



PROGRAM : BACHELOR OF ENGINEERING TECHNOLOGY
INDUSTRIAL ENGINEERING TECHNOLOGY

SUBJECT : **ENGINEERING WORK STUDY IB**

CODE : **EWSMIB1**

DATE : SUPPLEMENTARY EXAMINATIONS 2020
10 JANUARY 2020

DURATION : 8:00AM – 11:00AM

WEIGHT : 40 : 60

TOTAL MARKS : 100

EXAMINER : MRS R STEENKAMP

MODERATOR : MR A BALOYI

NUMBER OF PAGES : 6 PAGES
ANNEXURES 5 PAGES

REQUIREMENTS : STUDENTS MAY USE CALCULATORS

INSTRUCTIONS TO CANDIDATES:

PLEASE ANSWER ALL THE QUESTIONS.
IF REQUIRED MAKE REALISTIC ASSUMPTIONS

QUESTION 1

1.1.

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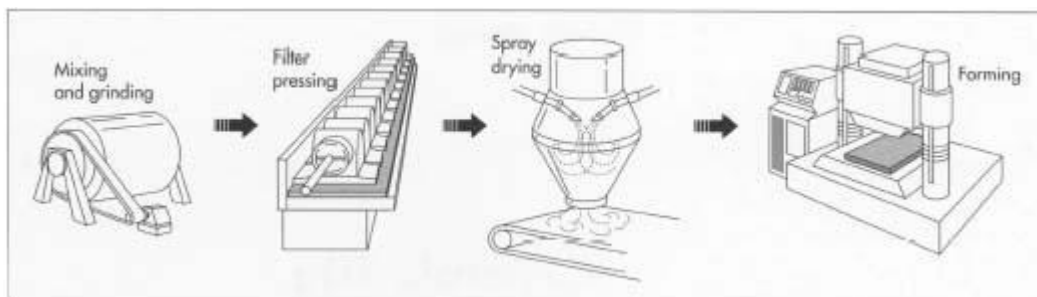
raw a single column process chart use Appendix 1:

Mrs Chauke is going to the bank to change her bank account. She leaves her vehicle and walks to the bank's front door. She enters the bank and goes to the information desk to find out who she should see to have her account changed. The desk refers her to a consultant and she takes a number and sits down until she is called. Once called she walks to the consultant's desk sits down and discussed business with the consultant, she signs several forms and checks all the detail on the form. Once everything is signed the consultant finalizes the change and provides her with a new card and instructions of how to activate the card. Mrs Chauke returns to her vehicle and leaves.

[18]

QUESTION 2

Tileafrica is a company that manufactures ceramic tiles. One of their lines produces two types of tiles. As the industrial engineer you have been tasked to create a value stream map for the current process. The information that has been gathered is as follows. They operate 20 days per month and they send a shipment per week to Ital-tile distribution centre.



The external customer is Italtile

Italtile is an outlet that sells various types of tiles. They order two different types of ceramic tiles from Tileafrica. They sell 250 000 tiles per month, 125 000 of each type.

The supplier: AIMR

The supplier of raw kaolin as well as other minerals and raw materials for the manufacturing of ceramic tiles. AIMR delivers a week's inventory on Monday mornings based on an order placed Friday afternoon. The materials are delivered by truck.

Tileafrica's planning and control department

The planning and control department receives weekly firm orders from Italtile. Italtile provides a three and six month forecast. They interpret these orders using a MRP system they issue raw material orders and forecasts to AIMR (the supplier). Firm orders are placed once a week and 2 and 6 month forecasts are also sent to the supplier. The

MRP system is also used to schedule each workstation in the factory. They issue weekly work orders to each department early on Monday mornings. They work 8 hours per day, they have two 10 minute breaks and a 30 min lunch.

Value stream information

The manufacturing of tiles consists of five major processes. Mixing and grinding of raw materials. Ingredients are weighed, they are added together into an intensive mixer. This grinds the ingredients further, resulting in a finer particle size that improves the subsequent forming process. Most tile is formed by dry pressing. In this method, the free flowing powder—containing organic binder or a low percentage of moisture—flows from a hopper into the forming die. The material is compressed in a steel cavity.

1. Mixing and grinding. The cycle time is 7 minutes. There is no change over time. The machine reliability is 80%. There are three operators overseeing this process. Observed inventory is 1 week's raw materials before workstation 1. There is enough ground material to make 60 000 tiles.

