



รายการอ้างอิง

- "การพัฒนาขีดความสามารถทางเทคโนโลยีของอุตสาหกรรมไทย" (The Development of Thailand's Technological Capability in Industry) :  
รายงานวิชาการ , TDR, 2532.
- สำนักบริการวิชาการจุฬาลงกรณ์มหาวิทยาลัย และสถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง"รายงานการสำรวจและศึกษาสถานภาพทางเทคโนโลยีของอุตสาหกรรมอิเล็กทรอนิกส์ และคอมพิวเตอร์" ภาคที่ 4 วงจรรวม (IC) :  
รายงานวิชาการ ศูนย์เทคโนโลยีอิเล็กทรอนิกส์ และคอมพิวเตอร์แห่งชาติ  
กระทรวงวิทยาศาสตร์เทคโนโลยีและการพลังงาน, 2531.
- ไพโรจน์ วงศ์ศิริพัฒนกุล "การจัดแบบแผนกำลังคนในอุตสาหกรรมการผลิตแบบต่อเนื่อง"  
วิทยานิพนธ์ปริญญาโทบริหารธุรกิจ ภาควิชาวิศวกรรมอุตสาหกรรม คณะวิศวกรรม-  
ศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, 2525.
- ไพบุลย์ วิชาชัย "การพยากรณ์กำลังคนในอุตสาหกรรมประกอบรถยนต์ไทย" วิทยานิพนธ์  
ปริญญาโทบริหารธุรกิจ ภาควิชาวิศวกรรมอุตสาหกรรม คณะวิศวกรรมศาสตร์  
จุฬาลงกรณ์มหาวิทยาลัย, 2527.
- Hedley Malloch, "Evaluating Strategies on a Cost-Based Manpower Planning Model" : Personel Review , Vol 17, No. 3, 1988.
- Robert E. Stanford, "A Stochastic Model of Personel Mobility : Application of Reliability Theory in Manpower System Analysis" : Operation Research, Vol. 33, No. 1, 1985.
- Kemper W. Baker, "A Determination of Requirements : Personel for a Technical Organization" : The Journal of Industrial Engineering, Vol. 19, No. 9, 1968.

Raphael R. Thelwell, "An Evaluation of Linear Programming and Multiple Regression for Estimating Manpower Requirements" : The Journal of Industrial Engineering, Vol. 18, No. 3, 1967.

Saul I. Gass, "The Army Manpower Long-Range Planning System" : Operation Research, Vol. 36, No. 1, 1988.

Samuel James Siverd, "Manpower Planning : Attempts to Enhance Organizational Effectiveness" : Doctoral Dissertation, Graduate School of Industrial Administration, Carnegie-Mellon University

D.J. Bell, "Planning Corporate Manpower" : Long Man Group Limited, 1974.

John Bramham, "Practical Manpower Planning" : Institute of Personnel Management, 3rd Edition 1982.

David J. Bartholomeu & Andrew F. Forbes, "Statistical Technique for Manpower Planning" : John Willey & Sons Limited 1979.

C. J. Verhoeven, "Techniques in Corporate Manpower Planning : Method and Application " : Kluwer Bloston Inc. (Distributors for North America), Academic Plublishers Group (Distributors for outside North America"

"Machine to technician Ratio" :เอกสารทางวิชาการของบริษัท NS

Semiconductor International , May 1988

Semiconductor International , June 1989

Semiconductor International , April 1990

Semiconductor International , June 1990

Semiconductor International , September 1990

Surface Mount Technology , October 1989, Vol. 3 No. 6

Surface Mount Technology , January 1990, Vol. 4 No. 1

Solid State Technology , August 1990, Vol. 33 No. 8



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

MACHINE TO TECHNICIAN RATIO STUDY BY QURUING THEORY APPROACH.

(A LIMIT SOURCE MODEL, SINGLE SERVER, EXPONENTIAL DISTRIBUTION INPUT/OUTPUT)

1) QURUING THEORY CALCULATION.

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	15	1.31E+12	15	1.31E+12	0.0753	1.00E+00	1.00E+00	0.1248	-1	-1.2E-01
1	1.00E+00	15	1.31E+12	14	8.72E+10	0.0753	7.53E-02	1.13E+00	0.1409	0	0.0E+00
2	2.00E+00	15	1.31E+12	13	6.23E+09	0.0753	5.67E-03	1.19E+00	0.1485	1	1.5E-01
3	6.00E+00	15	1.31E+12	12	4.79E+08	0.0753	4.27E-04	1.16E+00	0.1454	2	2.9E-01
4	2.40E+01	15	1.31E+12	11	3.99E+07	0.0753	3.21E-05	1.05E+00	0.1313	3	3.9E-01
5	1.20E+02	15	1.31E+12	10	3.63E+06	0.0753	2.42E-06	8.71E-01	0.1087	4	4.3E-01
6	7.20E+02	15	1.31E+12	9	3.63E+05	0.0753	1.82E-07	6.56E-01	0.0818	5	4.1E-01
7	5.04E+03	15	1.31E+12	8	4.03E+04	0.0753	1.37E-08	4.44E-01	0.0554	6	3.3E-01
8	4.03E+04	15	1.31E+12	7	5.04E+03	0.0753	1.03E-09	2.68E-01	0.0334	7	2.3E-01
9	3.63E+05	15	1.31E+12	6	7.20E+02	0.0753	7.76E-11	1.41E-01	0.0176	8	1.4E-01
10	3.63E+06	15	1.31E+12	5	1.20E+02	0.0753	5.84E-12	6.37E-02	0.0079	9	7.2E-02
11	3.99E+07	15	1.31E+12	4	2.40E+01	0.0753	4.40E-13	2.40E-02	0.0030	10	3.0E-02
12	4.79E+08	15	1.31E+12	3	6.00E+00	0.0753	3.31E-14	7.22E-03	0.0009	11	9.9E-03
13	6.23E+09	15	1.31E+12	2	2.00E+00	0.0753	2.49E-15	1.63E-03	0.0002	12	2.4E-03
14	8.72E+10	15	1.31E+12	1	1.00E+00	0.0753	1.88E-16	2.45E-04	0.0000	13	4.0E-04
15	1.31E+12	15	1.31E+12	0	1.00E+00	0.0753	1.41E-17	1.85E-05	0.0000	14	3.2E-05
TOTAL								8.01E+00		Lq	2.5E+00
1/TOTAL=Po								1.25E-01		Wq	4.0E+02

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	14	8.72E+10	14	8.72E+10	0.0743	1.00E+00	1.00E+00	0.1670	-1	-1.7E-01
1	1.00E+00	14	8.72E+10	13	6.23E+09	0.0743	7.43E-02	1.04E+00	0.1737	0	0.0E+00
2	2.00E+00	14	8.72E+10	12	4.79E+08	0.0743	5.52E-03	1.01E+00	0.1678	1	1.7E-01
3	6.00E+00	14	8.72E+10	11	3.99E+07	0.0743	4.10E-04	8.96E-01	0.1497	2	3.0E-01
4	2.40E+01	14	8.72E+10	10	3.63E+06	0.0743	3.05E-05	7.33E-01	0.1224	3	3.7E-01
5	1.20E+02	14	8.72E+10	9	3.63E+05	0.0743	2.27E-06	5.45E-01	0.0909	4	3.6E-01
6	7.20E+02	14	8.72E+10	8	4.03E+04	0.0743	1.68E-07	3.64E-01	0.0608	5	3.0E-01
7	5.04E+03	14	8.72E+10	7	5.04E+03	0.0743	1.25E-08	2.17E-01	0.0362	6	2.2E-01
8	4.03E+04	14	8.72E+10	6	7.20E+02	0.0743	9.31E-10	1.13E-01	0.0188	7	1.3E-01
9	3.63E+05	14	8.72E+10	5	1.20E+02	0.0743	6.92E-11	5.02E-02	0.0084	8	6.7E-02
10	3.63E+06	14	8.72E+10	4	2.40E+01	0.0743	5.14E-12	1.87E-02	0.0031	9	2.8E-02
11	3.99E+07	14	8.72E+10	3	6.00E+00	0.0743	3.82E-13	5.55E-03	0.0009	10	9.3E-03
12	4.79E+08	14	8.72E+10	2	2.00E+00	0.0743	2.84E-14	1.24E-03	0.0002	11	2.3E-03
13	6.23E+09	14	8.72E+10	1	1.00E+00	0.0743	2.11E-15	1.84E-04	0.0000	12	3.7E-04
14	8.72E+10	14	8.72E+10	0	1.00E+00	0.0743	1.57E-16	1.37E-05	0.0000	13	3.0E-05
TOTAL								5.99E+00		Lq	2.0E+00
1/TOTAL								1.67E-01		Wq	3.1E+02

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	13	6.23E+09	13	6.23E+09	0.0734	1.00E+00	1.00E+00	0.2149	-1	-2.1E-01
1	1.00E+00	13	6.23E+09	12	4.79E+08	0.0734	7.34E-02	9.54E-01	0.2050	0	0.0E+00
2	2.00E+00	13	6.23E+09	11	3.99E+07	0.0734	5.38E-03	8.40E-01	0.1804	1	1.8E-01
3	6.00E+00	13	6.23E+09	10	3.63E+06	0.0734	3.95E-04	6.78E-01	0.1456	2	2.9E-01
4	2.40E+01	13	6.23E+09	9	3.63E+05	0.0734	2.90E-05	4.97E-01	0.1068	3	3.2E-01
5	1.20E+02	13	6.23E+09	8	4.03E+04	0.0734	2.13E-06	3.28E-01	0.0705	4	2.8E-01
6	7.20E+02	13	6.23E+09	7	5.04E+03	0.0734	1.56E-07	1.93E-01	0.0414	5	2.1E-01
7	5.04E+03	13	6.23E+09	6	7.20E+02	0.0734	1.14E-08	9.89E-02	0.0213	6	1.3E-01
8	4.03E+04	13	6.23E+09	5	1.20E+02	0.0734	8.39E-10	4.35E-02	0.0094	7	6.6E-02
9	3.63E+05	13	6.23E+09	4	2.40E+01	0.0734	6.16E-11	1.60E-02	0.0034	8	2.7E-02

