

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1. Conclusion

According to the analysis of Nonconformity analysis and problem solving based on quality control and ergonomic approaches, we can get conclusion as follows:

1. Analyzing of quality control aspect and human aspect on nonconformity problem that had been done concluded that :

- The aspects of setting on machining process in general had stand on the requirement of setting. In other word machining setting problems were not exists during the machining process.
- The inconsistence of quality control on cutting tool condition, inspection and cleaning of katal and scraps had resulted nonconforming dimension (not meet the specification). So those activities was the main problem that should controlled by solution.

2. Analyzing on human posture based on human capability and limitation in conducting the work (body working load and body limitation) that had been done concluded that:

- The Highest workload had been occurred when operator comes up and down jig that result 1118 Newton and Cumulative trauma disorder conduct

on both activities (with high frequency and range of fluctuation (load range of 24.70 Newton increasing to 480.3 Newton and 20,70 to 1118 Newton) and over flexion condition had been indicated.

- Biomechanical graph result on inspection activities indicated over work load shares that will disturb the inspection process that give unstable of process quality, fatigue of work and injure in body segment and physiologies problem uncomforted situation of the process on cleaning activities was occur.
- Unduly heavy work had been classified on activities. It had been conduct in the over of human limitation risk to greatly occur the possible of fatigue quickly refer to human error and human body injured. Energy expenditure analysis result indicated that in 141.81 minute had been resulted very high total work load (769329.8092 Newton per day or 2927.0441 Newton per machining cycle). That force load value effect on the high expenditure of energy that is 18.5924 Kcal / minute. The actual resting time that less than the requirement of resting time calculation (actual = 60 minutes, recommended 126 minutes). The solution to solve it must be needed.

3. Evaluating the relationship and potential causes of Quality control and Ergonomic that influenced on existing nonconformity problem had been

concluded that Correlation of ergonomics and quality aspect on this case of study is situation of unergonomics of working environment cause high work load to body segment of operator in activity process its machinery and later then give the high expenditure energy. Fatigue and injured problems in some part of body had been occurred. Then become constraint to operator to done activities on quality control or quality operation like inspection and others, so some problems external influencing quality from process directing and influence the result from quality which in the end result the quality which is not expected.

6.2. Recommendation

The recommendation from this study are:

1. Improve the standard operational for reducing human error and physiology aspect on operator. This effort can support by standard procedural of the measurement process to improve the correctness of measurement, the use of coolant and machine setting.
2. Redesign jig facilities by analysis of anthropometric and biomechanics design support - problem solving of fatigue on biomechanics aspect design and anthropometry as human centred design.
3. Redesign the jig facilities with develop work safety device on it such as railings, ladders, levelling platform to improve the human posture during the machining process to reduce work load and high energy expenditure.

4. Redesign the job of work method to analysed the better work condition.
5. According to the Snook and Ciriello (1991) that mentioned about the correlation of frequently work load and resting time, decreasing capabilities of human muscles when done frequently work load can be solved by the arrangement of load, frequency, and time resting. Sjogaard et.al (1979) had been mentioned that to increased endurance time can be improve by the short term of rest on each of activities on process. So by applying the arrangement of the frequently short resting time on the machining process activities can reduced the fatigue problem.

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APPENDICES





APPENDIX A

BOOM ZX-30 PROFILE

Flow Process of Boom Product, Dimension table and specification from Inspection Sheet on Boom ZX-30 product, Part Process and Route Card of Boom ZX-30, Technical Drawing of Plate hole B,C,D.

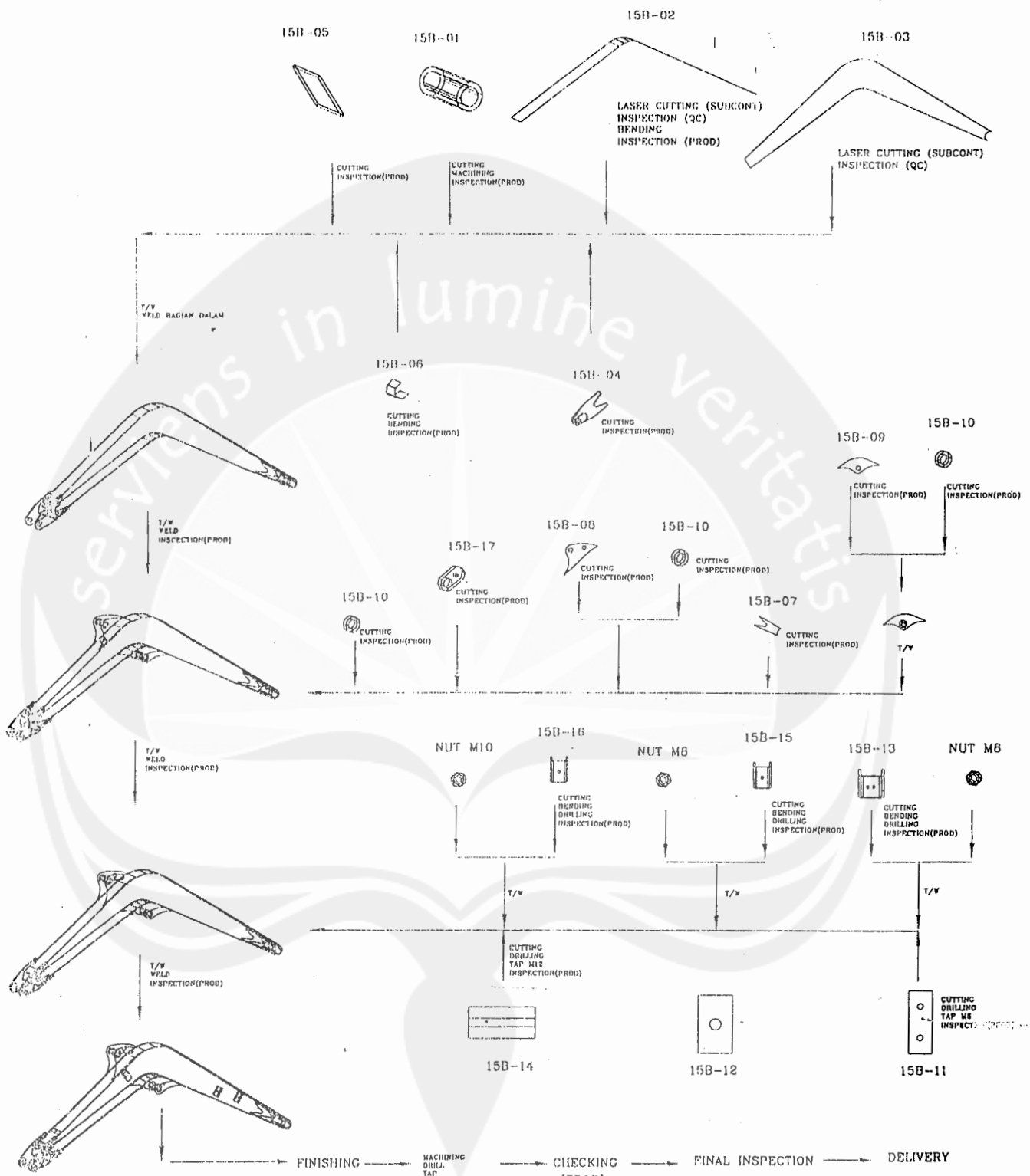
FLOW PROSES

PROJECT : NEW MINI
SUBJECT : ROOM EXIS

DRAWING NO : E 6020300

QTY =

SHEET NO : 1/1
REVISION : 0



REV	DESCRIPTION	DATE	DWG	CHECK'D	APPROV'D
APPROVED BY	CHECKED BY	PREPARED BY			
(SJ)	(BO)	(SUHANA)			

NOTES :
1. GUNAKAN JIG NO. 1 UNTUK ASSEMBLY
2. GUNAKAN JIG NO. 2 UNTUK PROSES MACHINING (BORING)

APPROVED BY	DISTRIBUTED TO:	DESCRIPTION	JUDGEMENT	
			Accept	Reject

Revisi: A2 by mas. Date : 09/06/03 Chkd by R.amn.

PART PROCESS & ROUTE CARD

SOURCE : HITACHI

PART : BOOM ZX30 DWG NO. X 6021552

MODEL NO. 1101-2

BOOM ZX30

NOTE:

- ⊙ Potong lurus tidak lihat Gambar
 ⊙ Potong lihat Gambar component
 X Tidak ada process

Revision	0				
Prepared By	NNA 24/09/02				
Checked By	SH 24/09/02				
Approved By	SHJ 24/09/02				

NO	CUTTING PLAN	DRAWING NUMBER	PART NO	PART NAME	MATERIAL SIZE	SPEC MAT	QTY UNIT	QTY Total	WEIGHT	AREA M2	PART PROCESS																REMARKS
											Cutting				Bending				Machining								
											Cutt Qty	Tgl Nama	Bev Qty	Tgl Nama	Ben Qty	Tgl Nama	Rol Qty	Tgl Nama	Dril Qty	Tgl Nama	Tap Qty	Tgl Nama	Mach Qty	Tgl Nama	Delv Qty	Tgl Nama	
		H3076437	ZX30B-00-00	BOSS	102 155 137	C22	1		3.04	0.01	X		X		X		X		X		X		X				Import Part
2		H3076437	ZX30B-00-01	BOSS	103 155 137	C22	1		3.04	0.01	X		X		X		X		X		X		X				Import Part
3			ZX30B-01	Plate	6 152 2642	SS400	1		19.00	0.81	⊙		X		⊙		X		X		X		X				Cutting Laser
4			ZX30B-C2	Plate	6 152 1415	SS400	1		10.02	0.43	⊙		⊙		⊙		X		X		X		X				Cutting Laser
			ZX30B-03	Plate	6 152 968.5	SS400	1		6.93	0.29	⊙		⊙		X		X		X		X		X				Cutting Laser
6			ZX30B-04	Plate	4.5 693.5 2207	SS400	1		15.30	0.87	⊙		⊙		X		X		X		X		X				Cutting Laser
7			ZX30B-05	Plate	4.5 693.5 2207	SS400	1		15.30	0.87	⊙		⊙		X		X		X		X		X				Cutting Laser
8			ZX30B-07	Plate	4.5 115 125	SS400	1		0.51	0.03	●		X		X		X		X		X		X				Shering
9			ZX30B-08	Plate	9 134 286	SS400	1		2.69	0.08	NC		X		⊙		X		X		X		X				
10			ZX30B-09	Plate	4.5 125 229	SS400	1		1.01	0.06	●		X		X		X		X		X		X				Shering
11			ZX30B-10	Plate	12 278 323	SS400	2		5.42	0.12	NC		X		X		X		X		X		X				
12			ZX30B-11	Plate	12 118 344	SS400	2		3.68	0.08	NC		X		X		X		X		X		X				
13			ZX30B-12	Plate	25 Ø70	SS400	2		1.02	0.01	NC		X		X		X		⊙		X		X				
14			ZX30B-13	Plate	22 Ø90	SS400	2		1.76	0.02	NC		X		X		X		⊙		X		X				

PART PROCESS & ROUTE CARD

PROJECT : H.C.M.E

SUBJECT : BOOM ZX30 DWG NO. X 6021552

SHEET NO : 1 OF 2

BOOM ZX30

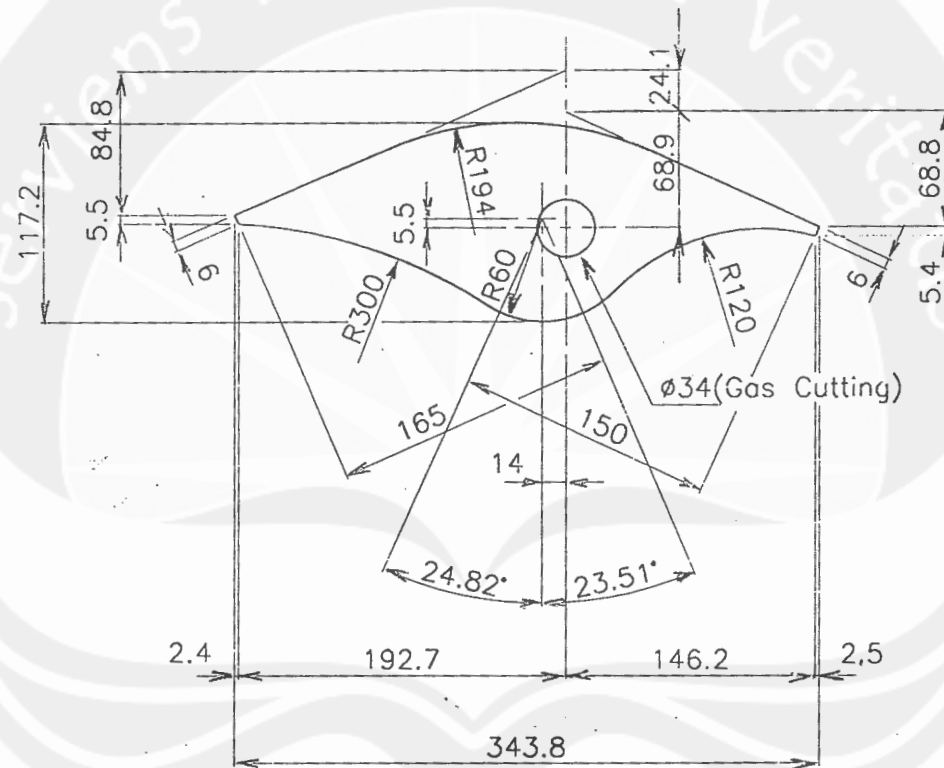
NOTE :

- Potong lurus tidak lihat Gambar
- ◎ Potong lihat Gambar component
- X Tidak ada proses

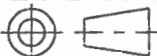
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Checked By	SH 24/09/02			
Approved By	SHJ 24/09/02			

NO	CUTT PLAN	DRAWING NUMBER	PART NO	PART NAME	MATERIAL SIZE			SPEC MAT	QTY UNIT	QTY Total	WEIGHT	AREA M2	PART PROCESS																REMARKS	
													Cutting				Bend ng				Machining									
													Cutt	Tgl	Bev	Tgl	Ben	Tgl	Rol	Tgl	Dr	Tgl	Tap	Tgl	Mach	Tgl	Delv	Tgl		
													Qty	Nama	Qty	Nama	Qty	Nama	Qty	Nama	Qty	Nama	Qty	Nama	Qty	Nama	Qty	Nama		
15		X9745354	ZX30B-14/00	Plate	3.2	60	70 ✓	SS400	2		0.24	0.02	●	✓	X		◎		X		◎	✓	X		X					Shering
16			ZX30B-14/01	Nut Weld	M10		1.5	SS400	2		0.00	0.00	X		X		X		X		X		X		X					Purchase part
17		X43388226	ZX30B-15	Plate	9	22	130	SS400	2		0.42	0.01	●		X		X		X		◎	✓	◎		X					
18		X4392161	ZX30B-16	Plate	19	25	75	SS400	2		0.54	0.01	●		X		X		X		◎	✓	◎		X					
19			ZX30B-17	Plate	6	22	125 ✓	SS400	1		0.13	0.01	●		X		X		X		◎	✓	◎		X					
20			ZX30B-18	Plate	6	22	142	SS400	2		0.28	0.01	◎	✓	X		X		X		X		X		X					
21		X4276601	ZX30B-19	R Bar	Ø25		25 ✓	SS400	1		0.80	0.00	SAW	✓	X		X		X		◎	✓	◎		X					
22		X4473499	ZX30B-20	Plate	19	22	130	SS400	1		0.12	0.00	●		X		X		X		◎	✓	◎		X					
24		X9743936	ZX30B-21/00	Plate	2.3	40	80	SS400	2		1.36	0.15	●	✓	X		◎		X		◎	✓	X		X					Shering
25			ZX30B-21/01	Nut Weld	M8-		1.25	SS400	4		0.00	0.00	X		X		X		X		X		X		X					Purchase part
26		X4417300	ZX30B-22	Plate	19	25	60	SS400	2		0.42	0.01	●	✓	X		X		X		◎	✓	◎		X					
27		X3062283	ZX30B-23	Bracket Forging	25	168	280	SS400	2		9.22	0.15	X		X		X		X		X		X		X					Import Part
TOTAL WEIGHT :								102.25	4.02																					

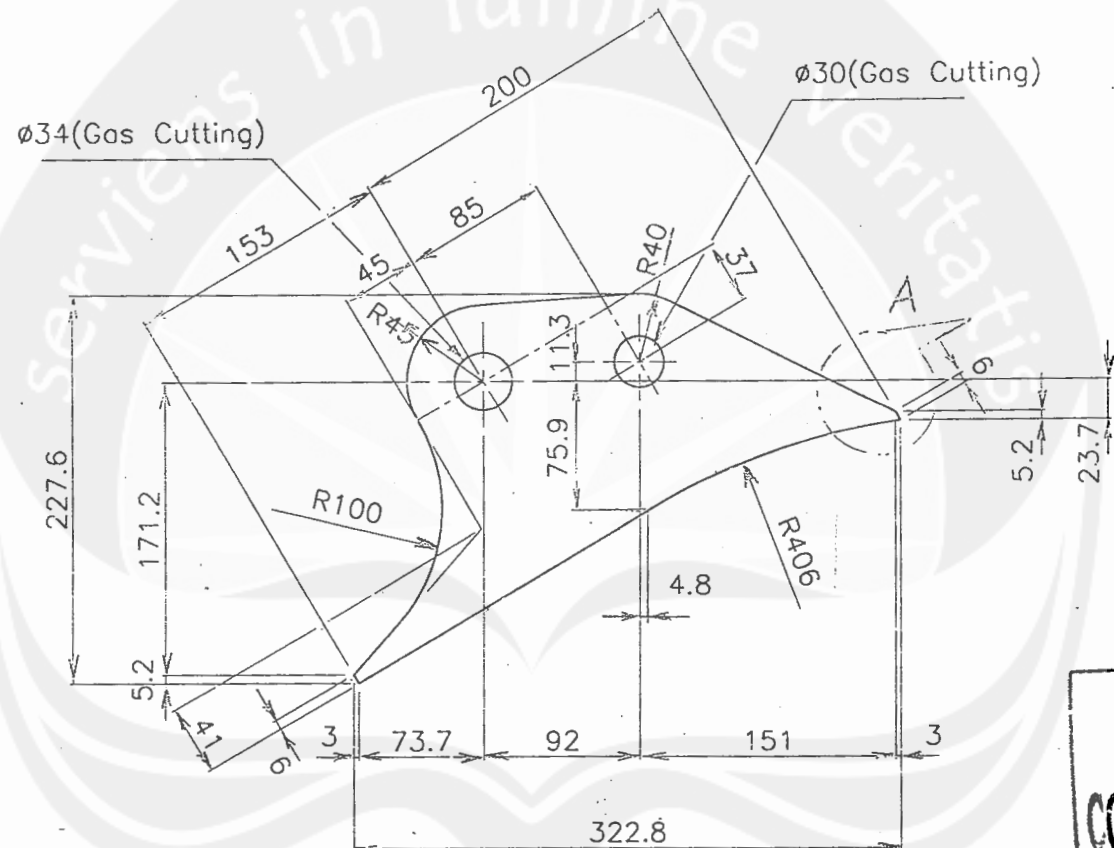
REV	DESCRIPTION	DATE	DRWN	CHCK'D	APPRV'D



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24 SEP 2002
CONTROLLED DOCUMENT

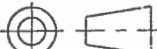
MATERIAL SIZE : PL 12X117.2X343.8		SPEC'S : SS400		PARTNO : ZX30B-11	
DWG TITTLE : PLATE (u/BOOM ZX 30)		NO REQ : 2 pc/U		SCALE : NTS	REF. DWG NO : X 6021552
PROJECT : H C M E			DRWN BY : RN 20-9-'02		SHEET NO : 12/26
			CHCK'D BY: <i>SH 240902</i>		0
			APPRV'D BY: <i>Maj 240902</i>		
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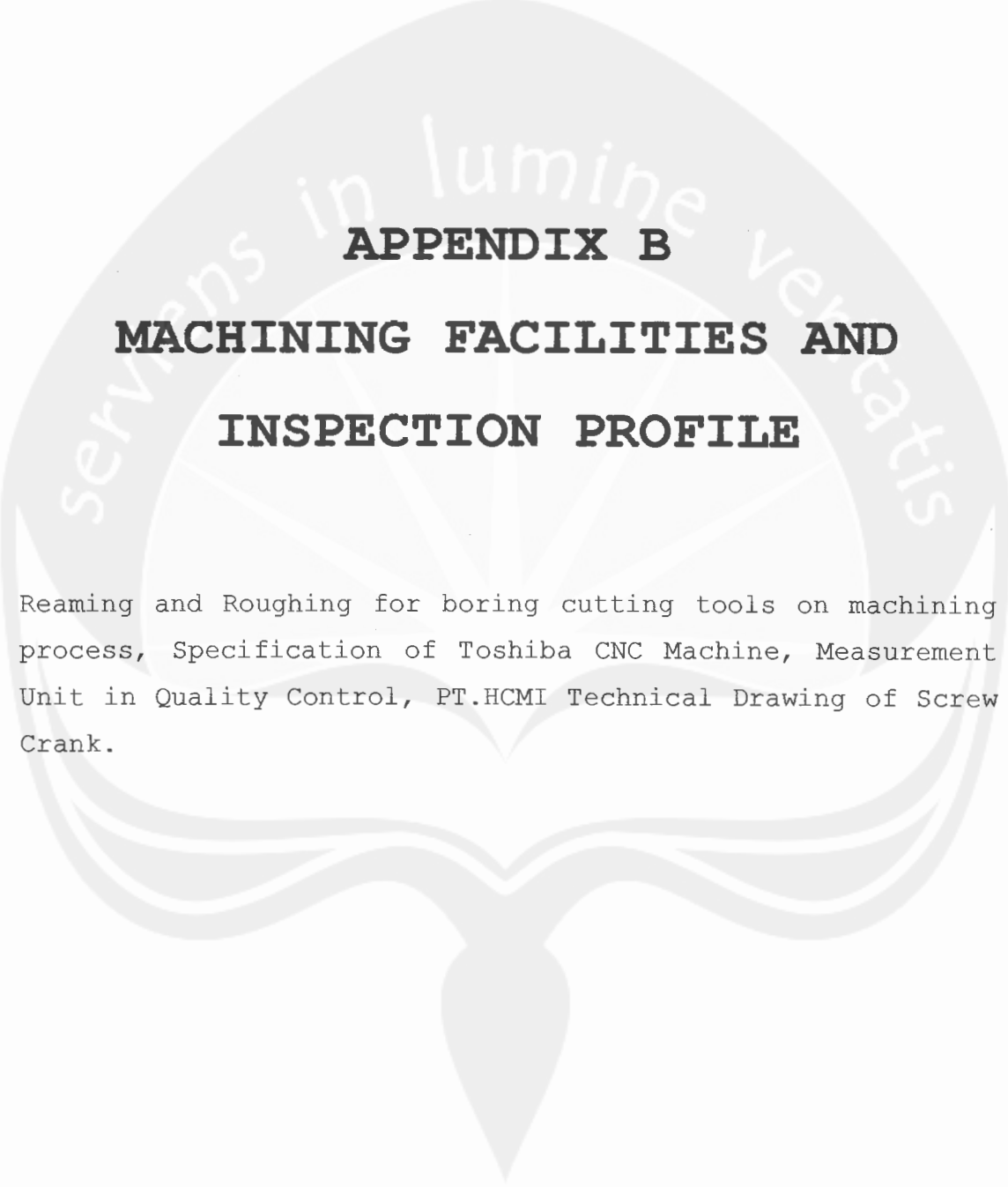
REV	DESCRIPTION	DATE	DRWN	CHCK'D	APPRV'D



DETAIL 'A'

FOR FABRICATION
24 SEP 2002
CONTROLLED DOCUMENT

MATERIAL SIZE : PL 12X277.6X322.8		SPEC'S : SS400		PARTNO : ZX30B-10	
DWG TITTLE : PLATE (w/BOOM ZX 30)		NO REQ : 2 pc/U		REF DWG NO : X 6021552-	
PROJECT : H C M E				SCALE : NTS	
		DRWN BY : RN 20-9-'02		SHEET NO : 11/26	
		CHCK'D BY: SH 240902		REV	
		APPRV'D BY: [Signature]		0	
HITACHI PT HITACHI CONSTRUCTION MACHINERY INDONESIA					

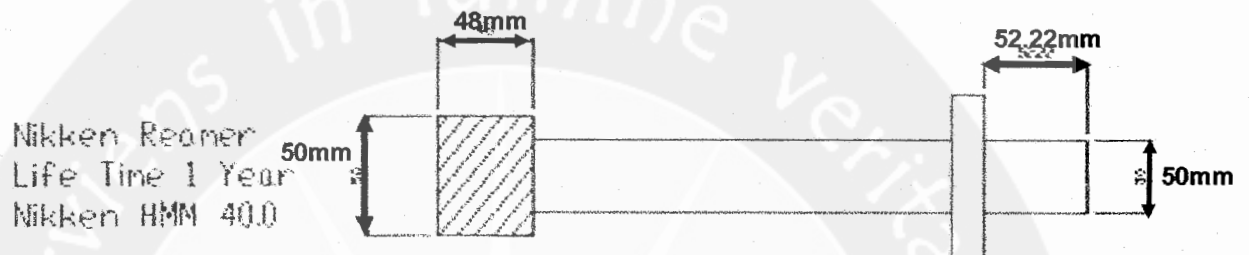
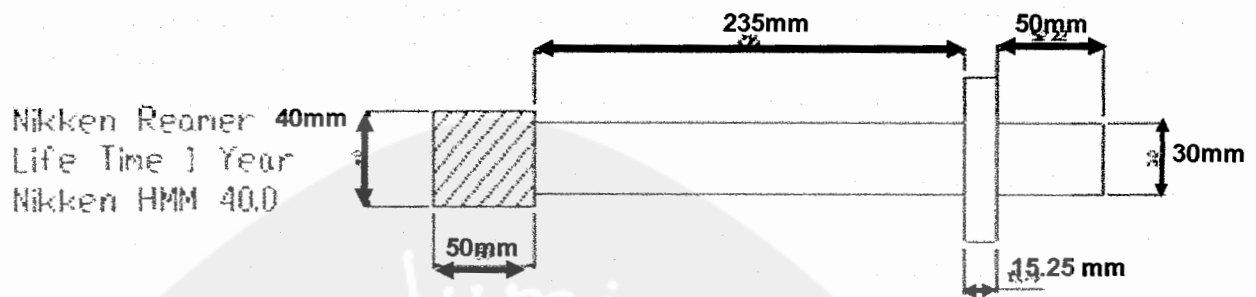


APPENDIX B

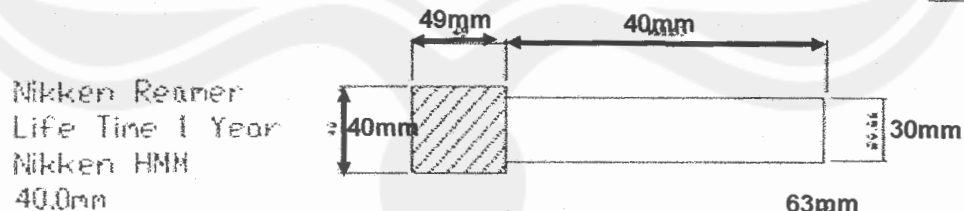
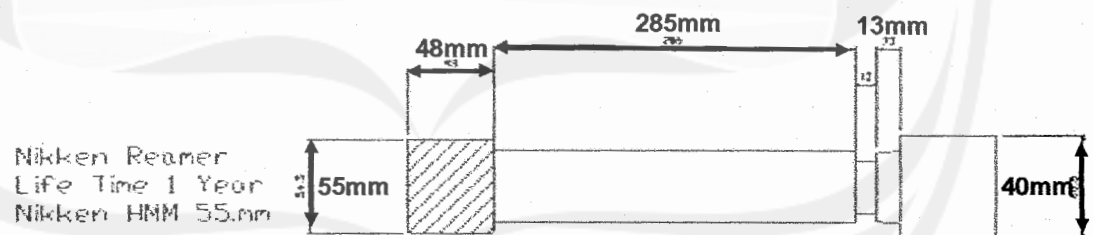
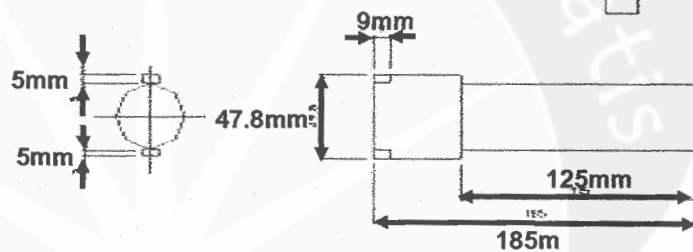
MACHINING FACILITIES AND INSPECTION PROFILE

Reaming and Roughing for boring cutting tools on machining process, Specification of Toshiba CNC Machine, Measurement Unit in Quality Control, PT.HCMI Technical Drawing of Screw Crank.

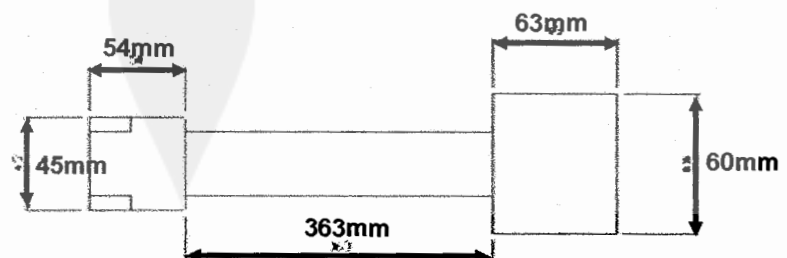
Reaming and Roughing for boring cutting tools on machining Process of Boom ZX 30

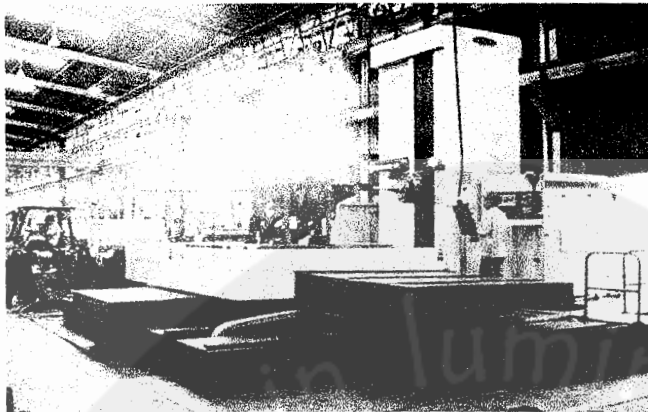


Roughing 50 mm
2 mata pahat.

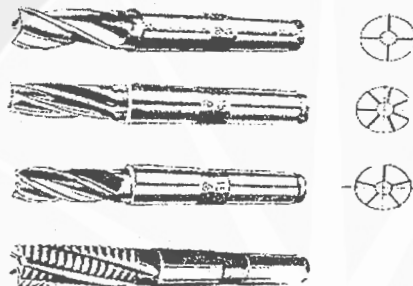


Roughing 45 mm
2 mata pahat.





Gambar Mesin CNC Toshiba, Jig serta Produk yang sedang dalam proses machining



Gambar cutting tool tapping dalam proses machining

Spesifikasi dari mesin CNC Toshiba

Dimensi travel on X axis = 1500 mm
Y axis = 1200 mm
Z axis = 1150 mm

Speed spindel 25 sampai 8000 rpm
2 step spindle nose
Cutting feedrate : 1 -10.000 mm / min
Max tool dia : No. 40 Dia 82 - 110
Max tool Magazine : 30 tool
Panjang max tool : 350 cm
Berat max tool : 20 kg
Waktu ganti Tool : 5 detik
Spindle Motor : Type AC 11 / 7,5 Hp
Supply Ac : 200/220 +/-10 %
Oil tank Cap. : 280 liter
Berat keseluruhan : 7500 kg

Figure of Toshiba Machining Facilities (adapted from PT.HCMI Documentation)

Measurement Unit In Quality Control.

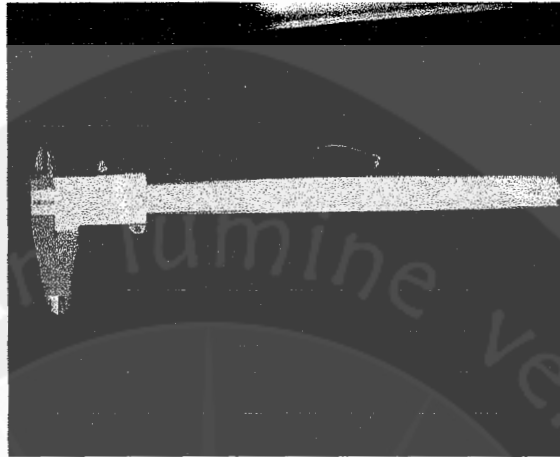


Figure of Vernier Caliper that used for measure the linear dimension or diameter from hole object or solid cylinder.



Cylinder Gauge that used for measure the diameter of inside hole of cylinder.

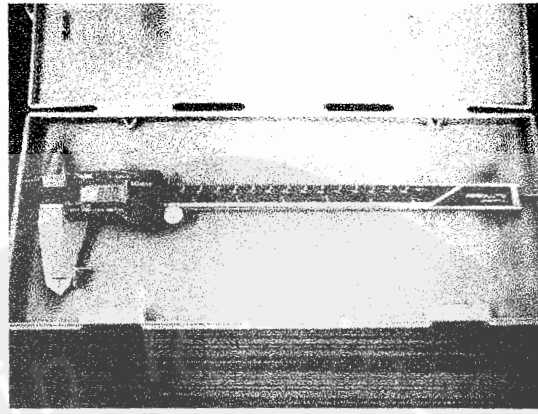


Figure of Digital Vernier caliper that used for measure the linear dimension or diameter from hole object or solid cylinder. (with better accuracy than analog).

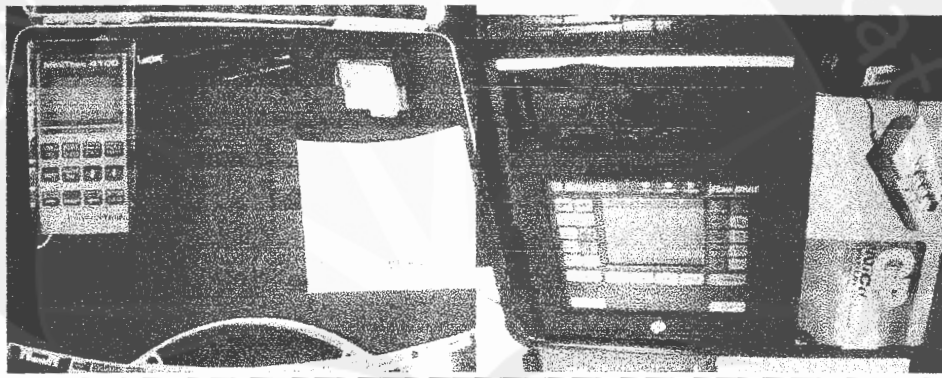


Figure set of ultrasonic Thickness Gauge that used for measure the thickness of steel plate.

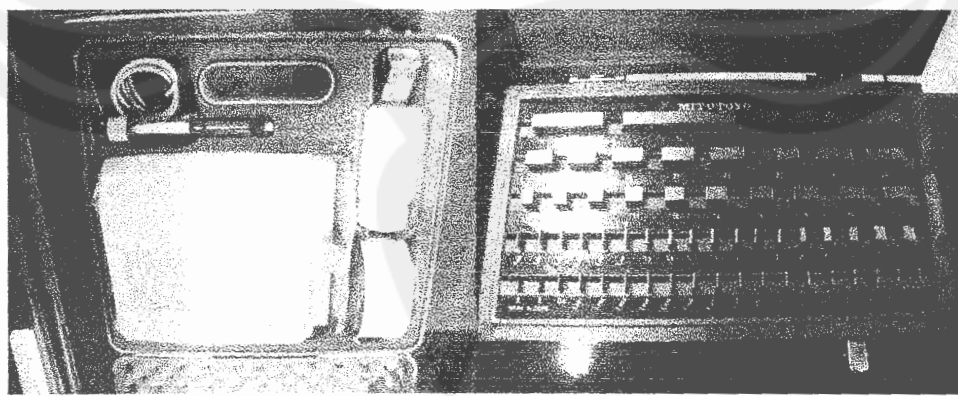
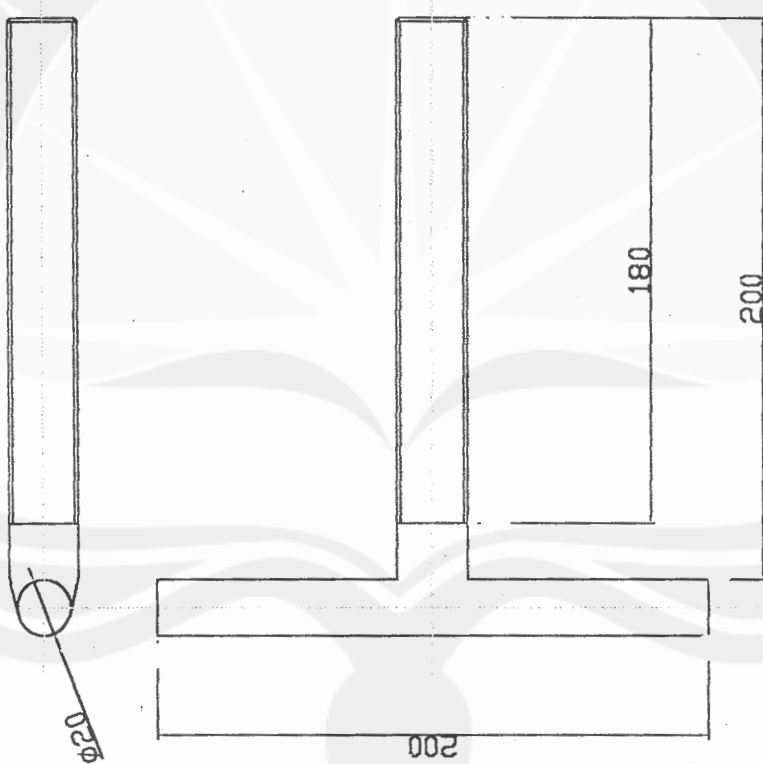


Figure set of ultrasonic Thickness Gauge (left) and set of block gauge for the calibration of measurement unit (right).



