOSE						
			18	HA15		Open Pliers To Part Close Pliers
			21	TB15		
			7	TA15		
		Total	46	TMU		
AM - OPEN AND REMOVE VICE GRIP PLIERS						
Assist RH			18	HA15		Open Aside
			16	TA80		
		Total	34	TMU		

APPENDIX U: ANALYSIS OF WORK TASKS OBTAINED AWAY  
FROM TEST SITE USING SYSTEM II

There follows the development of standard data, based upon the simplified data system described earlier and identified as System II, for work tasks obtained away from the test site. The times are expressed in 0.01 minutes at 100 B.S.I. performance level.

Tool	Operation and Description		Symbol	0.01 Min.	
Vice (Bench, Pipe and Wood)	Assemble	Small Easy to Handle Part or Pipe ≤ 6'-0" Long	T16-II	13.088	
	Remove	Large or Heavy Part or Part > 6"-0" Long	T17-II	14.471	
SPRING CLAMP ASSEMBLE AND REMOVE			T18-II	3.586	
VICE GRIP PLIER	ASSEMBLE AND REMOVE		T19-II	11.980	
C-Clamp	Assemble	≤ 6"	Easy to Place Little or No Align.	T20-II	12.725
			Difficult to Place, More Exact- ing Align.	T21-II	14.417
			Easy to Place Little or No Align.	T22-II	23.233
			Difficult to Place, More Exact- ing Align.	T23-II	27.121
	Remove	All Classifica- tion		T24-II	4.402
Wood Hand- Screw Clamp	Assemble		T25-II	16.454	
	Remove		T26-II	7.878	

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T16-II		<u>VICE AND REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE, OR PIPE &lt; 6'-0" LONG</u>			
	K1	Vice and Remove Small Easy to Handle Part	16.456	1/2	8.228
	K3	Vice and Remove Small Section of Pipe (< 6'-0" Long)	9.719	1/2	4.860
				Total	13.088
T17-II		<u>VICE AND REMOVE LARGE OR HEAVY PART FROM BENCH VICE, OR PIPE &gt; 6'-0" Long</u>			
	K2	Vice and Remove Large or Heavy Part from Vice	18.545	1/2	9.273
	K4	Vice and Remove Large Section of Pipe (> 6'-0" long)	10.396	1/2	5.198
				Total	14.471
T18-II		<u>ASSEMBLE AND REMOVE SPRING CLAMP</u>			
	AF	Assemble Spring Clamp			2.450
	AG	Remove Spring Clamp			1.136
				Total	3.586
T19-II		<u>ASSEMBLE AND REMOVE VICE-GRIP PLIERS</u>			
	AH	Close Pliers for Gauging			1.642
	AJ	Adjust Screw: (2) Revolutions	1.703	2	3.406
	AL	Try Vice-Pliers Over Part			2.101
	AJ	Additional Adjustment			1.703
	AL	Move and Close Pliers			2.101
	AM	Remove Pliers			1.027
				Total	11.980

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T20-II	<u>ASSEMBLE EASY TO PLACE C-CLAMP WITH SOME ALIGNMENT (2" - 6" CLAMP)</u>				
	T	Adjust Clamp 1"			3.779
	V	Place Clamp and Align			3.223
	T	Take up Slack in Clamp			3.779
	B	Tighten Clamp			1.944
				Total	12.725
T21-II	<u>ASSEMBLE DIFFICULT TO PLACE C-CLAMP WITH MORE EXACTING ALIGNMENT (2" - 6" CLAMP)</u>				
	T	Adjust Clamp			3.779
	W	Place Clamp and Align			1.027
	T	Take up Slack in Clamp			3.779
	B	Tighten Clamp		3	5.832
				Total	14.417
T22-II	<u>ASSEMBLE EASY TO PLACE CLAMP WITH SOME ALIGNMENT (8" AND OVER CLAMP)</u>				
	U	Adjust Cl-Clamp 3"			11.118
	Y	Place C-Clamp and Align			6.465
	U	Take up Slack		1/3	3.706
	B	Tighten			1.944
				Total	23.233
T23-II	<u>ASSEMBLE DIFFICULT TO PLACE C-CLAMP WITH MORE EXACTING ALIGNMENT (8" AND OVER CLAMP)</u>				
	U	Adjust C-Clamp			11.118
	Y	Place C-Clamp and Align			6.465
	U	Take up Slack		1/3	3.706
	B	Tighten Clamp and Loosen Once to Complete Alignment	1.944	3	5.832
				Total	27.121