10	3.63E+06	13	6.23E+09	3	6.00E+00	0.0734	4.52E-12	4.69E-03	0.0010	9	9.1E-03
11	3.99E+07	13	6.23E+09	2	2.00E+00	0.0734	3.31E-13	1.03E-03	0.0002	10	2.2E-03
12	4.79E+08	13	6.23E+09	1	1.00E+00	0.0734	2.43E-14	1.51E-04	0.0000	11	3.6E-04
13	6.23E+09	13	6.23E+09	0	1.00E+00	0.0734	1.78E-15	1.11E-05	0.0000	12	2.9E-05
			6.23E+09							Lo	1.5E+00
										Wq	2.4E+02
							TOTAL	4.65E+00			
							1/TOTAL	2.15E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	12	4.79E+08	12	4.79E+08	0.0724	1.00E+00	1.00E+00	0.2677	-1	-2.7E-01
1	1.00E+00	12	4.79E+08	11	3.99E+07	0.0724	7.24E-02	8.69E-01	0.2326	0	0.0E+00
2	2.00E+00	12	4.79E+08	10	3.63E+06	0.0724	5.24E-03	6.92E-01	0.1852	1	1.9E-01
3	6.00E+00	12	4.79E+08	9	3.63E+05	0.0724	3.80E-04	5.01E-01	0.1341	2	2.7E-01
4	2.40E+01	12	4.79E+08	8	4.03E+04	0.0724	2.75E-05	3.27E-01	0.0874	3	2.6E-01
5	1.20E+02	12	4.79E+08	7	5.04E+03	0.0724	1.99E-06	1.89E-01	0.0506	4	2.0E-01
6	7.20E+02	12	4.79E+08	6	7.20E+02	0.0724	1.44E-07	9.59E-02	0.0257	5	1.3E-01
7	5.04E+03	12	4.79E+08	5	1.20E+02	0.0724	1.04E-08	4.17E-02	0.0111	6	6.7E-02
8	4.03E+04	12	4.79E+08	4	2.40E+01	0.0724	7.56E-10	1.51E-02	0.0040	7	2.8E-02
9	3.63E+05	12	4.79E+08	3	6.00E+00	0.0724	5.47E-11	4.37E-03	0.0012	8	9.4E-03
10	3.63E+06	12	4.79E+08	2	2.00E+00	0.0724	3.96E-12	9.49E-04	0.0003	9	2.3E-03
11	3.99E+07	12	4.79E+08	1	1.00E+00	0.0724	2.87E-13	1.37E-04	0.0000	10	3.7E-04
12	4.79E+08	12	4.79E+08	0	1.00E+00	0.0724	2.08E-14	9.95E-06	0.0000	11	2.9E-05
										Lo	1.2E+00
										Wq	1.8E+02
							TOTAL	3.74E+00			
							1/TOTAL	2.68E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	11	3.99E+07	11	3.99E+07	0.0715	1.00E+00	1.00E+00	0.3242	-1	-3.2E-01
1	1.00E+00	11	3.99E+07	10	3.63E+06	0.0715	7.15E-02	7.86E-01	0.2548	0	0.0E+00
2	2.00E+00	11	3.99E+07	9	3.63E+05	0.0715	5.11E-03	5.62E-01	0.1821	1	1.8E-01
3	6.00E+00	11	3.99E+07	8	4.03E+04	0.0715	3.65E-04	3.61E-01	0.1171	2	2.3E-01
4	2.40E+01	11	3.99E+07	7	5.04E+03	0.0715	2.61E-05	2.06E-01	0.0669	3	2.0E-01
5	1.20E+02	11	3.99E+07	6	7.20E+02	0.0715	1.86E-06	1.03E-01	0.0335	4	1.3E-01
6	7.20E+02	11	3.99E+07	5	1.20E+02	0.0715	1.33E-07	4.43E-02	0.0144	5	7.2E-02
7	5.04E+03	11	3.99E+07	4	2.40E+01	0.0715	9.51E-09	1.58E-02	0.0051	6	3.1E-02
8	4.03E+04	11	3.99E+07	3	6.00E+00	0.0715	6.80E-10	4.52E-03	0.0015	7	1.0E-02
9	3.63E+05	11	3.99E+07	2	2.00E+00	0.0715	4.86E-11	9.69E-04	0.0003	8	2.5E-03
10	3.63E+06	11	3.99E+07	1	1.00E+00	0.0715	3.47E-12	1.39E-04	0.0000	9	4.0E-04
11	3.99E+07	11	3.99E+07	0	1.00E+00	0.0715	2.48E-13	9.90E-06	0.0000	10	3.2E-05
										Lo	8.7E-01
										Wq	1.4E+02
							TOTAL	3.08E+00			
							1/TOTAL	3.24E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	10	3.63E+06	10	3.63E+06	0.0705	1.00E+00	1.00E+00	0.3836	-1	-3.8E-01
1	1.00E+00	10	3.63E+06	9	3.63E+05	0.0705	7.05E-02	7.05E-01	0.2704	0	0.0E+00
2	2.00E+00	10	3.63E+06	8	4.03E+04	0.0705	4.97E-03	4.47E-01	0.1716	1	1.7E-01
3	6.00E+00	10	3.63E+06	7	5.04E+03	0.0705	3.50E-04	2.52E-01	0.0968	2	1.9E-01
4	2.40E+01	10	3.63E+06	6	7.20E+02	0.0705	2.47E-05	1.25E-01	0.0478	3	1.4E-01
5	1.20E+02	10	3.63E+06	5	1.20E+02	0.0705	1.74E-06	5.27E-02	0.0202	4	8.1E-02
6	7.20E+02	10	3.63E+06	4	2.40E+01	0.0705	1.23E-07	1.86E-02	0.0071	5	3.6E-02

7	5.04E+03	10	3.63E+06	3	6.00E+00	0.0705	8.66E-09	5.24E-03	0.0020	6	1.2E-02
8	4.03E+04	10	3.63E+06	2	2.00E+00	0.0705	6.11E-10	1.11E-03	0.0004	7	3.0E-03
9	3.63E+05	10	3.63E+06	1	1.00E+00	0.0705	4.30E-11	1.56E-04	0.0001	8	4.8E-04
10	3.63E+06	10	3.63E+06	0	1.00E+00	0.0705	3.03E-12	1.10E-05	0.0000	9	3.8E-05
										Lq	6.4E-01
										Wq	1.0E+02
							TOTAL	2.61E+00			
							1/TOTAL	3.84E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	9	3.63E+05	9	3.63E+05	0.0696	1.00E+00	1.00E+00	0.4449	-1	-4.4E-01
1	1.00E+00	9	3.63E+05	8	4.03E+04	0.0696	6.96E-02	6.26E-01	0.2785	0	0.0E+00
2	2.00E+00	9	3.63E+05	7	5.04E+03	0.0696	4.84E-03	3.48E-01	0.1550	1	1.5E-01
3	6.00E+00	9	3.63E+05	6	7.20E+02	0.0696	3.36E-04	1.70E-01	0.0754	2	1.5E-01
4	2.40E+01	9	3.63E+05	5	1.20E+02	0.0696	2.34E-05	7.08E-02	0.0315	3	9.4E-02
5	1.20E+02	9	3.63E+05	4	2.40E+01	0.0696	1.63E-06	2.46E-02	0.0110	4	4.4E-02
6	7.20E+02	9	3.63E+05	3	6.00E+00	0.0696	1.13E-07	6.85E-03	0.0030	5	1.5E-02
7	5.04E+03	9	3.63E+05	2	2.00E+00	0.0696	7.88E-09	1.43E-03	0.0006	6	3.8E-03
8	4.03E+04	9	3.63E+05	1	1.00E+00	0.0696	5.48E-10	1.99E-04	0.0001	7	6.2E-04
9	3.63E+05	9	3.63E+05	0	1.00E+00	0.0696	3.81E-11	1.38E-05	0.0000	8	4.9E-05
										Lq	4.6E-01
										Wq	7.4E+01
							TOTAL	2.25E+00			
							1/TOTAL	4.45E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	8	4.03E+04	8	4.03E+04	0.0686	1.00E+00	1.00E+00	0.5074	-1	-5.1E-01
1	1.00E+00	8	4.03E+04	7	5.04E+03	0.0686	6.86E-02	5.49E-01	0.2785	0	0.0E+00
2	2.00E+00	8	4.03E+04	6	7.20E+02	0.0686	4.71E-03	2.64E-01	0.1337	1	1.3E-01
3	6.00E+00	8	4.03E+04	5	1.20E+02	0.0686	3.23E-04	1.09E-01	0.0551	2	1.1E-01
4	2.40E+01	8	4.03E+04	4	2.40E+01	0.0686	2.22E-05	3.72E-02	0.0189	3	5.7E-02
5	1.20E+02	8	4.03E+04	3	6.00E+00	0.0686	1.52E-06	1.02E-02	0.0052	4	2.1E-02
6	7.20E+02	8	4.03E+04	2	2.00E+00	0.0686	1.04E-07	2.10E-03	0.0011	5	5.3E-03
7	5.04E+03	8	4.03E+04	1	1.00E+00	0.0686	7.15E-09	2.88E-04	0.0001	6	8.8E-04
8	4.03E+04	8	4.03E+04	0	1.00E+00	0.0686	4.91E-10	1.98E-05	0.0000	7	7.0E-05
										Lq	3.3E-01
										Wq	5.2E+01
							TOTAL	1.97E+00			
							1/TOTAL	5.07E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	7	5.04E+03	7	5.04E+03	0.0677	1.00E+00	1.00E+00	0.5706	-1	-5.7E-01
1	1.00E+00	7	5.04E+03	6	7.20E+02	0.0677	6.77E-02	4.74E-01	0.2702	0	0.0E+00
2	2.00E+00	7	5.04E+03	5	1.20E+02	0.0677	4.58E-03	1.92E-01	0.1097	1	1.1E-01
3	6.00E+00	7	5.04E+03	4	2.40E+01	0.0677	3.10E-04	6.50E-02	0.0371	2	7.4E-02
4	2.40E+01	7	5.04E+03	3	6.00E+00	0.0677	2.10E-05	1.76E-02	0.0100	3	3.0E-02
5	1.20E+02	7	5.04E+03	2	2.00E+00	0.0677	1.42E-06	3.57E-03	0.0020	4	8.2E-03
6	7.20E+02	7	5.04E+03	1	1.00E+00	0.0677	9.59E-08	4.84E-04	0.0003	5	1.4E-03

7	5.04E+03	7	5.04E+03	0	1.00E+00	0.0677	6.49E-09		3.27E-05	0.0000	6	1.1E-04
											Lq	2.2E-01
											Wq	3.6E+01
							TOTAL		1.75E+00			
							1/TOTAL		5.71E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	6	7.20E+02	6	7.20E+02	0.0667	1.00E+00	1.00E+00	0.6339	-1	-6.3E-01
1	1.00E+00	6	7.20E+02	5	1.20E+02	0.0667	6.67E-02	4.00E-01	0.2537	0	0.0E+00
2	2.00E+00	6	7.20E+02	4	2.40E+01	0.0667	4.45E-03	1.34E-01	0.0846	1	8.5E-02
3	6.00E+00	6	7.20E+02	3	6.00E+00	0.0667	2.97E-04	3.56E-02	0.0226	2	4.5E-02
4	2.40E+01	6	7.20E+02	2	2.00E+00	0.0667	1.98E-05	7.13E-03	0.0045	3	1.4E-02
5	1.20E+02	6	7.20E+02	1	1.00E+00	0.0667	1.32E-06	9.52E-04	0.0006	4	2.4E-03
6	7.20E+02	6	7.20E+02	0	1.00E+00	0.0667	8.82E-08	6.35E-05	0.0000	5	2.0E-04
										Lq	1.5E-01
										Wq	2.3E+01
							TOTAL		1.58E+00		
							1/TOTAL		6.34E-01		

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	5	1.20E+02	5	1.20E+02	0.0658	1.00E+00	1.00E+00	0.6969	-1	-7.0E-01
1	1.00E+00	5	1.20E+02	4	2.40E+01	0.0658	6.58E-02	3.29E-01	0.2292	0	0.0E+00
2	2.00E+00	5	1.20E+02	3	6.00E+00	0.0658	4.33E-03	8.65E-02	0.0603	1	6.0E-02
3	6.00E+00	5	1.20E+02	2	2.00E+00	0.0658	2.85E-04	1.71E-02	0.0119	2	2.4E-02
4	2.40E+01	5	1.20E+02	1	1.00E+00	0.0658	1.87E-05	2.25E-03	0.0016	3	4.7E-03
5	1.20E+02	5	1.20E+02	0	1.00E+00	0.0658	1.23E-06	1.48E-04	0.0001	4	4.1E-04
										Lq	8.9E-02
										Wq	1.4E+01
							TOTAL		1.43E+00		
							1/TOTAL		6.97E-01		

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	4	2.40E+01	4	2.40E+01	0.0648	1.00E+00	1.00E+00	0.7595	-1	-7.6E-01
1	1.00E+00	4	2.40E+01	3	6.00E+00	0.0648	6.48E-02	2.59E-01	0.1969	0	0.0E+00
2	2.00E+00	4	2.40E+01	2	2.00E+00	0.0648	4.20E-03	5.04E-02	0.0383	1	3.8E-02
3	6.00E+00	4	2.40E+01	1	1.00E+00	0.0648	2.72E-04	6.54E-03	0.0050	2	9.9E-03
4	2.40E+01	4	2.40E+01	0	1.00E+00	0.0648	1.77E-05	4.24E-04	0.0003	3	9.7E-04
										Lq	4.9E-02
										Wq	7.9E+00
							TOTAL		1.32E+00		
							1/TOTAL		7.59E-01		

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n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	3	6.00E+00	3	6.00E+00	0.0639	1.00E+00	1.00E+00	0.8212	-1	-8.2E-01
1	1.00E+00	3	6.00E+00	2	2.00E+00	0.0639	6.39E-02	1.92E-01	0.1574	0	0.0E+00
2	2.00E+00	3	6.00E+00	1	1.00E+00	0.0639	4.08E-03	2.45E-02	0.0201	1	2.0E-02
3	6.00E+00	3	6.00E+00	0	1.00E+00	0.0639	2.61E-04	1.56E-03	0.0013	2	2.6E-03
									Lq	2.3E-02	
									Wq	3.6E+00	
TOTAL									1.22E+00		
1/TOTAL									8.21E-01		

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	2	2.00E+00	2	2.00E+00	0.0630	1.00E+00	1.00E+00	0.8820	-1	-8.8E-01
1	1.00E+00	2	2.00E+00	1	1.00E+00	0.0630	6.30E-02	1.26E-01	0.1110	0	0.0E+00
2	2.00E+00	2	2.00E+00	0	1.00E+00	0.0630	3.96E-03	7.93E-03	0.0070	1	7.0E-03
									Lq	7.0E-03	
									Wq	1.1E+00	
TOTAL									1.13E+00		
1/TOTAL									8.82E-01		

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	1	1.00E+00	1	1.00E+00	0.0620	1.00E+00	1.00E+00	0.9416	-1	-9.4E-01
1	1.00E+00	1	1.00E+00	0	1.00E+00	0.0620	6.20E-02	6.20E-02	0.0584	0	0.0E+00
									Lq	0.0E+00	
									Wq	0.0E+00	
TOTAL									1.06E+00		
1/TOTAL									9.42E-01		

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## 2) QUEUING PARAMETERS SUMMARY.