FOR FABRICATION
 2023.05.20
 2023.05.20

MATERIAL SIZE		SPECS		PART NO. 7X 30	
DWG TITLE	NO. REQ	SCALE	REF DWG NO.	REV.	
Screw Bracket 2P/1	2P/1				
PROJECT		DRAWN BY	CHECK'D BY	SHEET NO.	
Hig Arm 7X 30					
		APPROV'D BY			

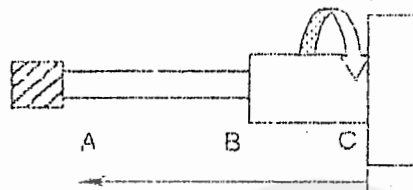
HITACHI

APPENDIX C
PT.HCMI 'S Problem
Identification Document

Vibration Measurement result of Machining Facilities of PT HCMI, and Root Cause Identification of Nonconformity on hole of Boom ZX-30 by PT.HCMI.

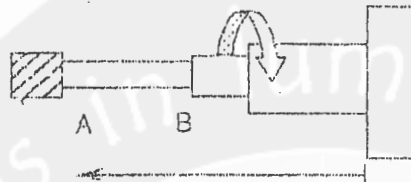
VIBRATION CHECK RESULT - 2nd - *finishing purpose*
20/05/03

1. TOSHIBA OHCM



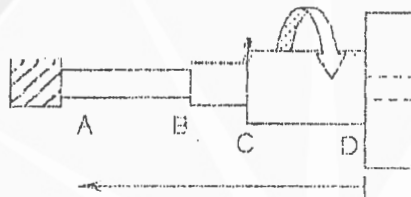
450 mm	0,060
290 mm	0,010
40 mm	0,003

2. NEW TOSHIBA



620 mm	0,005
480 mm	0,005

3. KURAKI



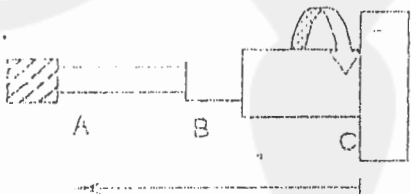
630 mm	0,100
550 mm	0,070
510 mm	0,060
490 mm	0,060

4. NOMURA



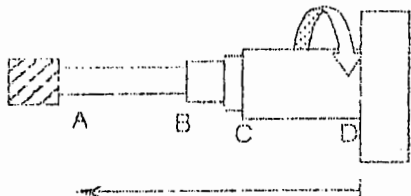
520 mm	0,010
340 mm	0,005
50 mm	0,000

5. JIG MILL



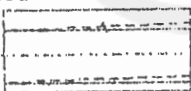
380 mm	0,030
250 mm	0,020
20 mm	0,030

6. SHIBAURA



400 mm	0,010
260 mm	0,005
220 mm	0,005
70 mm	0,005

3. Root Cause

1 Scratch inside hole	TECHNICAL	1. Chip is too long Chip was splinned on arbor	1. Feeding is too slow 2. No step feeding by NC machine 3. Return (pull back) rotating arbor 4. Broken reamer 
		2. Chip is trapped on curve of boss 	
	OPERATION	1. Operator does not pull out chip consistently	1. Operator does not totally understand why he has to pull out chip 2. It is not described clearly on working instruction.
Over Size	TECHNICAL		
	OPERATION	1. Operator does not check the result of finished boring/reaming consistently (not all hole is checked)	1. Operator claim that they sure if the reamer is good so that the inspection of hole can be done by random. 2. SCS not provide the place to put the data (hole inspection result)
4 Center line run out 0,85 mm, standard = 2 act = 2,85	OPERATION	1. Operator does not check CL after clamping 2. Operator does not check the hole will be machined properly	1. Operator claim that they sure if the goods already checked when set up (no need to check more) 2. Operator claim that they sure if the goods already OK in previous process - no need to check tightly 3. Operator does not provide proper setting method.
5 Can not be machining 6 Bushing can not be reamed 			
3 Perpendicularity run out 0,53 standard=0,12 act = 0,65		TA & IG requested to QC (KWT) to re-check on 10-04-03 → ?	



APPENDIX D

QUALITY CONTROL ANALYSIS

Factors For Constructing Variables Control Charts, Quality Control Data on B,C,D Hole 40 mm of diameter Boom ZX-30, Analysis Result of Best Performance of Machining Process.

Appendix VI

Factors for constructing variables control charts

Observations in Sample, n	Chart for Averages ($\bar{X}$)					Chart for Standard Deviations						Chart for Ranges (R)				
	Factors for Control Limits			Factors for Center Line		Factors for Control Limits				Factors for Center Line		Factors for Control Limits				
	A	A_2	A_3	c_4	$1/c_4$	B_3	B_4	B_5	B_6	d_2	$1/d_2$	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	1.2533	0	3.267	0	2.606	1.128	0.8865	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	1.1284	0	2.568	0	2.276	1.693	0.5907	0.888	0	4.358	0	2.575
4	1.500	0.729	1.628	0.9213	1.0854	0	2.266	0	2.088	2.059	0.4857	0.830	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	1.0638	0	2.089	0	1.964	2.326	0.4299	0.864	0	4.918	0	2.115
6	1.225	0.483	1.287	0.9515	1.0510	0.030	1.970	0.029	1.874	2.534	0.3946	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	1.04230	0.118	1.882	0.113	1.806	2.704	0.3698	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	1.0363	0.185	1.815	0.179	1.751	2.847	0.3512	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	1.0317	0.239	1.761	0.232	1.707	2.970	0.3367	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	1.0281	0.284	1.716	0.276	1.669	3.078	0.3249	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	1.0252	0.321	1.679	0.313	1.637	3.173	0.3152	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	1.0229	0.354	1.646	0.346	1.610	3.258	0.3069	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	1.0210	0.382	1.618	0.374	1.585	3.336	0.2998	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	1.0194	0.406	1.594	0.399	1.563	3.407	0.2935	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	1.0180	0.428	1.572	0.421	1.544	3.472	0.2880	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	1.0168	0.448	1.552	0.440	1.526	3.532	0.2831	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	1.0157	0.466	1.534	0.458	1.511	3.588	0.2787	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	1.0148	0.482	1.518	0.475	1.496	3.640	0.2747	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	1.0140	0.497	1.503	0.490	1.483	3.689	0.2711	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	1.0133	0.510	1.490	0.504	1.470	3.735	0.2677	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	1.0126	0.523	1.477	0.516	1.459	3.778	0.2647	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	1.0119	0.534	1.466	0.528	1.448	3.819	0.2618	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	1.0114	0.545	1.455	0.539	1.438	3.858	0.2592	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	1.0109	0.555	1.445	0.549	1.429	3.895	0.2567	0.712	1.759	6.031	0.451	1.548
25	0.600	0.153	0.606	0.9896	1.0105	0.565	1.435	0.559	1.420	3.931	0.2544	0.708	1.806	6.056	0.459	1.541

For $n > 25$

$$A = \frac{3}{\sqrt{n}}, \quad A_2 = \frac{3}{c_4 \sqrt{n}}, \quad c_4 \approx \frac{4(n-1)}{4n-3}$$

$$B_3 = 1 - \frac{2}{c_4 \sqrt{2(n-1)}}, \quad B_4 = 1 + \frac{2}{c_4 \sqrt{2(n-1)}}$$

$$B_5 = c_4 - \frac{3}{\sqrt{2(n-1)}}, \quad B_6 = c_4 + \frac{3}{\sqrt{2(n-1)}}$$

Quality Control Data on B,C,D Hole 40 mm of Diameter Boom ZX 30

Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Production Date	Operator	Stamp No.	No. of record	No. of subgroup	Hole Point	Record On				Vibration (0/1)				Chip / Scrap Length Condition (mm)				Oval Effect (0 / 1)	Action Record	Diameter Of Ø 40 Result		Average	
							Roughing Boring Process		Reaming Boring Process		Roughing	Reaming	Roughing (Cm)	Reaming (Cm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)						
							Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
1	27-Jul		785	1	1	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10 15 20	10 15 20	15.00	15.00
				2	1	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10 15 20	10 15 20	15.00	15.00
				3	1	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10 25 30	10 25 30	21.67	21.67
				4	1	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10 25 30	10 25 30	21.67	21.67
				5	1	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10 30 15	10 30 15	15.00	18.33
				6	1	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10 20 10	10 30 15	15.00	18.33
2	27-Jul		815	7	2	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		20 30 35	20 30 35	28.33	28.33
				8	2	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		20 30 35	20 30 35	28.33	28.33
				9	2	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10 15 15	10 15 15	13.33	13.33
				10	2	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10 15 15	10 15 15	13.33	13.33
				11	2	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		15 15 15	15 15 15	15.00	15.00
				12	2	D2	235	94	235	95	0	0	0	0	10	30	1	100	0		15 15 15	15 15 15	15.00	15.00
3	27-Jul		809	13	3	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10 15 20	10 15 20	11.87	15.00
				14	3	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10 15 20	10 15 20	13.33	16.67
				15	3	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10 15 20	10 15 20	15.00	11.87
				16	3	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10 15 20	10 15 20	15.00	15.00
				17	3	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		10 15 20	10 15 20	11.87	15.00
				18	3	D2	235	94	235	95	1	0	0	0	10	30	1	100	0		10 15 20	10 15 20	15.00	15.00
4	27-Jul		810	19	4	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10 15 20	10 15 20	15.00	15.00
				20	4	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10 15 20	10 15 20	15.00	15.00
				21	4	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10 15 20	10 15 20	15.00	15.00
				22	4	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10 15 20	10 15 20	15.00	16.67
				23	4	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		10 15	10 15	15.00	15.00

Quality Control Data on B,C,D Hole 40 mm of Diameter Boom ZX 30

Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Production Date	Operator	Stamp No.	No. of record	No. of subgroup	Hole Point	Record On				Vibration (0/1)				Chip / Scrap Length Condition (mm)				Oval Effect	Action Record	Diameter Of Ø 40 Result		Average	
							Roughing Boring Process		Reaming Boring Process		Roughing		Reaming		Roughing (Cm)		Reaming (Cm)				X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)
							Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
5	27-Jul	811	24	4	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		20	20	15.00	11.67	
			25	5	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10	15			
			26	5	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		15	10			
			27	5	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		5	10			
			28	5	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10	15			
			29	5	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		5	10			
6	28-Jul	Bpk Sutrisno	799	30	5	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10	15	11.67	11.67
				31	6	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		5	5		
				32	6	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	10		
				33	6	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		15	15		
				34	6	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		5	5		
				35	6	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10		
7	28-Jul	Bpk Sutrisno	808	36	6	D2	235	94	235	95	1	1	0	0	10	30	1	100	0	Changing roughing Insert	20	40	18.33	25.00
				37	7	B1	360	200	235	93	0	0	0	0	5	10	30	50	1		25	20		
				38	7	B2	615	45	235	93	1	1	0	0	5	10	30	50	1		15	15		
				39	7	C1	335	14	235	93	1	1	0	0	5	10	20	50	1		20	20		
				40	7	C2	335	14	235	93	1	1	0	0	5	10	20	50	1		10	10		
				41	7	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15		
8	28-Jul	Bpk Sutrisno	807	42	7	D2	235	94	235	95	0	0	0	0	10	30	1	100	0	Changing roughing Insert	20	20	15.00	15.00
				43	8	B1	665	47	235	93	0	0	0	0	5	10	100	200	0		15	15		
				44	8	B2	665	47	235	93	0	0	0	0	5	10	100	200	0		20	20		
				45	8	C1	335	14	450	24	1	1	0	0	5	10	100	200	1		10	10		
				46	8	C2	335	14	235	93	1	1	0	0	5	10	20	50	1		15	15		
				47	8	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		20	20		

Quality Control Data on B,C,D Hole 40 mm of Diameter Boom ZX 30

Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Production Date	Operator	Stamp No.	No. of record	No. Of subgroup	Hole Point	Record On				Vibration (3/1)		Chip / Scrap Length Condition (mm)				Oval Effect Roughing (0 / 1)	Action Record	Diameter Of Ø 40 Result		Average			
							Roughing Boring Process		Reaming Boring Process		Roughing	Reaming	Roughing (Cm)		Reaming (Cm)				X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)		
							Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
9	28-Jul		820	48	8	D2	235	94	235	95	0	0	0	0	10	30	1	100	0		20	20	15.00	15.00
				49	9	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10	15	10.00	8.33
				50	9	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	15	10.00	8.33
				51	9	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10	10	10.00	11.87
				52	9	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10	10	10.00	11.87
10	28-Jul	Bpk Sutrisno	819	53	9	D1	235	94	235	95	1	1	0	0	10	30	1	100	0	Changing Insert of Roughing	10	10	8.33	10.00
				54	9	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10	15	8.33	10.00
				55	10	B1	520	140	235	95	0	1	0	0	10	30	10	100	1		10	10	11.87	15.00
				56	10	B2	510	42	235	95	0	1	0	0	10	30	10	100	1		15	20	18.33	13.33
				57	10	C1	395	28	235	91	0	0	0	0	10	30	10	100	1		15	10	20.00	11.87
11	28-Jul		812	58	10	C2	395	28	435	36	0	1	0	0	10	30	10	100	1		20	10	18.33	13.33
				59	10	D1	235	94	235	94	0	0	0	0	10	30	20	50	0		15	15	20.00	11.87
				60	10	D2	235	94	235	94	0	0	0	0	10	30	20	50	0		20	10	18.33	13.33
				61	11	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		20	15	11.87	15.00
				62	11	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	10	18.33	13.33
12	29-Jul		789	63	11	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		25	20	21.87	18.33
				64	11	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		20	20	11.87	15.00
				65	11	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10	15	20.00	11.87
				66	11	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		15	10	20.00	16.87
				67	12	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		20	25	16.87	10.00
				68	12	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		15	10	10.00	10.00
				69	12	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10	10	15.00	11.87
				70	12	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		20	15	10.00	10.00
				71	12	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10	5	13.33	8.33

Quality Control Data on B,C,D Hole 40 mm of Diameter Boom ZX 30

Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Production Date	Operator	Stamp No.	No. of record	No. of subgroup	Hole Point	Record On				Vibration (0/1)				Chip / Scrap Length Condition (mm)				Oval Effect	Action Record	Diameter Of Ø 40 Result		Average	
							Roughing Boring Process		Reaming Boring Process		Roughing		Reaming		Roughing (Cm)		Reaming (Cm)				X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)
							Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
13	28-Jul		798	72	12	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		15	10	10.00	10.00
				73	13	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10	5	10.00	8.33
				74	13	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	10	11.67	20.00
				75	13	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10	15	10.00	10.00
				76	13	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10	5	11.67	11.67
		Bpk Sutrisno	790	77	13	D1	235	94	235	95	1	1	0	0	10	30	1	100	0	Tool Setting	10	10	10.00	11.67
				78	13	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10	15	11.67	13.33
				79	14	B1	505	31	810	83	0	0	0	0	10	40	10	100	0		10	15	15.00	18.67
				80	14	B2	505	31	810	83	0	0	0	0	10	40	10	100	0		20	20	20.00	18.33
				81	14	C1	405	23	235	95	0	0	0	0	10	40	10	100	1		20	25	18.67	15.00
			814	82	14	C2	370	18	235	95	0	0	0	0	10	40	10	100	1		20	15	18.67	18.33
				83	14	D1	890	54	235	96	0	0	0	0	10	30	10	200	0		15	20	20.00	20.00
				84	14	D2	890	54	235	96	0	0	0	0	10	30	10	200	0		20	30	20.00	15.00
				85	15	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		20	15	18.67	15.00
				86	15	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	10	15.00	13.33
			803	87	15	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		20	20	15.00	11.67
				88	15	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		15	10	18.33	18.33
				89	15	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		20	20	13.33	11.67
				90	15	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		25	15	20.00	23.33
				91	16	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		20	35	15.00	18.33
				92	16	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	20	18.67	18.67
				93	16	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		20	15	20.00	20.00
				94	16	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		30	25	18.67	15.00
				95	16	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		20	10	20.00	20.00

Quality Control Data on B,C,D Hole 40 mm of Diameter Boom ZX 30

Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Production Date	Operator	Stamp No.	No. of record	No. of subgroup	Hole Point	Record On				Vibration (0/1)				Chip / Scrap Length Condition (mm)				Oval Effect	Action Record	Diameter Of Ø 40 Result		Average	
							Roughing Boring Process		Reaming Boring Process		Roughing	Reaming	Roughing (Cm)	Reaming (Cm)	Roughing (mm)	Reaming (mm)	Roughing (mm)	Reaming (mm)			X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)
							Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
17	29-Jul		808	96	16	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		30	30	18.33	18.33
				97	17	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10	20		
				98	17	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		20	10		
				99	17	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		25	15		
				100	17	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		30	20		
				101	17	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		20	20		
				102	17	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		25	15		
18	30-Jul	Bpk. Sutrisno	804	103	18	B1	400	36	235	95	0	0	0	0	20	30	10	200	0		10	15	20.00	23.33
				104	18	B2	400	36	235	95	0	0	0	0	20	30	10	200	0		20	20		
				105	18	C1	28	235	360	24	0	0	0	0	10	30	10	200	0		30	30		
				106	18	C2	28	235	360	24	0	0	0	0	10	30	200	300	0		5	5		
				107	18	D1	94	235	800	82	0	0	0	0	10	30	100	300	0		10	10		
				108	18	D2	94	235	800	82	0	0	0	0	10	30	100	300	0		15	15		
				109	18																20	20		
19	30-Jul	Bpk Sutrisno	798	110	19	B1	480	34	800	68	0	0	0	0	10	30	200	500	0		10	5	15.00	11.87
				111	19	B2	480	34	800	68	0	0	0	0	10	30	200	500	0		15	10		
				112	19	C1	395	28	400	30	0	0	0	0	10	30	200	500	0		20	20		
				113	19	C2	395	28	400	30	0	0	0	0	10	30	200	500	0		10	10		
				114	19	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		15	15		
				115	19	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		20	20		
				116	19																10	10		
20	30-Jul	Bpk Sutrisno	791	117	20	B1	480	34	235	95	0	0	0	0	10	30	50	100	0		25	15	15.00	18.33
				118	20	B2	480	34	235	95	0	0	0	0	10	30	50	100	0		10	10		
				119	20	C1	395	25	235	94	0	0	0	0	10	30	50	100	1		20	15		
				120	20	C2	395	25	235	94	0	0	0	0	10	30	50	100	1		10	10		
				121	20	D1	800	74	235	82	0	0	0	0	10	30	10	200	0		25	15		

Quality Control Data on B,C,D Hole 40 mm of Diameter Boom ZX 30

Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Production Date	Operator	Stamp No.	No. of record	No. of subgroup	Hole Point	Record On				Vibration (0/1)				Chip / Scrap Length Condition (mm)				Oval Effect	Action Record	Diameter Of Ø 40 Result		Average	
							Roughing Boring Process		Reaming Boring Process		Roughing		Reaming		Roughing (Cm)		Reaming (Cm)				X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)
							Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
21	30-Jul	Bpk Sutrisno	792	120	20	D2	800	74	235	92	0	0	0	0	10	30	10	200	0		20	25	18.67	11.67
				121	21	B1	480	34	235	95	0	0	0	0	10	30	50	100	0		10	10	11.67	15.00
				122	21	B2	480	34	235	95	0	0	0	0	10	30	50	100	0		10	10	18.33	16.67
				123	21	C1	395	25	235	94	0	0	0	0	10	30	50	100	1		10	10	15.00	15.00
				124	21	C2	395	25	235	94	0	0	0	0	10	30	50	100	1		10	10	18.33	16.67
22	30-Jul		801	125	21	D1	800	74	235	92	0	0	0	0	10	30	10	200	0		20	20	8.33	15.00
				126	21	D2	800	74	235	92	0	0	0	0	10	30	10	200	0		5	15	15.00	13.33
				127	22	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10	15	15.00	16.67
				128	22	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	10	11.67	18.33
				129	22	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10	15	11.67	15.00
23	30-Jul		802	130	22	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10	15	13.33	15.00
				131	22	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10	15.00	13.33
				132	22	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10	15.00	18.33
				133	23	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10	15	13.33	15.00
				134	23	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	10	18.33	15.00
24	30-Jul		822	135	23	C1	395	28	235	93	0	1	0	0	10	20	1	100	1	Changing Roughing Insert	10	10	18.33	16.67
				136	23	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10	10	16.67	15.00
				137	23	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10	15.00	13.33
				138	23	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10	13.33	15.00
				139	24	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		10	15	15.00	20.00
				140	24	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	25	16.67	15.00
				141	24	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10	10	15.00	15.00
				142	24	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10	5	16.67	18.33
				143	24	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10	11.67	16.67
																					5	15		

Quality Control Data on B,C,D Hole 40 mm of Diameter Boom ZX 30

Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Production Date	Operator	Stamp No.	No. of record	No. Of subgroup	Hole Point	Record On				Vibration (0/1)				Chip / Scrap Length Condition (mm)				Oval Effect Roughing (0 / 1)	Action Record	Diameter Of Ø 40 Result		Average	
							Roughing Boring Process		Reaming Boring Process		Roughing	Reaming	Roughing (Cm)	Reaming (Cm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)						
							Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
25	30-Jul		788	144	24	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		20 5 10 10 10 15 20 10 15 20 10 15 20 10 			

Quality Control Data on B,C,D Hole 40 mm of Diameter Boom ZX 30

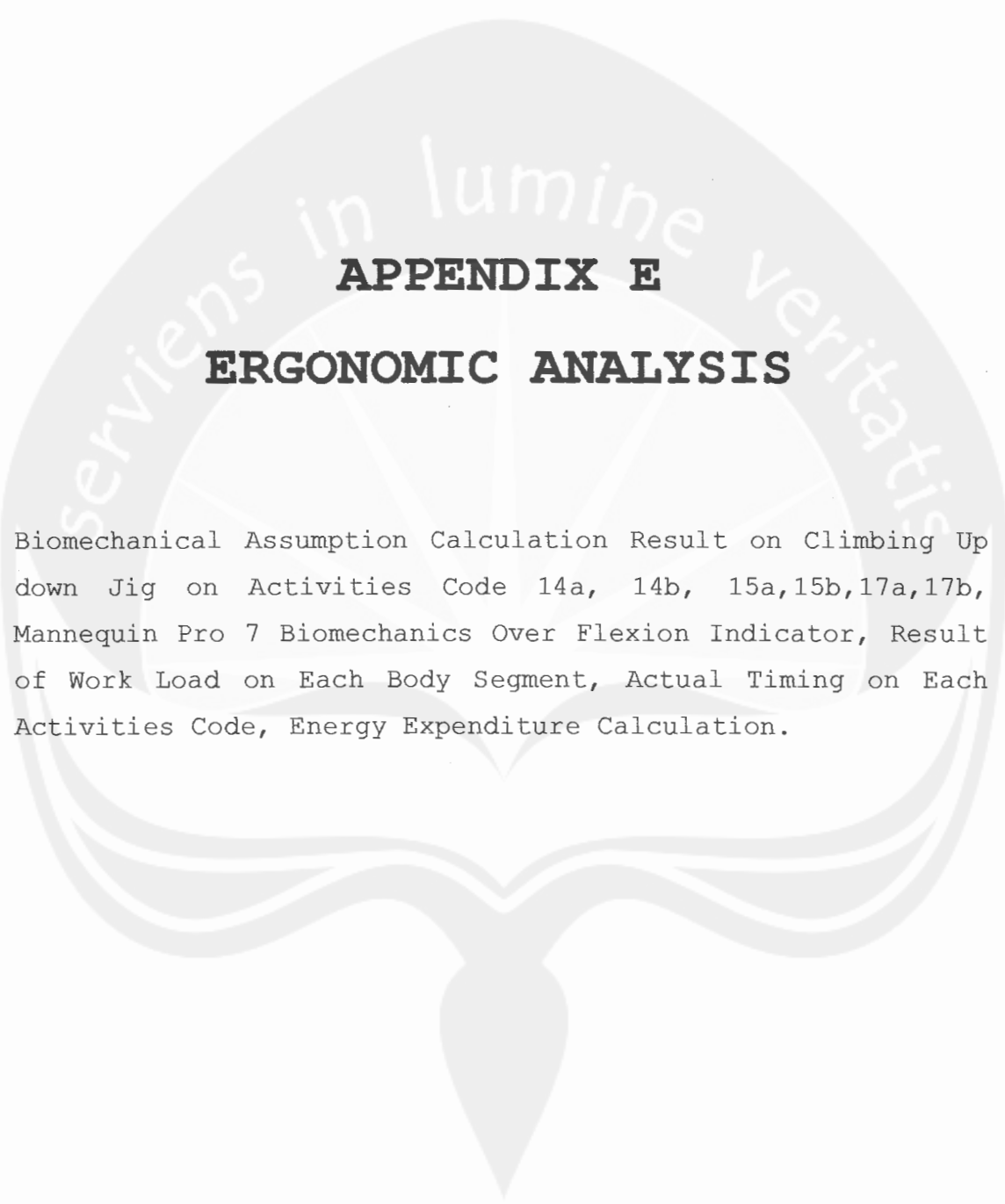
Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Production Date	Operator	Stamp No.	No. of record	No. of subgroup	Hole Point	Record On				Vibration (3/1)				Chip / Scrap Length Condition (mm)				Oval Effect	Action Record	Diameter Of Ø 40 Result		Average	
							Roughing Boring Process		Reaming Boring Process		Roughing		Reaming		Roughing (Cm)		Reaming (Cm)				X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)
							Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
29	31-Jul		830	168	28	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		30	10	20.00	15.00
				169	29	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		20	15		
				170	29	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		30	20		
				171	29	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10	10		
				172	29	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10	10		
30	31-Jul		800	173	29	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		15	15	11.67	11.67
				174	29	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10		
				175	30	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		15	15		
				176	30	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	10		
				177	30	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10	10		
31	2-Aug		828	178	30	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		20	20	13.33	20.00
				179	30	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		0	20		
				180	30	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		20	20		
				181	31	B1	480	34	235	95	0	1	0	0	5	10	100	300	1		20	20		
				182	31	B2	480	34	235	95	0	1	0	0	5	10	100	300	1		10	10		
				183	31	C1	395	28	235	93	0	1	0	0	10	20	1	100	1		10	10	11.67	11.67
				184	31	C2	395	28	235	93	1	1	0	0	10	20	1	100	1		10	10		
				185	31	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10		
				186	31	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10		
				187	31	D1	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10		
				188	31	D2	235	94	235	95	1	1	0	0	10	30	1	100	0		10	10		

Analysis Result of Best Performance of Machining Process

Note : For Vibration and Oval Effect Table that 1 means vibration had been occurred, 0 means vibration had not been occurred

No. of Product	Operator	Stamp No:	No: of record	No. : Of subgroup	Hole Point	Record On				Vibration (1/0)				Chip / Scrap Length Condition (Cm)				Oval Effect Roughing (0 / 1)	Action Record	Diameter Of Ø 40 Result		Average	
						Proses Roughing		Proses Reaming		Roughing		Reaming		Roughing (Cm)		Reaming (Cm)				X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)	X (10 ⁻³) (mm)	Y (10 ⁻³) (mm)
						Rpm Mesin (rpm)	Cutting Speed (mm/m)	Rpm Mesin (rpm)	Cutting Speed (mm/m)														
2	Bpk Sutrisno	815	11	2	D1	235	94	235	95	0	0	0	0	10	30	1	100	0	Changing roughing Insert	15	15	15.00	15.00
			12	2	D2	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15	15.00	15.00
3	Bpk Sutrisno	809	17	3	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15	11.87	15.00
			18	3	D2	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15	15.00	15.00
7	Bpk Sutrisno	808	23	4	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15	15	15
			37	7	B1	380	200	235	93	0	0	0	0	5	10	30	50	0		15	15	15	15
			41	7	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15	15	15
			42	7	D2	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15	15	15
8	Bpk Sutrisno	807	43	8	B1	865	47	235	93	0	0	0	0	5	10	100	200	0		15	15	15	15
			44	8	B2	865	47	235	93	0	0	0	0	5	10	100	200	0		15	15	15	15
8	Bpk Sutrisno	807	47	8	D1	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15	15	15
			48	8	D2	235	94	235	95	0	0	0	0	10	30	1	100	0		15	15	15	15



APPENDIX E

ERGONOMIC ANALYSIS

Biomechanical Assumption Calculation Result on Climbing Up down Jig on Activities Code 14a, 14b, 15a,15b,17a,17b, Mannequin Pro 7 Biomechanics Over Flexion Indicator, Result of Work Load on Each Body Segment, Actual Timing on Each Activities Code, Energy Expenditure Calculation.

Biomechanical Assumption On Climbing Up and down Jig on Activities Code 14a, 14b, 15a, 15b, 17a and 17b

Force assumption result on 15 a and 15 b (the red colour is force assumption for 15 a and yellow colour is force assumption for 15 b).

h (M)	RX (N)	RG (N)	Ry (N)	FM (N)
5	3772.401		1059.336	4125.524
10	3149.45	1418.704	1448.704	3582.872
15	2409.291	1642.82	1672.82	2947.387
20	1572.886	1652.374	1682.374	2198.989
25	672.0721	1372.485	1402.485	1298.149
30	-231.008	656.9802	686.9802	149.4386

Force assumption result on 14 a and 14 b (the red colour is force assumption for 14 a and yellow colour is force assumption for 14 b).

h (M)	RX (N)	RG (N)	Ry (N)	FM (N)
10	4295.121		496.5273	4619.705
15	4548.76	88.67063	58.67063	4899.515
20	4175.508	684.4096	654.4096	4500.3
25	3658.002	1178.513	1148.513	4023.806
30	3010.218	1538.105	1508.105	3463.675
35	2248.905	1723.787	1693.787	2807.621
40	1396.54	1682.694	1652.694	2032.851
45	488.6032	1331.37	1301.37	1093.264
50	-400.137	493.9481	463.9481	-130.552

Force assumption result on 17 a and 17 b (the red colour is force assumption for 17 a and yellow colour is force assumption for 17 b).

h (M)	RX (N)	RG (N)	Ry (N)	FM (N)
10	3658.002		1148.513	4023.806
20	2248.905	1723.787	1693.787	2807.621
30	488.6032	1331.37	1301.37	1093.264

Manequin Pro 7 Biomechanics Over Flexion Indicator

For Shoulder, Wrist and Hip body segment		
Axis	Value of result on Degree	Indicator of movement
X	+	Extension
	-	Flexion
Y	+	External Rotational Lateral
	-	Internal Rotational Medial
Z	+	Abduction
	-	Adduction

For Knee body segment		
Axis	Value of result on Degree	Indicator of movement
X	+	Flexion
	-	Extension
Y		
Z		

For Elbow body segment		
Axis	Value of result on Degree	Indicator of movement
X	+	Flexion
	-	Extension
Y	+	Internal Rotational Medial
	-	External Rotational Lateral
Z	+	Adduction
	-	Abduction

For Ankle body segment		
Axis	Value of result on Degree	Indicator of movement
X	+	Extension
	-	Flexion
Y		
Z		

Result of Work Load on Each Body Segment (all In Newton)

Marking Position	Head	Neck	Left Shoulder	Left Elbow	Left Wrist	Right Shoulder	Right Elbow	Right Wrist	Back	Left Hip	Left knee	Left Ankle	Right Hip	Right Knee	Right Ankle
0	41.9	50.6	29.4	15.4	4.6	29.9	15.6	4.5	265.8	179.2	253.2	284.6	179.9	255.8	287.7
1	41.9	50.6	23.4	15.4	4.6	29.9	15.6	4.5	265.8	180.3	254.3	285.7	178.8	254.7	286.6
4	41.9	50.6	29.4	15.4	4.6	29.9	15.6	4.5	265.8	180.7	254.7	286.1	178.3	254.3	286.2
7	41.9	50.6	29.4	15.4	4.6	29.9	15.6	4.5	265.8	180.9	254.9	286.3	178.1	254.1	286
10	41.9	50.6	29.4	15.4	4.6	29.9	15.6	4.5	265.8	181.2	255.2	286.7	177.8	253.8	285.6
14a	41.9	50.6	164.6	162.7	162.1	164.7	162.7	162.1	419.1	113.4	39.4	8	439.8	513.8	545.6
13a	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
13c	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
13d1	41.9	50.6	29.4	15.4	4.6	45.2	37.3	34.2	268	113.4	39.4	8	116.2	40.2	8.3
13d2	41.9	50.6	29.4	15.4	4.6	45.2	37.3	34.2	268	113.4	39.4	8	116.2	40.2	8.3
14b	41.9	50.6	164.6	162.7	162.1	164.7	162.7	162.1	419.1	113.4	39.4	8	1010.1	1085.1	1118
14a	41.9	50.6	164.6	162.7	162.1	164.7	162.7	162.1	419.1	113.4	39.4	8	439.8	513.8	545.6
15a	41.9	50.6	164.6	162.7	162.1	164.7	162.7	162.1	419.1	776.2	850.2	881.7	116.2	40.2	8.3
16a	41.9	50.6	210.1	219.2	226.6	209.7	219.1	226.7	330.3	161.6	235.3	267	116.2	40.2	8.3
15b	41.9	50.36	164.69	162.7	162.1	164.7	162.7	162.1	419.1	498.9	572.9	604.4	116.2	40.2	8.3
17a	41.9	50.6	164.6	162.4	162.1	164.7	162.7	162.1	419.1	824.6	898.3	930.1	116.2	40.2	8.3
17b	41.9	50.6	164.6	162.7	162.1	164.7	162.7	162.1	419.1	456.5	530.5	562	116.2	40.2	8.3
18	41.9	50.6	29.4	15.4	4.6	29.9	15.6	4.5	265.8	180.8	254.3	286.3	173.2	254.2	286.1
21 a	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
21d1	41.9	50.6	29.4	15.4	4.6	45.2	37.3	34.2	286	132	255.8	287.2	173.6	254.4	286.2
21d2	41.9	50.6	29.4	15.4	4.6	45.2	37.3	34.2	268	181.5	255.2	286.6	179.2	254.9	286.7
21b	41.9	50.6	29.4	15.4	4.6	29.9	15.3	4.5	265.8	131	255	286.5	178	254	285.9
21c	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
24a	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
24d1	41.9	50.6	29.4	15.4	4.6	45.2	37.3	34.2	268	182.3	256.1	287.5	173.3	254.1	285.9
24c	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
24d2	41.9	50.6	29.4	15.4	4.6	45.2	37.3	34.2	268	181.2	255	286.4	179.4	255.1	286.9
24b	41.9	50.6	29.4	15.4	4.6	29.9	15.3	4.5	265.8	180.9	254.9	286.3	173.1	254.1	285.8
25a	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
25d1	41.9	50.6	29.4	15.4	4.6	45.2	37.3	34.2	268	181.9	255.6	287	173.8	254.5	286.3
25c	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	297.5	347	370.5	301.9	352.6	376.1
25d2	41.9	50.6	29.4	15.4	4.6	45.2	37.3	34.2	268	181.6	255.3	286.7	179.1	254.8	286.3
25b	41.9	50.6	29.4	15.4	4.6	480.9	480.3	480	548.7	113.4	39.4	8	116.2	40.2	8.3
29a	41.8	50.7	29.4	15.6	4.4	480.9	480.0	480.0	548.5	113.4	39.6	8.0	116.1	40.0	8.3
29c	115.7	119.1	111.8	109	108	251.8	250.5	250	364.9	156.5	114.8	108.2	153.5	115.1	108.2

Result of Work Load on Each Body Segment (all In Newton)