2. Dry Pressing. The material is compressed in a steel cavity by steel plungers and is then ejected by the bottom plunger. Two operators are responsible for this machine. The cycle time is 40seconds. The change over time is 15 min. Machine reliability is 95%. Observed Inventory 50 000 compressed tiles of each type is available after the dry pressing.

3. Drying. Ceramic tile usually must be dried (at high relative humidity) after forming. Drying removes the water at a slow enough rate to prevent shrinkage cracks. Continuous or tunnel driers are used that are heated using gas or oil, infrared lamps, or microwave energy. One operator oversees this process. The cycle time is 48 hours. There is no change over time. The reliability is 85%. Observed inventory is 66 000 type one tile and 55 000 type two tiles.

4. Glazing. Similar methods are used as for the tile body. Raw materials are weighed, mixed and dry or wet milled. The milled glazes are then applied. The cycle time is 2 minutes and the changeover time is 15 minutes. Reliability is 90%. There are four operators responsible for this process. Observed inventory is 88 000 tile 1 and 80 000 tile 2.

5. Firing. After glazing, the tile must be heated intensely to strengthen it and give it the desired porosity. Kilns, are used for firing tile. The firing temperatures are around 1,300 degrees Celsius. There are four operators responsible for firing. Cycle time is 5 hours and the changeover time is 20 minutes. Reliability is 80%.

6. Shipping department

The shipping department removes parts from the finished goods warehouse according to orders tiles are shipped by truck.

- | | | |
|------|---|-------------|
| 2.1. | Draw the Value Stream map | (18) |
| 2.2. | Solve the Takt time. | (2) |
| 2.3. | Make a suggestion as to how to improve the process? | (2) |
| | | [22] |
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QUESTION 3

Apply the PTS system to the following sub-assembly of a chair. Chair legs are in container 2m from the work area. The chair rails are in a container next to the chair legs. The diameter of the chair legs and rails are larger than 20mm. The operator collects a leg and two rails from the containers. The operators grasps each with one hand and then transfers them to the other hand. When the operator stands in front of the containers he has to reach 20 cm but he does not have to bend. The operator then moves back to the working area and lays the rails and leg on the work surface assuming he stand 30cm from the work surface.

[12]**QUESTION 4**

	Ratin g	Time	Rest allow ance	Elem ent	Ratin g	Time
Element 1	110	4	5%	Element 1	100	5
Element 2	90	17	7%	Element 2	95	16.2
Element 3	120	3	4%	Element 3	105	5
Element 4	95	11	5%	Element 4	90	12
Element 5	95	9.9	10%	Element 5	90	10
Element 1	95	5.5		Element 1	105	4.5
Element 2	95	16		Element 2	90	16.8
Element 3	110	3.7		Element 3	105	4.2
Element 4	85	12.3		Element 4	95	11.5
Element 5	105	8.7		Element 5	110	8
Element 1	90	6				
Element 2	85	17.7				
Element 3	105	4.1				
Element 4	80	12.9				
Element 5	100	9				

The contingency allowance is 5% and process allowance is 10%

5.1. Solve representative basic time.

(10)

5.2. Determine allowed time.

(2)

[21]

QUESTION 5

SAB decided to use the 20 Keys as a replacement to their previous Quality Audit performed at all their packaging suppliers. The 20 Keys benchmarking system was perceived as more objective and would change a supplier's paradigm on World Class Manufacturing standards.

The supplier found that housekeeping improved and this reduced risk to the company. It was found that by encouraging employees to increase suggestions for improvements unexpected improvements were realised. This led to reduced customer complaints as well as reduced customer claims

Suggestion boxes were made available for obtaining ideas for improvement. It was found that suggestion boxes might be useful if you use it for comments about a new product name, or proposals for a new menu in the canteen, but it is not effective at all for generating ideas for operations improvement.

Improvements in general and sustainable improvements in particular were problematic areas, improvements could come from only one (or any combination) of the following three aspects:

1. Technical improvements – such as new technology or automation. 2. Process improvements – covering aspects such as quick change-overs, modapts/work study, waste elimination and many more techniques. 3. Attitude improvements – such as motivational leadership and teamwork.