N	Po	Lq	Wq
1	9.42E-01	0.00E+00	0.00E+00
2	8.82E-01	6.99E-03	1.12E+00
3	8.21E-01	2.27E-02	3.63E+00
4	7.59E-01	4.92E-02	7.86E+00
5	6.97E-01	8.92E-02	1.42E+01
6	6.34E-01	1.46E-01	2.33E+01
7	5.71E-01	2.24E-01	3.56E+01
8	5.07E-01	3.28E-01	5.21E+01
9	4.45E-01	4.64E-01	7.38E+01
10	3.84E-01	6.40E-01	1.02E+02
11	3.24E-01	8.67E-01	1.38E+02
12	2.68E-01	1.15E+00	1.83E+02
13	2.15E-01	1.51E+00	2.40E+02
14	1.67E-01	1.96E+00	3.10E+02
15	1.25E-01	2.50E+00	3.95E+02

Lq=NUMBER OF MACHINE WAITING FOR TECHNICIAN.  
Wq=TOTAL MACHINE INTERFERENCE TIME.

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## 3) DETERMINE MACHINE TO TECHNICIAN RATIO.

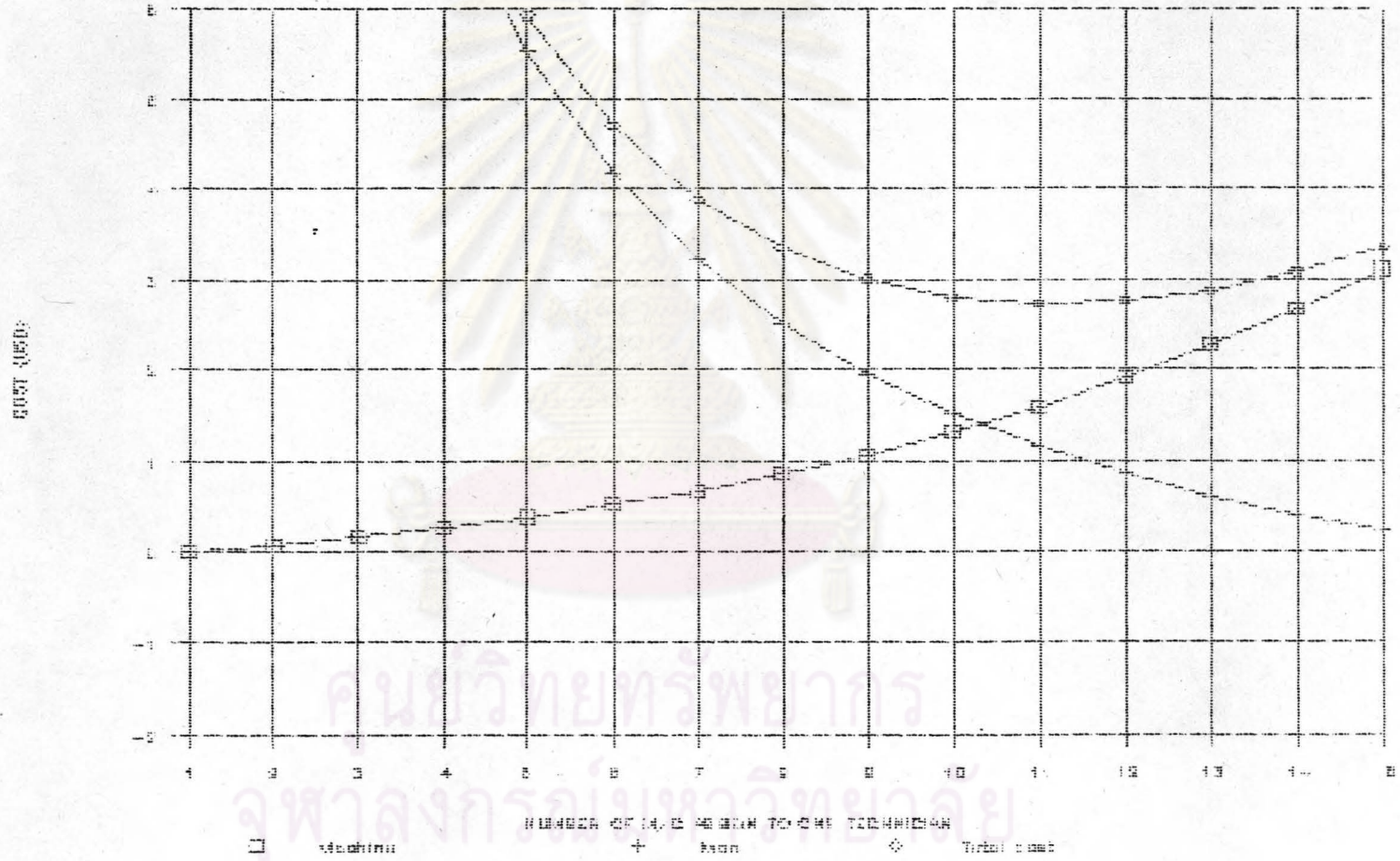
P	S	N	M	TECH	Tz	HRS/YEAR	OVERHAUL	P1	S1	X=P1/S1	I	Me	Is
160.34	9.79	1	19	19.00	90.0	2083	0.1411	160.2034	9.9355	16.1243	0.0000	1.0000	0.0584
160.34	9.79	2	19	9.50	90.0	2083	0.2822	160.0623	10.0766	15.8845	0.5595	0.9967	0.0592
160.34	9.79	3	19	6.33	90.0	2083	0.4233	159.9212	10.2177	15.6513	1.2092	0.9929	0.0601
160.34	9.79	4	19	4.75	90.0	2083	0.5644	159.7801	10.3588	15.4245	1.9655	0.9886	0.0609
160.34	9.79	5	19	3.80	90.0	2083	0.7055	159.6390	10.4999	15.2038	2.8481	0.9835	0.0617
160.34	9.79	6	19	3.17	90.0	2083	0.8466	159.4979	10.6410	14.9890	3.8809	0.9777	0.0625
160.34	9.79	7	19	2.71	90.0	2083	0.9877	159.3568	10.7821	14.7797	5.0928	0.9709	0.0634
160.34	9.79	8	19	2.38	90.0	2083	1.1288	159.2157	10.9232	14.5759	6.5184	0.9631	0.0642
160.34	9.79	9	19	2.11	90.0	2083	1.2699	159.0746	11.0643	14.3773	8.1982	0.9540	0.0650
160.34	9.79	10	19	1.90	90.0	2083	1.4110	158.9335	11.2054	14.1836	10.1792	0.9435	0.0659
160.34	9.79	11	19	1.73	90.0	2083	1.5521	158.7924	11.3465	13.9948	12.5132	0.9315	0.0667
160.34	9.79	12	19	1.58	90.0	2083	1.6932	158.6513	11.4876	13.8107	15.2543	0.9177	0.0675
160.34	9.79	13	19	1.46	90.0	2083	1.8343	158.5102	11.6287	13.6310	18.4534	0.9022	0.0683
160.34	9.79	14	19	1.36	90.0	2083	1.9753	158.3691	11.7698	13.4556	22.1493	0.8848	0.0692
160.34	9.79	15	19	1.27	90.0	2083	2.1164	158.2280	11.9109	13.2843	26.3565	0.8659	0.0700

Ns	Ni	Np	TTL Ns	TTL Ni	TTL Np	A	B	C1	C2	C	N
0.0584	0.0000	0.9416	1.109536	0.000000	17.89046	2.08612	1.22118	0.00000	37.32161	37.32161	1
0.1181	0.0066	1.8754	1.121604	0.062275	17.81612	2.08612	1.22118	0.07605	17.47832	17.55437	2
0.1789	0.0212	2.7999	1.132997	0.134085	17.73292	2.08612	1.22118	0.16374	10.84851	11.01226	3
0.2408	0.0457	3.7136	1.143595	0.216987	17.63942	2.08612	1.22118	0.26498	7.52339	7.78837	4
0.3035	0.0823	4.6142	1.153257	0.312819	17.53392	2.08612	1.22118	0.38201	5.52142	5.90343	5
0.3669	0.1338	5.4993	1.161818	0.423729	17.41445	2.08612	1.22118	0.51745	4.18235	4.69980	6
0.4307	0.2034	6.3658	1.169081	0.552205	17.27871	2.08612	1.22118	0.67434	3.22348	3.89782	7
0.4947	0.2952	7.2102	1.174823	0.701070	17.12411	2.08612	1.22118	0.85614	2.50371	3.35985	8
0.5584	0.4137	8.0279	1.178789	0.873436	16.94777	2.08612	1.22118	1.06663	1.94493	3.01156	9
0.6214	0.5645	8.8141	1.180706	1.072574	16.74672	2.08612	1.22118	1.30981	1.50053	2.81034	10
0.6833	0.7536	9.5631	1.180296	1.301657	16.51805	2.08612	1.22118	1.58956	1.14106	2.73062	11
0.7436	0.9874	10.2691	1.177305	1.563337	16.25936	2.08612	1.22118	1.90912	0.84702	2.75615	12
0.8016	1.2720	10.9264	1.171549	1.859118	15.96933	2.08612	1.22118	2.27033	0.60495	2.87528	13
0.8569	1.6126	11.5304	1.162973	2.188570	15.64846	2.08612	1.22118	2.67265	0.40506	3.07771	14
0.9092	2.0120	12.0788	1.151715	2.548529	15.29976	2.08612	1.22118	3.11222	0.23980	3.35203	15

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

# IDLE TIME COST OF SAW MACHINE

SINGLE BEAM MODEL



คณะวิศวกรรมศาสตร์  
 จุฬาลงกรณ์มหาวิทยาลัย

## MACHINE TO TECHNICIAN RATIO STUDY BY QUEUING THEORY APPROACH.

(A LIMIT SOURCE MODEL, SINGLE SERVER, EXPONENTIAL DISTRIBUTION INPUT/OUTPUT)

## 1) QUEUING THEORY CALCULATION.

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	15	1.31E+12	15	1.31E+12	0.0967	1.00E+00	1.00E+00	0.0434	-1	-4.3E-02
1	1.00E+00	15	1.31E+12	14	8.72E+10	0.0967	9.67E-02	1.45E+00	0.0630	0	0.0E+00
2	2.00E+00	15	1.31E+12	13	6.23E+09	0.0967	9.36E-03	1.97E+00	0.0853	1	8.5E-02
3	6.00E+00	15	1.31E+12	12	4.79E+08	0.0967	9.05E-04	2.47E+00	0.1073	2	2.1E-01
4	2.40E+01	15	1.31E+12	11	3.99E+07	0.0967	8.76E-05	2.87E+00	0.1246	3	3.7E-01
5	1.20E+02	15	1.31E+12	10	3.63E+06	0.0967	8.47E-06	3.05E+00	0.1326	4	5.3E-01
6	7.20E+02	15	1.31E+12	9	3.63E+05	0.0967	8.20E-07	2.95E+00	0.1282	5	6.4E-01
7	5.04E+03	15	1.31E+12	8	4.03E+04	0.0967	7.93E-08	2.57E+00	0.1117	6	6.7E-01
8	4.03E+04	15	1.31E+12	7	5.04E+03	0.0967	7.67E-09	1.99E+00	0.0864	7	6.0E-01
9	3.63E+05	15	1.31E+12	6	7.20E+02	0.0967	7.42E-10	1.35E+00	0.0585	8	4.7E-01
10	3.63E+06	15	1.31E+12	5	1.20E+02	0.0967	7.18E-11	7.83E-01	0.0340	9	3.1E-01
11	3.99E+07	15	1.31E+12	4	2.40E+01	0.0967	6.95E-12	3.79E-01	0.0164	10	1.6E-01
12	4.79E+08	15	1.31E+12	3	6.00E+00	0.0967	6.72E-13	1.46E-01	0.0064	11	7.0E-02
13	6.23E+09	15	1.31E+12	2	2.00E+00	0.0967	6.50E-14	4.25E-02	0.0018	12	2.2E-02
14	8.72E+10	15	1.31E+12	1	1.00E+00	0.0967	6.29E-15	8.23E-03	0.0004	13	4.6E-03
15	1.31E+12	15	1.31E+12	0	1.00E+00	0.0967	6.09E-16	7.96E-04	0.0000	14	4.8E-04
								TOTAL	2.30E+01	Lq	4.2E+00
								1/TOTAL=Po	4.34E-02	Wq	3.3E+02