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T24-II	<u>REMOVE C-CLAMP</u>				
	B	Loosen Clamp			1.944
	T	Run Screw Out 1/2" Approx.	3.779	1/2	1.890
	R	Remove Clamp			0.568
				Total	4.402
T25-II	<u>ASSEMBLE WOOD HAND-SCREW CLAMP (TWIN SCREWDRIVER TYPE HANDLES)</u>				
	AA	Adjust Wood Hand Screw Jack			3.779
	AB	Place Clamp to Part			1.533
	AD	Adjust (2) Hand Screws (3) Revs Each	1.136	6	6.816
	AD	Adjust (2) Hand Screws Approx (1) Rev. Each for Jaw Alignment	1.136	2	2.272
	AE	Tighten Each Hand Screw	1.027	2	2.054
				Total	16.454
T26-II	<u>REMOVE WOOD HAND-SCREW CLAMP</u>				
	AE	Loosen Each Hand Screw	1.027	2	2.054
	AD	Open Each Hand Screw Approx. 1-1/2 Revs.	1.136	3	3.408
	F	Remove Clamp from Part			2.416
				Total	7.878
K1	<u>VICE AND REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE</u>				
	A	Adjust Opening			5.155
	D	Place Small Part into Vice			2.419
	B	Tighten and Loosen Vice	1.944	2	3.888
	A	Adjust Vice Opening Before Tightening and After Loosening	5.155	1/2	2.578
	F	Remove Small Part from Vice			2.416
				Total	16.456

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
K2		<u>VICE</u> AND REMOVE LARGE OR HEAVY PART FROM BENCH		<u>VICE</u>	
	A	Adjust Vice Open			5.155
	E	Place Part into Vice			5.282
	B	Tighten and Later Loosen	1.944	2	3.888
	A	Adjust Vice Opening Before Tightening and After Loosening	5.155	1/2	2.578
	G	Remove Large Part from Vice			1.642
				Total	18.545
K3		<u>VICE</u> AND REMOVE SMALL SECTION OF PIPE (< 6'-0" LONG) FROM <u>PIPE</u> <u>VICE</u>			
	M	Pipe into Vice			0.917
	L	Close Pipe Vice			0.568
	H	Adjust Jaws, Close and Later Open			4.237
	B	Tighten and Later Loosen Vice			1.944
	J	Open Pipe Vice			1.485
	R	Remove Pipe			0.568
				Total	9.719
K4		<u>VICE</u> AND REMOVE LARGE SECTION OF PIPE (> 6'-0" LONG) FROM <u>PIPE</u> <u>VICE</u>			
	P	Large Section of Pipe into Vice			1.594
	L	Close Pipe Vice			0.568
	H	Adjust Jaws, Close, Open Later			4.237
	B	Tighten and Loosen Later			1.944
	J	Open Pipe Vice			1.485
	S	Remove Pipe from Vice			0.568
				Total	10.396