Marking Position	Head	Neck	Left Shoulder	Left Elbow	Left Wrist	Right Shoulder	Right Elbow	Right Wrist	Back	Left Hip	Left knee	Left Ankle	Right Hip	Right Knee	Right Ankle
29b	41.9	50.6	29.4	15.4	4.6	29.9	15.6	4.5	265.8	113.4	39.4	8	116.2	40.2	8.3
29d1	41.9	50.6	29.4	15.4	4.6	59	46.3	37.2	290.8	194.1	268	299.4	189.7	265.6	297.4
29d2	41.9	50.6	29.4	15.4	4.6	24.7	25.4	30.9	243	168.1	242	273.4	167.8	243.6	275.5
29d3	41.9	50.6	29.4	15.4	4.6	59	46.3	37.2	290.8	192.5	266.4	297.8	191.3	267.1	299
30a	41.9	50.6	251.7	250.5	250.0	29.9	15.6	4.5	364.9	113.4	39.4	8.0	116.2	40.2	8.3
30d1	41.9	50.6	58.5	46.2	37.3	29.9	15.6	4.5	290.8	174.1	268	299.4	189.7	265.5	297.4
30c	41.9	50.6	251.7	250.5	250	29.9	15.6	4.5	364.9	113.4	39.4	8	116.2	40.2	8.3
30d2	41.9	50.6	24.6	25.5	30.9	29.9	15.6	4.5	243	113.4	39.4	8	116.2	40.2	8.3
30b	41.9	50.6	29.4	15.4	4.6	29.9	15.6	4.5	265.8	180.7	254.6	286.1	178.4	254.4	286.2
33a	41.9	50.6	251.7	250.5	250	29.9	15.6	4.5	364.9	113.4	39.4	8	116.2	40.2	8.3
33c	41.9	50.6	251.7	250.5	250	29.9	15.6	4.5	364.9	113.4	39.4	8	116.2	40.2	8.3
33b	41.9	50.6	29.4	15.4	4.6	29.9	15.6	4.5	265.8	181.4	255.3	286.8	177.7	253.7	285.5
33d1	41.9	50.6	58.5	46.2	37.3	29.9	15.6	4.5	290.8	194.3	268.2	299.6	183.5	265.4	297.2
33d2	41.9	50.6	24.6	25.5	30.9	29.9	15.6	4.5	243	169.2	243.1	274.5	166.7	242.5	274.4
34c	41.9	40.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
34b	41.9	50.6	29.4	15.4	4.6	480.9	480.3	480	548.7	113.4	39.4	8	116.2	40.2	8.3
34a	41.9	50.6	29.4	15.4	4.6	251.8	250.5	250	364.9	113.4	39.4	8	116.2	40.2	8.3
34d1	41.9	50.6	29.4	15.4	4.6	59	46.3	37.2	290.8	193.5	267.4	298.8	190.3	266.2	298
34d2	41.9	50.6	29.4	15.4	4.6	24.7	25.4	30.9	243	168.7	242.5	274	167.2	243.1	274.9
13b	41.9	50.6	29.4	15.4	4.6	24.7	25.4	30.9	24.3	168.7	242.5	274	167.2	243.1	274.9

Actual Timing on Each Activities Codes

Activities		Machining Process																														Average	Time Result
Code		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	(Minutes)	(Minutes)
0		3.2	3.2	3.3	3.2	3.3	3.1	3.1	3.6	3.2	3.5	3.2	3.8	3.2	3.1	3.4	3.3	4	5	3.5	3.3	3.1	3.5	3.3	3.5	3.3	3.6	3.2	3.3	3.5	3.3	3.40	3.5
1		3.5	3	3	3.6	3.5	3	4	3.5	4	3.4	3.5	4	3.5	3.4	4	5	6	4	5	3	3.5	6	3.5	3.5	3.6	4	5	3	3.5	3	3.82	3.5
4		3	4	5	3	5	5	3	3	3	5	5	4	2	3	3	3	3	3	4	2	3	3	3	2	3	3	3	3	3	3	3.33	3.5
7		4	5	6	5	3	3	3	2	3	5	5	3	3	3	3	3	3	4	3	3	3	3	3	5	3	3	3	3	3	3	3.47	3.5
Activities		Machining Process																														Average	Time Result
Code		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	(Second)	(Minutes)
10		7	8	8	7	8	6	8	7	8	7	8	8	8	8	7	8	7	8	9	8	7	8	9	9	7	8	7	9	8	7	7.73	0.1333
14a		4	5	6	4	5	5	5	5	6	5	8	5	6	5	7	5	5	5	4	5	5	5	5	5	5	6	5	6	5	6	5.27	0.0500
13a		6	5	6	4	6	6	6	6	5	6	7	6	5	6	5	6	4	6	5	6	5	4	5	6	7	6	6	6	6	6	5.63	0.0800
13c		5	5	5	4	5	7	5	6	5	6	5	5	5	5	7	5	2	5	4	5	8	5	6	5	5	5	5	6	5	5	5.13	0.0300
13d1		5	5	6	4	5	6	5	6	5	6	5	6	7	5	5	5	4	5	5	5	6	5	6	4	5	6	5	6	5	5	5.27	0.0300
13d2		5	6	4	5	6	5	6	4	5	6	7	5	6	5	4	5	6	4	6	5	3	5	6	5	4	5	6	5	4	5	5.10	0.0333
14b		3	2	5	4	5	3	5	6	2	5	3	5	3	5	5	4	3	3	3	2	3	2	3	2	3	4	3	2	3	2	3.43	0.0500
14a		3	3	6	3	3	3	3	3	2	3	2	3	5	3	2	3	2	3	3	3	2	3	3	3	3	3	5	3	5	3	3.13	0.0500
15a		2	2	2	2	2	2	2	2	2	2	2	3	2	3	2	3	2	2	2	2	2	2	3	2	2	2	2	2	2	5	2.23	0.0300
16a		3	2	3	2	3	4	2	3	2	3	5	3	2	3	3	2	4	2	3	2	4	2	3	2	3	4	3	2	3	2	2.80	0.0500
15b		2	3	5	3	2	3	4	2	3	2	3	2	3	6	3	2	3	4	2	3	5	2	3	5	2	3	5	3	2	4	3.13	0.0333
17a		2	3	5	2	6	2	3	5	4	2	3	3	4	3	2	3	2	3	5	3	5	3	5	3	5	3	5	3	2	4	3.43	0.0300
17b		3	2	3	4	3	2	3	5	2	3	2	3	2	3	5	3	5	3	3	3	3	4	2	3	2	2	2	3	2	3	2.93	0.0500
18		8	5	7	5	8	4	8	6	8	8	8	7	8	9	10	11	15	15	14	15	10	10	10	15	10	14	10	15	10	15	9.93	5.0000
21 a		6	5	6	6	5	6	3	6	5	4	5	2	6	5	2	3	5	2	4	5	5	5	5	4	4	6	5	6	5	6	4.73	0.0833
21d1		5	6	4	6	5	5	6	5	6	5	6	5	5	6	6	5	5	6	6	6	6	5	6	4	5	6	5	6	5	6	5.43	0.0833
21d2		2	3	2	3	2	2	2	3	2	3	2	3	4	3	2	3	2	3	2	2	2	2	2	2	2	2	3	2	3	2	2.40	0.0333
21b		2	3	2	4	2	3	2	5	2	2	2	3	2	3	2	2	4	2	3	2	3	2	3	2	3	2	5	2	3	2	2.63	0.0500
21c		5	5	5	5	5	5	4	5	4	5	5	2	5	5	2	5	3	5	5	2	5	5	5	3	5	3	5	4	5	5	4.40	0.0833
24a		5	6	5	6	5	5	5	4	5	5	6	5	5	5	5	5	5	5	3	5	5	4	5	5	5	5	5	5	5	5	4.97	0.0333
24d1		2	3	2	3	4	2	3	5	3	2	3	2	2	2	2	2	2	2	3	4	2	2	2	2	2	2	2	3	2	3	2.50	0.0833
24c		5	6	2	5	5	5	5	3	4	5	6	7	5	5	5	5	8	5	5	5	5	5	5	8	5	5	5	5	5	5	5.13	0.0833
24d2		2	3	2	3	2	3	4	2	3	2	2	2	2	2	3	2	2	2	4	2	2	2	2	2	2	2	2	3	2	2	2.33	0.0833
24b		5	2	5	3	3	5	3	5	5	5	5	5	6	5	5	5	5	5	4	5	5	3	5	5	5	5	2	5	5	5	4.53	0.0833
25a		5	2	5	3	5	5	2	5	5	5	5	5	6	8	5	5	5	4	5	4	5	2	5	3	5	5	5	9	5	6	4.80	0.0833
25d1		2	2	3	2	3	2	4	2	6	2	3	2	3	2	2	2	2	5	2	3	2	2	2	2	2	2	2	2	2	4	2.53	0.0833
25c		2	2	2	2	2	2	2	3	2	2	3	2	2	2	2	3	2	3	2	2	2	2	3	2	4	2	3	2	4	2	2.37	0.0333
25d2		2	3	2	3	2	5	2	2	2	2	3	2	4	2	2	5	2	3	2	2	2	5	2	4	2	3	2	2	2	2	2.60	0.0833
25b		2	5	2	3	5	5	5	5	5	6	8	5	7	5	5	5	7	5	5	2	5	4	5	5	2	5	4	7	5	2	4.70	0.0833
29a		5	5	5	6	8	5	5	5	4	5	5	6	7	5	5	2	5	4	6	5	3	5	2	7	5	5	5	5	7	5	5.07	0.0333
29c		5	6	4	5	6	5	2	3	5	7	5	6	5	5	5	6	5	5	5	5	5	5	7	5	5	5	5	5	5	7	5.13	0.0333
29b		3	3	5	2	3	5	4	5	2	2	2	2	5	2	4	3	2	5	2	2	2	2	2	5	4	5	2	2	2	2	3.03	0.0500
29d1		2	2	2	2	2	2	5	4	2	2	2	2	2	5	2	2	2	2	5	5	4	2	2	2	2	2	2	2	2	2	2.53	0.0833

Activities Code	Machining Process																														Average (Second)	Time Result (Minutes)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
29d2	5	4	5	4	5	5	5	4	5	2	5	3	5	5	5	5	5	7	5	5	5	4	5	5	5	5	5	5	4	5	4.73	0.0833
29d3	2	3	2	4	2	3	2	2	2	3	2	2	2	2	2	4	2	2	2	2	3	2	2	2	2	2	4	2	2	2	2.33	0.0333
30a	4	3	5	3	5	5	5	5	4	5	8	5	5	5	7	5	5	5	1	5	2	5	5	5	5	5	5	2	5	5	4.63	0.0833
30d1	5	5	4	5	4	5	5	5	5	5	4	5	5	5	5	5	3	5	5	5	5	5	7	5	5	5	9	5	5	5	5.03	0.0833
30c	2	3	4	2	2	2	4	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	4	2	2	2	2	4	2	2	2.33	0.0333
30d2	5	4	5	4	5	5	5	4	5	7	5	5	5	5	7	5	5	5	5	5	6	5	5	5	5	5	5	5	4	5	5.03	0.0833
30b	2	2	2	3	2	4	2	3	2	2	5	2	2	2	3	2	2	2	2	5	2	2	2	2	2	2	4	2	2	2	2.43	0.0333
33a	2	3	2	4	2	2	2	2	4	2	4	2	2	2	2	5	2	2	2	2	2	2	3	2	2	2	2	4	2	2	2.43	0.0333
33c	2	4	2	2	4	2	2	2	4	2	2	2	2	5	2	2	2	2	3	2	2	2	4	2	2	2	2	2	2	2	2.40	0.0333
33b	4	5	4	5	5	5	5	2	5	7	5	5	5	4	5	5	5	7	5	5	5	6	5	5	5	5	5	4	5	5	4.93	0.0833
33d1	5	5	5	4	5	6	7	5	5	5	8	5	5	5	5	7	5	5	5	5	4	5	5	5	6	5	5	5	5	5	5.23	0.0833
33d2	5	5	4	5	5	5	6	5	5	7	5	5	5	5	5	5	7	5	5	5	5	4	5	5	5	5	5	8	5	5	5.20	0.0833
34c	2	2	4	2	2	2	2	4	2	2	3	2	2	2	2	4	2	2	2	2	2	2	2	4	2	2	2	5	2	2	2.40	0.0333
34b	2	2	4	2	2	2	4	2	2	3	2	2	2	5	2	2	2	4	2	2	2	2	4	2	2	2	3	2	2	2	2.43	0.0333
34a	5	5	6	5	5	5	6	5	5	4	5	5	5	3	5	5	5	5	4	5	5	5	6	5	5	5	5	5	4	4.93	0.0833	
34d1	5	5	5	6	4	5	5	5	6	5	5	5	4	5	6	5	5	5	5	5	4	5	5	5	5	5	6	5	5	5	5.03	0.0833
34d2	5	5	4	5	5	5	5	6	5	5	5	5	5	5	7	5	5	5	4	5	5	6	5	5	5	7	5	5	5	5	5.13	0.0833
13b	5	5	4	5	6	5	5	5	7	5	5	4	5	4	5	4	5	5	5	6	5	5	7	5	5	5	4	5	5	5	5.03	0.0833

Energy Expenditure Calculation

No.	Activities code	Distance per sequence (Cm)	F Total	Usaha per seq (joule /time)	Time (Minutes)	Kcal/operation/m inute	Total Kcal/merit (Kcal /merit)
1	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
2	17a	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
3	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
4	17a	129.58	4308.20	5582.5656	0.05	26.66745753	26.6675
5	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
6	18	158.19	1898.00	3002.4462	5.00	0.143424391	0.1434
7	14a	174.6	3150.50	5500.7730	0.05	26.27674119	26.2767
8	14b	186.34	4864.50	9064.5093	0.05	43.30041702	43.3004
9	13b	216.88	2025.30	4392.4706	0.08	12.58948306	12.5895
10	14b	186.34	4864.50	9064.5093	0.05	43.30041702	43.3004
11	14a	174.6	3150.50	5500.7730	0.05	26.27674119	26.2767
12	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
13	17a	129.58	2563.10	3321.2650	0.05	15.86541024	15.8654
14	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
15	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
16	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
17		216.38			0.00		
18	13a	10	2025.30	202.5300	0.08	0.580481513	0.5805
19		216.38			0.00		
20	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
21	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
22	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
23	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
24	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
25		162.34			0.00		
26	21d1	243	1988.80	4832.7840	0.08	14.42863285	14.4286
27	21a	8	1584.60	126.7680	0.08	0.363336199	0.3633
28	24d1	243	1898.00	4612.1400	0.08	13.76988392	13.7699
29	24a	8	1584.60	126.7680	0.03	1.009267221	1.0093
30		162.65			0.00		
31	14a	174.6	3150.50	5500.7730	0.05	26.27674119	26.2767
32	14b	186.34	4864.50	9064.5093	0.05	43.30041702	43.3004
33		218.37			0.00		
34	13d1	243	852.10	2070.6030	0.03	14.8366509	14.8367
35	13a	8	2025.30	162.0240	0.03	1.160963027	1.1610
36		218.37			0.00		
37	14b	186.34	4864.50	9064.5093	0.05	43.30041702	43.3004
38	14a	174.6	3150.50	5500.7730	0.05	26.27674119	26.2767
39	24b	162.65	1898.00	3087.0970	0.08	8.848085411	8.8481
40	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
41	7	144.5	1898.00	2742.6100	3.50	0.187160327	0.1872
42	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
43	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
44	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
45	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
46	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
47	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
48		90.81			0.00		
49	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497

No.	Activities code	Distance per sequence (Cm)	F Total	Usaha per seq (juole /time)	Time (Minutes)	Kcal/operation/m inute	Total Kcal/menit (Kcal /menit)
50	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
51		159.46			0.00		
52	25d1	243	2457.30	5971.2390	0.08	17.1144712	17.1145
53	25a	10	1584.60	158.4600	0.08	0.454170249	0.4542
54		159.46			0.00		
55	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
56	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
57		90.81		0.0000	0.00		
58	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
59	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
60		125.66		0.0000	0.00		
61	29d1	243	2089.40	5077.2420	0.08	15.15848022	15.1585
62	29a	8	2456.75	196.5402	0.03	1.564760747	1.5648
63		125.66		0.0000	0.00		
64	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
65	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
66	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
67		160.61		0.0000	0.00		
68	30d1	243	1585.10	3851.7930	0.08	11.03981943	11.0398
69	30a	8	1585.10	126.8080	0.08	0.363450846	0.3635
70	33d1	243	2083.50	5062.9050	0.03	36.27762253	36.2776
71	33a	8	1585.10	126.8080	0.08	0.363450846	0.3635
72		160.61		0.0000	0.00		
73	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
74	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
75		122.47		0.0000	0.00		
76	34d1	243	2089.40	5077.2420	0.08	15.15848022	15.1585
77	34a	8	1584.60	126.7680	0.03	1.009267221	1.0093
78		122.47		0.0000	0.00		
79	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
80	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
81	4	90.81	1898.00		3.50		2.2500
82	0	90.81	1898.10		3.50		2.2500
83	4	90.81	1898.00		3.50		2.2500
84	0	90.81	1898.10		3.50		2.2500
85	4	90.81	1898.00		3.50		2.2500
86	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
87	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
88	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
89	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
90	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
91	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
92	4	164.65	1898.00	3125.0570	3.50	0.213259155	0.2133
93	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
94	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981

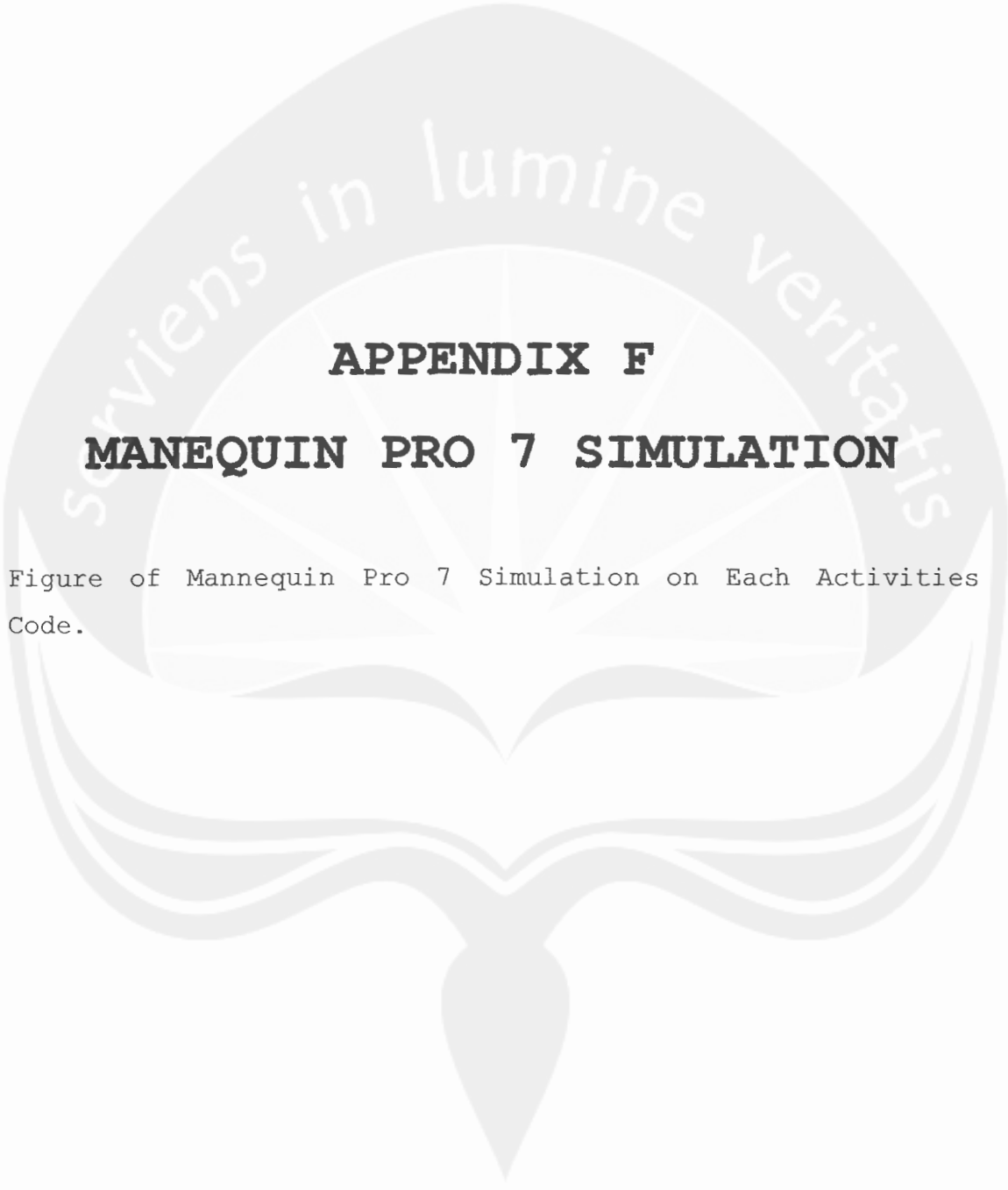
No.	Activities code	Distance per sequence (Cm)	F Total	Usaha per seq (juole /time)	Time (Minutes)	Kcal/operation/m inute	Total Kcal/menit (Kcal /menit)
95	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
96	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
97	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
98	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
99	4	164.65	1898.00		3.50	0	2.25
100	4	164.65	1898.00		3.50	0	2.25
101	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
102	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
103	1	125.45	1892.10	2373.6395	3.50	2.1	2.1000
104	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
105	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
106		90.81		0.0000	0.00		0.0000
107	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
108	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
109	1	125.45	1892.10	2373.6395	3.50	2.1	2.1000
110	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
111	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
112	4	90.81	1898.00	1723.5738	3.50	0.11761958	2.2500
113	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
114	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
115	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
116	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
117	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
118	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
119	4	164.65	1898.00	3125.0570	3.50	0.213259155	2.2500
120	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
121	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
122	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
123	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
124	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
125	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
126	4	90.81	1898.00		3.50	0	2.2500
127	0	90.81	1898.10		3.50	0	2.2500
128	4	90.81	1898.00		3.50	0	2.2500
129	0	90.81	1898.10		3.50	0	2.2500
130	4	90.81	1898.00		3.50	0	2.2500
131	4	90.81	1898.00		3.50	0	2.2500
132	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
133	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
134	1	125.45	1892.10	2373.6395	3.50	2.1	2.1000
135	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
136	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
137	15a	90.81	4163.35	3780.7381	0.03	27.09041369	27.0904
138	15b	93.02	3331.25	3098.7288	0.03	22.2035594	22.2036
139		116.29		0.0000	0.00		
140	1	125.45	1892.10	2373.6395	3.50	2.1	2.1000
141	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
142	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
143	4	164.65	1898.00	3125.0570	3.50	2.25	2.2500
144	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
145	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
146	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483

No.	Activities code	Distance per sequence (Cm)	F Total	Usaha per seq (juole /time)	Time (Minutes)	Kcal/operation/m inute	Total Kcal/menit (Kcal /menit)
147	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
148	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
149	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
150	4	155.64	1898.00		3.50		2.25
151	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
152	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
153	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
154	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
155	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
156	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
157	4	90.81	1898.00		3.50		2.25
158	0	90.81	1898.10		3.50		2.25
159	0	90.81	1898.10		3.50		2.25
160	4	90.81	1898.00		3.50		2.25
161	4	90.81	1898.00		3.50		2.25
162	0	90.81	1898.10		3.50		2.25
163	0	90.81	1898.10		3.50		2.25
164	4	90.81	1898.00		3.50		2.25
165	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
166	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
167	1	125.45	1892.10	2373.6395	3.50	2.1	2.1000
168	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
169	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
170	15a	90.81	4163.35	3780.7381	0.03	27.09041369	27.0904
171	15b	93.02	3331.25	3098.7288	0.03	22.2035594	22.2036
172	1	116.29	1898.00	2207.1842	0.03	15.81530668	15.8153
173	15b	125.45	1892.10	2373.6395	3.50	0.161981155	0.1620
174	15a	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
175	4	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
176	15a	164.65	1898.00	3125.0570	3.50	0.213259155	0.2133
177	15b	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
178		116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
179		125.66		0.0000	0.00		
180	29c	8	2442.10	195.3680	0.03	1.555428171	1.5554
181	29d2	243	1836.30	4462.2090	0.08	12.78936371	12.7894
182		125.66		0.0000	0.00		
183	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
184	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
185	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
186		160.61		0.0000	0.00		
187	30c	8	1585.10	126.8080	0.03	1.009585682	1.0096
188	30d2	243	792.00	1924.5600	0.08	5.516079106	5.5161
189	33c	8	1898.10	151.8480	0.03	1.20894239	1.2089
190	33d2	243	1836.90	4463.6670	0.08	12.79354256	12.7935
191		160.61		0.0000	0.00		
192	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
193	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
194		122.47		0.0000	0.00		
195	34c	8	1584.60	126.7680	0.03	0.363336199	0.3633
196	34d2	243	1836.30	4462.2090	0.08	12.78936371	12.7894
197		122.47		0.0000	0.00		
198	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580

No.	Activities code	Distance per sequence (Cm)	F Total	Usaha per seq (joule /time)	Time (Minutes)	Kcal/operation/m inute	Total Kcal/menit (Kcal /menit)
199	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
200		90.81		0.0000	0.00		
201	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
202	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
203	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
204	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
205	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
206		162.34		0.0000	0.00		
207	21c	8	1584.60	126.7680	0.08	0.363336199	0.3633
208	21d2	243	1970.70	4788.8010	0.03	34.31356406	34.3136
209	24c	8	1898.00	151.8400	0.08	0.435196331	0.4352
210	24d2	243	1898.00	4612.1400	0.08	13.21908856	13.2191
211		162.65		0.0000	0.00		
212	14a	174.6	3150.50	5500.7730	0.05	26.27674119	26.2767
213	14b	186.34	4864.50	9064.5093	0.05	43.30041702	43.3004
214		216.38		0.0000	0.00		
215	13c	8	2457.30	196.5840	0.03	1.408598452	1.4086
216	13d2	243	852.10	2070.6030	0.03	14.8366509	14.8367
217		216.38		0.0000	0.00		
218	14b	186.34	4864.50	9064.5093	0.05	43.30041702	43.3004
219	14a	174.6	3150.50	5500.7730	0.05	26.27674119	26.2767
220	24b	162.65	1898.00	3087.0970	0.08	8.848085411	8.8481
221	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
222				jalanhorizontal	0.00		
223	7a	10	1617.60	161.7600	0.08	3	3.0000
224				jalanhorizontal	0.00		
225	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
226	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
227	21b	155.64	1584.60	2466.2714	0.08	7.068705761	7.0687
228	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
229	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
230	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
231	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
232	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
233		90.81			0.00		
234	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
235	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
236		159.46		0.0000	0.00		
237	25c	8	3305.00	264.4000	0.03	1.894525652	1.8945
238	25d2	243	2457.30	5971.2390	0.08	17.1144712	17.1145
239		159.46		0.0000	0.00		
240	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
241	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
242	1	125.45	1892.10	2373.6395	3.50	2.1	2.1000
243	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
244	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
245	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
246	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
247	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
248	18	116.29	1898.00	2207.1842	5.00	0.105435378	0.1054
249	14a	174.6	4163.35	7269.2091	0.05	34.72441531	34.7244

No.	Activities code	Distance per sequence (Cm)	F Total	Usaha per seq (joule /time)	Time (Minutes)	Kcal/operation/minute	Total Kcal/merit (Kcal /merit)
250	14b	186.34	3331.25	6207.4513	0.05	29.65248519	29.6525
251	13b	216.88	2025.30	4392.4706	0.08	12.58948306	12.5895
252	14b	186.34	4864.50	9064.5093	0.05	43.30041702	43.3004
253	14a	174.6	3150.50	5500.7730	0.05	26.27674119	26.2767
254	17b	143.72	3204.20	4605.0762	0.05	21.99807127	21.9981
255	17a	129.58	4308.20	5582.5656	0.03	40.0011863	40.0012
256	29b	125.66	2456.75	3087.1553	0.08	8.848252597	8.8483
257	15b	116.29	3331.25	3873.9106	0.03	27.7580297	27.7580
258	15a	93.02	4163.35	3872.7482	0.03	27.74970027	27.7497
Total F (Newtom)			655657.89	Total Time (minutes)	141.81		
Total of Work (Joule)				769329.8092		Total Kcal/ merit	4183.2979
Total of Work (K Joule)				769.3298092		AVG Kcal/ merit	18.5924

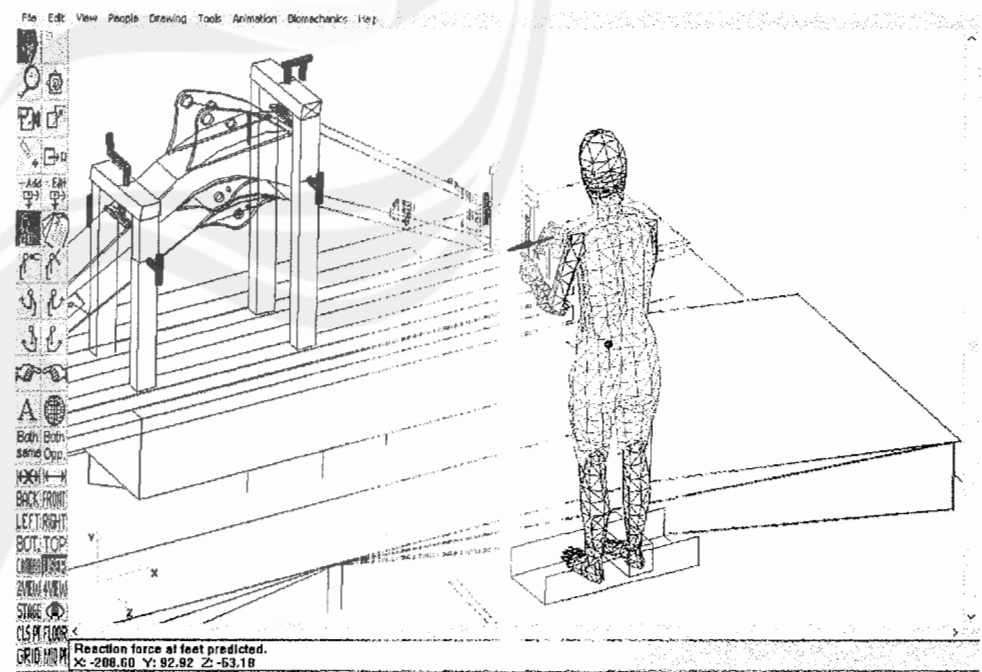
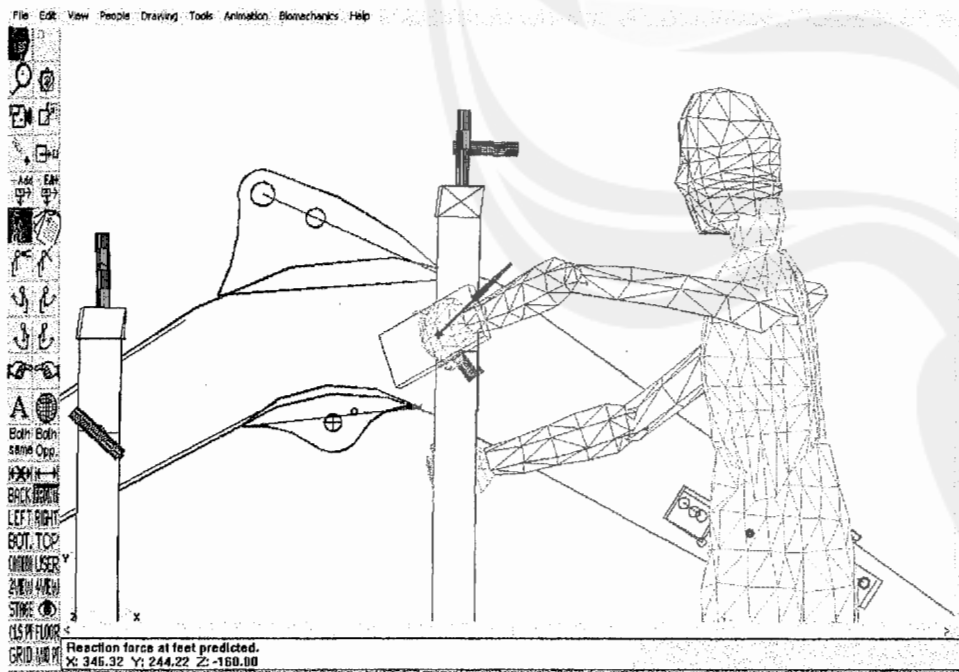
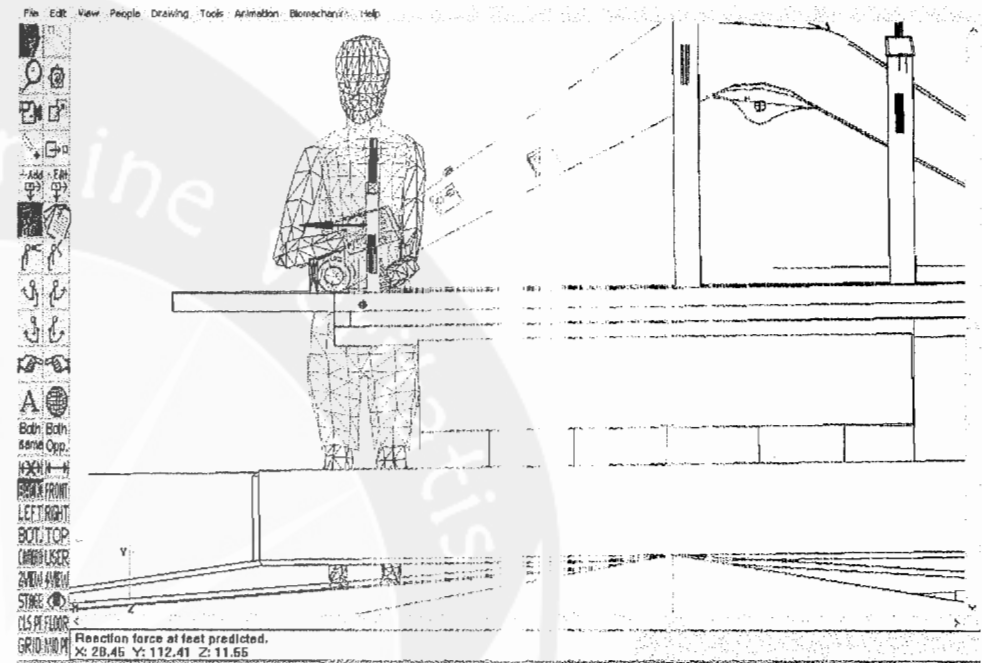
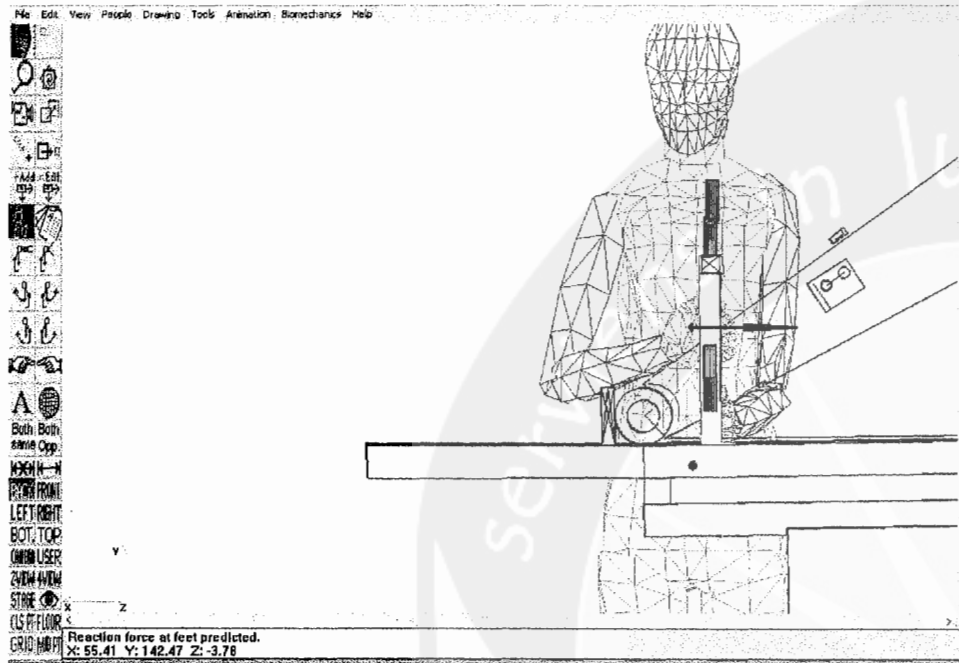




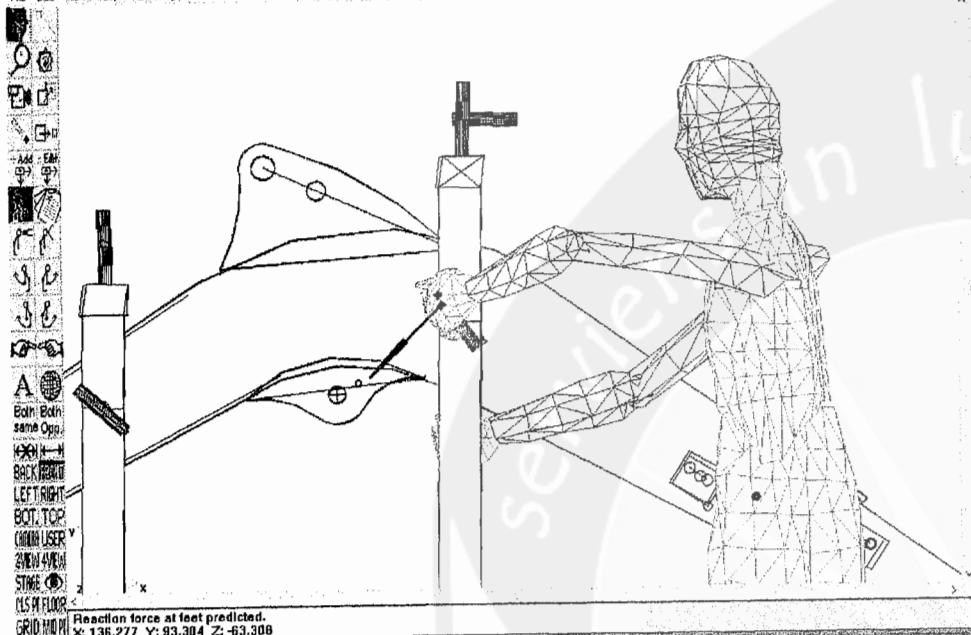
APPENDIX F

MANEQUIN PRO 7 SIMULATION

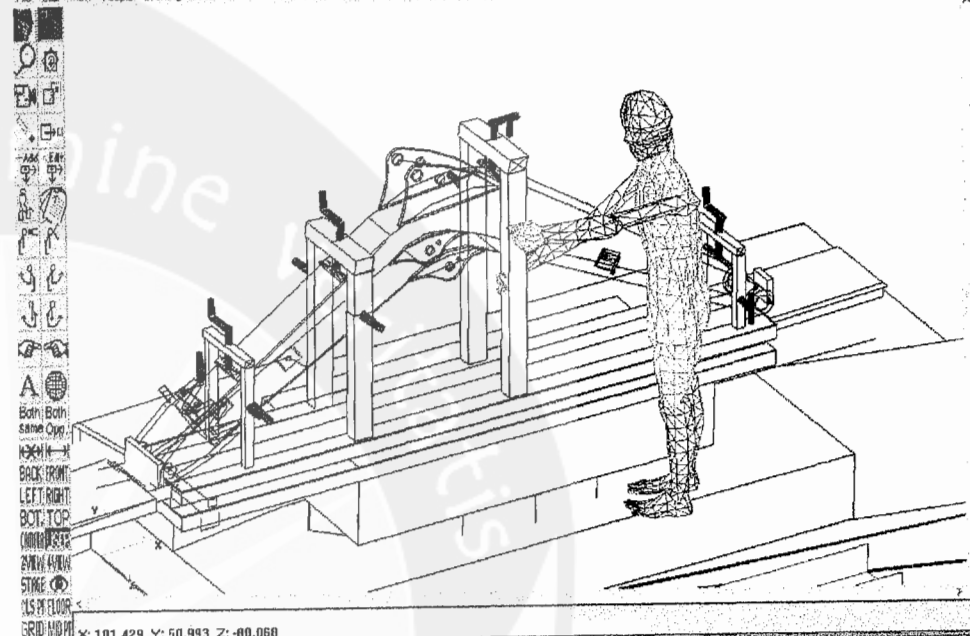
Figure of Mannequin Pro 7 Simulation on Each Activities Code.