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	14	8.72E+10	14	8.72E+10	0.0957	1.00E+00	1.00E+00	0.0691	-1	-6.9E-02
1	1.00E+00	14	8.72E+10	13	6.23E+09	0.0957	9.57E-02	1.34E+00	0.0926	0	0.0E+00
2	2.00E+00	14	8.72E+10	12	4.79E+08	0.0957	9.15E-03	1.67E+00	0.1151	1	1.2E-01
3	6.00E+00	14	8.72E+10	11	3.99E+07	0.0957	8.76E-04	1.91E+00	0.1321	2	2.6E-01
4	2.40E+01	14	8.72E+10	10	3.63E+06	0.0957	8.38E-05	2.01E+00	0.1391	3	4.2E-01
5	1.20E+02	14	8.72E+10	9	3.63E+05	0.0957	8.01E-06	1.92E+00	0.1330	4	5.3E-01
6	7.20E+02	14	8.72E+10	8	4.03E+04	0.0957	7.67E-07	1.66E+00	0.1145	5	5.7E-01
7	5.04E+03	14	8.72E+10	7	5.04E+03	0.0957	7.33E-08	1.27E+00	0.0877	6	5.3E-01
8	4.03E+04	14	8.72E+10	6	7.20E+02	0.0957	7.01E-09	8.49E-01	0.0587	7	4.1E-01
9	3.63E+05	14	8.72E+10	5	1.20E+02	0.0957	6.71E-10	4.88E-01	0.0337	8	2.7E-01
10	3.63E+06	14	8.72E+10	4	2.40E+01	0.0957	6.42E-11	2.33E-01	0.0161	9	1.5E-01
11	3.99E+07	14	8.72E+10	3	6.00E+00	0.0957	6.14E-12	8.92E-02	0.0062	10	6.2E-02
12	4.79E+08	14	8.72E+10	2	2.00E+00	0.0957	5.88E-13	2.56E-02	0.0018	11	1.9E-02
13	6.23E+09	14	8.72E+10	1	1.00E+00	0.0957	5.62E-14	4.90E-03	0.0003	12	4.1E-03
14	8.72E+10	14	8.72E+10	0	1.00E+00	0.0957	5.38E-15	4.69E-04	0.0000	13	4.2E-04
								TOTAL	1.45E+01	Lq	3.3E+00
								1/TOTAL	6.91E-02	Wq	2.7E+02

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	13	6.23E+09	13	6.23E+09	0.0946	1.00E+00	1.00E+00	0.1035	-1	-1.0E-01
1	1.00E+00	13	6.23E+09	12	4.79E+08	0.0946	9.46E-02	1.23E+00	0.1273	0	0.0E+00
2	2.00E+00	13	6.23E+09	11	3.99E+07	0.0946	8.95E-03	1.40E+00	0.1445	1	1.4E-01
3	6.00E+00	13	6.23E+09	10	3.63E+06	0.0946	8.46E-04	1.45E+00	0.1503	2	3.0E-01
4	2.40E+01	13	6.23E+09	9	3.63E+05	0.0946	8.00E-05	1.37E+00	0.1422	3	4.3E-01
5	1.20E+02	13	6.23E+09	8	4.03E+04	0.0946	7.57E-06	1.17E+00	0.1210	4	4.8E-01
6	7.20E+02	13	6.23E+09	7	5.04E+03	0.0946	7.16E-07	8.85E-01	0.0916	5	4.6E-01
7	5.04E+03	13	6.23E+09	6	7.20E+02	0.0946	6.77E-08	5.86E-01	0.0606	6	3.6E-01
8	4.03E+04	13	6.23E+09	5	1.20E+02	0.0946	6.41E-09	3.33E-01	0.0344	7	2.4E-01
9	3.63E+05	13	6.23E+09	4	2.40E+01	0.0946	6.06E-10	1.57E-01	0.0163	8	1.3E-01

10	3.63E+06	13	6.23E+09	3	6.00E+00	0.0946	5.73E-11	5.95E-02	0.0062	9	5.5E-02
11	3.99E+07	13	6.23E+09	2	2.00E+00	0.0946	5.42E-12	1.69E-02	0.0017	10	1.7E-02
12	4.79E+08	13	6.23E+09	1	1.00E+00	0.0946	5.13E-13	3.19E-03	0.0003	11	3.6E-03
13	6.23E+09	13	6.23E+09	0	1.00E+00	0.0946	4.85E-14	3.02E-04	0.0000	12	3.8E-04

6.23E+09

Lq 2.6E+00

Wq 2.1E+02

TOTAL 9.66E+00  
1/TOTAL 1.04E-01

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	12	4.79E+08	12	4.79E+08	0.0935	1.00E+00	1.00E+00	0.1468	-1	-1.5E-01
1	1.00E+00	12	4.79E+08	11	3.99E+07	0.0935	9.35E-02	1.12E+00	0.1647	0	0.0E+00
2	2.00E+00	12	4.79E+08	10	3.63E+06	0.0935	8.74E-03	1.15E+00	0.1694	1	1.7E-01
3	6.00E+00	12	4.79E+08	9	3.63E+05	0.0935	8.18E-04	1.08E+00	0.1584	2	3.2E-01
4	2.40E+01	12	4.79E+08	8	4.03E+04	0.0935	7.65E-05	9.09E-01	0.1333	3	4.0E-01
5	1.20E+02	12	4.79E+08	7	5.04E+03	0.0935	7.15E-06	6.80E-01	0.0997	4	4.0E-01
6	7.20E+02	12	4.79E+08	6	7.20E+02	0.0935	6.69E-07	4.45E-01	0.0653	5	3.3E-01
7	5.04E+03	12	4.79E+08	5	1.20E+02	0.0935	6.25E-08	2.50E-01	0.0366	6	2.2E-01
8	4.03E+04	12	4.79E+08	4	2.40E+01	0.0935	5.85E-09	1.17E-01	0.0171	7	1.2E-01
9	3.63E+05	12	4.79E+08	3	6.00E+00	0.0935	5.47E-10	4.37E-02	0.0064	8	5.1E-02
10	3.63E+06	12	4.79E+08	2	2.00E+00	0.0935	5.11E-11	1.22E-02	0.0018	9	1.6E-02
11	3.99E+07	12	4.79E+08	1	1.00E+00	0.0935	4.78E-12	2.29E-03	0.0003	10	3.4E-03
12	4.79E+08	12	4.79E+08	0	1.00E+00	0.0935	4.47E-13	2.14E-04	0.0000	11	3.5E-04

Lq 2.0E+00

Wq 1.6E+02

TOTAL 6.81E+00  
1/TOTAL 1.47E-01

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	11	3.99E+07	11	3.99E+07	0.0924	1.00E+00	1.00E+00	0.1983	-1	-2.0E-01
1	1.00E+00	11	3.99E+07	10	3.63E+06	0.0924	9.24E-02	1.02E+00	0.2017	0	0.0E+00
2	2.00E+00	11	3.99E+07	9	3.63E+05	0.0924	8.55E-03	9.40E-01	0.1864	1	1.9E-01
3	6.00E+00	11	3.99E+07	8	4.03E+04	0.0924	7.90E-04	7.82E-01	0.1551	2	3.1E-01
4	2.40E+01	11	3.99E+07	7	5.04E+03	0.0924	7.30E-05	5.78E-01	0.1147	3	3.4E-01
5	1.20E+02	11	3.99E+07	6	7.20E+02	0.0924	6.75E-06	3.74E-01	0.0742	4	3.0E-01
6	7.20E+02	11	3.99E+07	5	1.20E+02	0.0924	6.24E-07	2.08E-01	0.0412	5	2.1E-01
7	5.04E+03	11	3.99E+07	4	2.40E+01	0.0924	5.77E-08	9.60E-02	0.0190	6	1.1E-01
8	4.03E+04	11	3.99E+07	3	6.00E+00	0.0924	5.33E-09	3.55E-02	0.0070	7	4.9E-02
9	3.63E+05	11	3.99E+07	2	2.00E+00	0.0924	4.93E-10	9.84E-03	0.0020	8	1.6E-02
10	3.63E+06	11	3.99E+07	1	1.00E+00	0.0924	4.56E-11	1.82E-03	0.0004	9	3.2E-03
11	3.99E+07	11	3.99E+07	0	1.00E+00	0.0924	4.21E-12	1.68E-04	0.0000	10	3.3E-04

Lq 1.5E+00

Wq 1.2E+02

TOTAL 5.04E+00  
1/TOTAL 1.98E-01

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	10	3.63E+06	10	3.63E+06	0.0914	1.00E+00	1.00E+00	0.2571	-1	-2.6E-01
1	1.00E+00	10	3.63E+06	9	3.63E+05	0.0914	9.14E-02	9.14E-01	0.2349	0	0.0E+00
2	2.00E+00	10	3.63E+06	8	4.03E+04	0.0914	8.35E-03	7.51E-01	0.1932	1	1.9E-01
3	6.00E+00	10	3.63E+06	7	5.04E+03	0.0914	7.63E-04	5.49E-01	0.1412	2	2.8E-01
4	2.40E+01	10	3.63E+06	6	7.20E+02	0.0914	6.97E-05	3.51E-01	0.0903	3	2.7E-01
5	1.20E+02	10	3.63E+06	5	1.20E+02	0.0914	6.37E-06	1.93E-01	0.0495	4	2.0E-01
6	7.20E+02	10	3.63E+06	4	2.40E+01	0.0914	5.82E-07	8.80E-02	0.0226	5	1.1E-01