5.1. What are the first 7 keys you would implement, or improve and briefly discuss each?

[14]

QUESTION 6

Ergonomic Risk Factors

Excessive force was needed to move heavy material on the rolling pallet from under the rack. The rolling pallet was not easily pulled and manipulated, causing awkward

postures to compensate for it. Workers needed to apply excessive force to pull pallets and sometimes pulled in an awkward position.

6.1 Make three suggestions to improve this process

[6]

QUESTION 7

You are analysing the working time of an injection moulding operator, you need to determine how many observations you need to make. A preliminary study found that the operator is idle 15% of the time. If you are required to provide data with an error of 7% and a Confidence interval of 95% find the number of observations required.

7.1. Use the statistical method. (5)

7.2 Use a nomogram to determine the number of observations given that you now require a 99.9% confidence interval. (2)

[7]

TOTAL: 100
FULL MARKS: 100

Appendix 1

[illegible]

Appendix 2**PREDETERMINED TIME STANDARDS****Table 24. Methods-Time Measurement application data in tmu (Based metric weights and measures)****I. REACH — R**

Distance (cm)	Time (tmu)				Hand in motion		Case and description
	A	B	C or D	E	A	B	
2 or less	2.0	2.0	2.0	2.0	1.6	1.6	A. Reach to object in fixed location, or to object in other hand or on which other hand rests
4	3.4	3.4	5.1	3.2	3.0	2.4	
6	4.5	4.5	6.5	4.4	3.9	3.1	
8	5.5	5.5	7.5	5.5	4.6	3.7	
10	6.1	6.3	8.4	6.8	4.9	4.3	
12	6.4	7.4	9.1	7.3	5.2	4.8	B. Reach to single object in location which may vary slightly from cycle to cycle
14	6.8	8.2	9.7	7.8	5.5	5.4	
16	7.1	8.8	10.3	8.2	5.8	5.9	
18	7.5	9.4	10.8	8.7	6.1	6.5	
20	7.8	10.0	11.4	9.2	6.5	7.1	
22	8.1	10.5	11.9	9.7	6.8	7.7	C. Reach to object jumbled with other objects in a group so that search and select occur
24	8.5	11.1	12.5	10.2	7.1	8.2	
26	8.8	11.7	13.0	10.7	7.4	8.8	
28	9.2	12.2	13.6	11.2	7.7	9.4	
30	9.5	12.8	14.1	11.7	8.0	9.9	
35	10.4	14.2	15.5	12.9	8.8	11.4	D. Reach to a very small object or where accurate grasp is required
40	11.3	15.6	16.8	14.1	9.6	12.8	
45	12.1	17.0	18.2	15.3	10.4	14.2	
50	13.0	18.4	19.6	16.5	11.2	15.7	
55	13.9	19.8	20.9	17.8	12.0	17.1	
60	14.7	21.2	22.3	19.0	12.8	18.5	E. Reach to indefinite location to get hand in position for body balance or next motion or out of way
65	15.6	22.6	23.6	20.2	13.5	19.9	
70	16.5	24.1	25.0	21.4	14.3	21.4	
75	17.3	25.5	26.4	22.6	15.1	22.8	
80	18.2	26.9	27.7	23.9	15.9	24.2	

Engineering Work Study
 Project: **Measure Time Standards**

III. TURN--T

Weight (lb)	Time (sec) for degrees turned									
	20°	45°	60°	75°	90°	105°	120°	135°	150°	180°
Small (0) to (1)	2.8	3.5	4.1	4.8	5.4	6.1	6.8	7.4	8.1	8.7
Medium (1) to (5)	4.4	5.5	6.5	7.5	8.5	9.6	10.6	11.5	12.7	13.7
Large (5.1) to (15)	8.4	10.5	12.3	14.4	16.2	18.3	20.4	22.2	24.3	26.1

III. APPLY PRESSURE--AP

Symbol	Unit	Description	Conversion			Remarks
			Symbol	Unit	Remarks	
APA	10.5	AP + DM + RLF	AP	3.4	Apply force	
			DM	4.2	Dwell, minimum	
APB	16.2	APA + Q2	RLF	3.0	Release force	