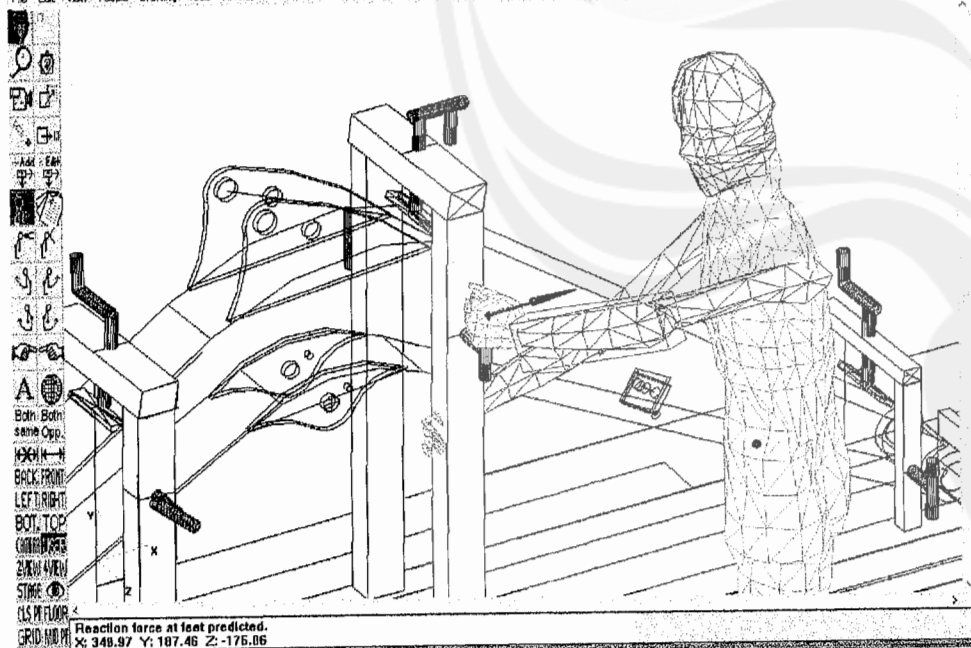
File Edit View People Drawing Tools Animation Biomechanics Help



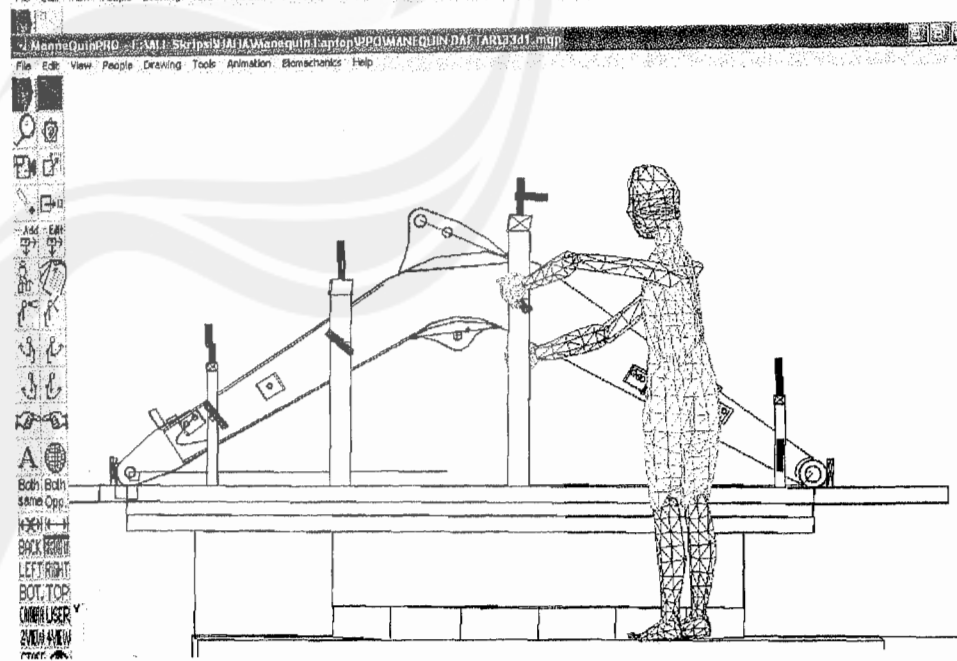
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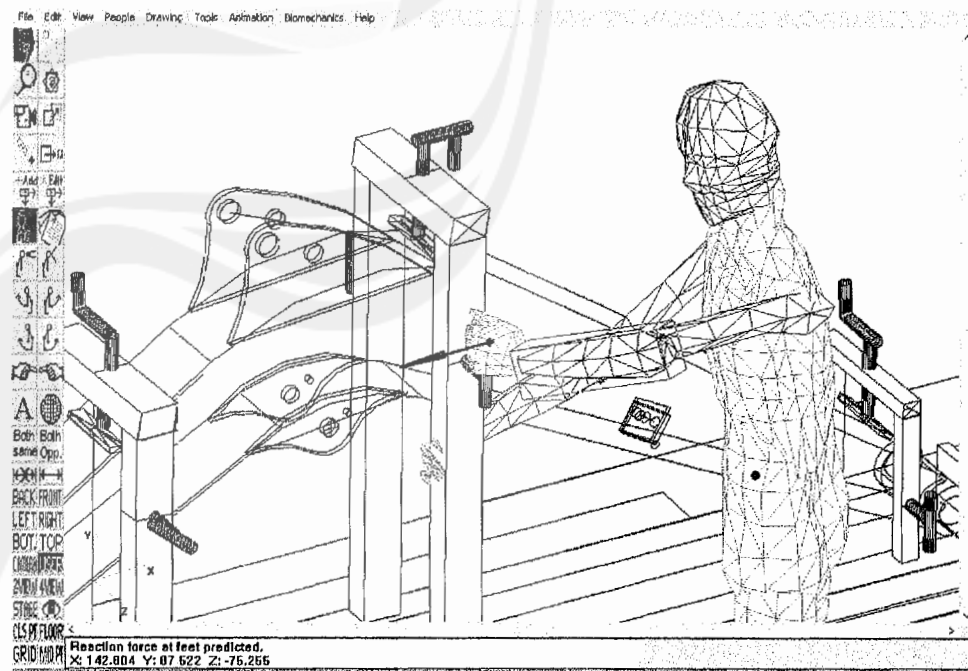
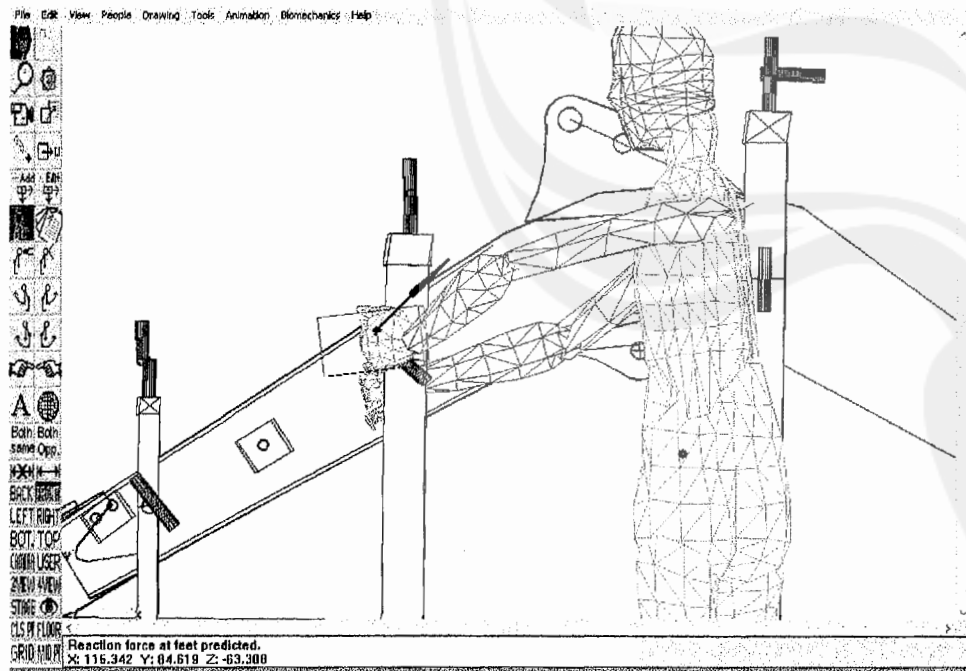
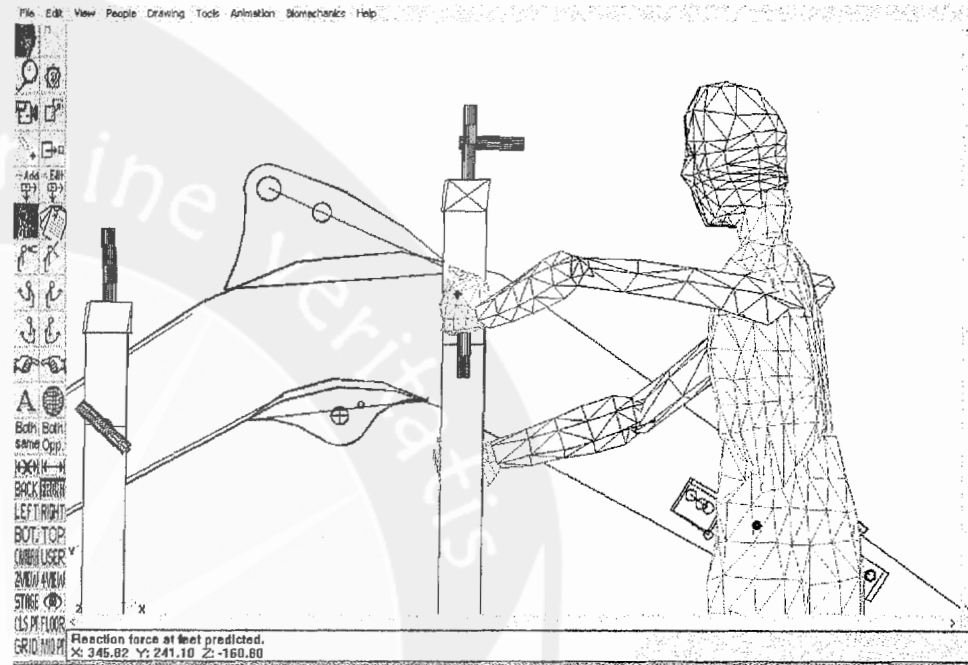
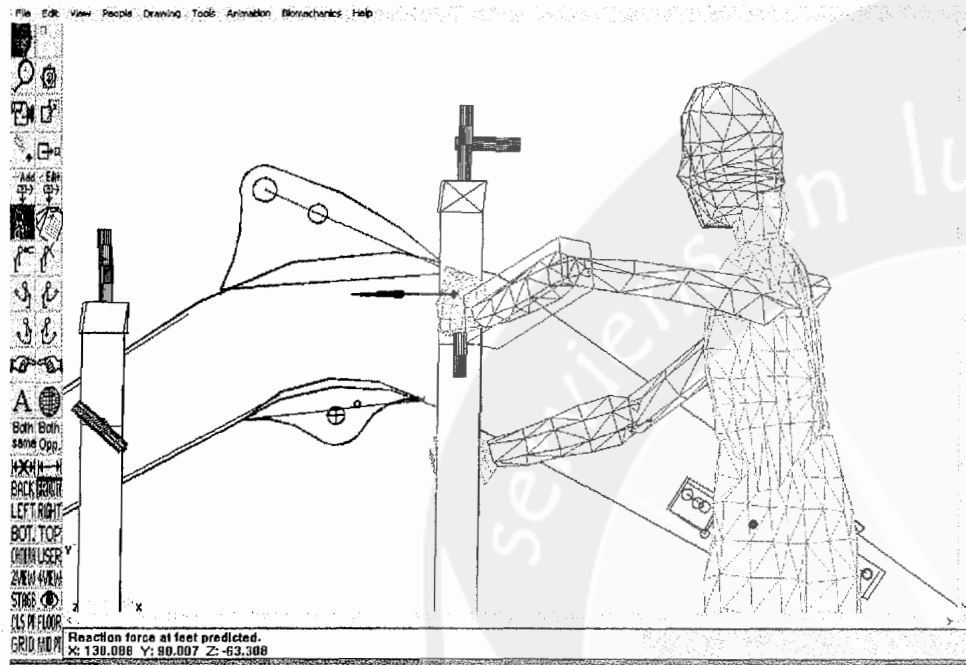


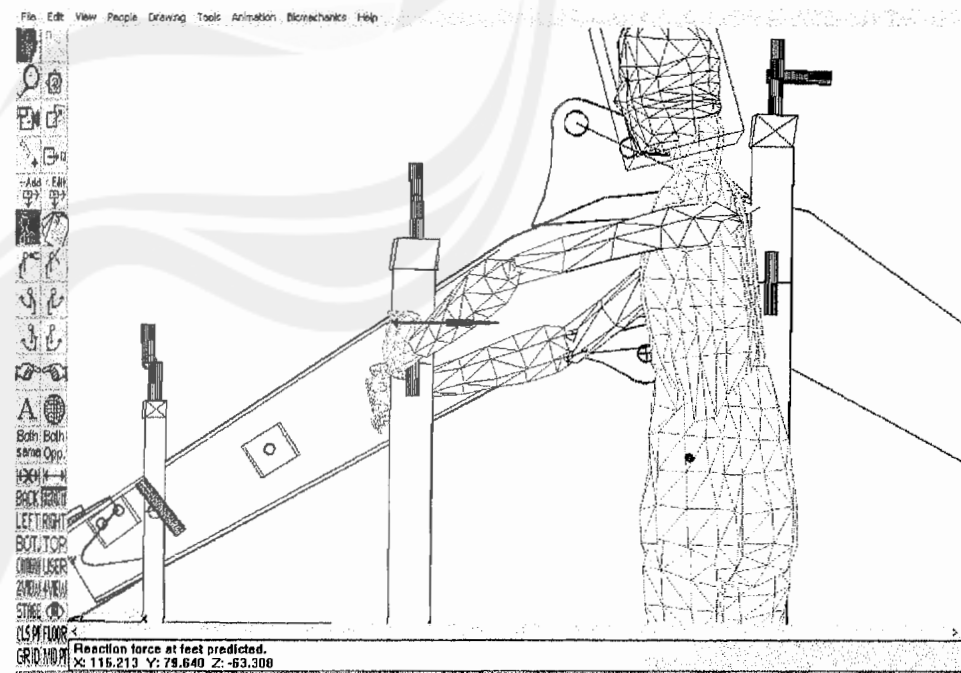
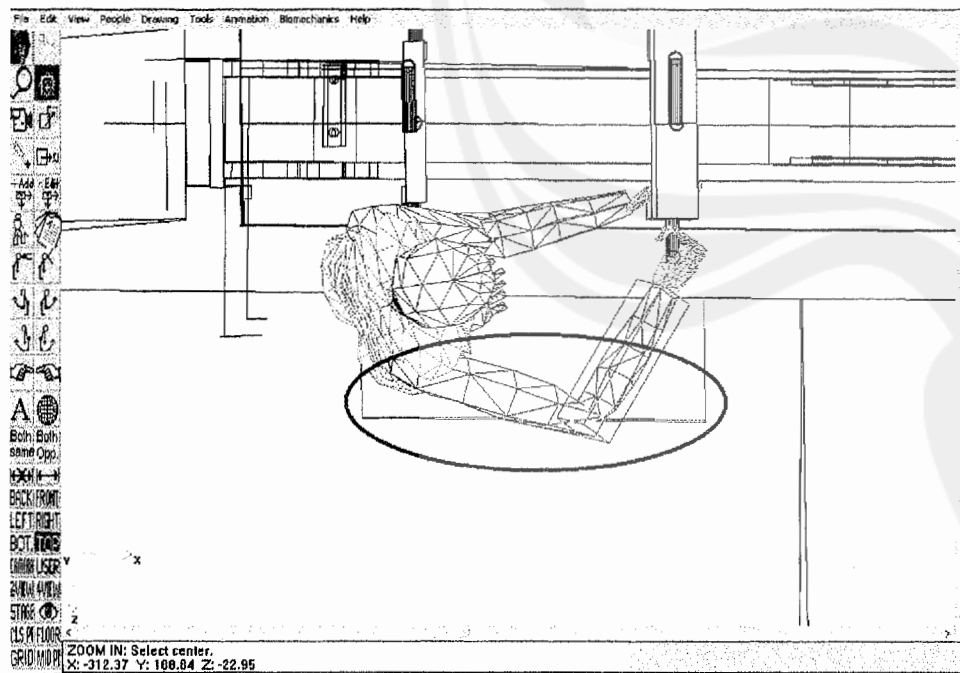
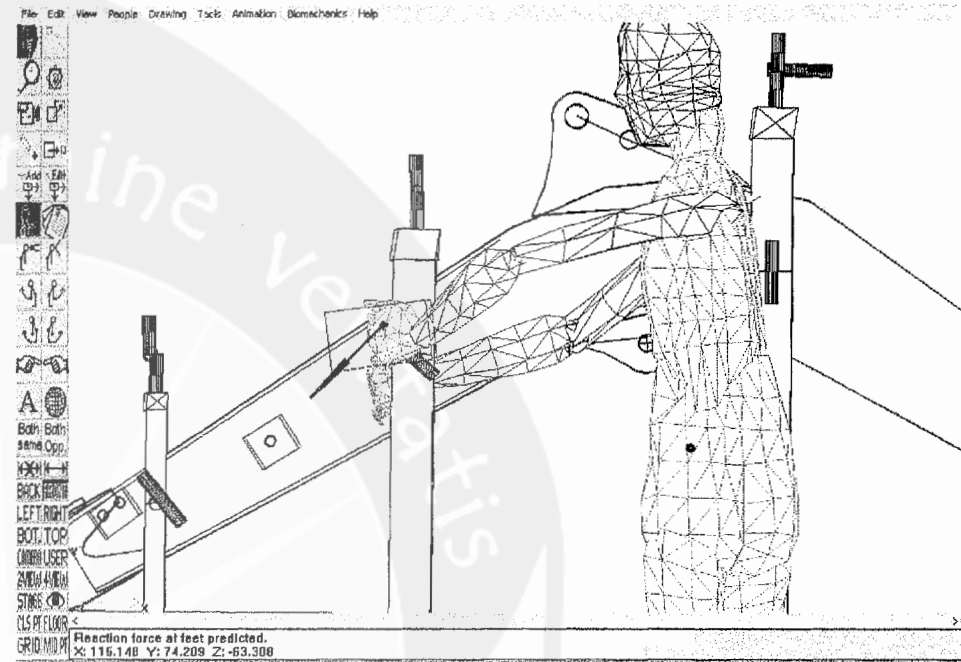
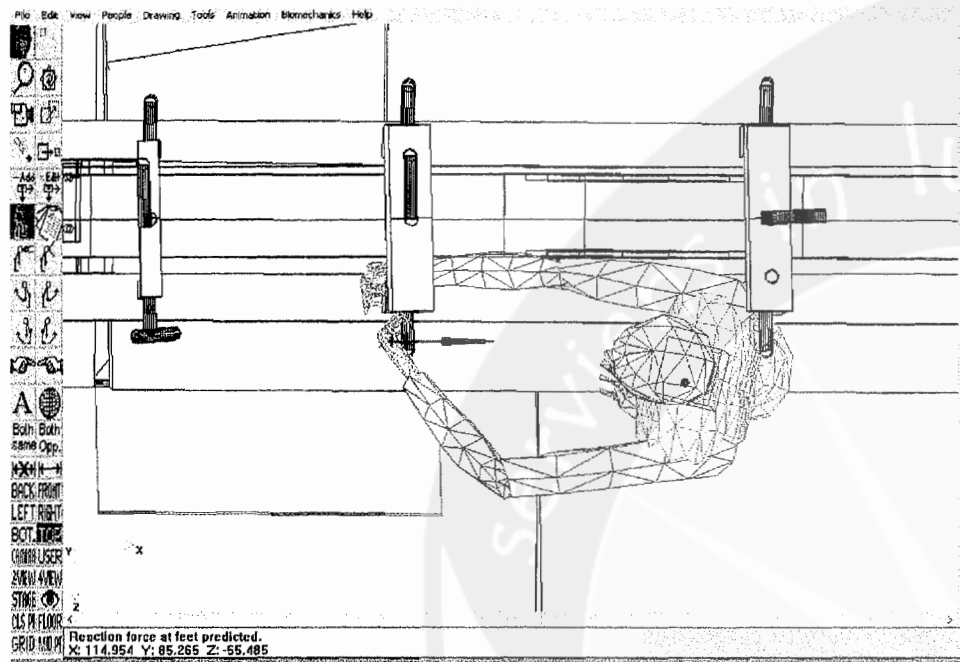
File Edit View People Drawing Tools Animation Biomechanics Help

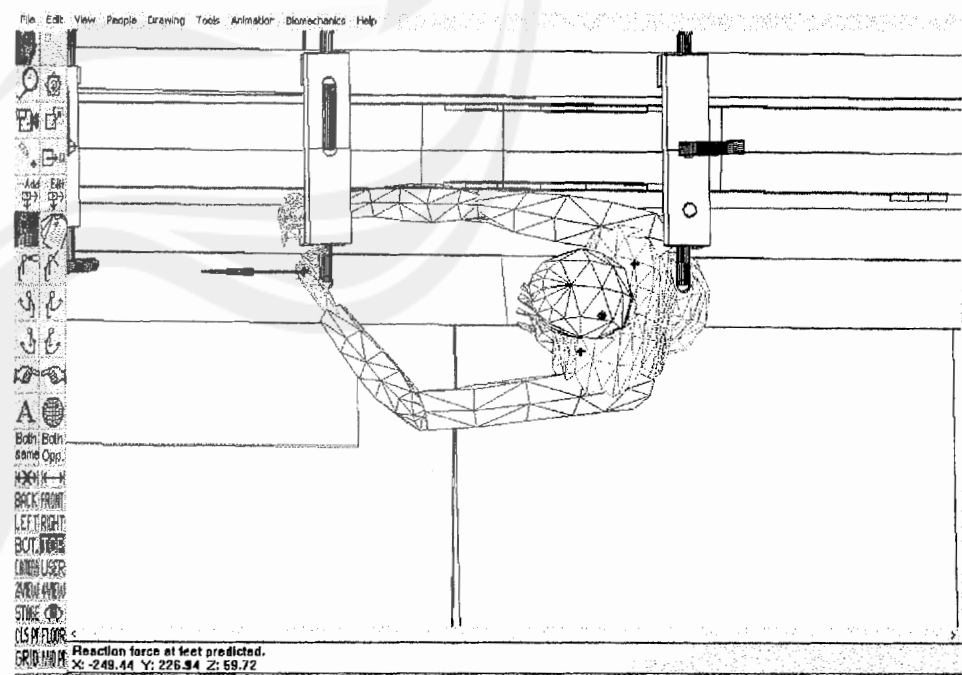
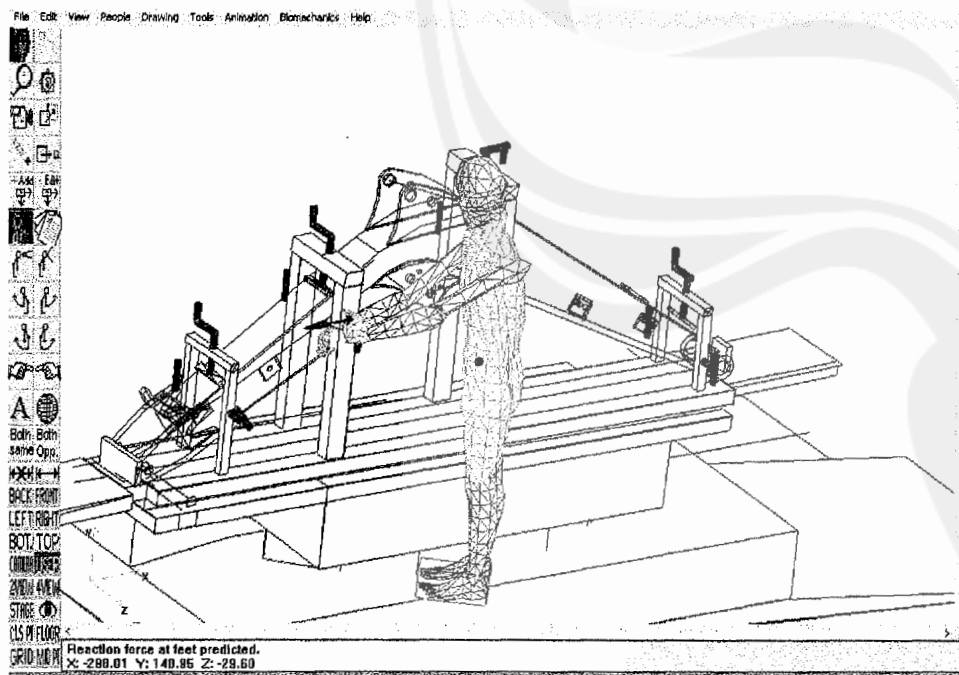
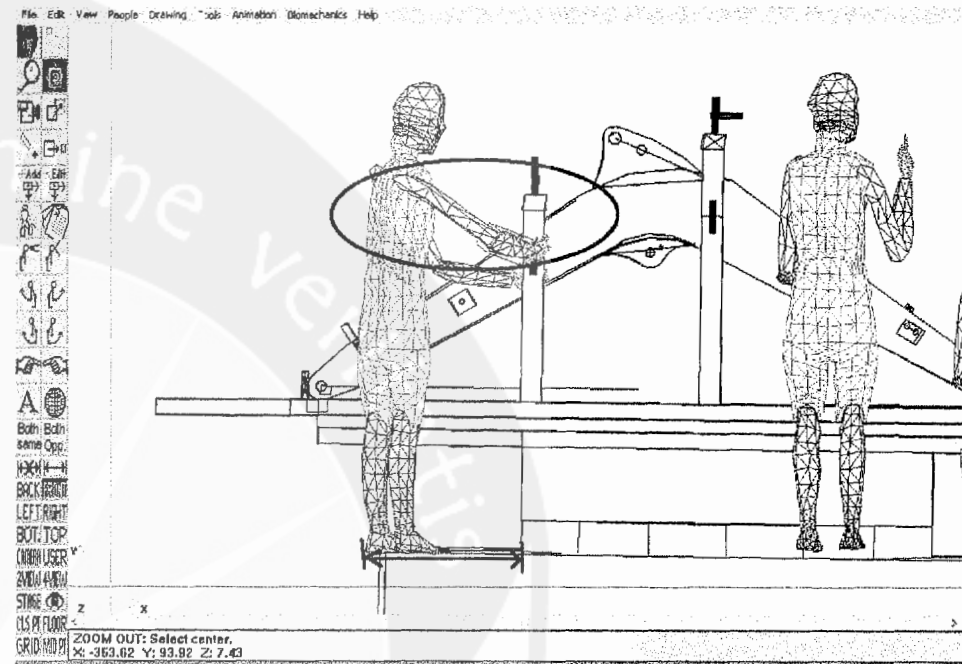
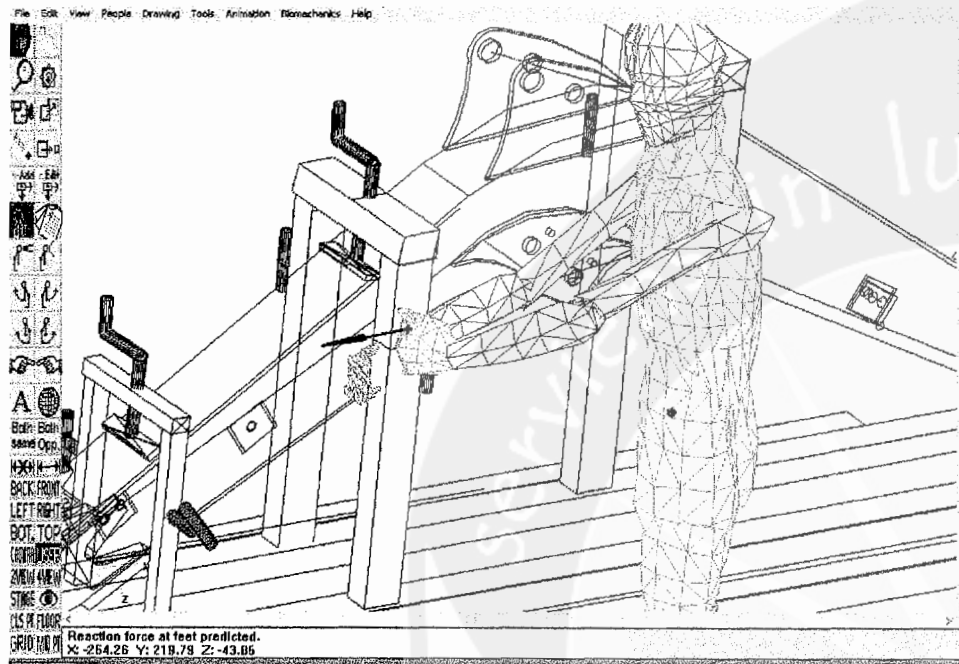