7	5.04E+03	10	3.63E+06	3	6.00E+00	0.0914	5.32E-08	3.22E-02	0.0083	6	5.0E-02
8	4.03E+04	10	3.63E+06	2	2.00E+00	0.0914	4.86E-09	8.82E-03	0.0023	7	1.6E-02
9	3.63E+05	10	3.63E+06	1	1.00E+00	0.0914	4.44E-10	1.61E-03	0.0004	8	3.3E-03
10	3.63E+06	10	3.63E+06	0	1.00E+00	0.0914	4.06E-11	1.47E-04	0.0000	9	3.4E-04
										Lq	1.1E+00
										Wq	9.0E+01
							TOTAL	3.89E+00			
							1/TOTAL	2.57E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	9	3.63E+05	9	3.63E+05	0.0903	1.00E+00	1.00E+00	0.3219	-1	-3.2E-01
1	1.00E+00	9	3.63E+05	8	4.03E+04	0.0903	9.03E-02	8.13E-01	0.2616	0	0.0E+00
2	2.00E+00	9	3.63E+05	7	5.04E+03	0.0903	8.15E-03	5.87E-01	0.1890	1	1.9E-01
3	6.00E+00	9	3.63E+05	6	7.20E+02	0.0903	7.36E-04	3.71E-01	0.1195	2	2.4E-01
4	2.40E+01	9	3.63E+05	5	1.20E+02	0.0903	6.65E-05	2.01E-01	0.0647	3	1.9E-01
5	1.20E+02	9	3.63E+05	4	2.40E+01	0.0903	6.01E-06	9.08E-02	0.0292	4	1.2E-01
6	7.20E+02	9	3.63E+05	3	6.00E+00	0.0903	5.42E-07	3.28E-02	0.0106	5	5.3E-02
7	5.04E+03	9	3.63E+05	2	2.00E+00	0.0903	4.90E-08	8.89E-03	0.0029	6	1.7E-02
8	4.03E+04	9	3.63E+05	1	1.00E+00	0.0903	4.42E-09	1.60E-03	0.0005	7	3.6E-03
9	3.63E+05	9	3.63E+05	0	1.00E+00	0.0903	3.99E-10	1.45E-04	0.0000	8	3.7E-04
										Lq	8.1E-01
										Wq	6.5E+01
							TOTAL	3.11E+00			
							1/TOTAL	3.22E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	8	4.03E+04	8	4.03E+04	0.0892	1.00E+00	1.00E+00	0.3913	-1	-3.9E-01
1	1.00E+00	8	4.03E+04	7	5.04E+03	0.0892	8.92E-02	7.14E-01	0.2794	0	0.0E+00
2	2.00E+00	8	4.03E+04	6	7.20E+02	0.0892	7.96E-03	4.46E-01	0.1745	1	1.7E-01
3	6.00E+00	8	4.03E+04	5	1.20E+02	0.0892	7.11E-04	2.39E-01	0.0934	2	1.9E-01
4	2.40E+01	8	4.03E+04	4	2.40E+01	0.0892	6.34E-05	1.07E-01	0.0417	3	1.3E-01
5	1.20E+02	8	4.03E+04	3	6.00E+00	0.0892	5.66E-06	3.80E-02	0.0149	4	6.0E-02
6	7.20E+02	8	4.03E+04	2	2.00E+00	0.0892	5.05E-07	1.02E-02	0.0040	5	2.0E-02
7	5.04E+03	8	4.03E+04	1	1.00E+00	0.0892	4.51E-08	1.82E-03	0.0007	6	4.3E-03
8	4.03E+04	8	4.03E+04	0	1.00E+00	0.0892	4.02E-09	1.62E-04	0.0001	7	4.4E-04
										Lq	5.7E-01
										Wq	4.6E+01
							TOTAL	2.56E+00			
							1/TOTAL	3.91E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	7	5.04E+03	7	5.04E+03	0.0882	1.00E+00	1.00E+00	0.4641	-1	-4.6E-01
1	1.00E+00	7	5.04E+03	6	7.20E+02	0.0882	8.82E-02	6.17E-01	0.2865	0	0.0E+00
2	2.00E+00	7	5.04E+03	5	1.20E+02	0.0882	7.77E-03	3.27E-01	0.1516	1	1.5E-01
3	6.00E+00	7	5.04E+03	4	2.40E+01	0.0882	6.86E-04	1.44E-01	0.0668	2	1.3E-01
4	2.40E+01	7	5.04E+03	3	6.00E+00	0.0882	6.04E-05	5.08E-02	0.0236	3	7.1E-02
5	1.20E+02	7	5.04E+03	2	2.00E+00	0.0882	5.33E-06	1.34E-02	0.0062	4	2.5E-02
6	7.20E+02	7	5.04E+03	1	1.00E+00	0.0882	4.70E-07	2.37E-03	0.0011	5	5.5E-03

7	5.04E+03	7	5.04E+03	0	1.00E+00	0.0882	4.14E-08		2.09E-04	0.0001	6	5.8E-04
											Lq	3.9E-01
											Wq	3.1E+01
							TOTAL		2.15E+00			
							1/TOTAL		4.64E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn	
0	1.00E+00	6	7.20E+02	6	7.20E+02	0.0871	1.00E+00	1.00E+00	0.5393	-1	-5.4E-01	
1	1.00E+00	6	7.20E+02	5	1.20E+02	0.0871	8.71E-02	5.23E-01	0.2819	0	0.0E+00	
2	2.00E+00	6	7.20E+02	4	2.40E+01	0.0871	7.59E-03	2.28E-01	0.1228	1	1.2E-01	
3	6.00E+00	6	7.20E+02	3	6.00E+00	0.0871	6.61E-04	7.93E-02	0.0428	2	8.6E-02	
4	2.40E+01	6	7.20E+02	2	2.00E+00	0.0871	5.76E-05	2.07E-02	0.0112	3	3.4E-02	
5	1.20E+02	6	7.20E+02	1	1.00E+00	0.0871	5.02E-06	3.61E-03	0.0019	4	7.8E-03	
6	7.20E+02	6	7.20E+02	0	1.00E+00	0.0871	4.37E-07	3.15E-04	0.0002	5	8.5E-04	
											Lq	2.5E-01
											Wq	2.0E+01
							TOTAL		1.85E+00			
							1/TOTAL		5.39E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn	
0	1.00E+00	5	1.20E+02	5	1.20E+02	0.0861	1.00E+00	1.00E+00	0.6159	-1	-6.2E-01	
1	1.00E+00	5	1.20E+02	4	2.40E+01	0.0861	8.61E-02	4.30E-01	0.2650	0	0.0E+00	
2	2.00E+00	5	1.20E+02	3	6.00E+00	0.0861	7.41E-03	1.48E-01	0.0912	1	9.1E-02	
3	6.00E+00	5	1.20E+02	2	2.00E+00	0.0861	6.37E-04	3.82E-02	0.0235	2	4.7E-02	
4	2.40E+01	5	1.20E+02	1	1.00E+00	0.0861	5.48E-05	6.58E-03	0.0041	3	1.2E-02	
5	1.20E+02	5	1.20E+02	0	1.00E+00	0.0861	4.72E-06	5.66E-04	0.0003	4	1.4E-03	
											Lq	1.5E-01
											Wq	1.2E+01
							TOTAL		1.62E+00			
							1/TOTAL		6.16E-01			

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n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn	
0	1.00E+00	4	2.40E+01	4	2.40E+01	0.0850	1.00E+00	1.00E+00	0.6932	-1	-6.9E-01	
1	1.00E+00	4	2.40E+01	3	6.00E+00	0.0850	8.50E-02	3.40E-01	0.2357	0	0.0E+00	
2	2.00E+00	4	2.40E+01	2	2.00E+00	0.0850	7.22E-03	8.67E-02	0.0601	1	6.0E-02	
3	6.00E+00	4	2.40E+01	1	1.00E+00	0.0850	6.14E-04	1.47E-02	0.0102	2	2.0E-02	
4	2.40E+01	4	2.40E+01	0	1.00E+00	0.0850	5.22E-05	1.25E-03	0.0009	3	2.6E-03	
											Lq	8.3E-02
											Wq	6.7E+00
							TOTAL		1.44E+00			
							1/TOTAL		6.93E-01			



n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	3	6.00E+00	3	6.00E+00	0.0839	1.00E+00	1.00E+00	0.7706	-1	-7.7E-01
1	1.00E+00	3	6.00E+00	2	2.00E+00	0.0839	8.39E-02	2.52E-01	0.1941	0	0.0E+00
2	2.00E+00	3	6.00E+00	1	1.00E+00	0.0839	7.05E-03	4.23E-02	0.0326	1	3.3E-02
3	6.00E+00	3	6.00E+00	0	1.00E+00	0.0839	5.91E-04	3.55E-03	0.0027	2	5.5E-03
									Lq	3.8E-02	
									Wq	3.1E+00	
									TOTAL	1.30E+00	
									1/TOTAL	7.71E-01	

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	2	2.00E+00	2	2.00E+00	0.0829	1.00E+00	1.00E+00	0.8478	-1	-8.5E-01
1	1.00E+00	2	2.00E+00	1	1.00E+00	0.0829	8.29E-02	1.66E-01	0.1405	0	0.0E+00
2	2.00E+00	2	2.00E+00	0	1.00E+00	0.0829	6.87E-03	1.37E-02	0.0116	1	1.2E-02
									Lq	1.2E-02	
									Wq	9.4E-01	
									TOTAL	1.18E+00	
									1/TOTAL	8.48E-01	

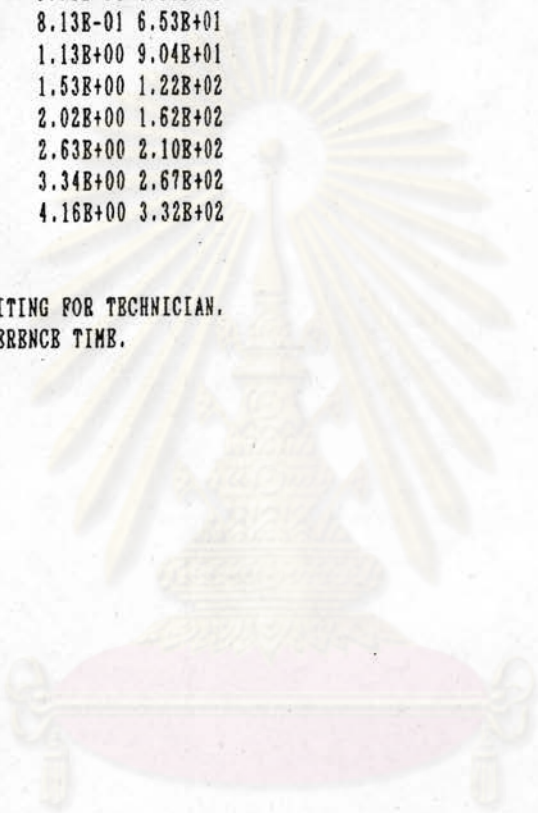
n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	1	1.00E+00	1	1.00E+00	0.0818	1.00E+00	1.00E+00	0.9244	-1	-9.2E-01
1	1.00E+00	1	1.00E+00	0	1.00E+00	0.0818	8.18E-02	8.18E-02	0.0756	0	0.0E+00
									Lq	0.0E+00	
									Wq	0.0E+00	
									TOTAL	1.08E+00	
									1/TOTAL	9.24E-01	

ศูนย์วิทยทรัพยากร  
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## 2) QUEUING PARAMETERS SUMMARY.

N	Po	Lq	Wq
1	9.24E-01	0.00E+00	0.00E+00
2	8.48E-01	1.16E-02	9.41E-01
3	7.71E-01	3.80E-02	3.07E+00
4	6.93E-01	8.31E-02	6.70E+00
5	6.16E-01	1.52E-01	1.22E+01
6	5.39E-01	2.51E-01	2.02E+01
7	4.64E-01	3.87E-01	3.11E+01
8	3.91E-01	5.71E-01	4.58E+01
9	3.22E-01	8.13E-01	6.53E+01
10	2.57E-01	1.13E+00	9.04E+01
11	1.98E-01	1.53E+00	1.22E+02
12	1.47E-01	2.02E+00	1.62E+02
13	1.04E-01	2.63E+00	2.10E+02
14	6.91E-02	3.34E+00	2.67E+02
15	4.34E-02	4.16E+00	3.32E+02

Lq=NUMBER OF MACHINE WAITING FOR TECHNICIAN.  
Wq=TOTAL MACHINE INTERFERENCE TIME.



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## 3) DETERMINE MACHINE TO TECHNICIAN RATIO.