Engineering Work Study
 Project: **Measure Time Standards**

B. MOVE--M

Distance (ft)	Time (sec)			Weight (lb) up to	Time (sec)		Case and description
	A	B	C		Static friction	Dynamic friction	
2 or less	2.0	2.0	2.0	1	0	1.00	A. Move object against stop or to other hand
4	3.1	4.0	4.5	2	1.6	1.64	
6	4.1	5.0	5.8	4	2.6	1.07	
8	5.1	5.9	6.9	6	4.3	1.12	
10	6.0	6.8	7.9	8	5.8	1.17	B. Move object to approximate or indefinite location
12	6.9	7.7	8.8	10	7.3	1.22	
14	7.7	8.5	9.8	12	8.8	1.27	
16	8.3	9.2	10.5	14	10.4	1.32	
18	9.0	9.8	11.1	16	11.9	1.36	C. Move object to exact location
20	9.6	10.5	11.7	18	13.4	1.41	
22	10.2	11.2	12.4	20	14.9	1.46	
24	10.8	11.8	13.0	22	16.4	1.51	
26	11.5	12.3	13.7	24	17.9	1.56	
28	12.1	12.8	14.4	26	19.4	1.61	
30	12.7	13.3	15.1	28	20.9	1.66	
35	14.3	14.5	16.8	30	22.5	1.71	
40	15.8	15.6	18.5	35	25.2	1.82	
45	17.4	16.8	20.1	40	28.6	1.95	
50	19.0	18.0	21.8	45	32.0	2.09	
55	20.5	19.2	23.5	50	35.3	2.23	
60	22.1	20.4	25.2	55	38.6	2.37	
65	23.6	21.6	26.9	60	41.9	2.51	
70	25.2	22.8	28.6	65	45.2	2.65	
75	26.7	24.0	30.3	70	48.5	2.79	
80	28.3	25.2	32.0	75	51.8	2.93	
85	29.8	26.4	33.7	80	55.1	3.07	
90	31.3	27.6	35.4	85	58.4	3.21	
95	32.8	28.8	37.1	90	61.7	3.35	
100	34.3	30.0	38.8	95	65.0	3.49	
105	35.8	31.2	40.5	100	68.3	3.63	
110	37.3	32.4	42.2	105	71.6	3.77	
115	38.8	33.6	43.9	110	74.9	3.91	
120	40.3	34.8	45.6	115	78.2	4.05	
125	41.8	36.0	47.3	120	81.5	4.19	
130	43.3	37.2	49.0	125	84.8	4.33	
135	44.8	38.4	50.7	130	88.1	4.47	
140	46.3	39.6	52.4	135	91.4	4.61	
145	47.8	40.8	54.1	140	94.7	4.75	
150	49.3	42.0	55.8	145	98.0	4.89	
155	50.8	43.2	57.5	150	101.3	5.03	
160	52.3	44.4	59.2	155	104.6	5.17	
165	53.8	45.6	60.9	160	107.9	5.31	
170	55.3	46.8	62.6	165	111.2	5.45	
175	56.8	48.0	64.3	170	114.5	5.59	
180	58.3	49.2	66.0	175	117.8	5.73	
185	59.8	50.4	67.7	180	121.1	5.87	
190	61.3	51.6	69.4	185	124.4	6.01	
195	62.8	52.8	71.1	190	127.7	6.15	
200	64.3	54.0	72.8	195	131.0	6.29	
205	65.8	55.2	74.5	200	134.3	6.43	
210	67.3	56.4	76.2	205	137.6	6.57	
215	68.8	57.6	77.9	210	140.9	6.71	
220	70.3	58.8	79.6	215	144.2	6.85	
225	71.8	60.0	81.3	220	147.5	6.99	
230	73.3	61.2	83.0	225	150.8	7.13	
235	74.8	62.4	84.7	230	154.1	7.27	
240	76.3	63.6	86.4	235	157.4	7.41	
245	77.8	64.8	88.1	240	160.7	7.55	
250	79.3	66.0	89.8	245	164.0	7.69	
255	80.8	67.2	91.5	250	167.3	7.83	
260	82.3	68.4	93.2	255	170.6	7.97	
265	83.8	69.6	94.9	260	173.9	8.11	
270	85.3	70.8	96.6	265	177.2	8.25	
275	86.8	72.0	98.3	270	180.5	8.39	
280	88.3	73.2	100.0	275	183.8	8.53	
285	89.8	74.4	101.7	280	187.1	8.67	
290	91.3	75.6	103.4	285	190.4	8.81	
295	92.8	76.8	105.1	290	193.7	8.95	
300	94.3	78.0	106.8	295	197.0	9.09	
305	95.8	79.2	108.5	300	200.3	9.23	
310	97.3	80.4	110.2	305	203.6	9.37	
315	98.8	81.6	111.9	310	206.9	9.51	
320	100.3	82.8	113.6	315	210.2	9.65	
325	101.8	84.0	115.3	320	213.5	9.79	
330	103.3	85.2	117.0	325	216.8	9.93	
335	104.8	86.4	118.7	330	220.1	10.07	
340	106.3	87.6	120.4	335	223.4	10.21	
345	107.8	88.8	122.1	340	226.7	10.35	
350	109.3	90.0	123.8	345	230.0	10.49	
355	110.8	91.2	125.5	350	233.3	10.63	
360	112.3	92.4	127.2	355	236.6	10.77	
365	113.8	93.6	128.9	360	239.9	10.91	
370	115.3	94.8	130.6	365	243.2	11.05	
375	116.8	96.0	132.3	370	246.5	11.19	
380	118.3	97.2	134.0	375	249.8	11.33	
385	119.8	98.4	135.7	380	253.1	11.47	
390	121.3	99.6	137.4	385	256.4	11.61	