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
A	<u>ADJUST BENCH VICE OPENING: 2" APPROX. (3/16" PER REVOLUTION)</u>				
	Handle			1	
	Open	10			
	Freq.	10		1	
B	<u>TIGHTEN AND LOOSEN VICE</u>				
	First Tighten			1	
	Change Hold	1			
	Loosen	1			
D	<u>EASY TO HANDLE PART INTO VICE</u>				
	To Jaws		1		
	Into Jaws		1		
	Freq.		2		
E	<u>PLACE LARGE OR HEAVY PART INTO BENCH VICE</u>				
	Part into Vice				1
	Change Hold	1			
	Align				1
	Freq.	1			2
	Time	5.2819			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
F	<u>REMOVE SMALL EASY TO HANDLE PART FROM BENCH VICE</u>				
	Clear Vice			1	
	Freq.			1	
	Time	2.415			
G	<u>REMOVE LARGE OR HEAVY PART FROM THE BENCH VICE</u>				
			1	1	
	Freq.		1	1	
	Time	1.6421			
H	<u>ADJUST PIPE VICE OPENING APPROXIMATELY 1" (1/8" PER REV.)</u>				
	Handle			1	
	Open	8			
	Freq.	8		1	
J	<u>OPEN PIPE VICE FRAME</u>				
	Obtain Dog			1	
	Release Dog	1			
	Freq.	2		1	
L	<u>CLOSE PIPE VICE FRAME</u>				
	Close			1	
	Freq.			1	
	Time	0.5678			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
M	<u>PLACE SMALL SECTION OF PIPE (<math>\leq 6'-0"</math> LONG) INTO PIPE VICE</u>				
	To Vice	1			
	Into Vice	1			
	Freq.	2			
	Time	0.9174			
P	<u>PLACE LARGE SECTION OF PIPE (<math>&gt; 6'-0"</math> LONG) INTO PIPE VICE</u>				
				1	
				1	
		1			
	Freq.	1		2	
	Time	1.5943			
R	<u>REMOVE SMALL SECTION OF PIPE (<math>\leq 6'-0"</math> LONG) FROM PIPE</u>				
	Remove			1	
	Freq.			1	
	Time	0.5678			
S	<u>REMOVE LARGE SECTION OF PIPE (<math>&gt; 6'-0"</math> LONG) FROM PIPE VICE</u>				
	Remove			1	
	Freq.			1	
	Time	0.5678			
T	<u>ADJUST C-CLAMP 1" (2" - 6" CLAMP - AVERAGE 4")</u>				
		7		1	
	Freq.	7		1	
	Time	3.7787			

ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
U	<u>ADJUST C-CLAMP 3" (8" CLAMP AND OVER - 12" AVERAGE)</u>				
	Adjust	23		1	
	Freq.	23		1	
	Time	11.1179			
V	<u>PLACE C-CLAMP AND ALIGN (2" - 6" CLAMP: EASY TO PLACE)</u>				
	1st Clamp		1		
	2nd Clamp		1		
	Realign 2nd Clamp		1		
	Freq.		3		
X	<u>REMOVE 2" TO 6" CLAMP FROM PART</u>				
	Remove	1		1	
	Freq.	1		1	
	Time	1.0265			
Y	<u>PLACE C-CLAMP AND ALIGN (8" CLAMP AND OVER) EASY TO PLACE</u>				
	1st Clamp				1
	2nd Clamp		1		
	Locate 2nd End			1	1
	Freq.		1	1	2
	Time	6.4653			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
Z	<u>PLACE C-CLAMP AND ALIGN (8" CLAMP AND OVER) PLACE</u>	DIFFICULT TO			
	1st Clamp				1
	2nd Clamp		1		
	Locate 2nd End			2	
					2
AA	Freq.		1	2	3
	Time	9.4447			
	<u>ADJUST WOOD HAND-SCREW CLAMP APPROXIMATELY 1" (1/16" PER REV.)</u>				
				1	
AB		7			
	Freq.	7		1	
	Time	3.7787			
	<u>PLACE WOOD HAND-SCREW CLAMP</u>				
AD	Clamp to Part		1		
	Into Clamp	1			
	Freq.	1	1		
	Time	1.533			
AD	<u>ADJUST ONE SIDE OF WOOD HAND-SCREW (ONE REVOLUTION)</u>				
	Adjust			2	
	Freq.			2	
	Time	1.1356			

## ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
AE	<u>LOOSEN AND TIGHTEN HAND-SCREWS</u>				
	Initial Tighten			1	
	Set	1			
	Freq.	1		1	
	Time	1.0265			
AF	<u>ATTACH SPRING CLAMP</u>				
	To Part and Open Clamp	1			
		1			
	Locate		1		
	Close	1			
	Freq.	3	1		
	Time	2.4504			
AG	<u>REMOVE SPRING CLAMP</u>				
	Open			1	
	Remove			1	
	Freq.			2	
	Time	1.1356			
AH	<u>CLOSE VICE GRIP PLIERS FOR GAUGING OPENING</u>				
	Close Pliers			1	
	To Part		1		
	Freq.		1	1	
	Time	1.6421			