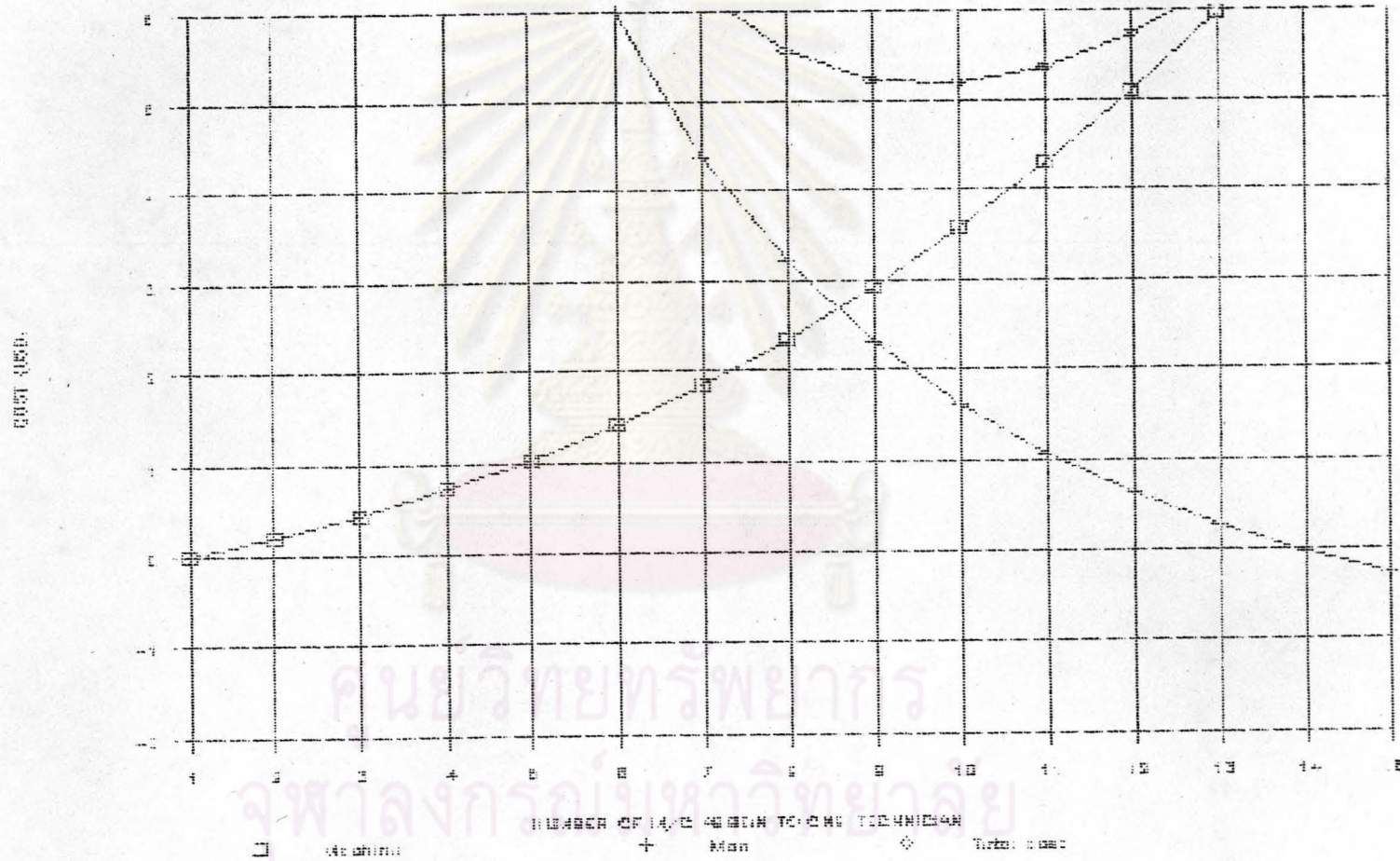
P	S	N	M	TECH	Tz	HRS/YEAR	OVERHAUL	PI	SI	X=PI/SI	I	Me	Ys
80.96	6.54	1	32	32.00	75.0	2083	0.0785	80.8809	6.6191	12.2194	0.0000	1.0000	0.0756
80.96	6.54	2	32	16.00	75.0	2083	0.1570	80.8024	6.6976	12.0644	0.4707	0.9946	0.0765
80.96	6.54	3	32	10.67	75.0	2083	0.2356	80.7239	6.7761	11.9130	1.0238	0.9884	0.0774
80.96	6.54	4	32	8.00	75.0	2083	0.3141	80.6454	6.8546	11.7651	1.6760	0.9812	0.0783
80.96	6.54	5	32	6.40	75.0	2083	0.3926	80.5668	6.9332	11.6205	2.4470	0.9728	0.0792
80.96	6.54	6	32	5.33	75.0	2083	0.4711	80.4883	7.0117	11.4792	3.3607	0.9630	0.0801
80.96	6.54	7	32	4.57	75.0	2083	0.5496	80.4098	7.0902	11.3410	4.4447	0.9517	0.0810
80.96	6.54	8	32	4.00	75.0	2083	0.6281	80.3313	7.1687	11.2058	5.7302	0.9385	0.0819
80.96	6.54	9	32	3.56	75.0	2083	0.7067	80.2528	7.2472	11.0736	7.2502	0.9235	0.0828
80.96	6.54	10	32	3.20	75.0	2083	0.7852	80.1743	7.3257	10.9442	9.0361	0.9064	0.0837
80.96	6.54	11	32	2.91	75.0	2083	0.8637	80.0957	7.4043	10.8175	11.1120	0.8873	0.0846
80.96	6.54	12	32	2.67	75.0	2083	0.9422	80.0172	7.4828	10.6935	13.4870	0.8664	0.0855
80.96	6.54	13	32	2.46	75.0	2083	1.0207	79.9387	7.5613	10.5721	16.1459	0.8442	0.0864
80.96	6.54	14	32	2.29	75.0	2083	1.0993	79.8602	7.6398	10.4531	19.0430	0.8213	0.0873
80.96	6.54	15	32	2.13	75.0	2083	1.1778	79.7817	7.7183	10.3366	22.1020	0.7983	0.0882

Ns	Ni	Np	TTL Ns	TTL Ni	TTL Np	A	B	C1	C2	C	Q/XMGR
0.0756	0.0000	0.9244	2.420693	0.000000	29.57931	2.08612	1.19465	0.00000	61.70591	61.70591	1
0.1523	0.0107	1.8370	2.436304	0.171207	29.39249	2.08612	1.19465	0.20453	28.29547	28.50000	2
0.2296	0.0347	2.7357	2.449463	0.370102	29.18044	2.08612	1.19465	0.44214	17.14205	17.58420	3
0.3075	0.0752	3.6174	2.459725	0.601413	28.93886	2.08612	1.19465	0.71848	11.55767	12.27614	4
0.3854	0.1360	4.4786	2.466574	0.870561	28.66286	2.08612	1.19465	1.04002	8.20559	9.24560	5
0.4630	0.2219	5.3151	2.469425	1.183584	28.34699	2.08612	1.19465	1.41397	5.97445	7.38842	6
0.5398	0.3384	6.1218	2.467638	1.546898	27.98546	2.08612	1.19465	1.84800	4.38875	6.23676	7
0.6151	0.4917	6.8932	2.460564	1.966801	27.57264	2.08612	1.19465	2.34964	3.21145	5.56108	8
0.6884	0.6887	7.6229	2.447609	2.448599	27.10379	2.08612	1.19465	2.92522	2.31131	5.23653	9
0.7589	0.9360	8.3051	2.428356	2.995297	26.57635	2.08612	1.19465	3.57833	1.60974	5.18807	10
0.8259	1.2395	8.9345	2.402714	3.605901	25.99139	2.08612	1.19465	4.30779	1.05636	5.36415	11
0.8892	1.6026	9.5082	2.371088	4.273663	25.35525	2.08612	1.19465	5.10553	0.61661	5.72215	12
0.9484	2.0251	10.0265	2.334503	4.984941	24.68056	2.08612	1.19465	5.95526	0.26501	6.22027	13
1.0039	2.5023	10.4938	2.294607	5.719526	23.98587	2.08612	1.19465	6.83283	-0.01855	6.81428	14
1.0563	3.0249	10.9188	2.253487	6.453031	23.29348	2.08612	1.19465	7.70912	-0.25066	7.45846	15

ศูนย์วิทยพัชกร  
จุฬาลงกรณ์มหาวิทยาลัย

# IDLE TIME COST OF G/A Machine

SINGLE SERVER MODEL



(A LIMIT SOURCE MODEL, SINGLE SERVER, EXPONENTIAL DISTRIBUTION INPUT/OUTPUT)

1) QUBUNG THEORY CALCULATION.

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/((N-n)!))*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	15	1.31E+12	15	1.31E+12	0.1132	1.00E+00	1.00E+00	0.0177	-1	-1.8E-02
1	1.00E+00	15	1.31E+12	14	8.72E+10	0.1132	1.13E-01	1.70E+00	0.0300	0	0.0E+00
2	2.00E+00	15	1.31E+12	13	6.23E+09	0.1132	1.28E-02	2.69E+00	0.0476	1	4.8E-02
3	6.00E+00	15	1.31E+12	12	4.79E+08	0.1132	1.45E-03	3.96E+00	0.0700	2	1.4E-01
4	2.40E+01	15	1.31E+12	11	3.99E+07	0.1132	1.64E-04	5.38E+00	0.0951	3	2.9E-01
5	1.20E+02	15	1.31E+12	10	3.63E+06	0.1132	1.86E-05	6.70E+00	0.1185	4	4.7E-01
6	7.20E+02	15	1.31E+12	9	3.63E+05	0.1132	2.10E-06	7.58E+00	0.1341	5	6.7E-01
7	5.04E+03	15	1.31E+12	8	4.03E+04	0.1132	2.38E-07	7.73E+00	0.1366	6	8.2E-01
8	4.03E+04	15	1.31E+12	7	5.04E+03	0.1132	2.70E-08	7.00E+00	0.1237	7	8.7E-01
9	3.63E+05	15	1.31E+12	6	7.20E+02	0.1132	3.05E-09	5.54E+00	0.0980	8	7.8E-01
10	3.63E+06	15	1.31E+12	5	1.20E+02	0.1132	3.46E-10	3.77E+00	0.0666	9	6.0E-01
11	3.99E+07	15	1.31E+12	4	2.40E+01	0.1132	3.91E-11	2.13E+00	0.0377	10	3.8E-01
12	4.79E+08	15	1.31E+12	3	6.00E+00	0.1132	4.43E-12	9.65E-01	0.0171	11	1.9E-01
13	6.23E+09	15	1.31E+12	2	2.00E+00	0.1132	5.01E-13	3.28E-01	0.0058	12	7.0E-02
14	8.72E+10	15	1.31E+12	1	1.00E+00	0.1132	5.67E-14	7.42E-02	0.0013	13	1.7E-02
15	1.31E+12	15	1.31E+12	0	1.00E+00	0.1132	6.42E-15	8.40E-03	0.0001	14	2.1E-03
								TOTAL	5.65E+01	Lq	5.3E+00
								1/TOTAL=Po	1.77E-02	Wq	8.2E+02

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/((N-n)!))*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	14	8.72E+10	14	8.72E+10	0.1116	1.00E+00	1.00E+00	0.0329	-1	-3.3E-02
1	1.00E+00	14	8.72E+10	13	6.23E+09	0.1116	1.12E-01	1.56E+00	0.0515	0	0.0E+00
2	2.00E+00	14	8.72E+10	12	4.79E+08	0.1116	1.25E-02	2.27E+00	0.0747	1	7.5E-02
3	6.00E+00	14	8.72E+10	11	3.99E+07	0.1116	1.39E-03	3.04E+00	0.1001	2	2.0E-01
4	2.40E+01	14	8.72E+10	10	3.63E+06	0.1116	1.55E-04	3.73E+00	0.1229	3	3.7E-01
5	1.20E+02	14	8.72E+10	9	3.63E+05	0.1116	1.73E-05	4.17E+00	0.1372	4	5.5E-01
6	7.20E+02	14	8.72E+10	8	4.03E+04	0.1116	1.94E-06	4.19E+00	0.1379	5	6.9E-01
7	5.04E+03	14	8.72E+10	7	5.04E+03	0.1116	2.16E-07	3.74E+00	0.1232	6	7.4E-01
8	4.03E+04	14	8.72E+10	6	7.20E+02	0.1116	2.41E-08	2.92E+00	0.0963	7	6.7E-01
9	3.63E+05	14	8.72E+10	5	1.20E+02	0.1116	2.69E-09	1.96E+00	0.0645	8	5.2E-01
10	3.63E+06	14	8.72E+10	4	2.40E+01	0.1116	3.01E-10	1.09E+00	0.0360	9	3.2E-01
11	3.99E+07	14	8.72E+10	3	6.00E+00	0.1116	3.36E-11	4.88E-01	0.0161	10	1.6E-01
12	4.79E+08	14	8.72E+10	2	2.00E+00	0.1116	3.75E-12	1.63E-01	0.0054	11	5.9E-02
13	6.23E+09	14	8.72E+10	1	1.00E+00	0.1116	4.19E-13	3.65E-02	0.0012	12	1.4E-02
14	8.72E+10	14	8.72E+10	0	1.00E+00	0.1116	4.67E-14	4.07E-03	0.0001	13	1.7E-03
								TOTAL	3.04E+01	Lq	4.4E+00
								1/TOTAL	3.29E-02	Wq	6.7E+02