395	122.8	100.8	139.1	390	259.7	11.75	
400	124.3	102.0	140.8	395	263.0	11.89	
405	125.8	103.2	142.5	400	266.3	12.03	
410	127.3	104.4	144.2	405	269.6	12.17	
415	128.8	105.6	145.9	410	272.9	12.31	
420	130.3	106.8	147.6	415	276.2	12.45	
425	131.8	108.0	149.3	420	279.5	12.59	
430	133.3	109.2	151.0	425	282.8	12.73	
435	134.8	110.4	152.7	430	286.1	12.87	
440	136.3	111.6	154.4	435	289.4	13.01	
445	137.8	112.8	156.1	440	292.7	13.15	
450	139.3	114.0	157.8	445	296.0	13.29	
455	140.8	115.2	159.5	450	299.3	13.43	
460	142.3	116.4	161.2	455	302.6	13.57	
465	143.8	117.6	162.9	460	305.9	13.71	
470	145.3	118.8	164.6	465	309.2	13.85	
475	146.8	120.0	166.3	470	312.5	13.99	
480	148.3	121.2	168.0	475	315.8	14.13	
485	149.8	122.4	169.7	480	319.1	14.27	
490	151.3	123.6	171.4	485	322.4	14.41	
495	152.8	124.8	173.1	490	325.7	14.55	
500	154.3	126.0	174.8	495	329.0	14.69	
505	155.8	127.2	176.5	500	332.3	14.83	
510	157.3	128.4	178.2	505	335.6	14.97	
515	158.8	129.6	179.9	510	338.9	15.11	
520	160.3	130.8	181.6	515	342.2	15.25	
525	161.8	132.0	183.3	520	345.5	15.39	
530	163.3	133.2	185.0	525	348.8	15.53	
535	164.8	134.4	186.7	530	352.1	15.67	
540	166.3	135.6	188.4	535	355.4	15.81	
545	167.8	136.8	190.1	540	358.7	15.95	
550	169.3	138.0	191.8	545	362.0	16.09	
555	170.8	139.2	193.5	550	365.3	16.23	
560	172.3	140.4	195.2	555	368.6	16.37	
565	173.8	141.6	196.9	560	371.9	16.51	
570	175.3	142.8	198.6	565	375.2	16.65	
575	176.8	144.0	200.3	570	378.5	16.79	
580	178.3	145.2	202.0	575	381.8	16.93	
585	179.8	146.4	203.7	580	385.1	17.07	
590	181.3	147.6	205.4	585	388.4	17.21	
595	182.8	148.8	207.1	590	391.7	17.35	
600	184.3	150.0	208.8	595	395.0	17.49	
605	185.8	151.2	210.5	600	398.3	17.63	
610	187.3	152.4	212.2	605	401.6	17.77	
615	188.8	153.6	213.9	610	404.9	17.91	
620	190.3	154.8	215.6	615	408.2	18.05	
625	191.8	156.0	217.3	620	411.5	18.19	
630	193.3	157.2	219.0	625	414.8	18.33	
635	194.8	158.4	220.7	630	418.1	18.47	
640	196.3	159.6	222.4	635	421.4	18.61	
645	197.8	160.8	224.1	640	424.7	18.75	
650	199.3	162.0	225.8	645	428.0	18.89	
655	200.8	163.2	227.5	650	431.3	19.03	
660	202.3	164.4	229.2	655	434.6	19.17	
665	203.8	165.6	230.9	660	437.9	19.31	
670	205.3	166.8	232.6	665	441.2	19.45	
675	206.8	168.0	234.3	670	444.5	19.59	
680	208.3	169.2	236.0	675	447.8	19.73	
685	209.8	170.4	237.7	680	451.1	19.87	
690	211.3	171.6	239.4	685	454.4	20.01	
695	212.8	172.8	241.1	690	457.7	20.15	
700	214.3	174.0	242.8	695	461.0	20.29	
705	215.8	175.2	244.5	700	464.3	20.43	
710	217.3	176.4	246.2	705	467.6	20.57	
715	218.8	177.6	247.9	710	470.9	20.71	
720	220.3	178.8	249.6	715	474.2	20.85	
725	221.8	180.0	251.3	720	477.5	20.99	
730	223.3	181.2	253.0	725	480.8	21.13	
735	224.8	182.4	254.7	730	484.1	21.27	
740	226.3	183.6	256.4	735	487.4	21.41	
745	227.8	184.8	258.1	740	490.7	21.55	
750	229.3	186.0	259.8	745	494.0	21.69	
755	230.8	187.2	261.5	750	497.3	21.83	
760	232.3	188.4	263.2	755	500.6	21.97	
765	233.8	189.6	264.9	760	503.9	22.11	
770	235.3	190.8	266.6	765	507.2	22.25	
775	236.8	192.0	268.3	770	510.5	22.39	
780	238.3	193.2	270.0	775	513.8	22.53	
785	239.8	194.4	271.7	780	517.1	22.67	
790	241.3	195.6	273.4	785	520.4	22.81	
795	242.8	196.8	275.1	790	523.7	22.95	
800	244.3	198.0	276.8	795	527.0	23.09	
805	245.8	199.2	278.5	800	530.3	23.23	
810	247.3	200.4	280.2	805	533.6	23.37	
815	248.8	201.6	281.9	810	536.9	23.51	