# ANALYSIS SHEET: SYSTEM II

BLOCK TIME 0.01 MINS		0.4587	1.0743	0.5678	2.4116
EL.	DESCRIPTION	DA	DB	CA	CB
AJ	<u>TURN ADJUSTING SCREW ONE REVOLUTION</u>				
	Turn			3	
	Freq.			3	
	Time	1.7034			
AL	<u>PLACE VICE GRIP PLIER TO PART AND CLOSE</u>				
	Open Pliers			1	
	To Part		1		
	Close Pliers	1			
	Freq.	1	1	1	
	Time	2.1008			
AM	<u>OPEN AND REMOVE VICE GRIP PLIERS</u>				
	Open			1	
	Aside	1			
	Freq.	1		1	
	Time	1.0265			

APPENDIX V: ANALYSIS OF WORK TASKS OBTAINED AWAY  
FROM THE TEST SITE USING SYSTEM IV

There follows the development of standard data, based upon the simplified data system described earlier and identified as System IV, for work tasks obtained away from the test site. The times are expressed in 0.01 minutes at 100 B.S.I. performance level.

TOOL	OPERATION AND DESCRIPTION			SYMBOL	0.01 MIN
Vice (Bench, Pipe and Wood)	Assemble <u>and</u> Remove	Small Easy to handle part on or tube ≤ 6'-0" Long		T16-IV	12.128
		Large or Heavy Part or Part > 6'-0" Long		T17-IV	13.187
Spring Clamp	Assemble and Remove			T18-IV	3.527
Vice Grip Plier	Assemble and Remove			T19-IV	14.658
C-Clamp	Assemble	≤ 6"	Easy to place little or no alignment	T20-IV	12.381
			Difficult to place, more exacting align	T21-IV	20.687
		> 6"	Easy to place little or no alignment	T22-IV	19.431
			Difficult to place, more exacting align	T23-IV	24.683
	Remove	All Classifications		T24-IV	4.888
	Wood Hand- screw Clamp	Assemble			T25-IV
Remove			T26-IV	9.845	

## SYNTHESIS

Sym.	Ref.	Description	Elem. O.OI mins.	Freq.	Total O.OI mins.
T16-IV	<u>Vice and Remove Small Easy to Handle Part From Bench Vice, or Pipe &lt; 6'-0" Long</u>				
	K1	Vice and Remove Small Easy to Handle Part	14.957	1/2	7.479
	K3	Vice and Remove Small Section of Pipe (56'-0" long)	9.297	1/2	4.649
	Total				12.128
T17-IV	<u>Vice and Remove Large or Heavy Part From Bench Vice, or Pipe &gt; 6'-0" Long</u>				
	K2	Vice and Remove Large or Heavy Part from Vice	16.651	1/2	8.326
	K4	Vice and Remove Large Section of Pipe (> 6'-0" long)	9.721	1/2	4.861
	Total				13.187
T18-IV	<u>Assemble and Remove Spring Clamp</u>				
	AF	Assemble Spring Clamp			2.453
	AG	Remove Spring Clamp			1.074
	Total				3.527

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T19-IV	<u>Assemble and Remove Vice-Grip Pliers</u>		0.749	2	
	AH	Close Pliers for Gauging			3.328
	AJ	Adjust Screw: (2) Revolutions			1.498
	AL	Try Vice-pliers Over Part			3.779
	AJ	Additional Adjustment			0.749
	AL	Move and Close Pliers			3.779
	AM	Remove Pliers			1.525
Total					14.658
T20-IV	<u>Assemble Easy to Place C-Clamp With Some Alignment (2"-6" Clamp)</u>				
	T	Adjust Clamp 1"			3.025
	V	Place Clamp and Align			3.705
	T	Take up Slack in Clamp			3.025
	B	Tighten Clamp			2.626
Total					12.381
T21-IV	<u>Assemble Difficult to Place C-Clamp With More Exacting Alignment (2"-6" Clamp)</u>				
	T	Adjust Clamp			3.025
	W	Place Clamp and Align			6.759
	T	Take up Slack in Clamp			3.025
	B	Tighten Clamp	2.626	3	7.878
Total					20.687