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/((N-n)!))*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	13	6.23E+09	13	6.23E+09	0.1101	1.00E+00	1.00E+00	0.0567	-1	-5.7E-02
1	1.00E+00	13	6.23E+09	12	4.79E+08	0.1101	1.10E-01	1.43E+00	0.0811	0	0.0E+00
2	2.00E+00	13	6.23E+09	11	3.99E+07	0.1101	1.21E-02	1.89E+00	0.1072	1	1.1E-01
3	6.00E+00	13	6.23E+09	10	3.63E+06	0.1101	1.33E-03	2.29E+00	0.1298	2	2.6E-01
4	2.40E+01	13	6.23E+09	9	3.63E+05	0.1101	1.47E-04	2.52E+00	0.1429	3	4.3E-01
5	1.20E+02	13	6.23E+09	8	4.03E+04	0.1101	1.62E-05	2.50E+00	0.1416	4	5.7E-01
6	7.20E+02	13	6.23E+09	7	5.04E+03	0.1101	1.78E-06	2.20E+00	0.1247	5	6.2E-01
7	5.04E+03	13	6.23E+09	6	7.20E+02	0.1101	1.96E-07	1.69E+00	0.0961	6	5.8E-01
8	4.03E+04	13	6.23E+09	5	1.20E+02	0.1101	2.16E-08	1.12E+00	0.0635	7	4.4E-01
9	3.63E+05	13	6.23E+09	4	2.40E+01	0.1101	2.38E-09	6.16E-01	0.0349	8	2.8E-01

10	3.63E+06	13	6.23E+09	3	6.00E+00	0.1101	2.61E-10	2.71E-01	0.0154	9	1.4E-01
11	3.99E+07	13	6.23E+09	2	2.00E+00	0.1101	2.88E-11	8.96E-02	0.0051	10	5.1E-02
12	4.79E+08	13	6.23E+09	1	1.00E+00	0.1101	3.17E-12	1.97E-02	0.0011	11	1.2E-02
13	6.23E+09	13	6.23E+09	0	1.00E+00	0.1101	3.49E-13	2.17E-03	0.0001	12	1.5E-03
			6.23E+09							Lq	3.5E+00
										Wq	5.3E+02

TOTAL 1.76E+01  
1/TOTAL 5.67E-02

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	12	4.79E+08	12	4.79E+08	0.1085	1.00E+00	1.00E+00	0.0906	-1	-9.1E-02
1	1.00E+00	12	4.79E+08	11	3.99E+07	0.1085	1.09E-01	1.30E+00	0.1180	0	0.0E+00
2	2.00E+00	12	4.79E+08	10	3.63E+06	0.1085	1.18E-02	1.56E+00	0.1408	1	1.4E-01
3	6.00E+00	12	4.79E+08	9	3.63E+05	0.1085	1.28E-03	1.69E+00	0.1529	2	3.1E-01
4	2.40E+01	12	4.79E+08	8	4.03E+04	0.1085	1.39E-04	1.65E+00	0.1493	3	4.5E-01
5	1.20E+02	12	4.79E+08	7	5.04E+03	0.1085	1.51E-05	1.43E+00	0.1297	4	5.2E-01
6	7.20E+02	12	4.79E+08	6	7.20E+02	0.1085	1.63E-06	1.09E+00	0.0985	5	4.9E-01
7	5.04E+03	12	4.79E+08	5	1.20E+02	0.1085	1.77E-07	7.08E-01	0.0642	6	3.8E-01
8	4.03E+04	12	4.79E+08	4	2.40E+01	0.1085	1.93E-08	3.84E-01	0.0348	7	2.4E-01
9	3.63E+05	12	4.79E+08	3	6.00E+00	0.1085	2.09E-09	1.67E-01	0.0151	8	1.2E-01
10	3.63E+06	12	4.79E+08	2	2.00E+00	0.1085	2.27E-10	5.43E-02	0.0049	9	4.4E-02
11	3.99E+07	12	4.79E+08	1	1.00E+00	0.1085	2.46E-11	1.18E-02	0.0011	10	1.1E-02
12	4.79E+08	12	4.79E+08	0	1.00E+00	0.1085	2.67E-12	1.28E-03	0.0001	11	1.3E-03
										Lq	2.7E+00
										Wq	4.2E+02

TOTAL 1.10E+01  
1/TOTAL 9.06E-02

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	11	3.99E+07	11	3.99E+07	0.1070	1.00E+00	1.00E+00	0.1353	-1	-1.4E-01
1	1.00E+00	11	3.99E+07	10	3.63E+06	0.1070	1.07E-01	1.18E+00	0.1593	0	0.0E+00
2	2.00E+00	11	3.99E+07	9	3.63E+05	0.1070	1.14E-02	1.26E+00	0.1704	1	1.7E-01
3	6.00E+00	11	3.99E+07	8	4.03E+04	0.1070	1.22E-03	1.21E+00	0.1641	2	3.3E-01
4	2.40E+01	11	3.99E+07	7	5.04E+03	0.1070	1.31E-04	1.04E+00	0.1405	3	4.2E-01
5	1.20E+02	11	3.99E+07	6	7.20E+02	0.1070	1.40E-05	7.77E-01	0.1052	4	4.2E-01
6	7.20E+02	11	3.99E+07	5	1.20E+02	0.1070	1.50E-06	4.99E-01	0.0675	5	3.4E-01
7	5.04E+03	11	3.99E+07	4	2.40E+01	0.1070	1.61E-07	2.67E-01	0.0361	6	2.2E-01
8	4.03E+04	11	3.99E+07	3	6.00E+00	0.1070	1.72E-08	1.14E-01	0.0155	7	1.1E-01
9	3.63E+05	11	3.99E+07	2	2.00E+00	0.1070	1.84E-09	3.67E-02	0.0050	8	4.0E-02
10	3.63E+06	11	3.99E+07	1	1.00E+00	0.1070	1.97E-10	7.85E-03	0.0011	9	9.6E-03
11	3.99E+07	11	3.99E+07	0	1.00E+00	0.1070	2.10E-11	8.40E-04	0.0001	10	1.1E-03
										Lq	2.1E+00
										Wq	3.2E+02

TOTAL 7.39E+00  
1/TOTAL 1.35E-01

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	10	3.63E+06	10	3.63E+06	0.1055	1.00E+00	1.00E+00	0.1906	-1	-1.9E-01
1	1.00E+00	10	3.63E+06	9	3.63E+05	0.1055	1.05E-01	1.05E+00	0.2010	0	0.0E+00
2	2.00E+00	10	3.63E+06	8	4.03E+04	0.1055	1.11E-02	1.00E+00	0.1907	1	1.9E-01
3	6.00E+00	10	3.63E+06	7	5.04E+03	0.1055	1.17E-03	8.44E-01	0.1609	2	3.2E-01
4	2.40E+01	10	3.63E+06	6	7.20E+02	0.1055	1.24E-04	6.23E-01	0.1188	3	3.6E-01
5	1.20E+02	10	3.63E+06	5	1.20E+02	0.1055	1.30E-05	3.94E-01	0.0752	4	3.0E-01
6	7.20E+02	10	3.63E+06	4	2.40E+01	0.1055	1.38E-06	2.08E-01	0.0396	5	2.0E-01

7	5.04E+03	10	3.63E+06	3	6.00E+00	0.1055	1.45E-07	8.77E-02	0.0167	6	1.0E-01
8	4.03E+04	10	3.63E+06	2	2.00E+00	0.1055	1.53E-08	2.77E-02	0.0053	7	3.7E-02
9	3.63E+05	10	3.63E+06	1	1.00E+00	0.1055	1.61E-09	5.85E-03	0.0011	8	8.9E-03
10	3.63E+06	10	3.63E+06	0	1.00E+00	0.1055	1.70E-10	6.17E-04	0.0001	9	1.1E-03
										Lq	1.5E+00
										Wq	2.3E+02
TOTAL										5.25E+00	
1/TOTAL										1.91E-01	

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	9	3.63E+05	9	3.63E+05	0.1039	1.00E+00	1.00E+00	0.2551	-1	-2.6E-01
1	1.00E+00	9	3.63E+05	8	4.03E+04	0.1039	1.04E-01	9.35E-01	0.2386	0	0.0E+00
2	2.00E+00	9	3.63E+05	7	5.04E+03	0.1039	1.08E-02	7.78E-01	0.1984	1	2.0E-01
3	6.00E+00	9	3.63E+05	6	7.20E+02	0.1039	1.12E-03	5.66E-01	0.1443	2	2.9E-01
4	2.40E+01	9	3.63E+05	5	1.20E+02	0.1039	1.17E-04	3.53E-01	0.0900	3	2.7E-01
5	1.20E+02	9	3.63E+05	4	2.40E+01	0.1039	1.21E-05	1.83E-01	0.0467	4	1.9E-01
6	7.20E+02	9	3.63E+05	3	6.00E+00	0.1039	1.26E-06	7.62E-02	0.0194	5	9.7E-02
7	5.04E+03	9	3.63E+05	2	2.00E+00	0.1039	1.31E-07	2.37E-02	0.0061	6	3.6E-02
8	4.03E+04	9	3.63E+05	1	1.00E+00	0.1039	1.36E-08	4.93E-03	0.0013	7	8.8E-03
9	3.63E+05	9	3.63E+05	0	1.00E+00	0.1039	1.41E-09	5.13E-04	0.0001	8	1.0E-03
										Lq	1.1E+00
										Wq	1.7E+02
TOTAL										3.92E+00	
1/TOTAL										2.55E-01	

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	8	4.03E+04	8	4.03E+04	0.1024	1.00E+00	1.00E+00	0.3273	-1	-3.3E-01
1	1.00E+00	8	4.03E+04	7	5.04E+03	0.1024	1.02E-01	8.19E-01	0.2681	0	0.0E+00
2	2.00E+00	8	4.03E+04	6	7.20E+02	0.1024	1.05E-02	5.87E-01	0.1921	1	1.9E-01
3	6.00E+00	8	4.03E+04	5	1.20E+02	0.1024	1.07E-03	3.61E-01	0.1180	2	2.4E-01
4	2.40E+01	8	4.03E+04	4	2.40E+01	0.1024	1.10E-04	1.85E-01	0.0604	3	1.8E-01
5	1.20E+02	8	4.03E+04	3	6.00E+00	0.1024	1.13E-05	7.56E-02	0.0247	4	9.9E-02
6	7.20E+02	8	4.03E+04	2	2.00E+00	0.1024	1.15E-06	2.32E-02	0.0076	5	3.8E-02
7	5.04E+03	8	4.03E+04	1	1.00E+00	0.1024	1.18E-07	4.76E-03	0.0016	6	9.3E-03
8	4.03E+04	8	4.03E+04	0	1.00E+00	0.1024	1.21E-08	4.87E-04	0.0002	7	1.1E-03
										Lq	7.6E-01
										Wq	1.2E+02
TOTAL										3.06E+00	
1/TOTAL										3.27E-01	

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	7	5.04E+03	7	5.04E+03	0.1009	1.00E+00	1.00E+00	0.4052	-1	-4.1E-01
1	1.00E+00	7	5.04E+03	6	7.20E+02	0.1009	1.01E-01	7.06E-01	0.2861	0	0.0E+00
2	2.00E+00	7	5.04E+03	5	1.20E+02	0.1009	1.02E-02	4.27E-01	0.1731	1	1.7E-01
3	6.00E+00	7	5.04E+03	4	2.40E+01	0.1009	1.03E-03	2.15E-01	0.0873	2	1.7E-01
4	2.40E+01	7	5.04E+03	3	6.00E+00	0.1009	1.03E-04	8.69E-02	0.0352	3	1.1E-01
5	1.20E+02	7	5.04E+03	2	2.00E+00	0.1009	1.04E-05	2.63E-02	0.0107	4	4.3E-02
6	7.20E+02	7	5.04E+03	1	1.00E+00	0.1009	1.05E-06	5.30E-03	0.0021	5	1.1E-02