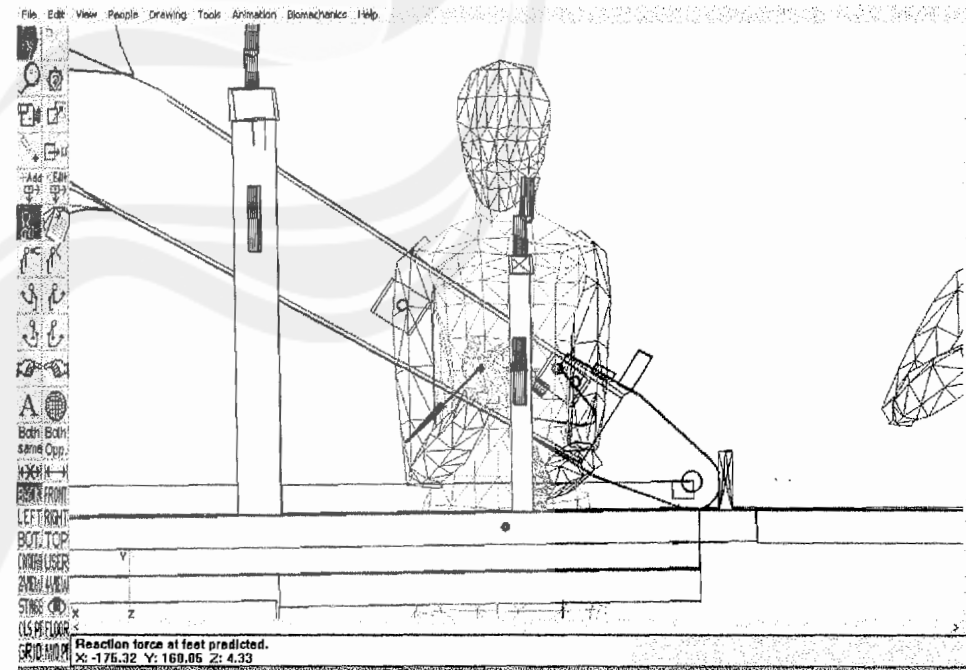
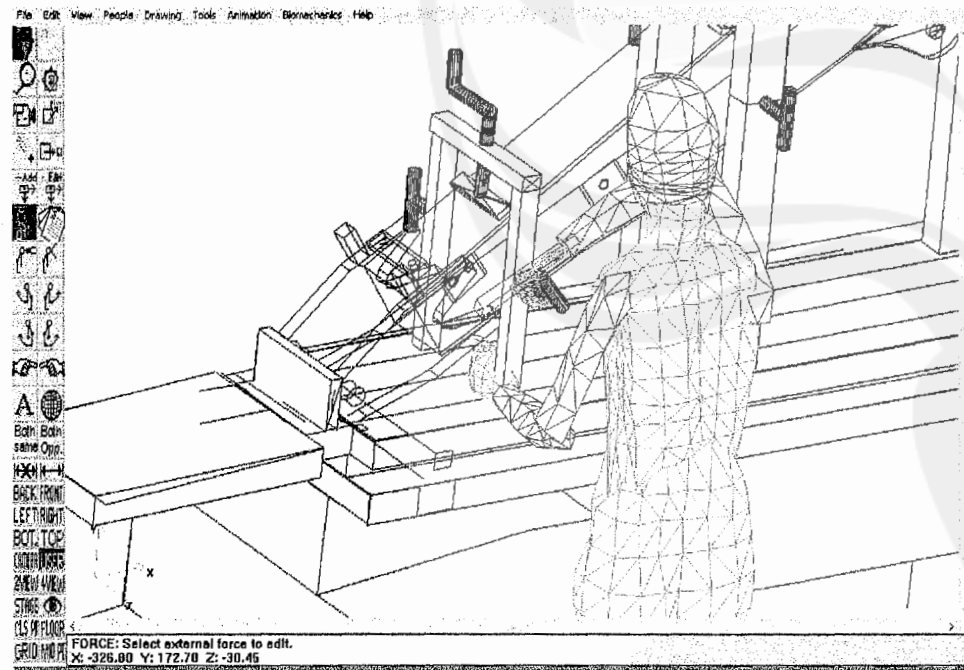
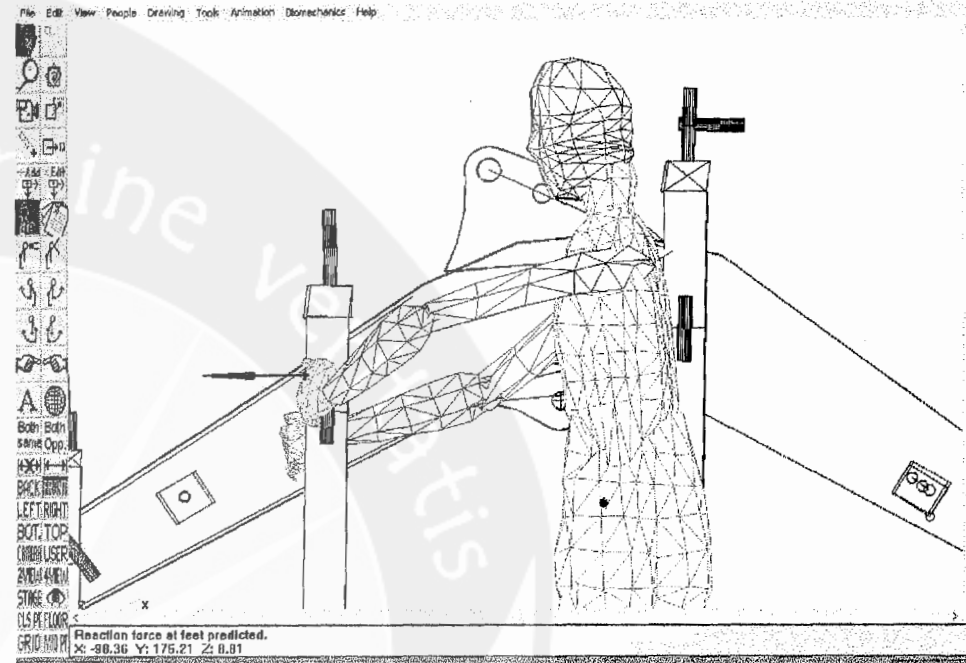
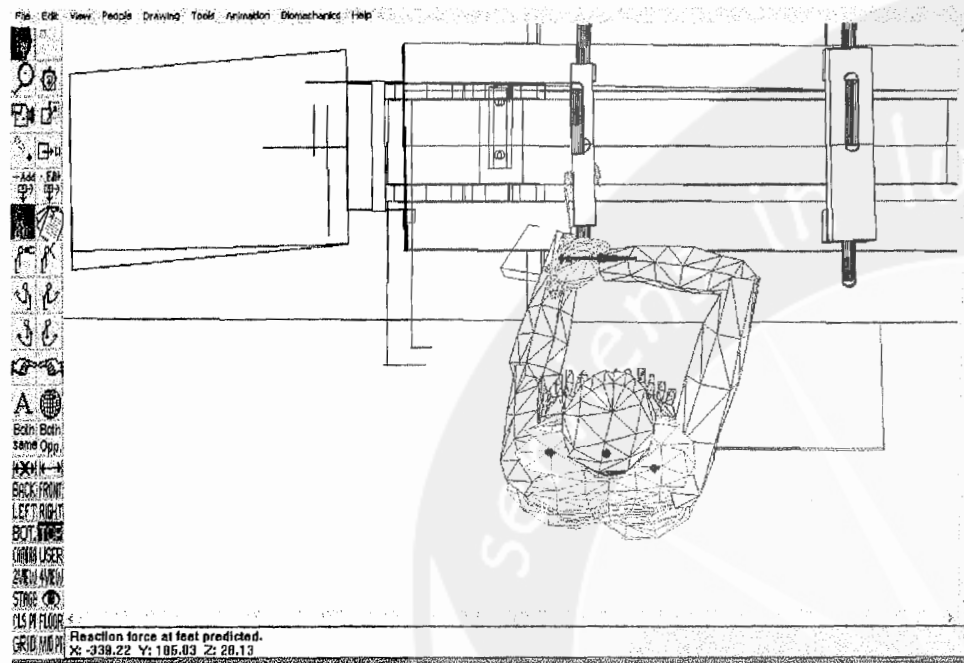
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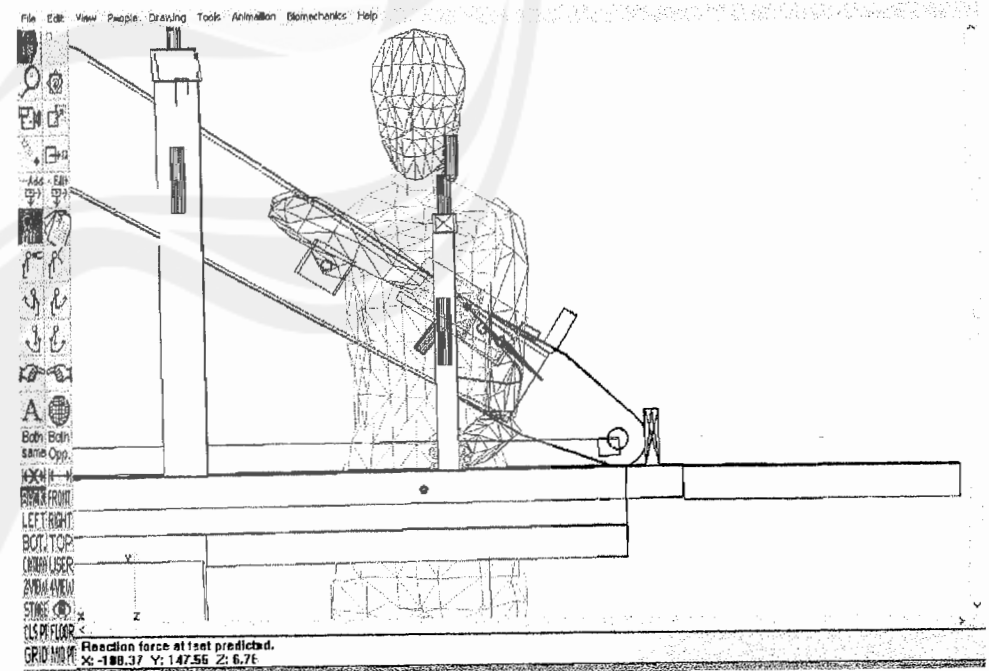
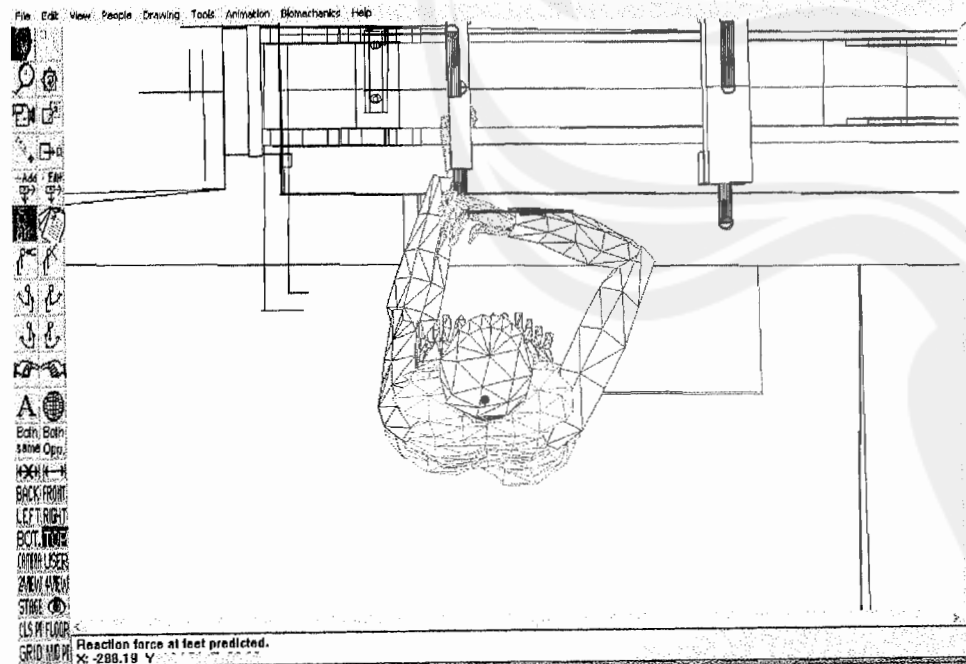
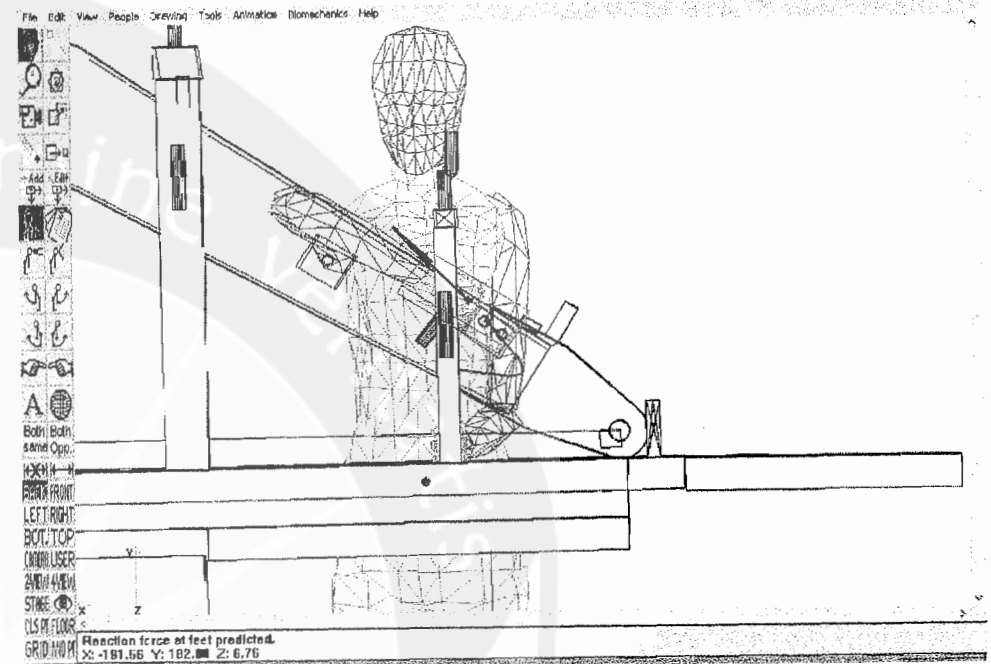
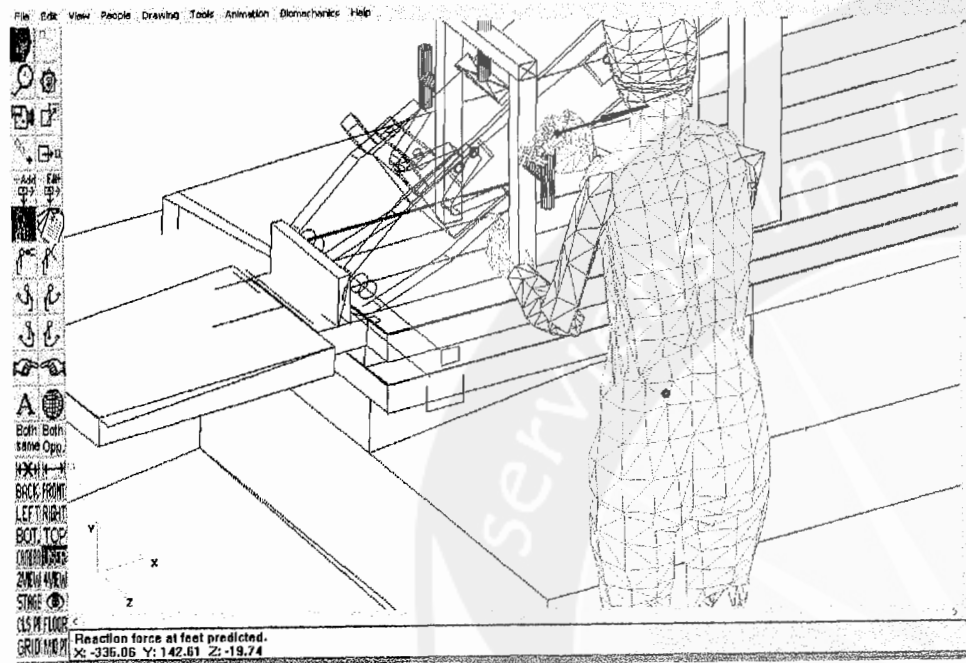


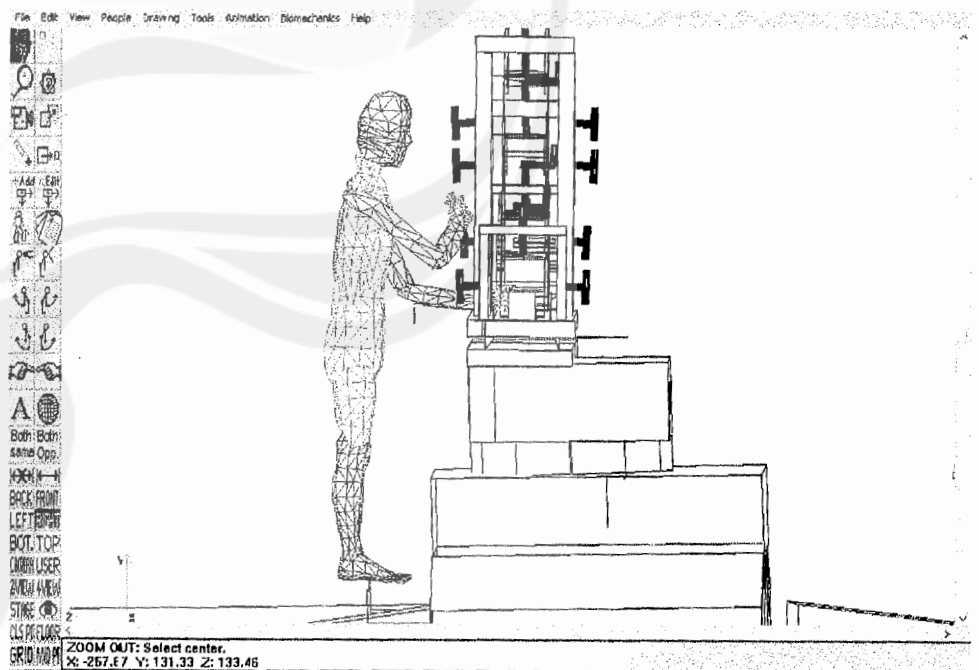
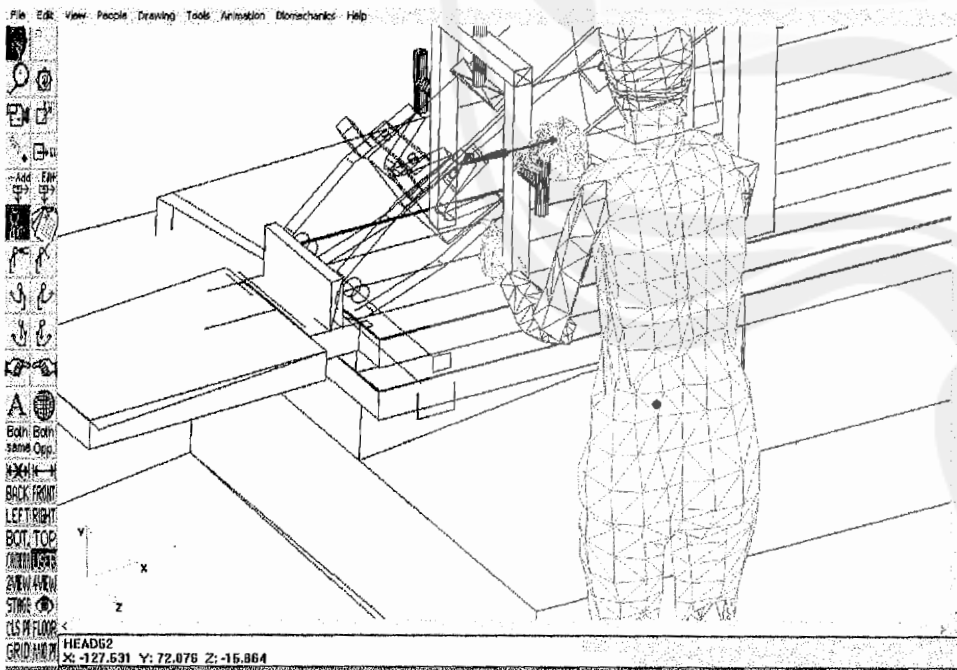
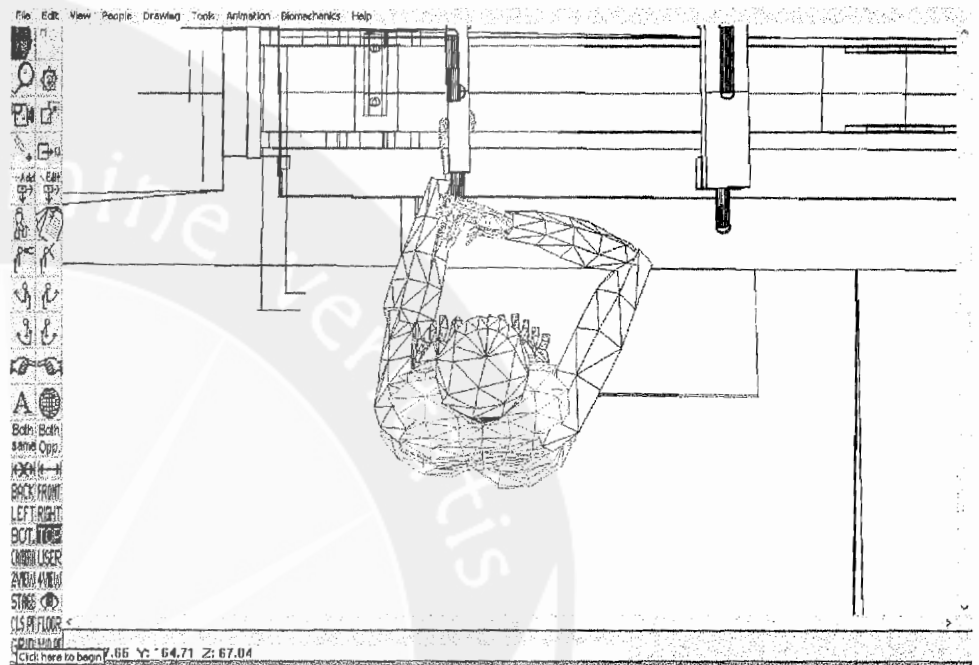
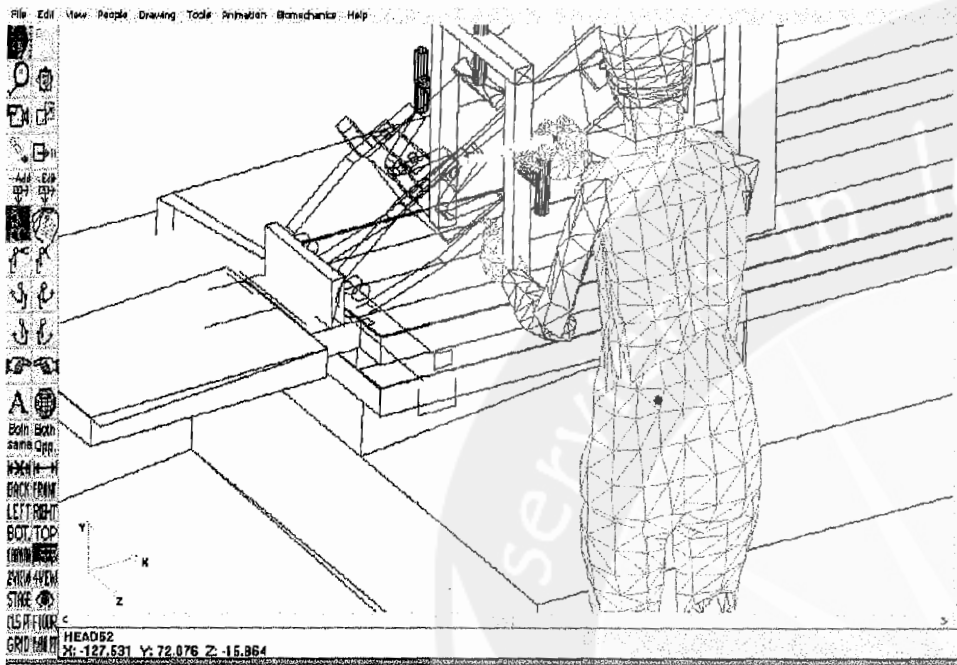


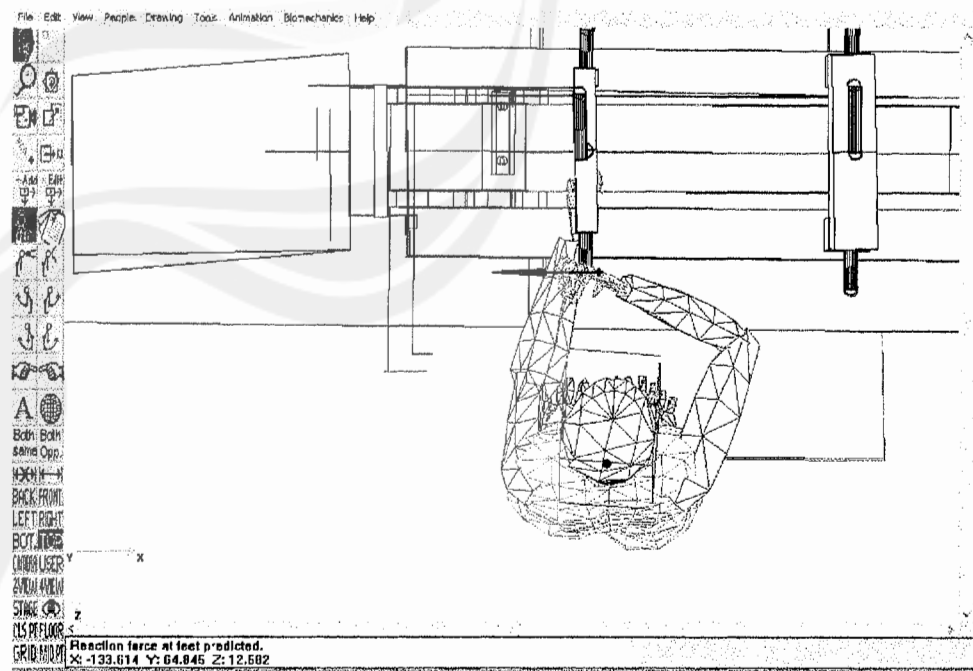
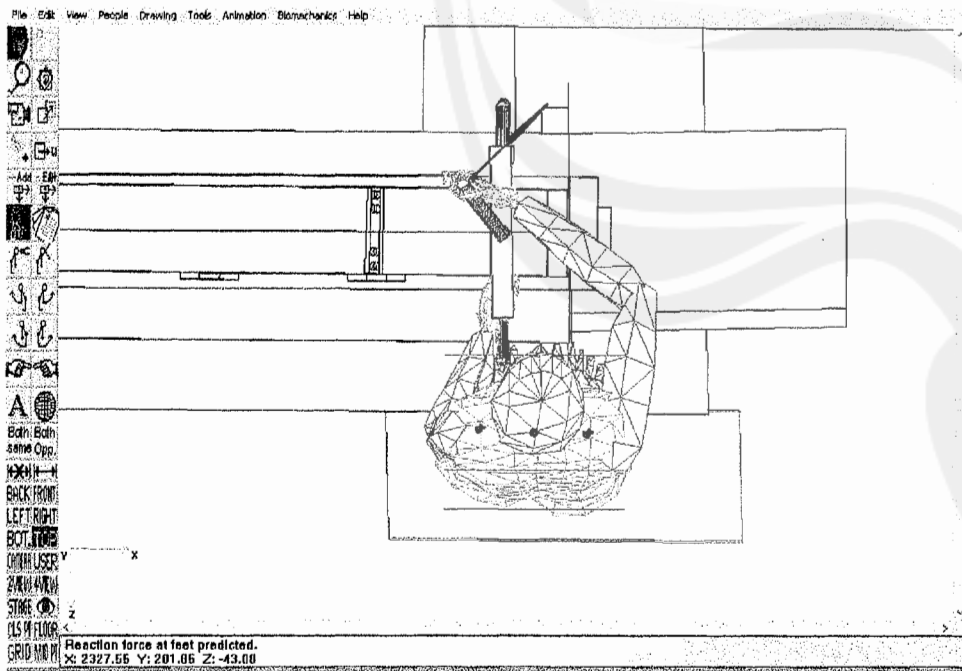
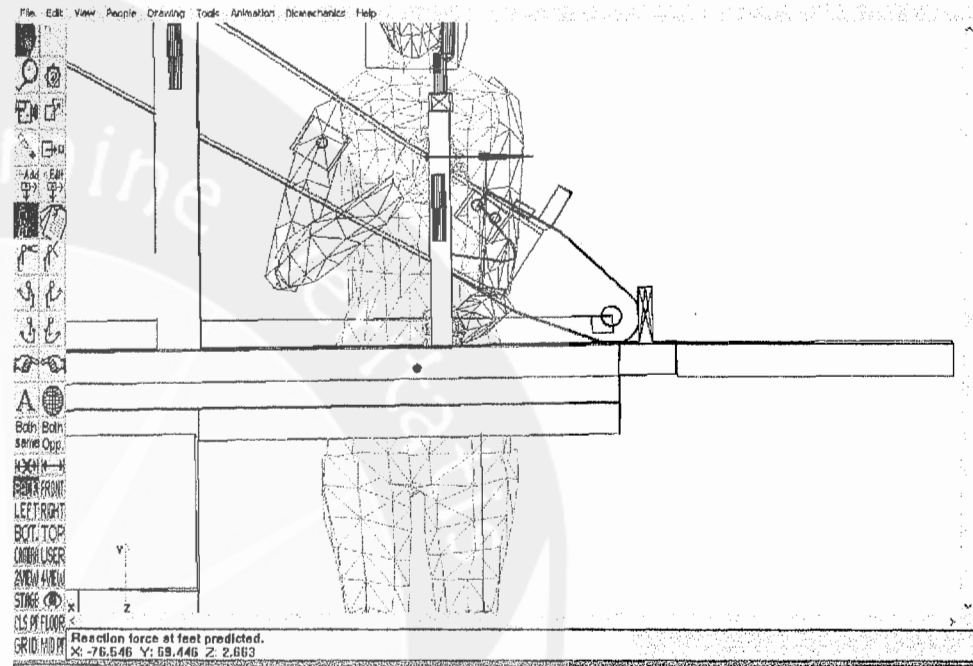
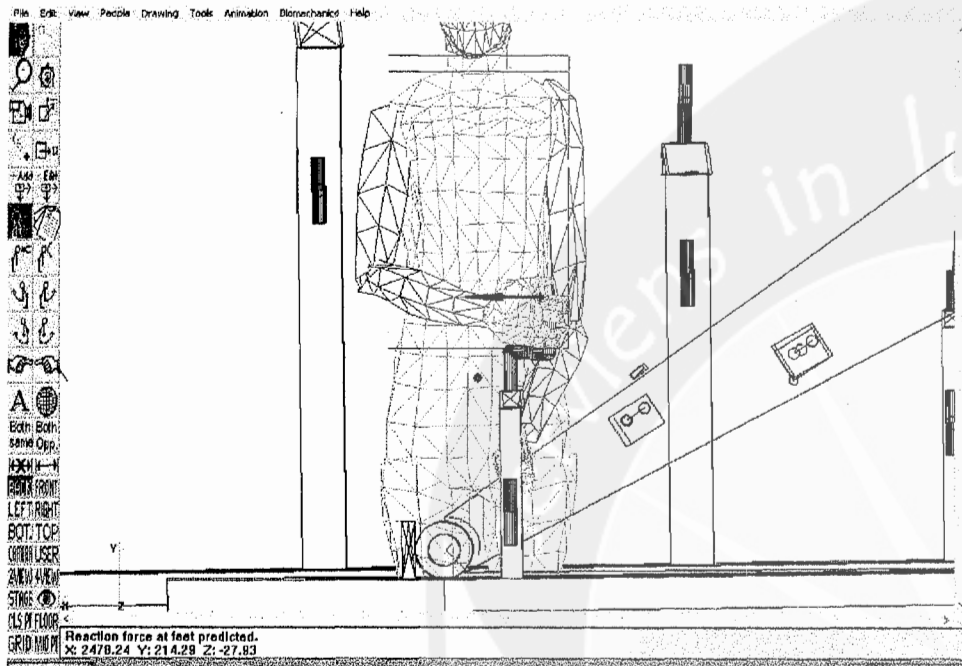


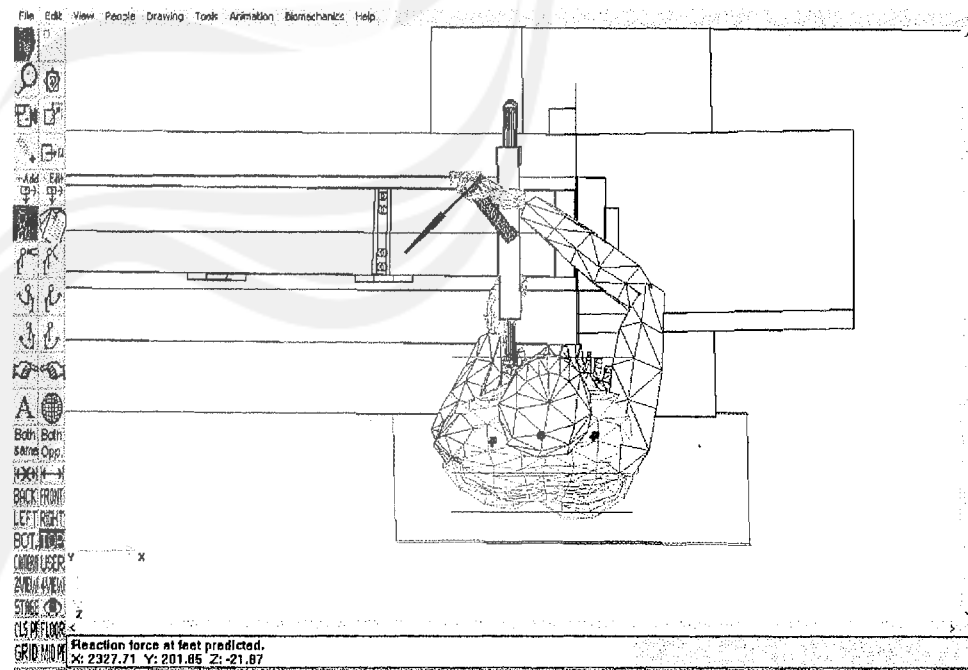
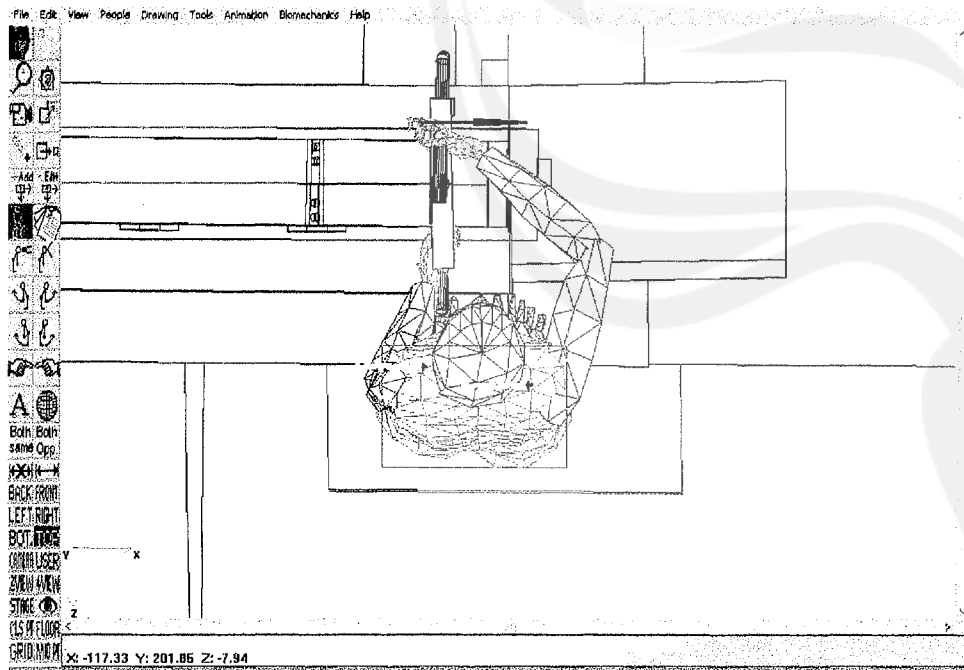
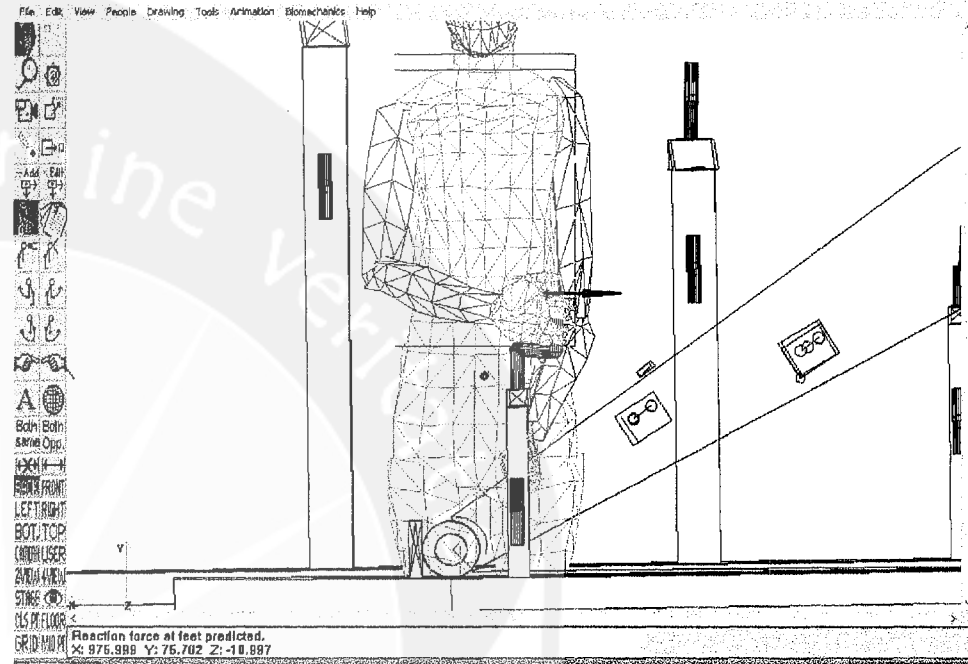
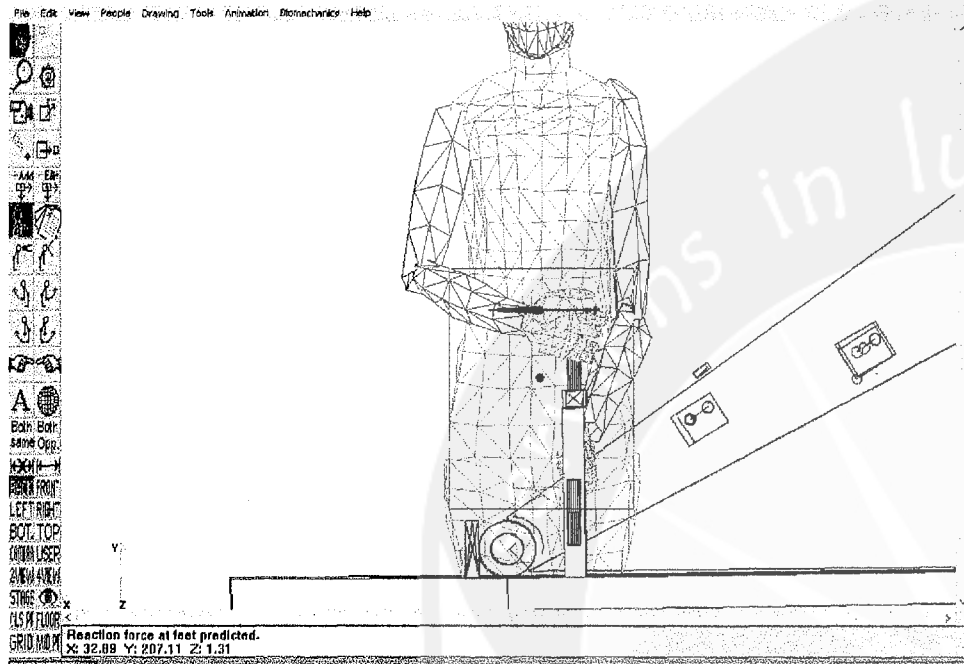