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T22-IV	<u>Assemble Easy to Place Clamp With Some Alignment (8" and Over Clamp)</u>				
	U	Adjust C-Clamp 3"			8.061
	Y	Place C-Clamp and Align			6.057
	U	Take up Slack	8.061	1/3	2.687
	B	Tighten			2.626
		Total			19.431
T23-IV	<u>Assemble Difficult to Place C-Clamp With More Exacting Alignment (8' and Over Clamp)</u>				
	U	Adjust C-Clamp			8.061
	Y	Place C-Clamp and Align			6.057
	U	Take up Slack	8.061	1/3	2.687
	B	Tighten Clamp and Loosen Once to Complete Alignment	2.626	3	7.878
		Total			24.683
T24-IV	<u>Remove C-Clamp</u>				
	B	Loosen Clamp			2.626
	T	Run Screw Out 1/2" Approx.	3.025	1/2	1.513
	R	Remove Clamp			0.749
		Total			4.888

# SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
T25-IV	<u>Assemble Wood Hand-Screw Clamp. (Twin Screwdriver Type Handset)</u>				
	AA	Adjust Wood Hand Screw Jack			0.650
	AB	Place Clamp to Part			1.803
	AD	Adjust (2) Hand Screws (3) Rev. each	1.498	6	8.988
	AD	Adjust (2) Hand Screw Approx. (1) Rev. each for Jaw Alignment	1.498	2	2.996
	AE	Tighten Each Hand Screw	2.301	2	4.602
		Total			19.039
T26-IV	<u>Remove Wood Hand-Screw Clamp</u>				
	AE	Loosen Each Hand Screw	2.301	2	4.602
	AD	Open Each Hand Screw Approx. 1½ Revs.	1.498	3	4.494
	F	Remove Clamp from Part			0.749
		Total			9.845

## SYNTHESIS

Sym.	Ref.	Description	Elem. TMU	Freq.	Total TMU
K1	<u>Vice and Remove Small Easy to Handle Part From Bench Vice</u>				
	A	Adjust Opening			4.000
	D	Place Small Part into Vice			2.956
	B	Tighten and Loosen Vice	2.626	2	5.252
	A	Adjust Vice Opening before Tightening and After Loosening	4.000	1/2	2.000
	F	Remove Small Part from Vice			0.749
		Total			14.957
K2	<u>Vice and Remove Large or Heavy Part From Bench Vice</u>				
	A	Adjust Vice Open			4.000
	E	Place Part into Vice			3.380
	B	Tighten and Later Loosen	2.626	2	5.252
	A	Adjust Vice Opening Before Tightening and After Loosening	4.000	1/2	2.000
	G	Remove Large Part from Vice			2.019
		Total			16.651



# ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
A	<u>Adjust Bench Vice Opening</u> <u>Approx. 1" (3/16" per rev.)</u>							
	Handle		1					
	Crank Open				11			
	Freq.		1		11			
	Time	3.9998						
B	<u>Tighten and Loosen Vice</u>							
	1st Tighten		1					
	Final Tighten				1			2
	Freq.		1		2			2
	Time	2.6259						
D.	<u>Easy to Handle Part Nuts</u> <u>Bench Via</u>							
	Part to Jaws						1	
	Into Jaws						1	
	Freq.						2	
	Time	2.9550						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
E	<u>Place Large or Heavy Part into Bench Vice</u>							
	Part into Vice						1	
	Change Hold		1				1	
	Align							
	Freq.		1				2	
	Time	3.37	97					
F	<u>Remove Small, Easy to Handle Part from Bench Vice</u>							
	Obtain		1					
	Aside				1			
	Freq.		1		1			
	Time	0.74	88					
G	<u>Remove Large or Heavy Part from Bench Vice</u>							
	Obtain Correct Holds		1					
			1					
			1					
			1					
	Remove from Vice							1
	Freq.		4			1		1
	Time	2.01	91					

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
H	<u>Adjust Pipe Vice Opening</u> <u>Approx. 1". (1/8" per rev.)</u>							
	Handle		1					
	Crank Open				8			
	Freq.		1		8			
	Time	3.0245						
J	<u>Open Pipe Vice Frame</u>							
	Obtain Dog		1					
					1			
	Release Dog		1		1			
	Freq.		2		2			
	Time	1.4976						
L.	<u>Close Pipe Vice Frame</u>							
	Close		1		1			
	Freq.		1		1			
	Time	0.7488						
M	<u>Place Small Section of Pipe</u> <u>(≤ 6'-0" long) into Pipe Vice</u>							
					1			
					1			
	Freq.				2			
	Time	0.6502						