PRESTANDARD TIME STANDARDS

Code	Time Band	Description
1	2.0	Normal release performed by opening fingers as independent motion
2	0	Contact release

VI. MESSAGE — D

Class of Effort	Time to handle	Difficult to handle
1. Loose — Very slight effort, blends with subsequent motion	4.0	5.7
2. Close — Normal effort, slight recoil	7.5	11.8
3. Tight — Considerable effort, hand recoils readily	22.9	34.7

VII. EYE TRAVEL AND EYE FOCUS — FT and FF

Eye travel time = $15.2 \times \sqrt{\frac{D}{T}}$ sec, with a minimum value of 20 sec

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 sec.

HUMAN MOTOR TOLERANCES STUDY

Code	Time Band	Description
1A	2.0	94% up grasp — small, medium or large object by itself, easily grasped
1B	3.5	Very small object or object lying close against a flat surface
1C	7.3	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter larger than 12 mm
1C2	8.7	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter 6 to 12 mm
1C3	10.6	Interference with grasp on bottom and one side of nearly cylindrical object. Diameter less than 6 mm
2	5.6	Regrasp
3	5.6	Transfer grasp
4A	7.3	Object jammed with other objects so search and select occur. Larger than 25 x 25 x 25 mm
4B	9.1	Object jammed with other objects so search and select occur. 6 x 6 x 3 mm to 25 x 25 x 25 mm
4C	12.9	Object jammed with other objects so search and select occur. Smaller than 6 x 6 x 3 mm
5	0	Contact, sliding or hook grasp

VI. POSITION — P

Class of Effort	Frequency	Grasp Difficulty	Difficult to handle
1. Loose — No pressure required	S	5.6	11.2
	SS	9.1	14.7
	NS	10.4	16.0
2. Close — Light pressure required	S	14.2	21.4
	SS	19.7	29.3
	NS	21.9	26.6
3. Tight — Heavy pressure required	S	43.0	40.6
	SS	48.5	52.1
	NS	47.8	53.4

*Chance of hand injury — 0 min. to 25 min.

Figure 91. Nomogram for determining number of observations