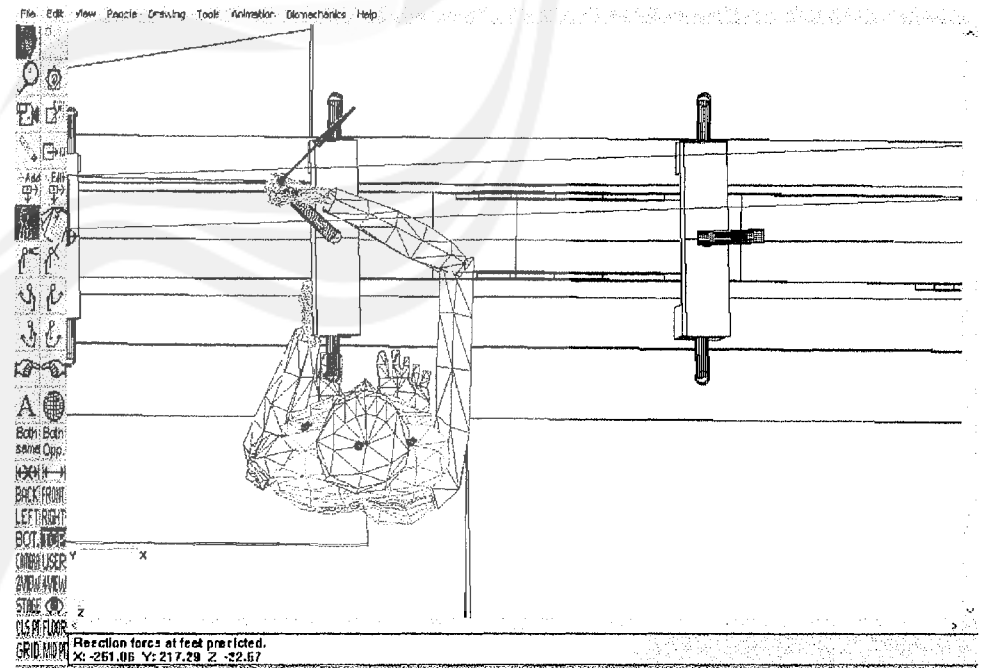
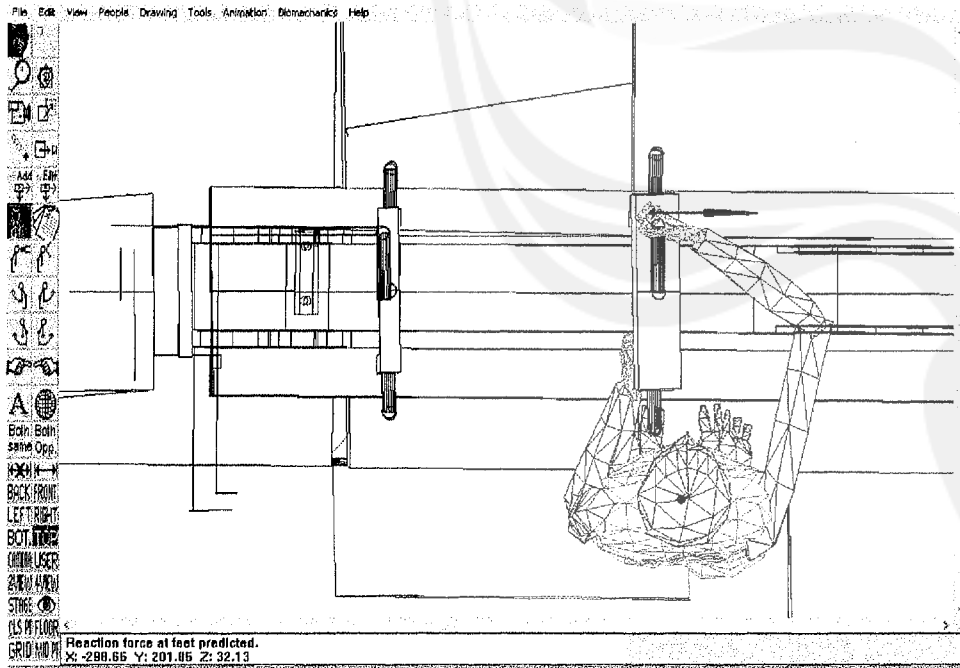
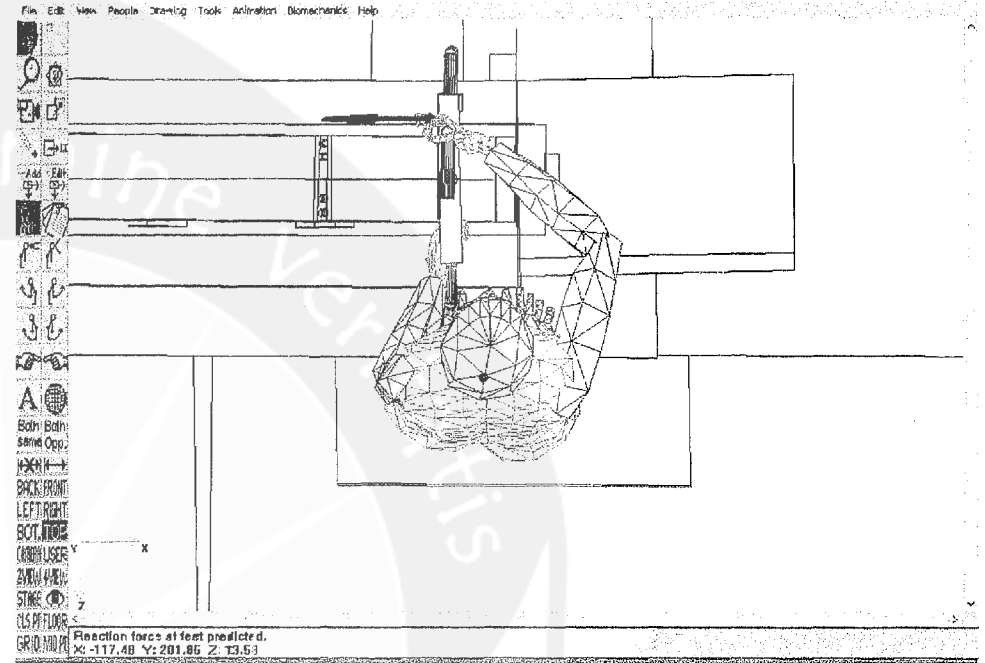
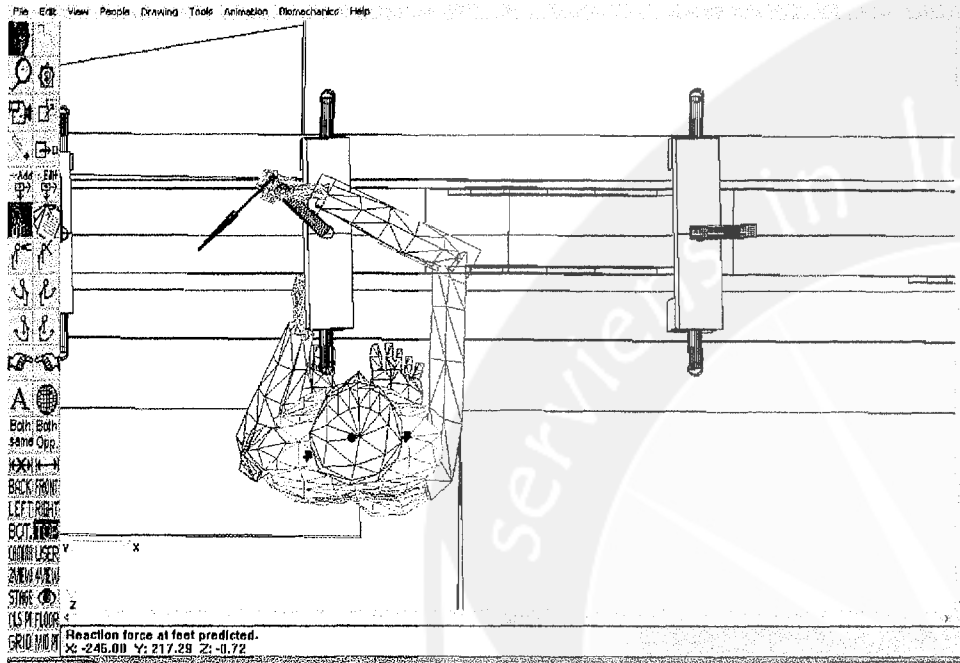


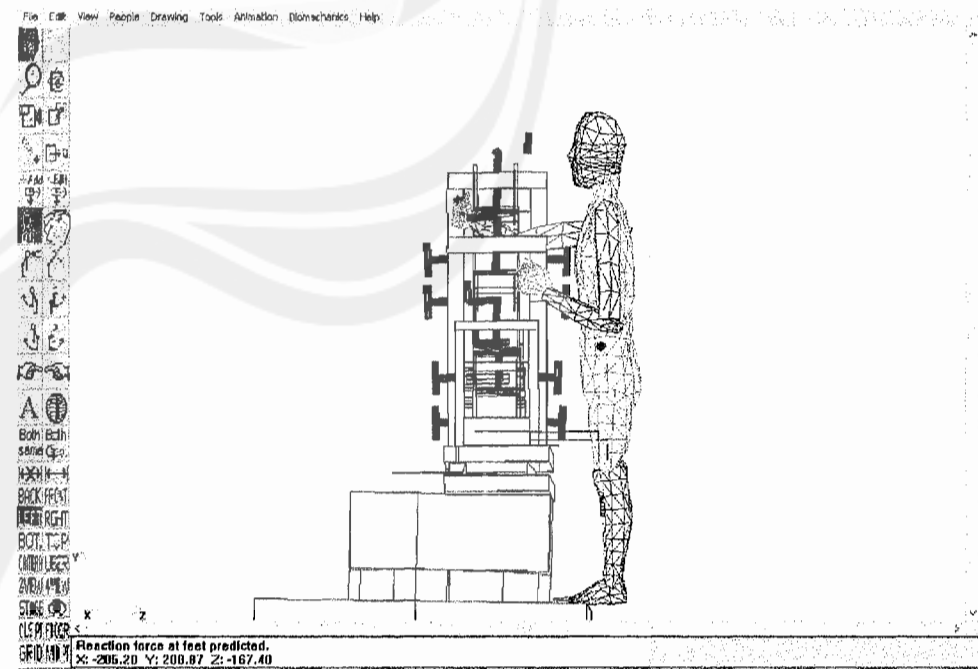
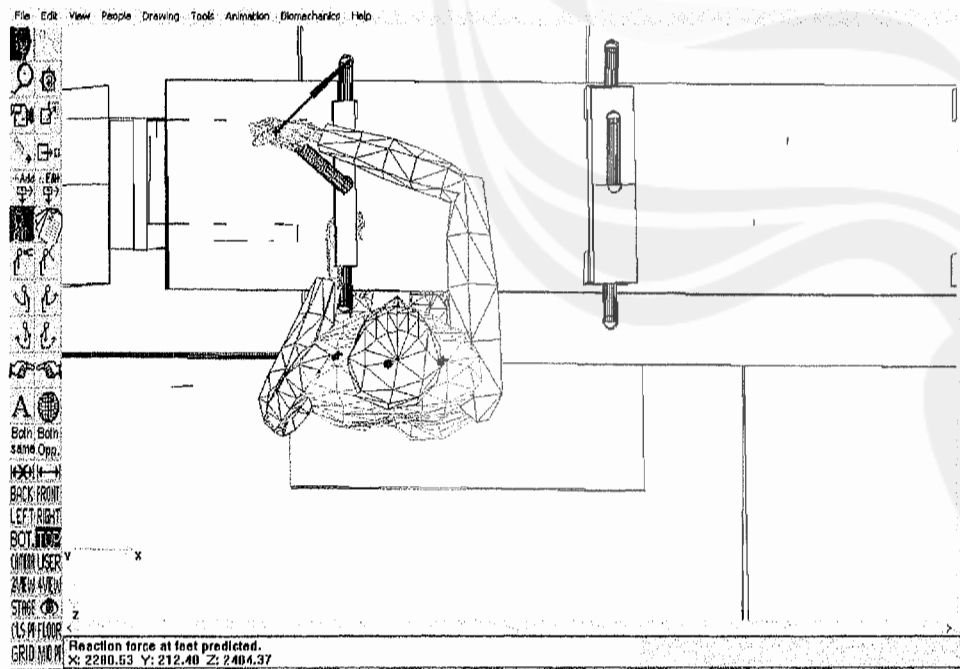
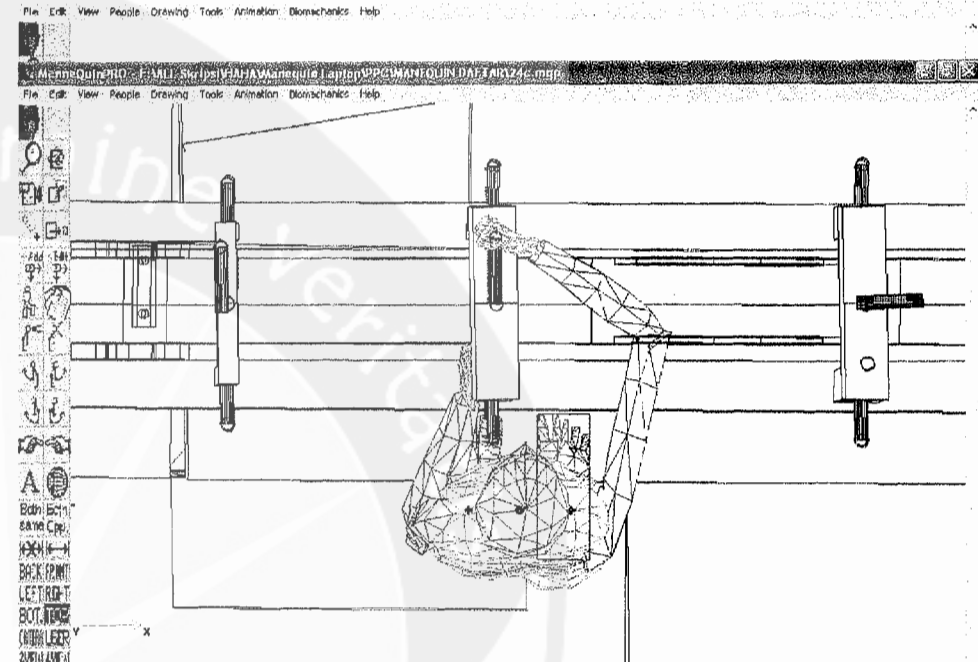
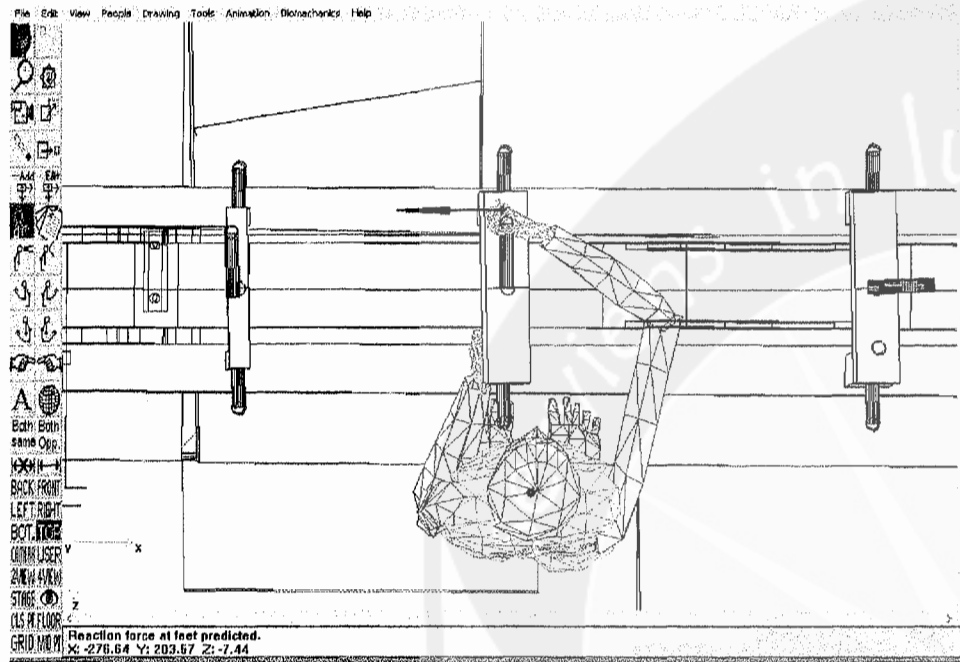


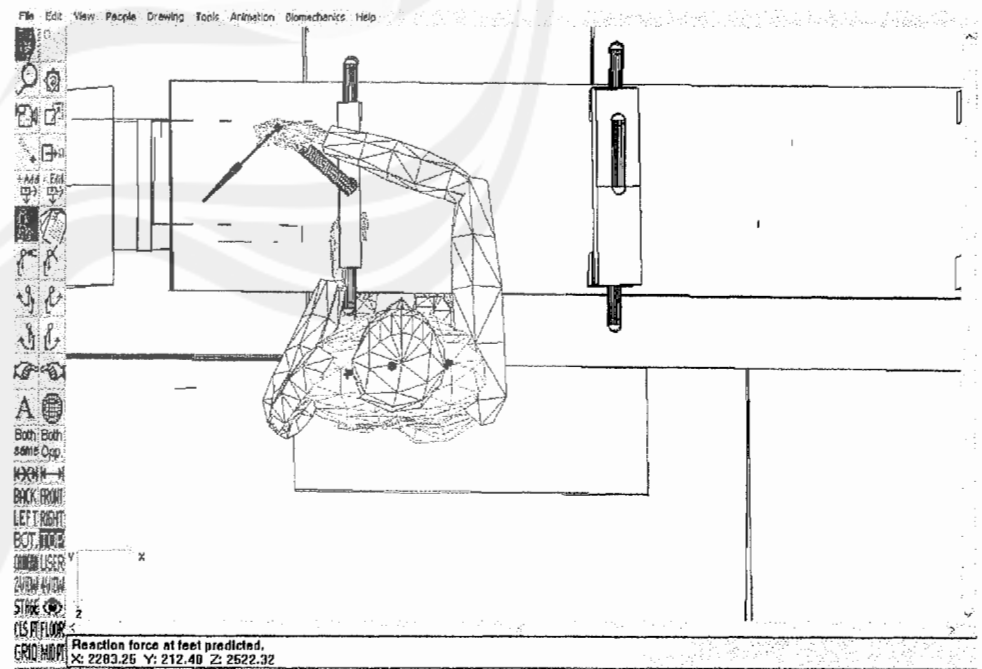
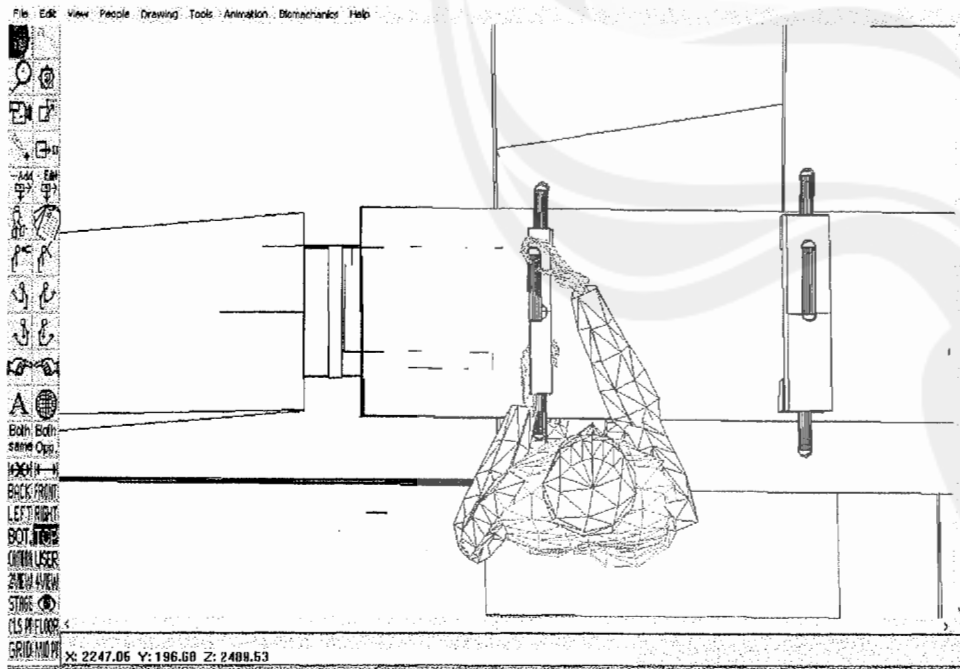
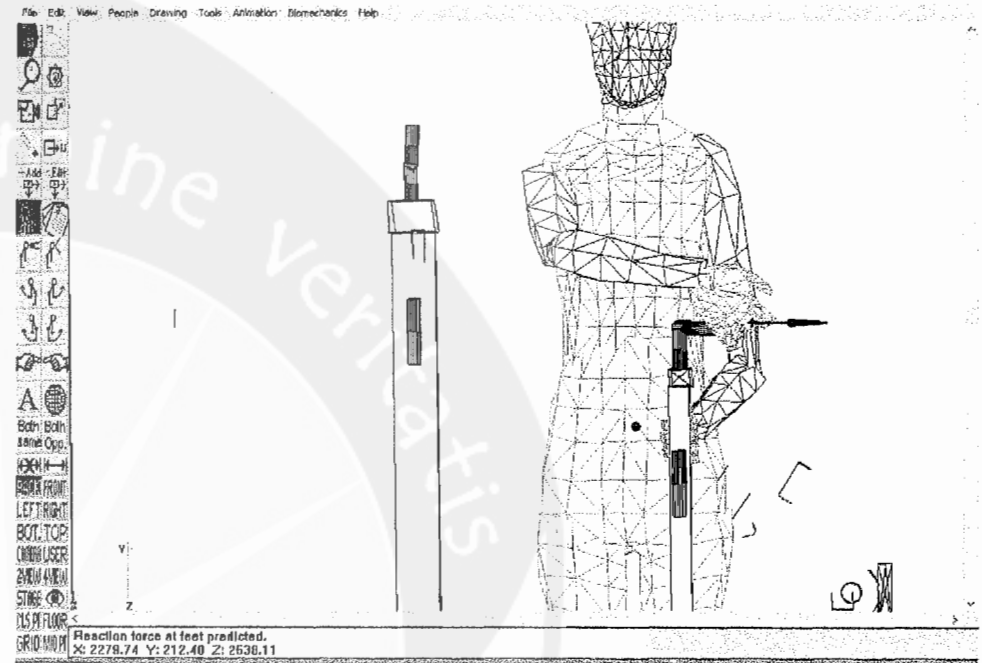
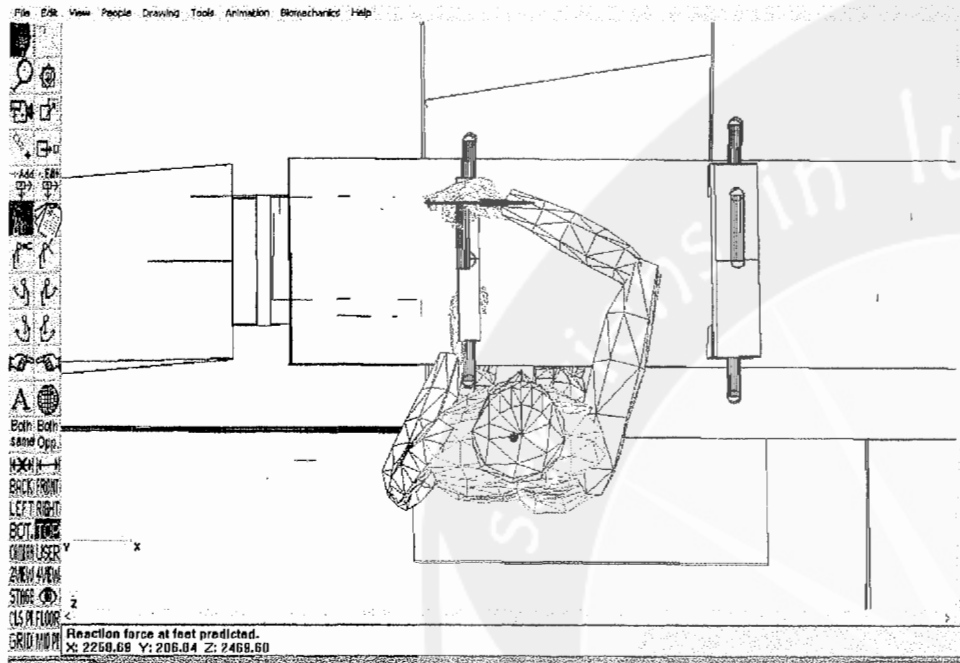




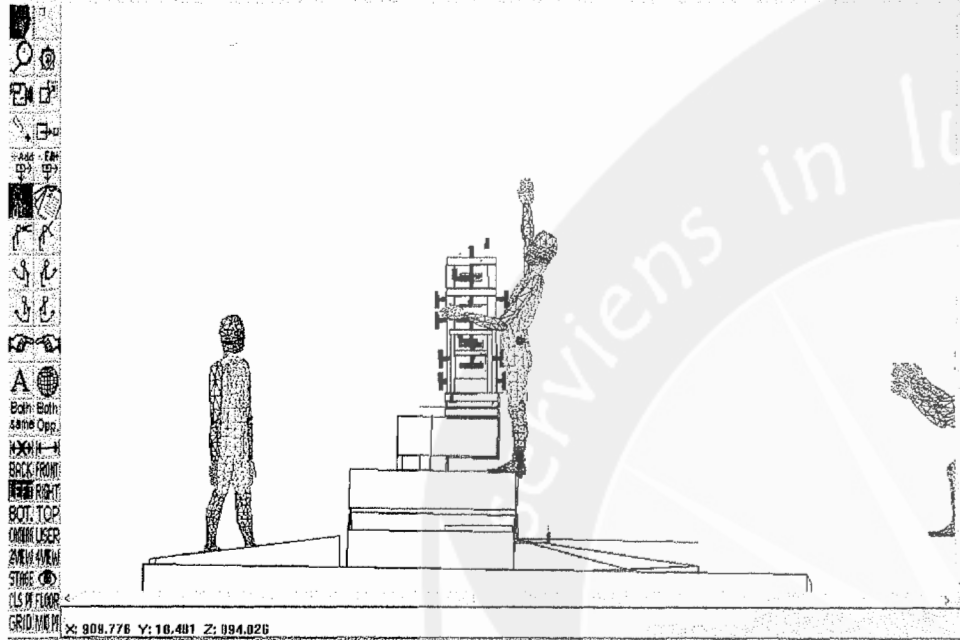




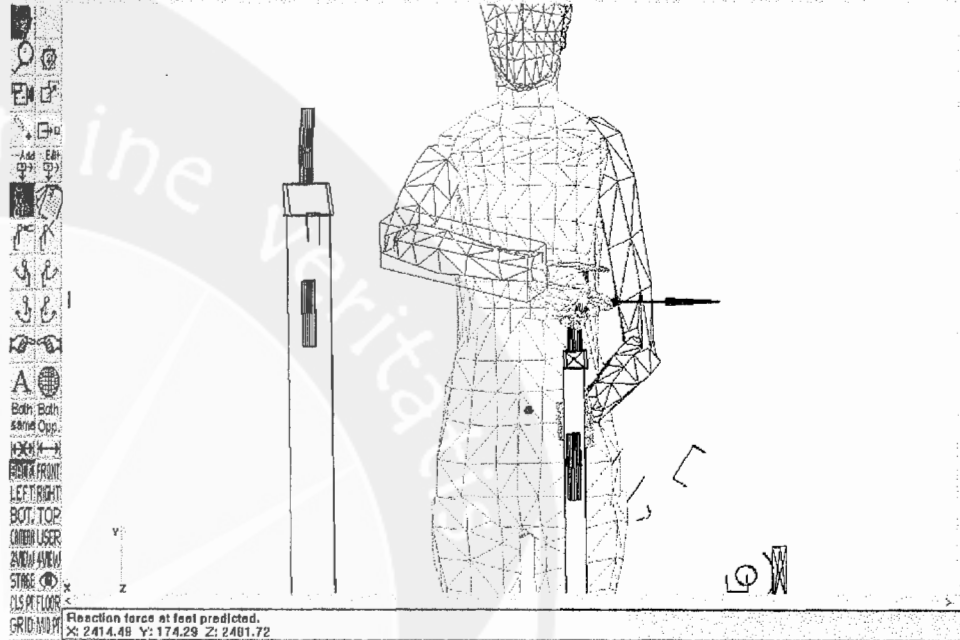




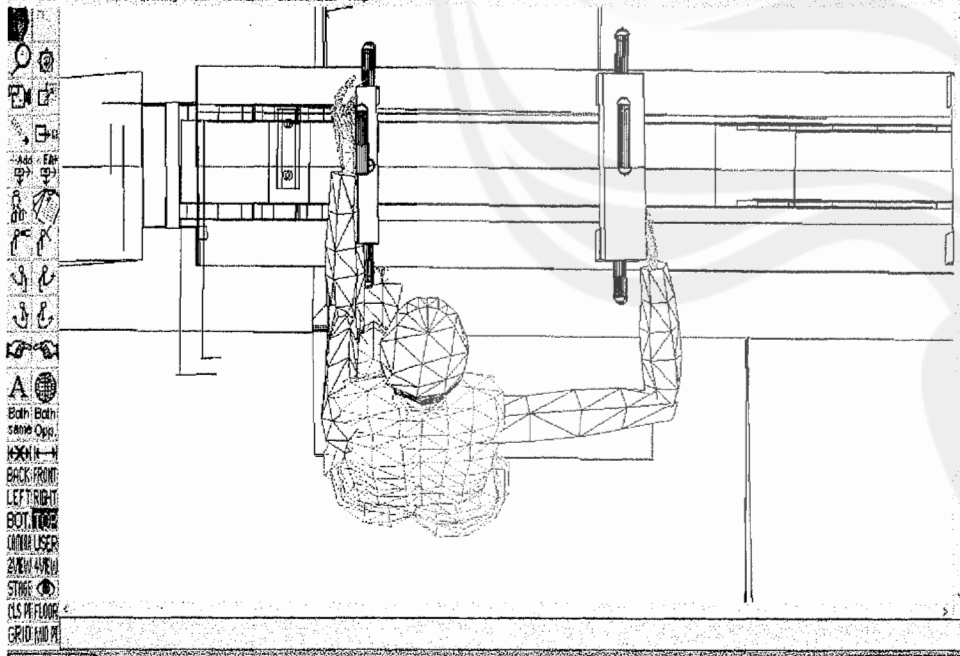
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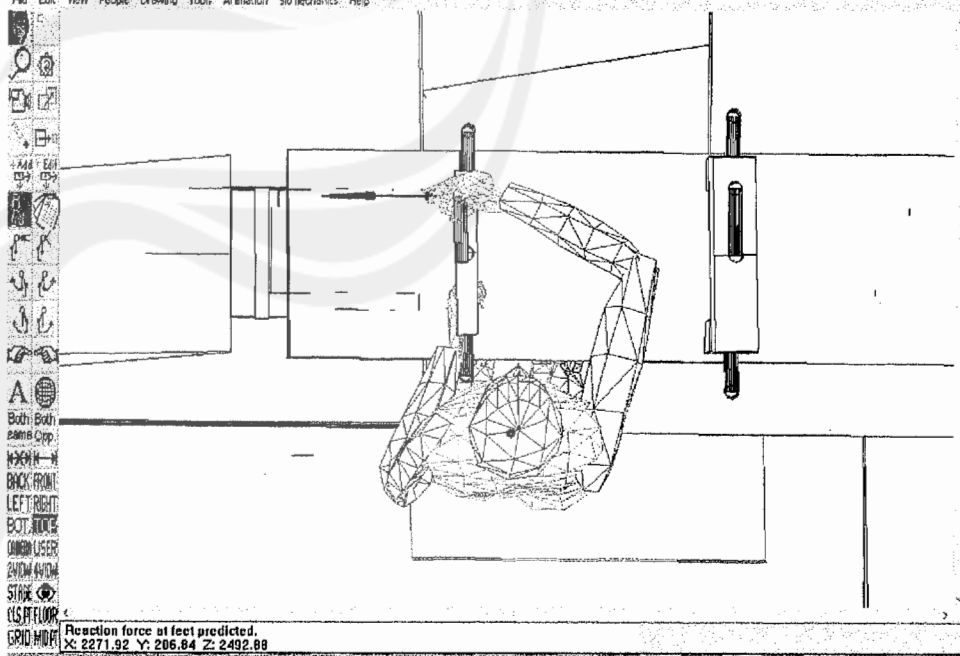
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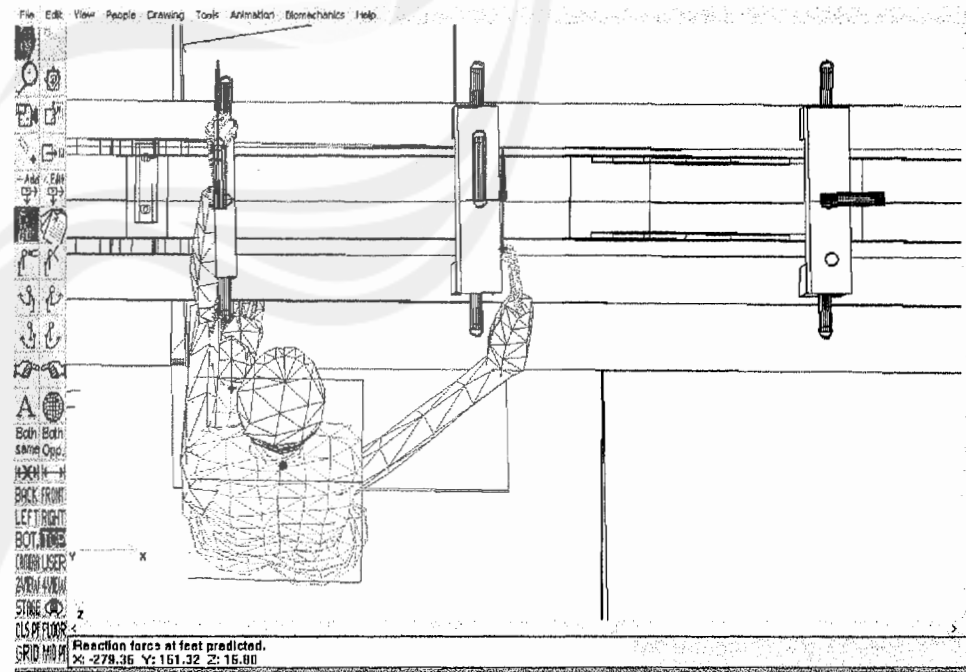
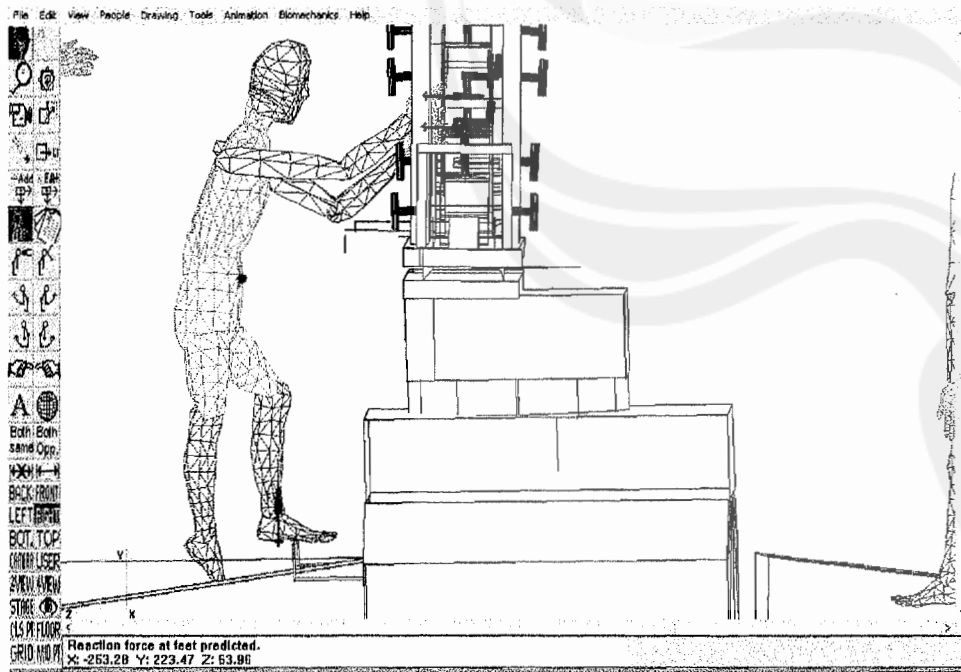
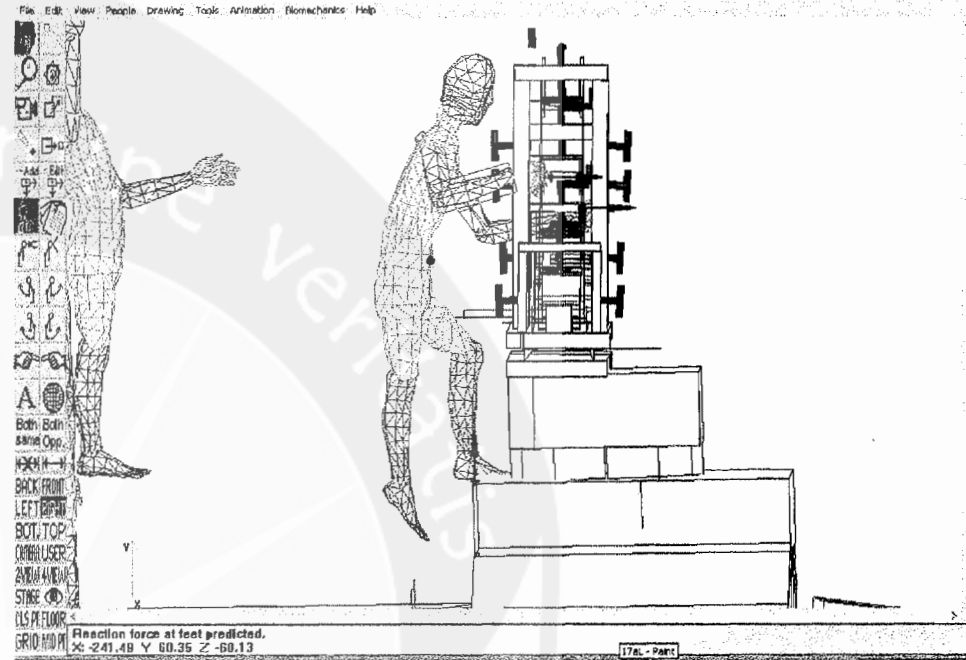
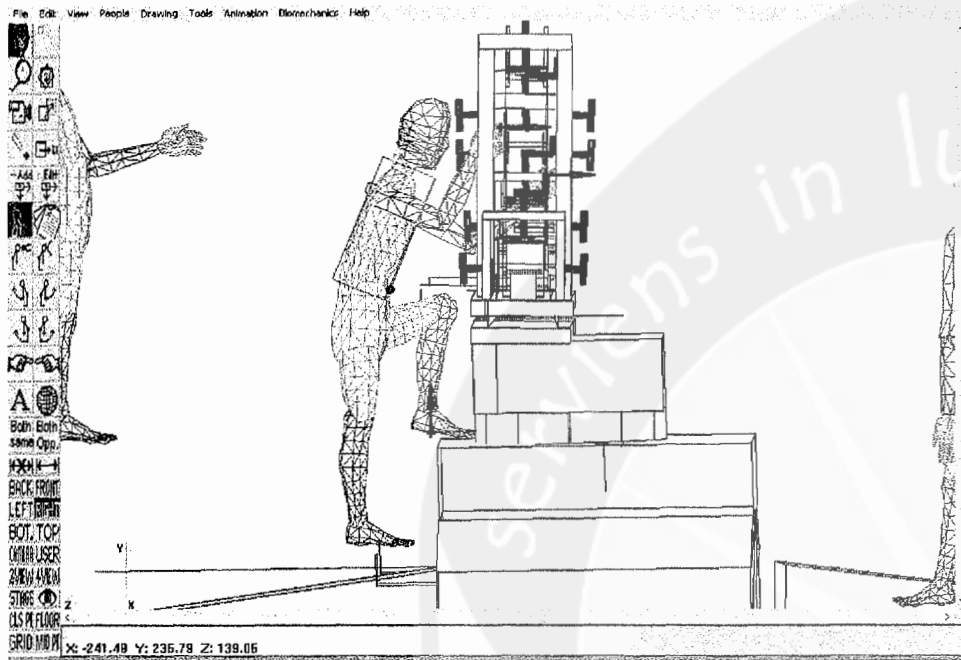