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
P	<u>Place Large Section of Pipe</u> <u>(&gt; 6'-0" long) Into Pipe Vice</u>							
	Into Vice				1			
	Slide in		1		1			
	Freq.		1		2			
	Time	1.0739						
R	<u>Remove Small Section of Pipe</u> <u>(&lt; 6'-0" long)</u>							
	Remove		1		1			
	Freq.		1		1			
	Time	0.7488						
S	<u>Remove Large Section of Pipe</u> <u>(&gt; 6'-0" long)</u>							
	Remove		1		1			
	Freq.		1		1			
	Time	0.7488						
T	<u>Adjust C-Clamp (2" to 6"</u> <u>Clamp - Average 4")</u>							
			1		8			
	Freq.		1		8			
	Time	3.0245						

ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
U	<u>Adjust C-Clamp 3" (8" Clamp and Over - 12" Average)</u>							
	Adjust	1			24			
	Freq.	1			24			
V	Time	8.06	06					
	<u>Place C-Clamp and Align (2" - 6" Clamp) Easy to Place</u>							
	1st Clamp				1			
	2nd Clamp						1	
	Set 2nd Clamp		1				1	
	Freq.		1		1		2	
W	Time	3.70	48					
	<u>Place C- Clamp and Align (2" to 6" Clamp) Difficult to Place</u>							
	1st Clamp						1	
	2nd Clamp						1	
	Set 2nd Clamp		2				2	
	Freq.		2				4	
	Time	6.75	94					

ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
X	<u>Remove 2" to 6" Clamp From Part</u>							
	Remove		1		1			
	Freq.		1		1			
	Time	0.74	88					
Y	<u>Place C- Clamp and Align</u> <u>(8" Clamp and Over) Easy to</u> <u>Align</u>							
	1st Clamp		1				1	
	2nd Clamp						1	
	Set 2nd Clamp and Align		1					1
	Freq.		2				3	1
	Time	6.05	74					
Z	<u>Place C-Clamp and Align</u> <u>(8" Clamp and Over) Difficult</u> <u>to Place</u>							
	Initial Place - (2) Ends		1				1	
	Align and Locate		2				1	
			2					2
	Freq.		5				4	2
	Time	9.58	25					

## ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AA	<u>Adjust Wood Hand-Screw Clamp</u> Approx. 1" (1/16" per rev.)							
	Adjust				1			
					1			
	Freq.				2			
AB								
	Time	0.6502						
	<u>Place Wood Hand-Screw Clamp</u> Clamp to Part Into Clamp							
					1		1	
AD								
	Freq.				1		1	
	Time	1.8031						
	<u>Adjust One Side of Wood Hand-Screw Clamp (One Revolution)</u> Adjust - Screw							
AE					2			
	Freq.		2		2			
	Time	1.4976						
	<u>Loosen or Tighten One Hand Screw</u>							
			1					
					1			1
	Freq.		1		1			2
	Time	2.3008						

# ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AF	<u>Attach Spring Clamp</u>							
	To Part: Open Clamp				1			
	Clamp onto Part				1		1	
	Close				1			
	Freq.				3		1	
AG	<u>Remove Spring Clamp</u>							
	Open Clamp		1					
	Remove Clmap				1			
	Freq.		1		2			
	Time	2.45	33					
AH	<u>Close Vice Grip Piers for Gauging Opening</u>							
	Pliers to RH				1			
	Close Pliers				1			1
	Pliers to Part						1	
	Adjusting Screw		1					
	Freq.		1		2		1	1
	Time	3.32	79					

# ANALYSIS SHEET: SYSTEM IV

BLOCK TIME 0.01 MINS.		0.2582	0.4237	0.9961	0.3251	0.3957	1.4780	0.7760
EL.	DESCRIPTION	OA	OB	OC	LA	LB	LC	S
AJ	<u>Turn Adjusting Screw One Revolution</u>							
	Turn		1		1			
	Freq.		1		1			
	Time	0.74	88					
AL	<u>Place Vice Grip Plier to Part and Close</u>							
	Open Pliers		1					1
	Close Pliers				1		1	1
	Freq.		1		1		1	2
	Time	3.77	88					
AM	<u>Open and Remove Vice Grip Pliers</u>							
	Open		1					1
	Tool Away				1			
	Freq.		1		1			1
	Time	1.52	48					