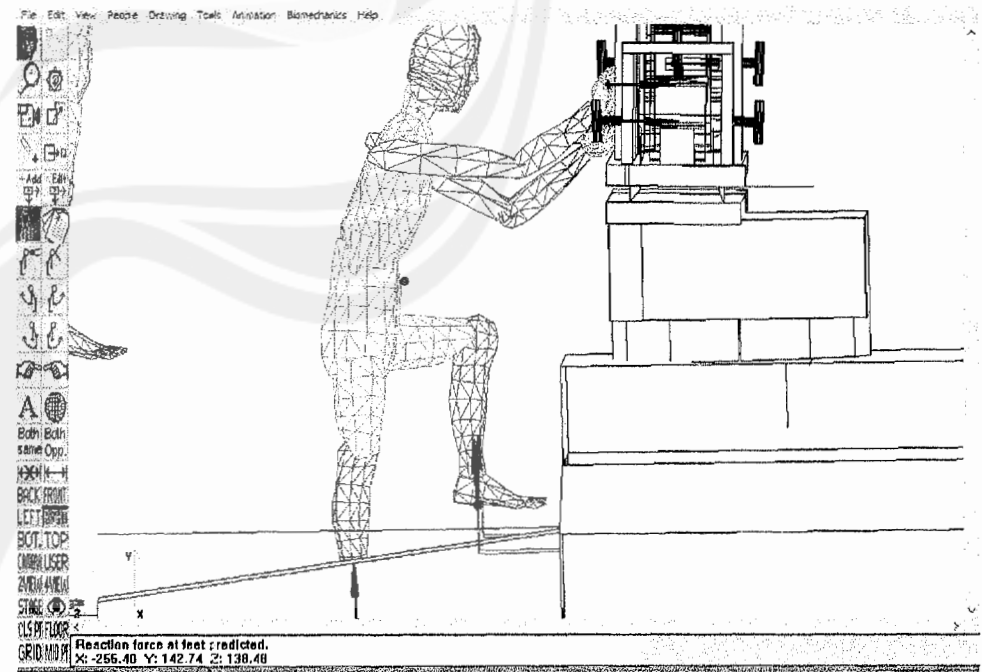
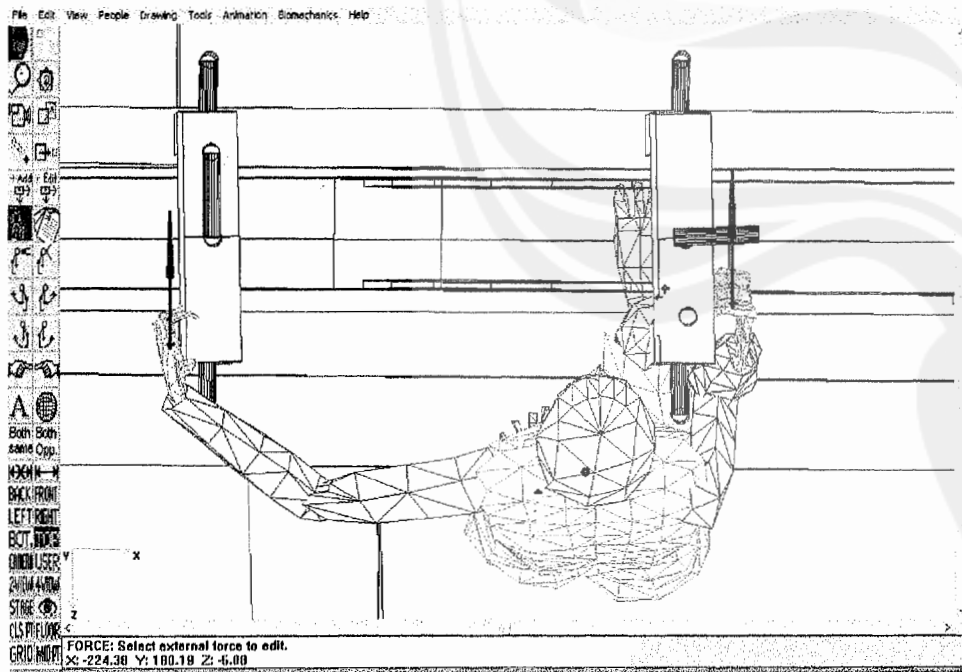
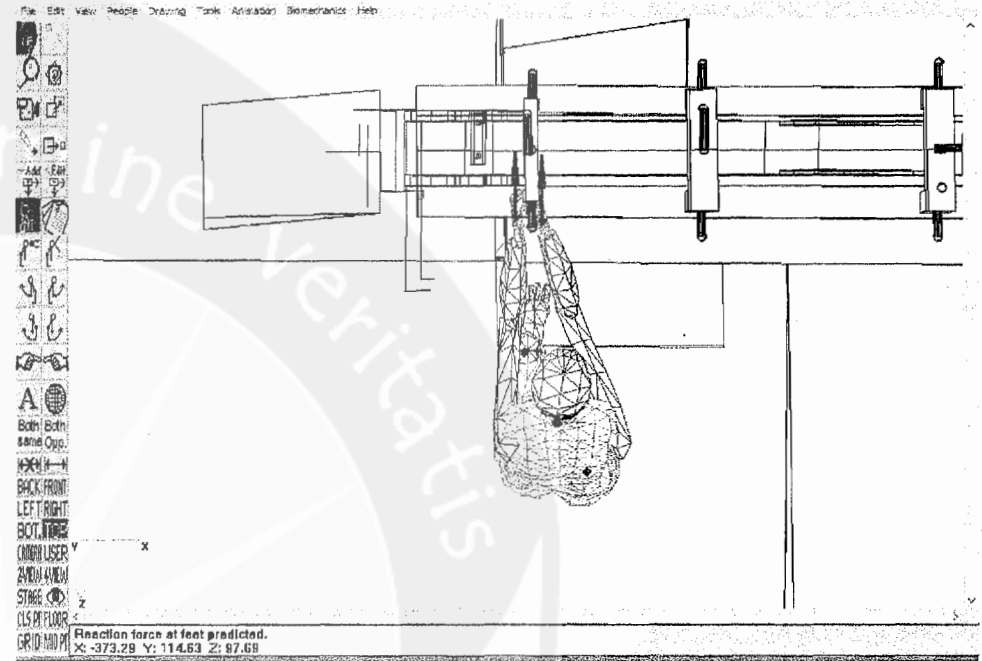
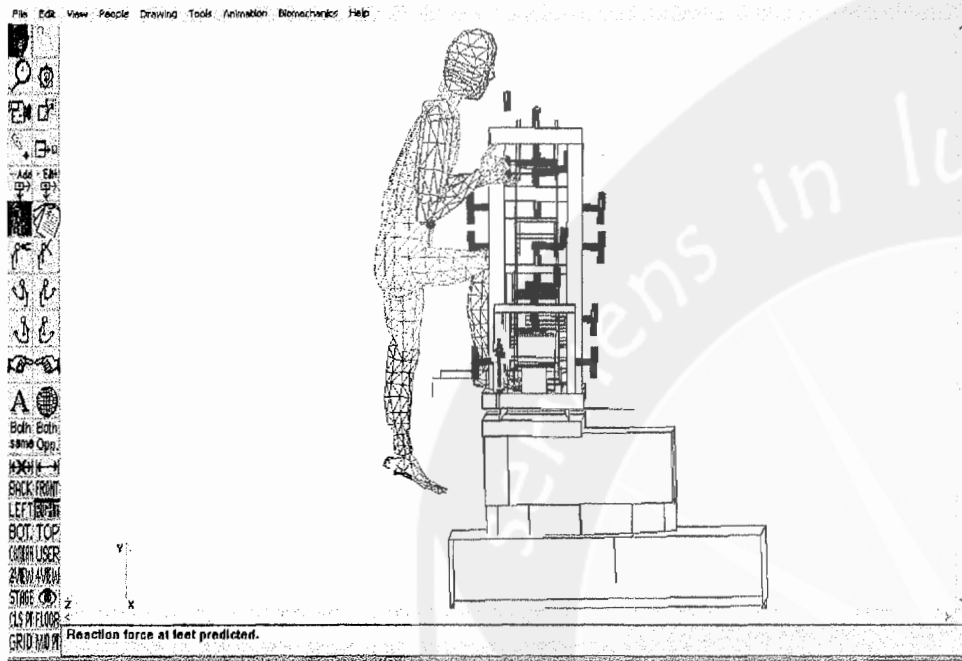
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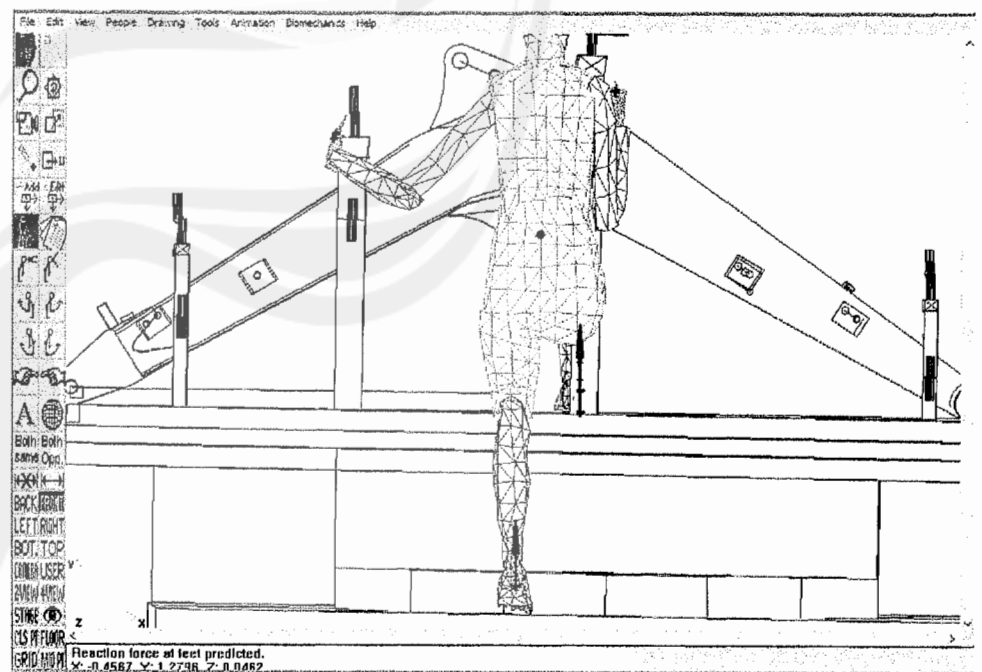
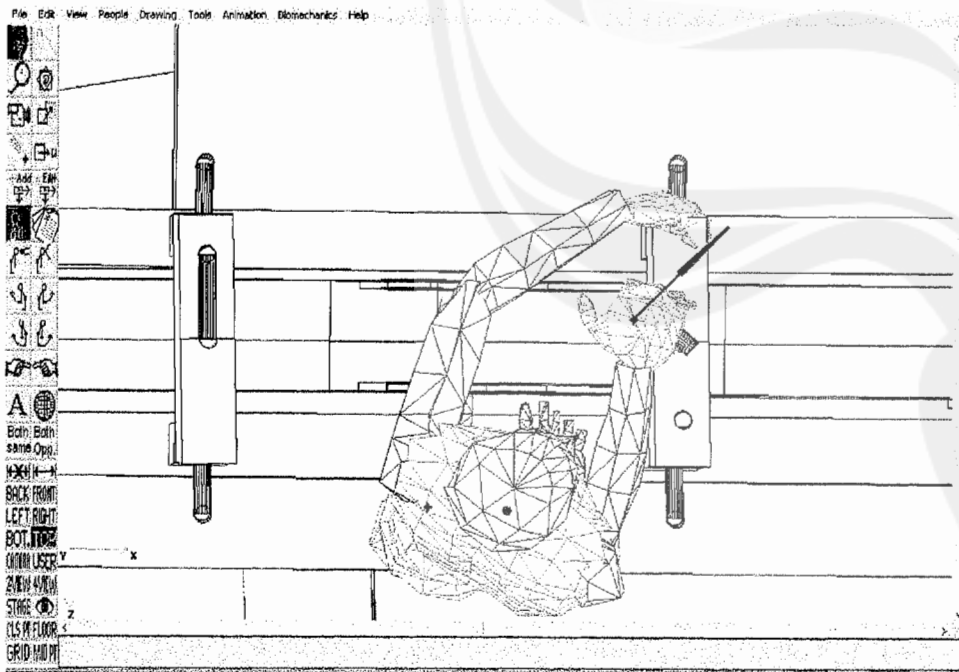
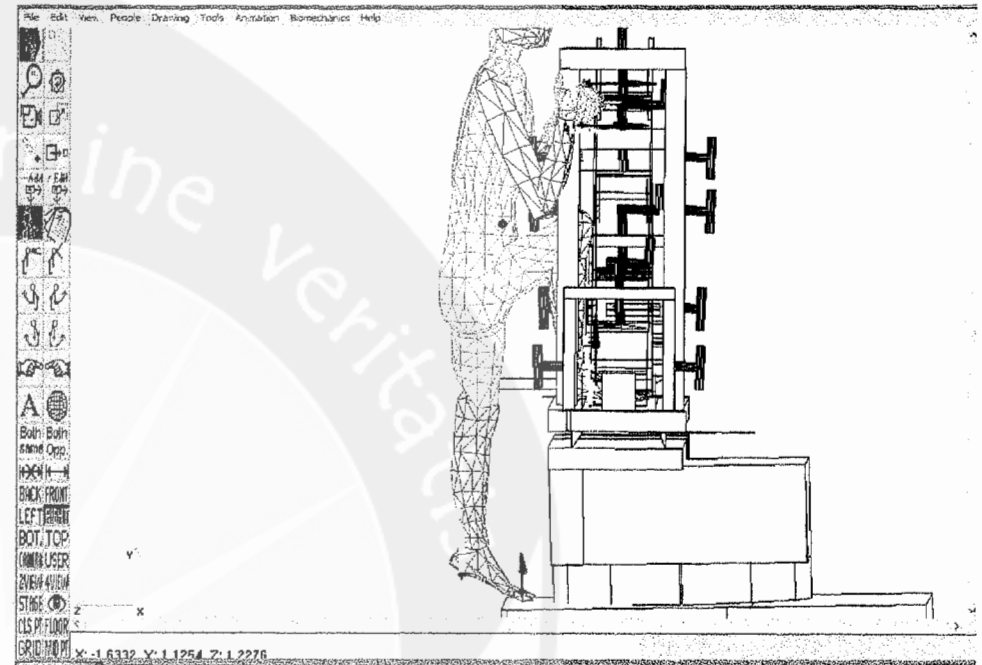
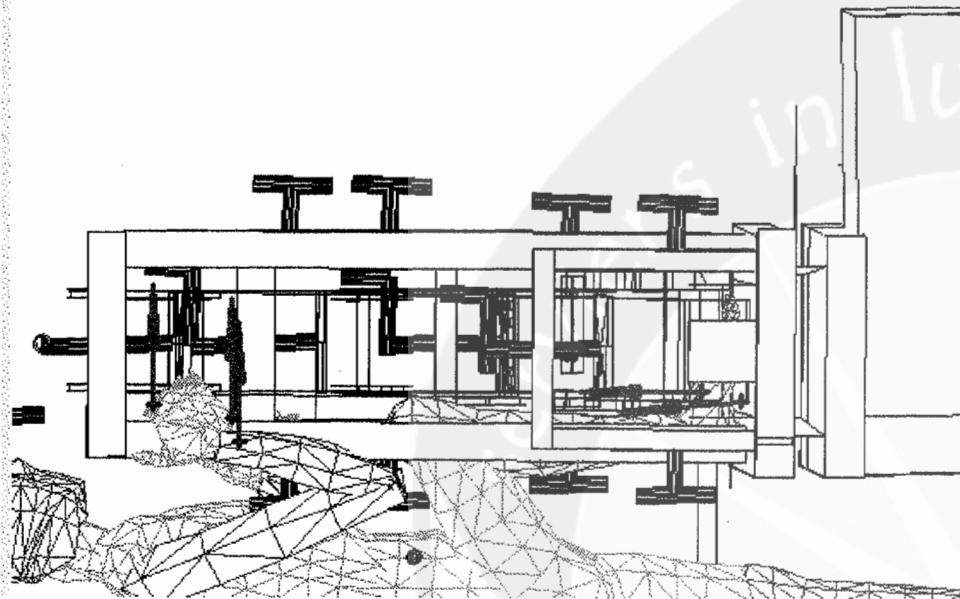


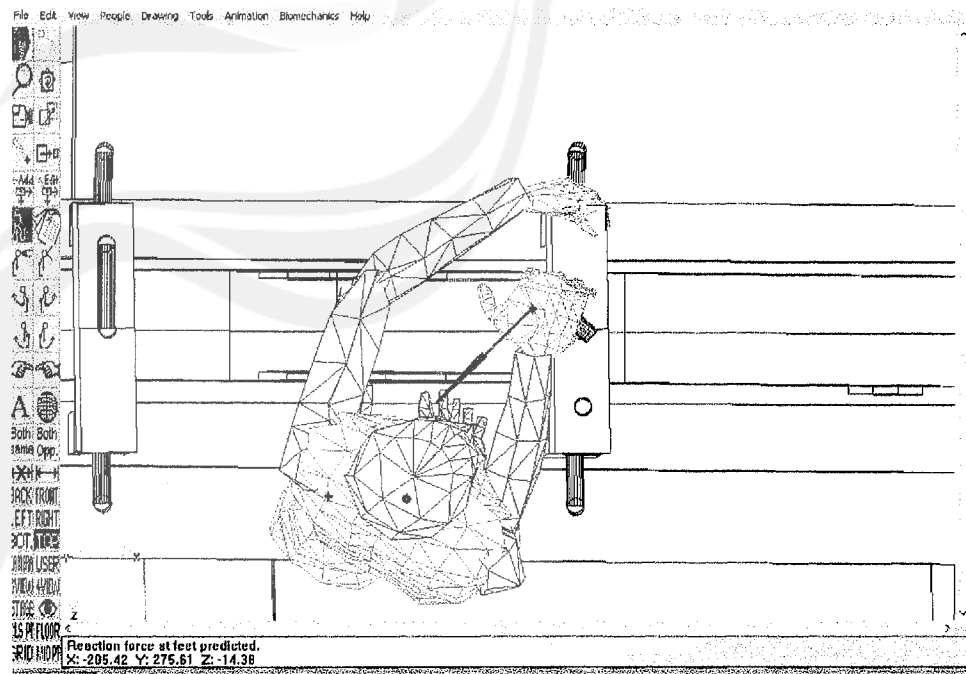
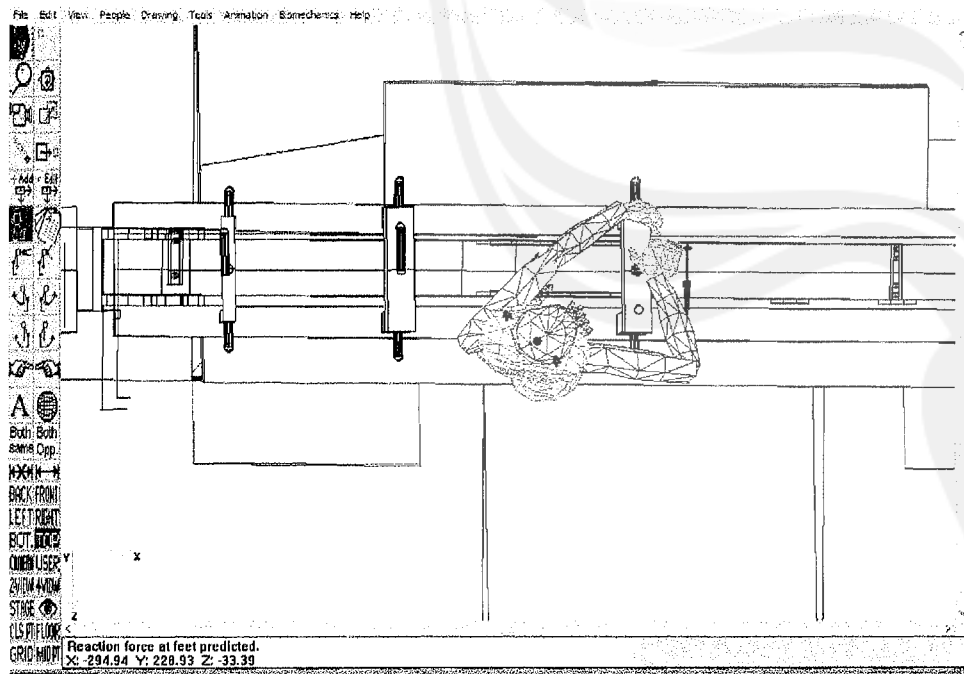
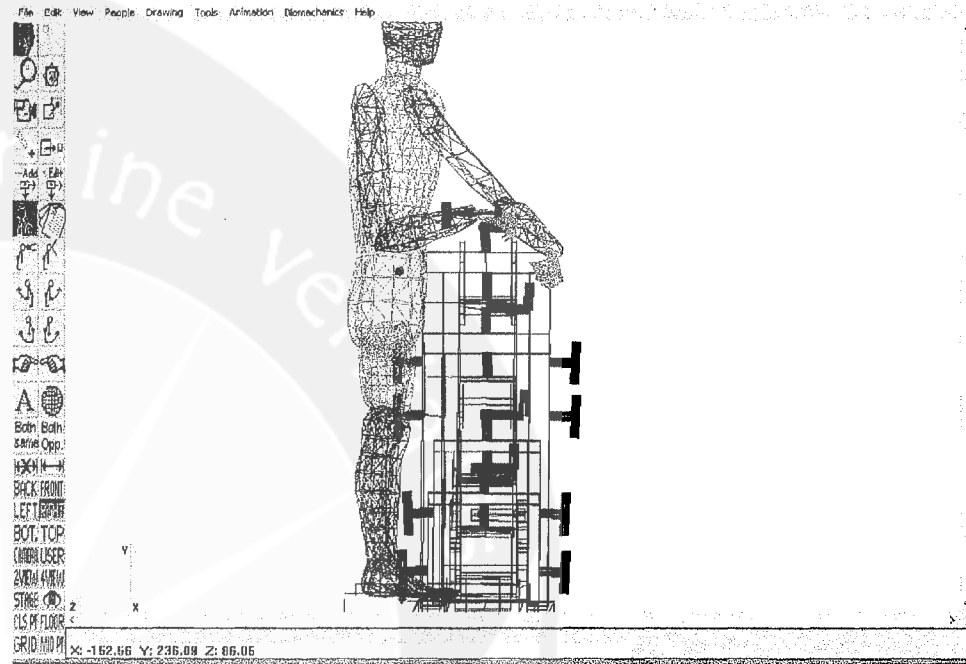
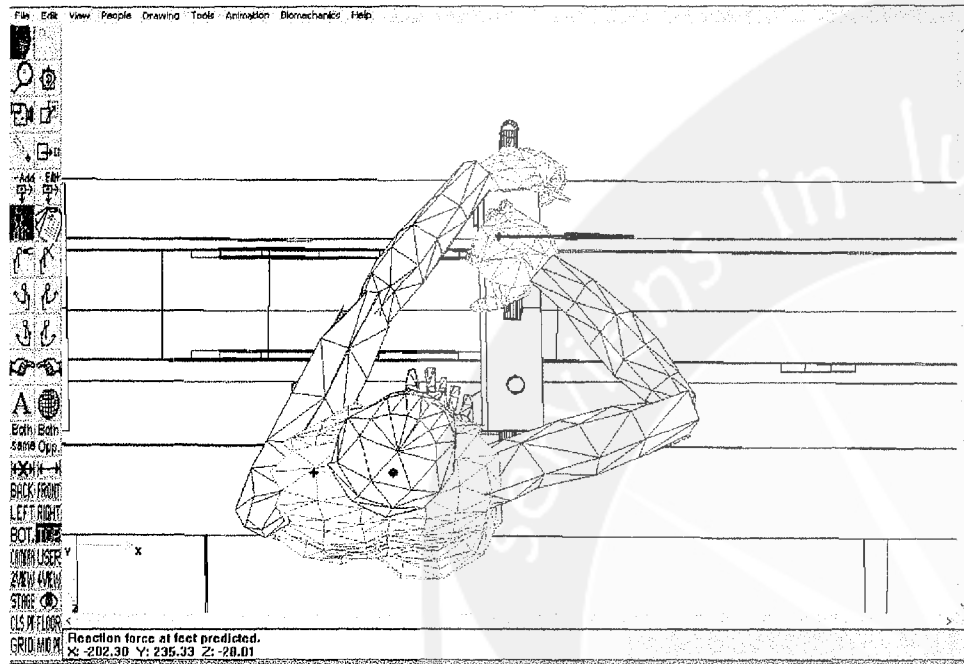
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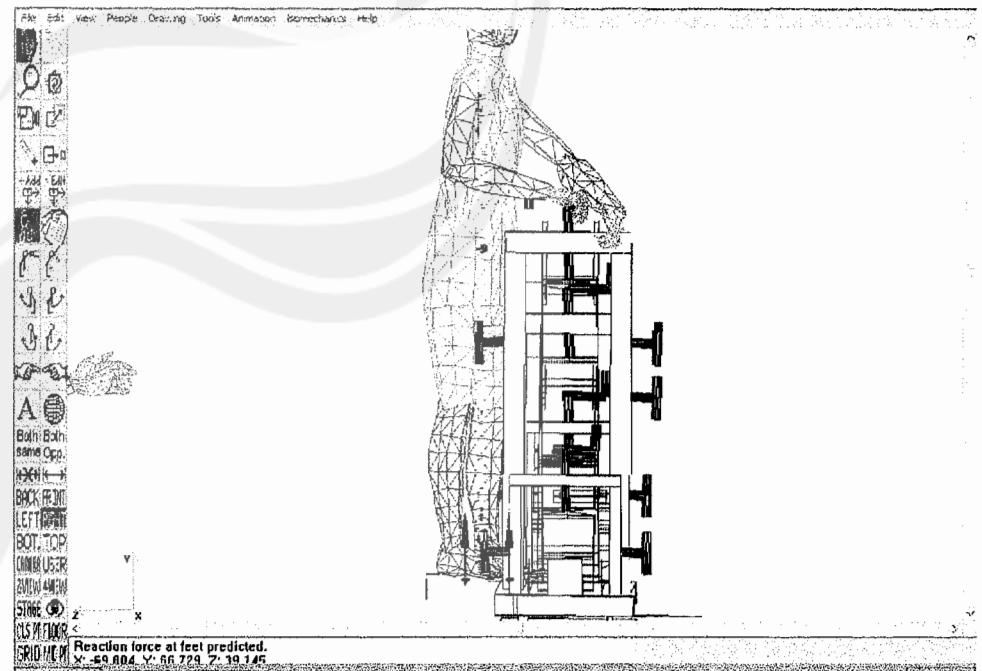
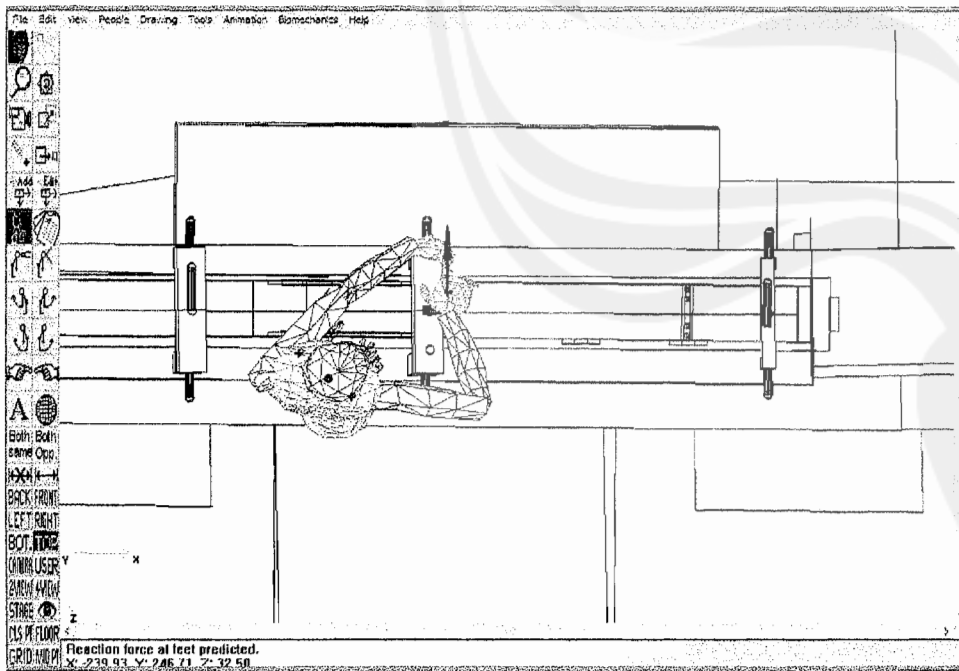
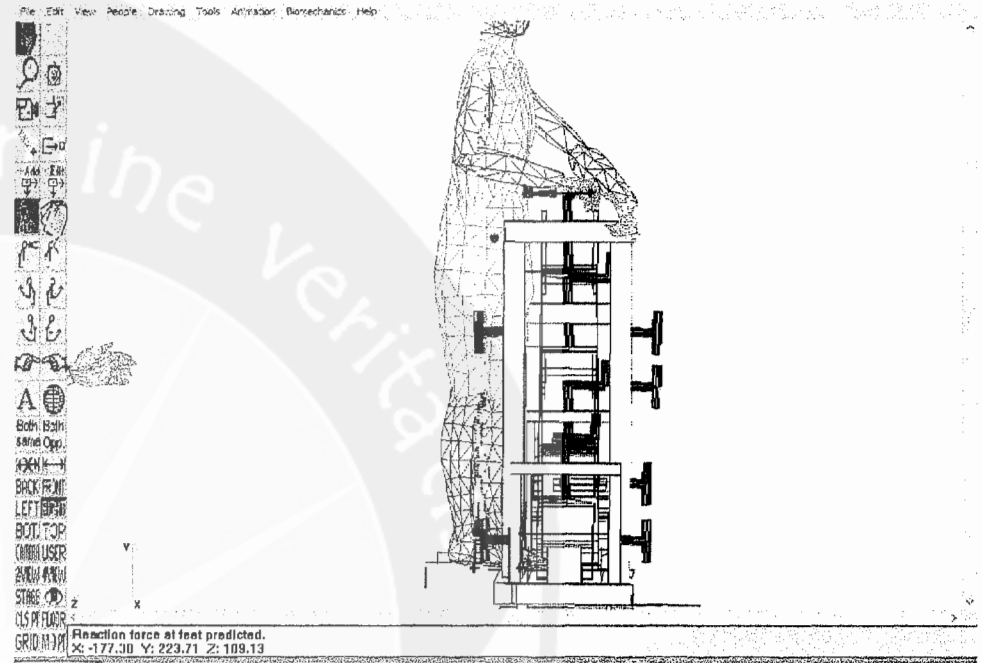
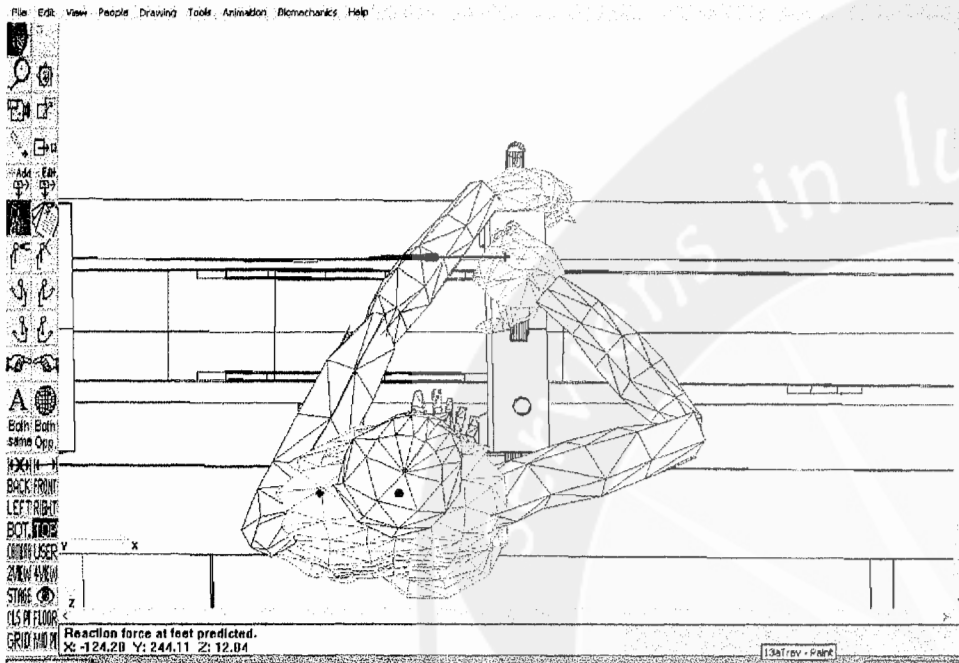


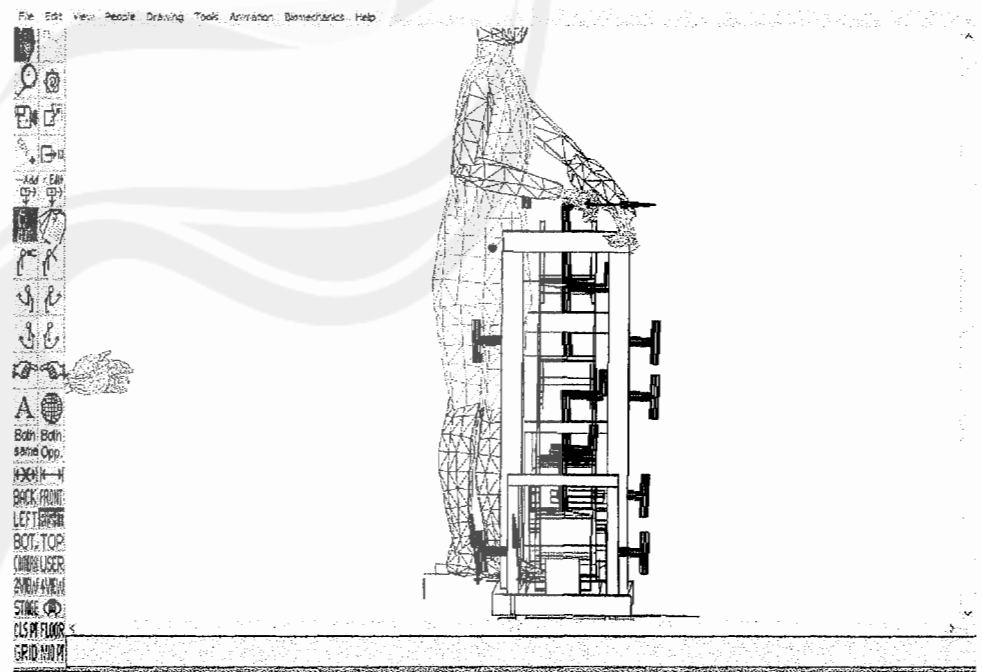
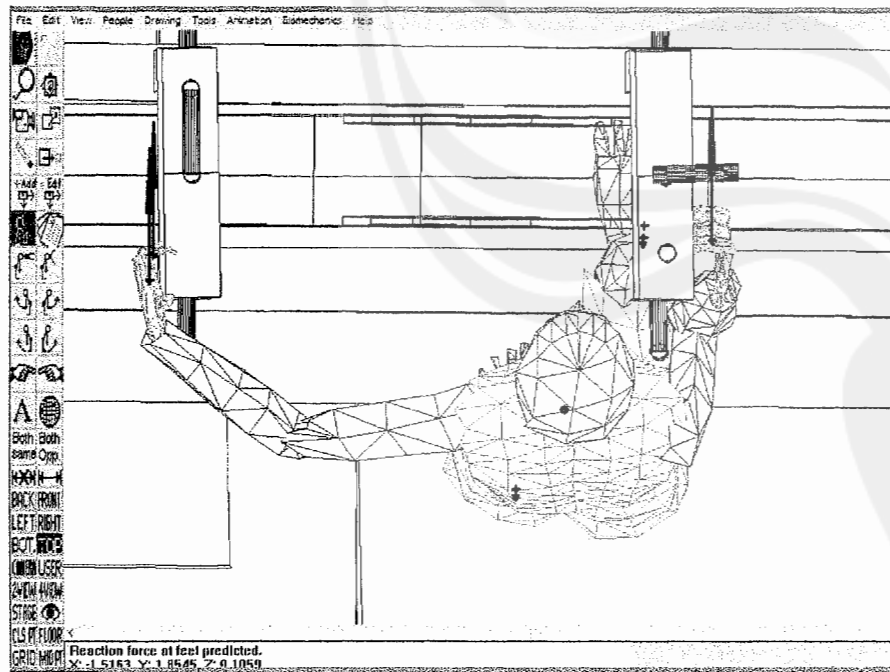
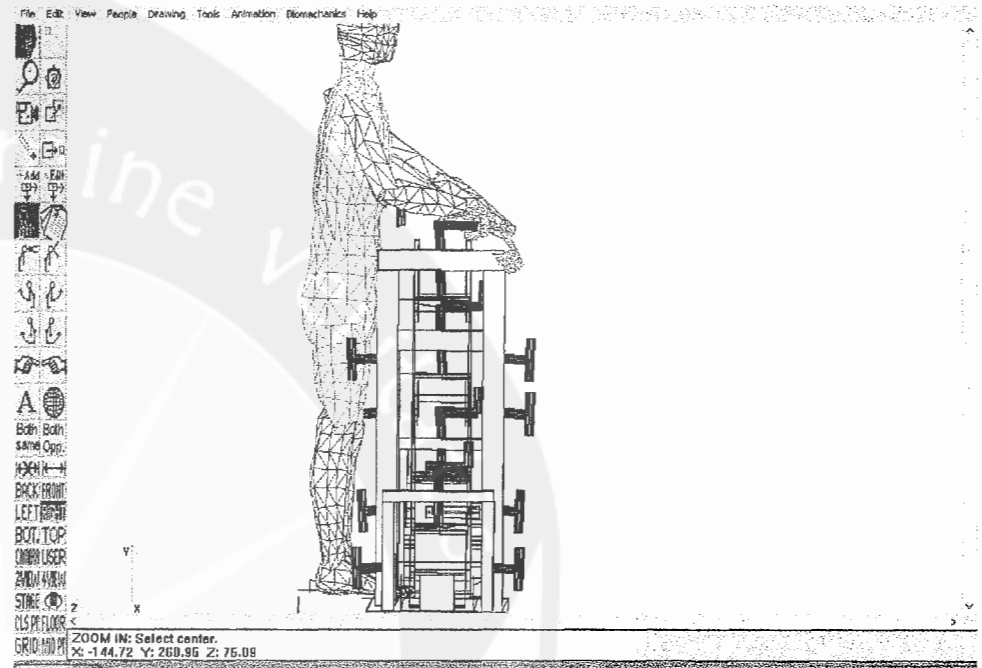
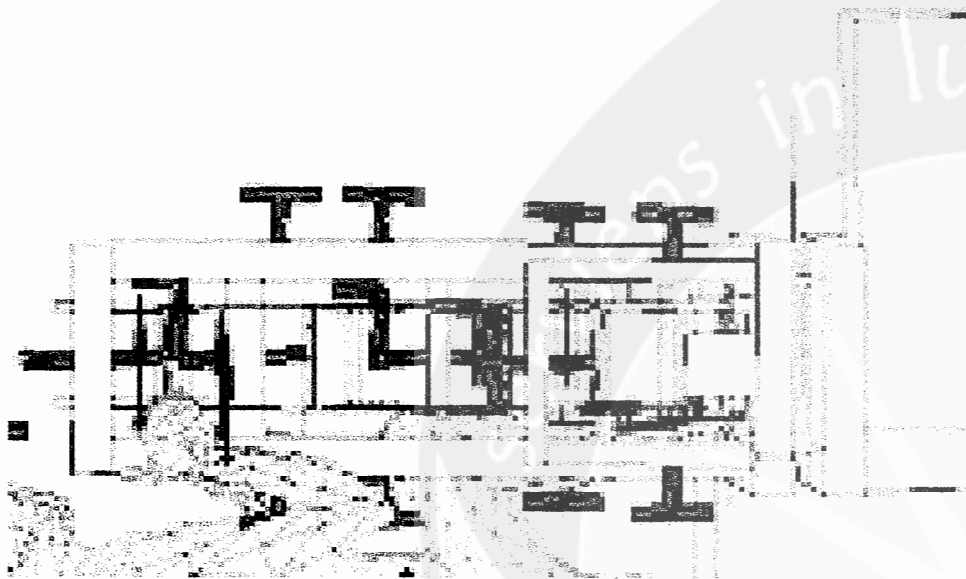


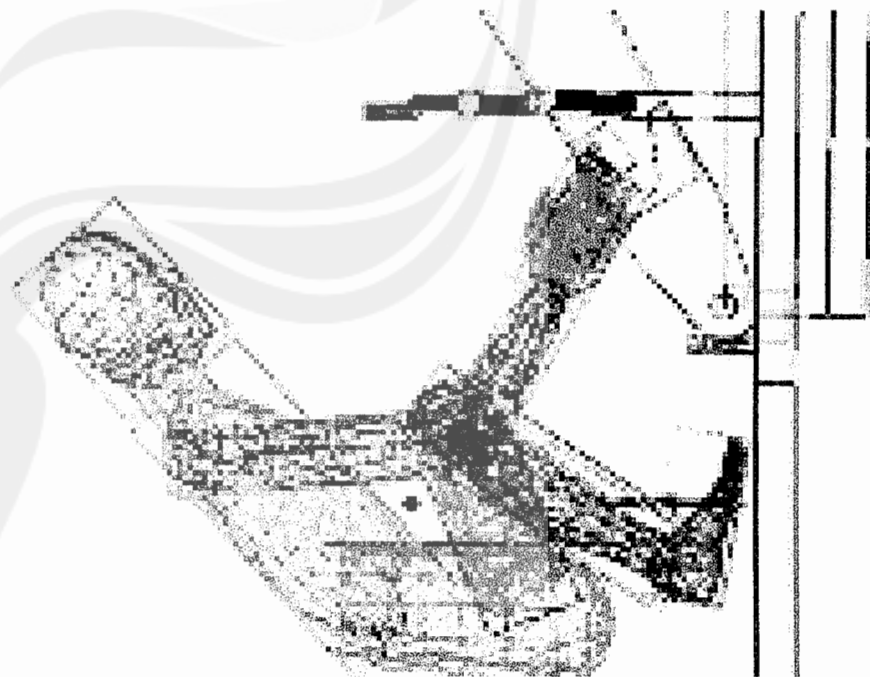
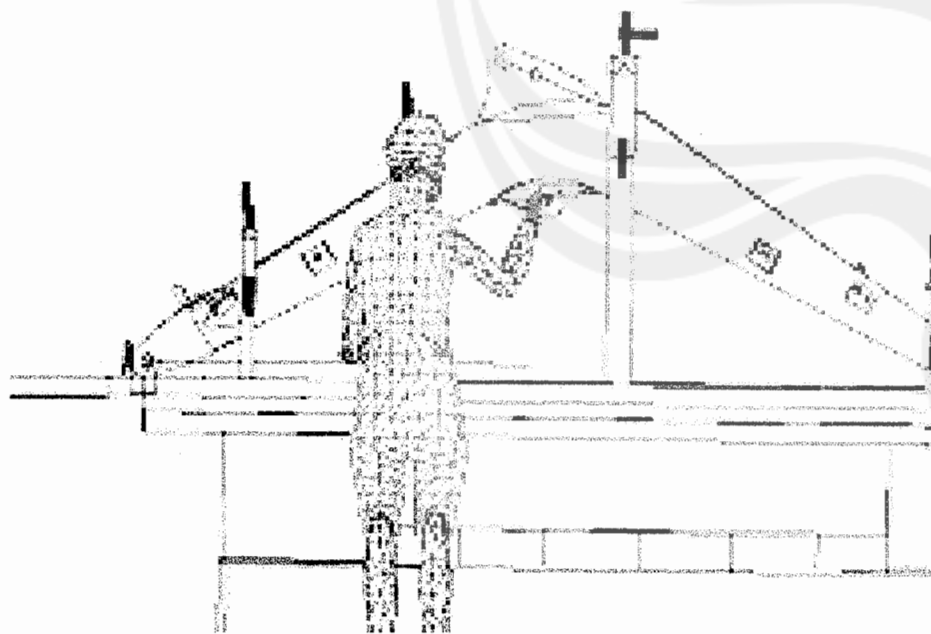
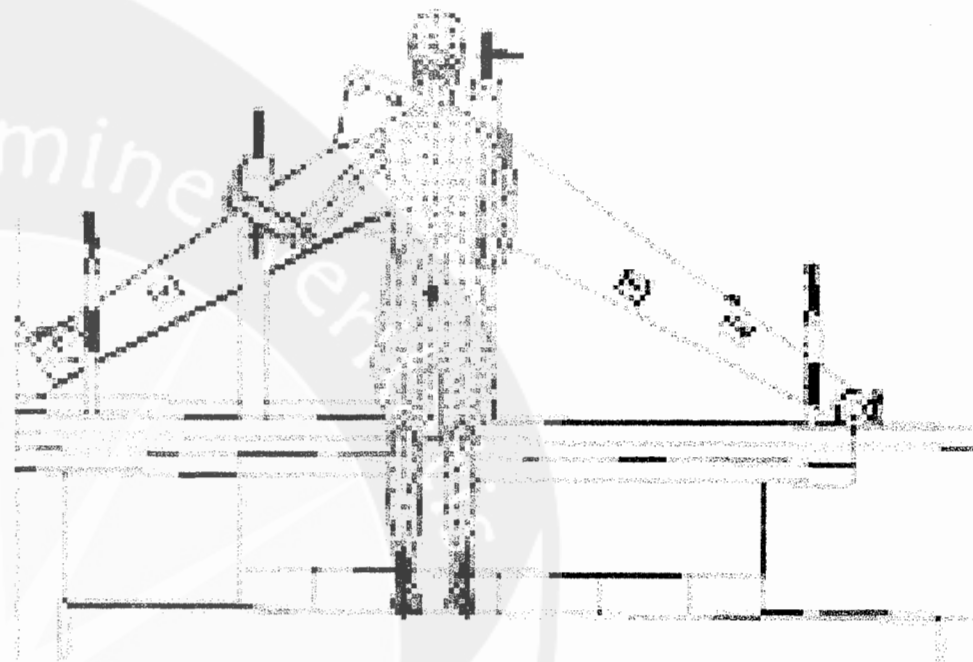
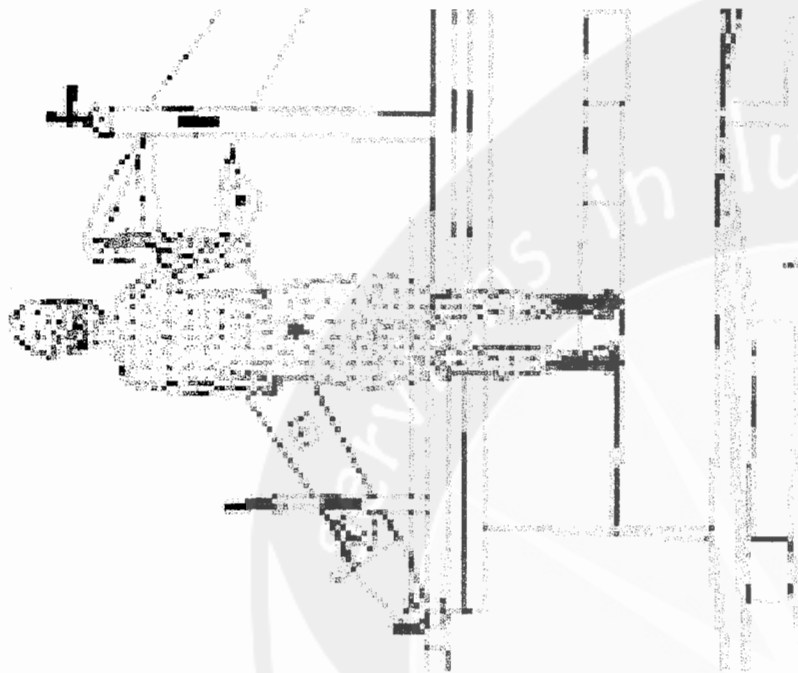


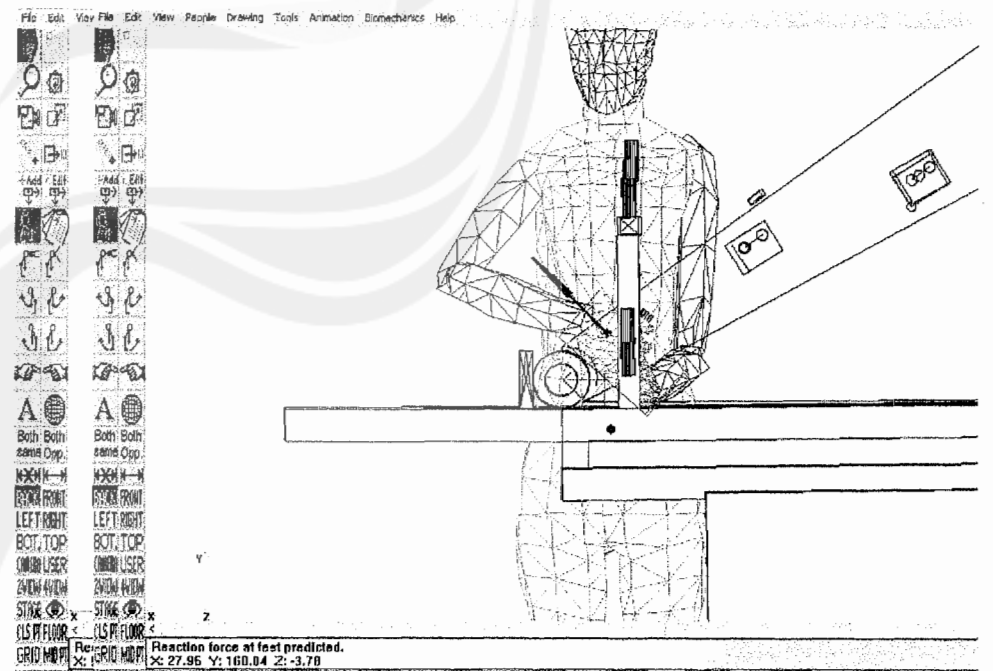
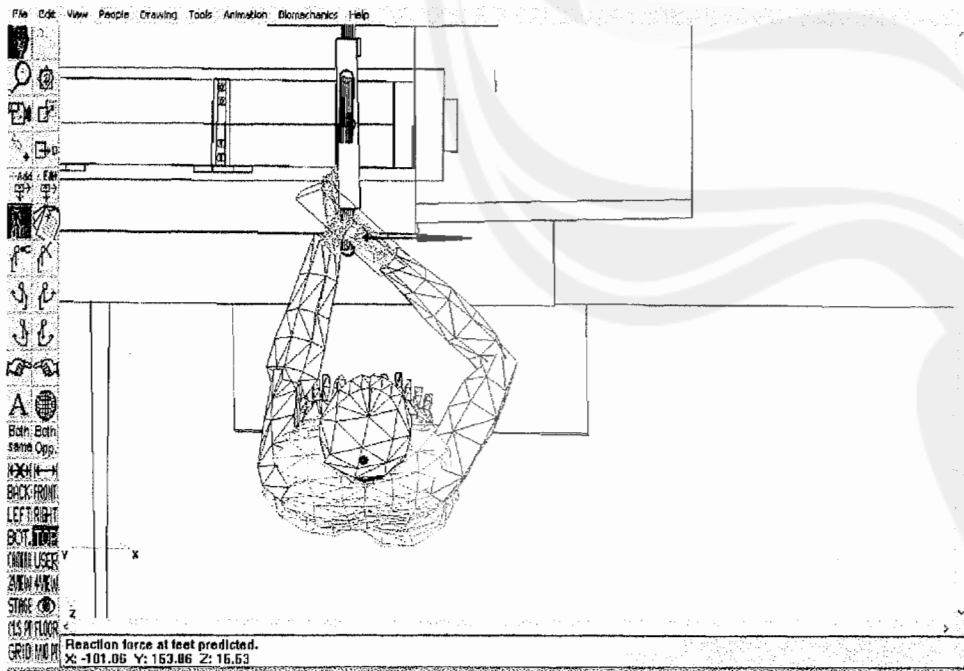
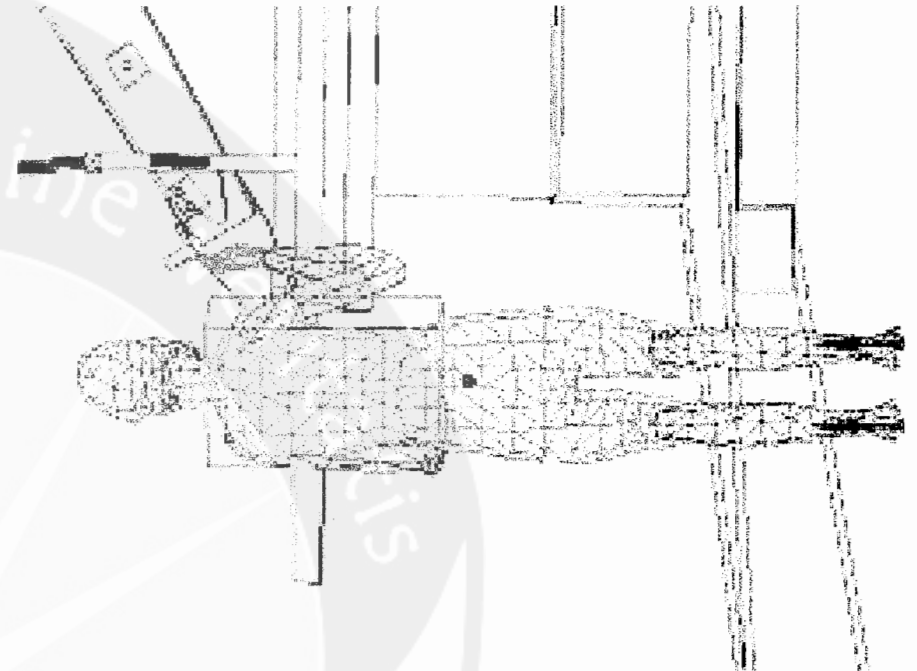
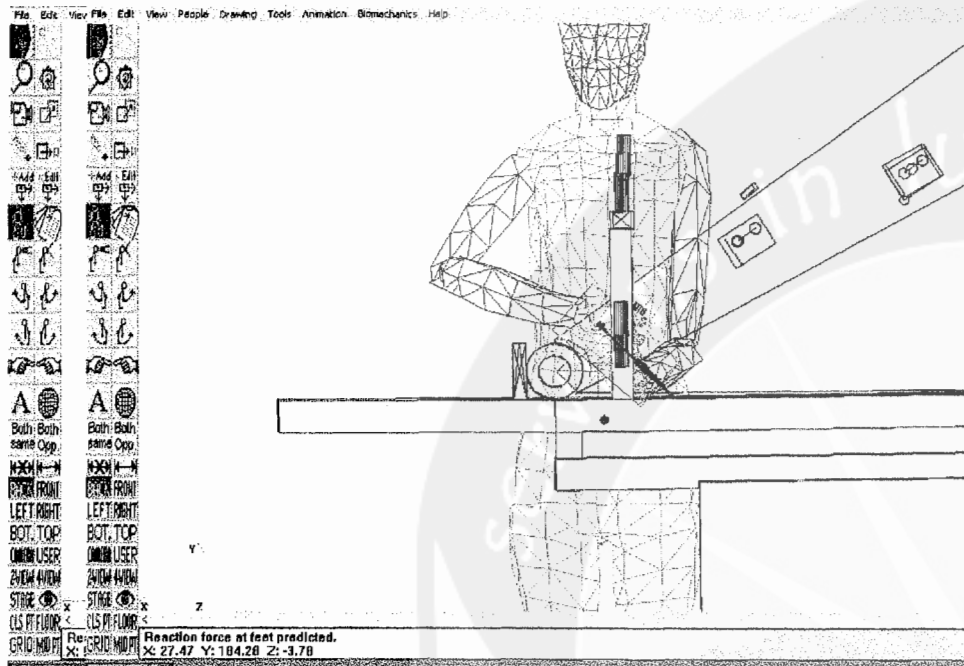


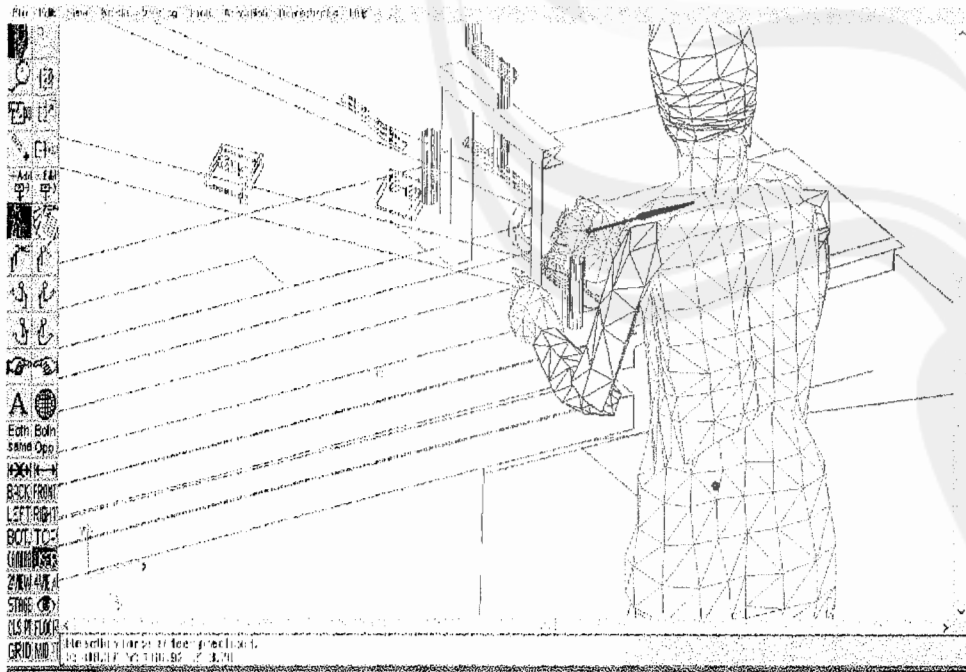


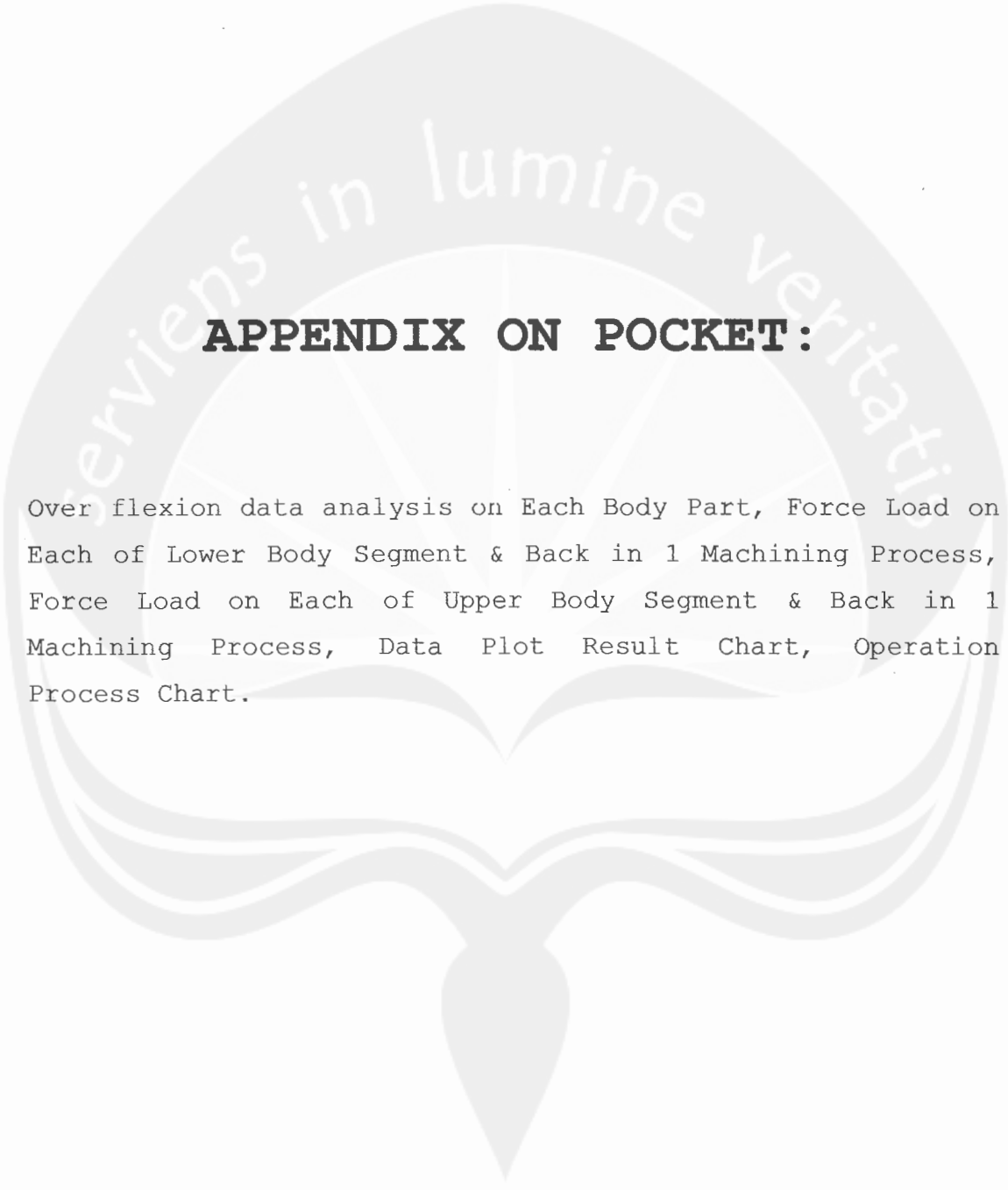










The background of the page features a large, light gray watermark of the University of Pavia logo. The logo is a shield-shaped emblem with a central sunburst or wheel-like design. The Latin motto "serviens in lumine veritatis" is written in a circular path around the central emblem.

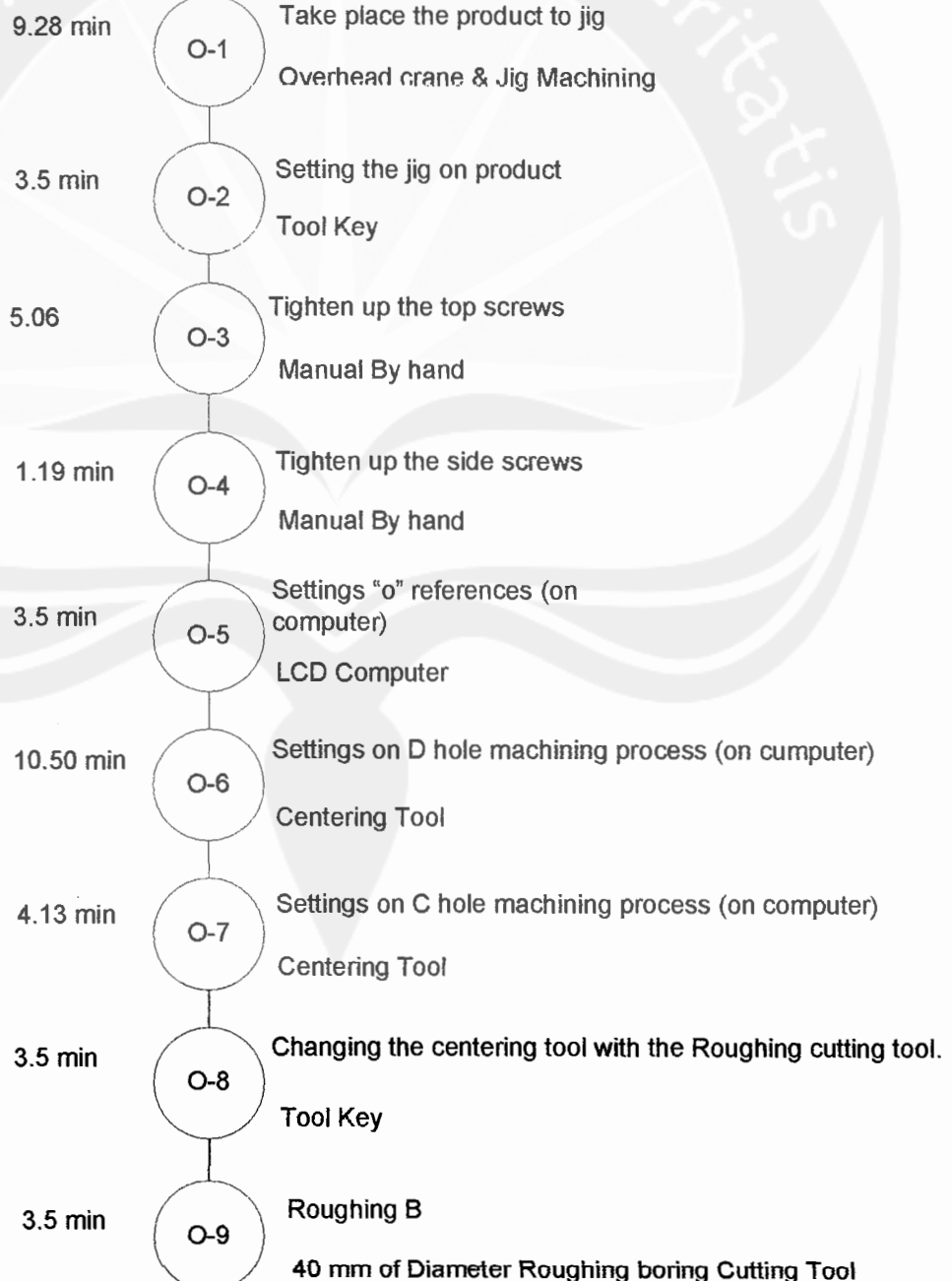
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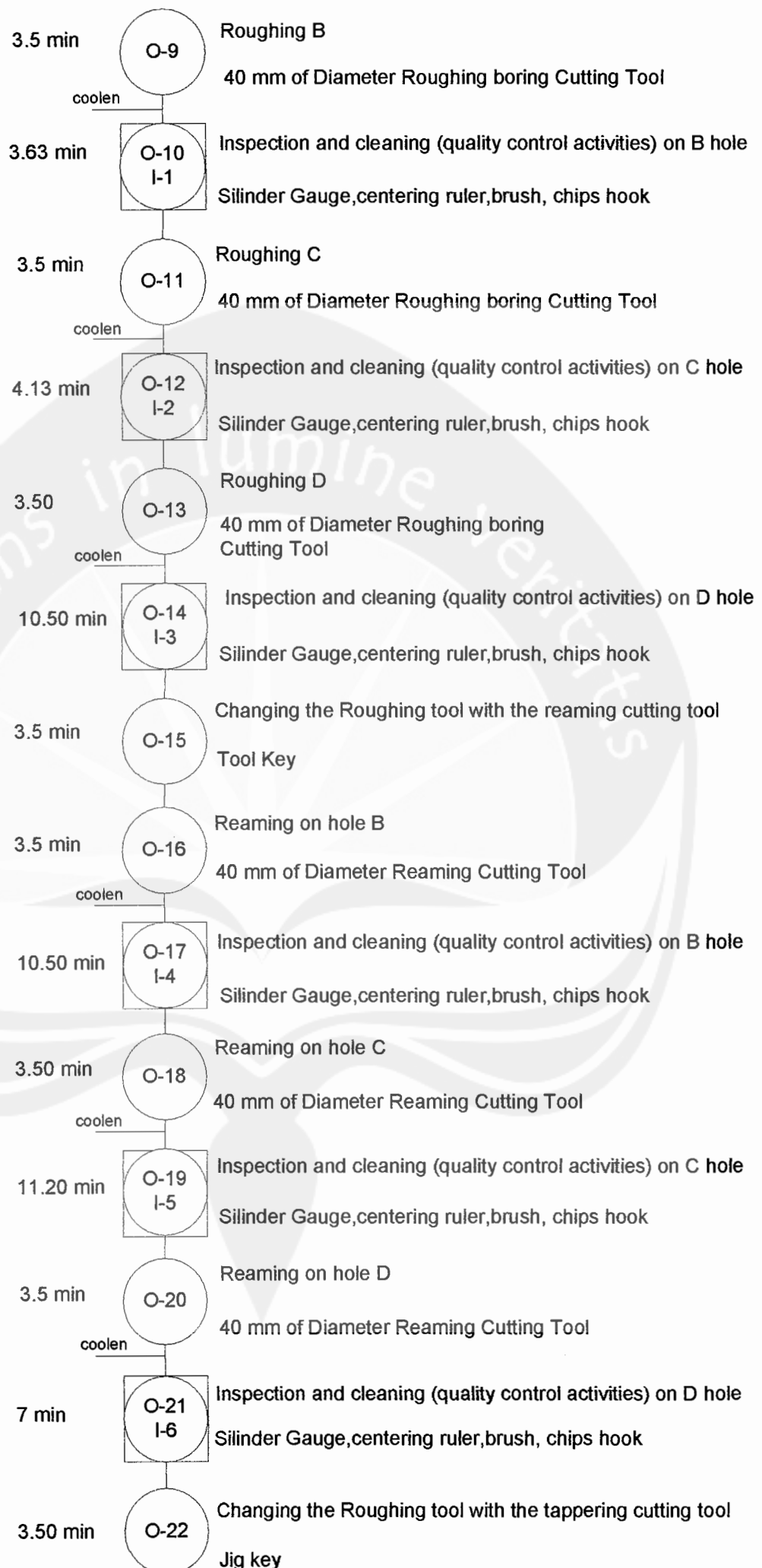
Over flexion data analysis on Each Body Part, Force Load on Each of Lower Body Segment & Back in 1 Machining Process, Force Load on Each of Upper Body Segment & Back in 1 Machining Process, Data Plot Result Chart, Operation Process Chart.

Operation Process Chart (Machining)

Object Name : Boom ZX -30
Diagram No. : ---
Made by : Roberto Ganis Hascariyo (01 14 02932)
Date : July, 25th 2004

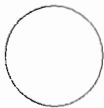
Boom -ZX 30







Resume

Activities	Amount	Time (Min)
	22	90.86 Minutes
	8	50.77 Minutes
TOTAL	30	141.63 Minutes