7	5.04E+03	7	5.04E+03	0	1.00E+00	0.1009	1.06E-07	5.35E-04	0.0002	6	1.3E-03
										Lq	5.1E-01
										Wq	7.9E+01
							TOTAL	2.47E+00			
							1/TOTAL	4.05E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	6	7.20E+02	6	7.20E+02	0.0993	1.00E+00	1.00E+00	0.4873	-1	-4.9E-01
1	1.00E+00	6	7.20E+02	5	1.20E+02	0.0993	9.93E-02	5.96E-01	0.2904	0	0.0E+00
2	2.00E+00	6	7.20E+02	4	2.40E+01	0.0993	9.87E-03	2.96E-01	0.1442	1	1.4E-01
3	6.00E+00	6	7.20E+02	3	6.00E+00	0.0993	9.80E-04	1.18E-01	0.0573	2	1.1E-01
4	2.40E+01	6	7.20E+02	2	2.00E+00	0.0993	9.74E-05	3.50E-02	0.0171	3	5.1E-02
5	1.20E+02	6	7.20E+02	1	1.00E+00	0.0993	9.67E-06	6.96E-03	0.0034	4	1.4E-02
6	7.20E+02	6	7.20E+02	0	1.00E+00	0.0993	9.61E-07	6.92E-04	0.0003	5	1.7E-03
										Lq	3.3E-01
										Wq	5.0E+01
							TOTAL	2.05E+00			
							1/TOTAL	4.87E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	5	1.20E+02	5	1.20E+02	0.0978	1.00E+00	1.00E+00	0.5719	-1	-5.7E-01
1	1.00E+00	5	1.20E+02	4	2.40E+01	0.0978	9.78E-02	4.89E-01	0.2797	0	0.0E+00
2	2.00E+00	5	1.20E+02	3	6.00E+00	0.0978	9.57E-03	1.91E-01	0.1094	1	1.1E-01
3	6.00E+00	5	1.20E+02	2	2.00E+00	0.0978	9.36E-04	5.61E-02	0.0321	2	6.4E-02
4	2.40E+01	5	1.20E+02	1	1.00E+00	0.0978	9.15E-05	1.10E-02	0.0063	3	1.9E-02
5	1.20E+02	5	1.20E+02	0	1.00E+00	0.0978	8.95E-06	1.07E-03	0.0006	4	2.5E-03
										Lq	1.9E-01
										Wq	3.0E+01
							TOTAL	1.75E+00			
							1/TOTAL	5.72E-01			

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1)^n	(N!/(N-n)!)*(S/P)^n	Pn	n-1	(n-1)Pn
0	1.00E+00	4	2.40E+01	4	2.40E+01	0.0963	1.00E+00	1.00E+00	0.6579	-1	-6.6E-01
1	1.00E+00	4	2.40E+01	3	6.00E+00	0.0963	9.63E-02	3.85E-01	0.2534	0	0.0E+00
2	2.00E+00	4	2.40E+01	2	2.00E+00	0.0963	9.27E-03	1.11E-01	0.0732	1	7.3E-02
3	6.00E+00	4	2.40E+01	1	1.00E+00	0.0963	8.93E-04	2.14E-02	0.0141	2	2.8E-02
4	2.40E+01	4	2.40E+01	0	1.00E+00	0.0963	8.60E-05	2.06E-03	0.0014	3	4.1E-03
										Lq	1.1E-01
										Wq	1.6E+01
							TOTAL	1.52E+00			
							1/TOTAL	6.58E-01			



n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	3	6.00E+00	3	6.00E+00	0.0948	1.00E+00	1.00E+00	0.7444	-1	-7.4E-01
1	1.00E+00	3	6.00E+00	2	2.00E+00	0.0948	9.48E-02	2.84E-01	0.2117	0	0.0E+00
2	2.00E+00	3	6.00E+00	1	1.00E+00	0.0948	8.98E-03	5.39E-02	0.0401	1	4.0E-02
3	6.00E+00	3	6.00E+00	0	1.00E+00	0.0948	8.52E-04	5.11E-03	0.0038	2	7.6E-03
									Lq	4.8E-02	
									Wq	7.4E+00	
TOTAL									1.34E+00		
1/TOTAL									7.44E-01		

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	2	2.00E+00	2	2.00E+00	0.0933	1.00E+00	1.00E+00	0.8306	-1	-8.3E-01
1	1.00E+00	2	2.00E+00	1	1.00E+00	0.0933	9.33E-02	1.87E-01	0.1550	0	0.0E+00
2	2.00E+00	2	2.00E+00	0	1.00E+00	0.0933	8.70E-03	1.74E-02	0.0145	1	1.4E-02
									Lq	1.4E-02	
									Wq	2.2E+00	
TOTAL									1.20E+00		
1/TOTAL									8.31E-01		

n	n!	N	N!	(N-n)	(N-n)!	S1/P1	(S1/P1) <sup>n</sup>	(N!/(N-n)!)*(S/P) <sup>n</sup>	Pn	n-1	(n-1)Pn
0	1.00E+00	1	1.00E+00	1	1.00E+00	0.0918	1.00E+00	1.00E+00	0.9159	-1	-9.2E-01
1	1.00E+00	1	1.00E+00	0	1.00E+00	0.0918	9.18E-02	9.18E-02	0.0841	0	0.0E+00
									Lq	0.0E+00	
									Wq	0.0E+00	
TOTAL									1.09E+00		
1/TOTAL									9.16E-01		

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## 2) QUEUING PARAMETERS SUMMARY.

N	Po	Lq	Wq
1	9.16E-01	0.00E+00	0.00E+00
2	8.31E-01	1.45E-02	2.25E+00
3	7.44E-01	4.77E-02	7.42E+00
4	6.58E-01	1.05E-01	1.64E+01
5	5.72E-01	1.95E-01	3.02E+01
6	4.87E-01	3.25E-01	5.04E+01
7	4.05E-01	5.08E-01	7.85E+01
8	3.27E-01	7.57E-01	1.17E+02
9	2.55E-01	1.09E+00	1.68E+02
10	1.91E-01	1.51E+00	2.33E+02
11	1.35E-01	2.05E+00	3.16E+02
12	9.06E-02	2.71E+00	4.16E+02
13	5.67E-02	3.49E+00	5.35E+02
14	3.29E-02	4.37E+00	6.69E+02
15	1.77E-02	5.34E+00	8.16E+02

Lq=NUMBER OF MACHINE WAITING FOR TECHNICIAN.  
Wq=TOTAL MACHINE INTERFERENCE TIME.

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## 3) DETERMINE MACHINE TO TECHNICIAN RATIO.

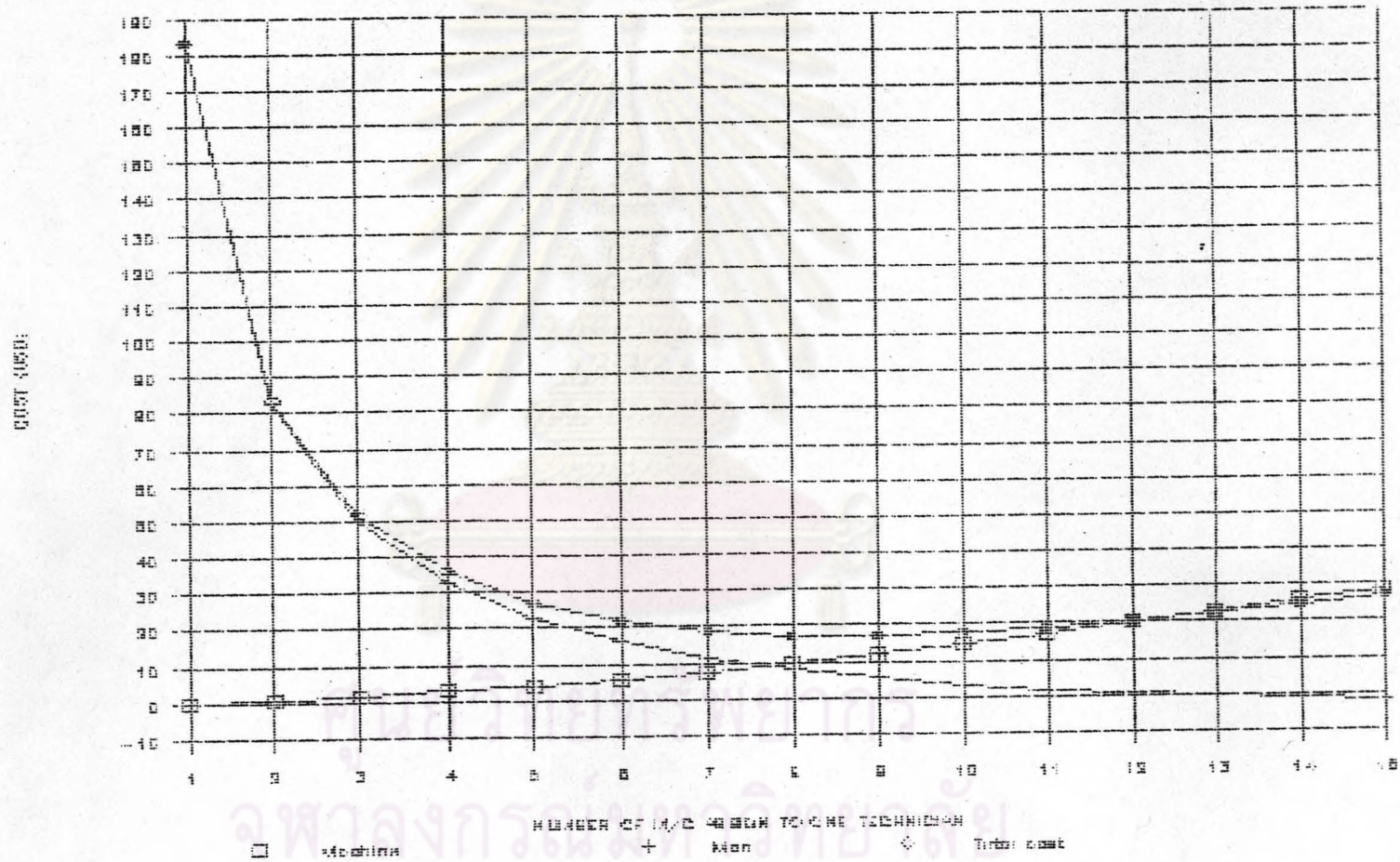
P	S	N	M	TECH	T <sub>e</sub>	HRS/YEAR	OVERHAUL	P1	S1	X=P1/S1	I	Me	Is
156.05	14.09	1	96	96.00	95.0	2083	0.2142	155.8367	14.3022	10.8960	0.0000	1.0000	0.0841
156.05	14.09	2	96	48.00	95.0	2083	0.4284	155.6225	14.5164	10.7205	1.1247	0.9934	0.0853
156.05	14.09	3	96	32.00	95.0	2083	0.6427	155.4083	14.7306	10.5500	2.4728	0.9857	0.0866
156.05	14.09	4	96	24.00	95.0	2083	0.8569	155.1941	14.9448	10.3845	4.0927	0.9765	0.0878
156.05	14.09	5	96	19.20	95.0	2083	1.0711	154.9798	15.1590	10.2236	6.0427	0.9657	0.0891
156.05	14.09	6	96	16.00	95.0	2083	1.2853	154.7656	15.3733	10.0672	8.3918	0.9530	0.0904
156.05	14.09	7	96	13.71	95.0	2083	1.4996	154.5514	15.5875	9.9151	11.2176	0.9381	0.0916
156.05	14.09	8	96	12.00	95.0	2083	1.7138	154.3372	15.8017	9.7671	14.6016	0.9210	0.0929
156.05	14.09	9	96	10.67	95.0	2083	1.9280	154.1230	16.0159	9.6231	18.6181	0.9014	0.0941
156.05	14.09	10	96	9.60	95.0	2083	2.1422	153.9087	16.2302	9.4829	23.3163	0.8795	0.0954
156.05	14.09	11	96	8.73	95.0	2083	2.3564	153.6945	16.4444	9.3463	28.6959	0.8557	0.0967
156.05	14.09	12	96	8.00	95.0	2083	2.5707	153.4803	16.6586	9.2133	34.6838	0.8307	0.0979
156.05	14.09	13	96	7.38	95.0	2083	2.7849	153.2661	16.8728	9.0836	41.1220	0.8053	0.0992
156.05	14.09	14	96	6.86	95.0	2083	2.9991	153.0518	17.0870	8.9572	47.7827	0.7807	0.1004
156.05	14.09	15	96	6.40	95.0	2083	3.2133	152.8376	17.3013	8.8339	54.4103	0.7577	0.1017

Ns	Ni	Np	TTL Ns	TTL Ni	TTL Np	A	B	C1	C2	C	Q/XMGR
0.0841	0.0000	0.9159	8.069918	0.00000	87.93008	2.08612	1.24060	0.00000	183.4325	183.4325	1
0.1695	0.0131	1.8173	8.137003	0.63043	87.23257	2.08612	1.24060	0.78212	83.1589	83.9410	2
0.2560	0.0430	2.7010	8.192594	1.37528	86.43213	2.08612	1.24060	1.70618	49.6650	51.3712	3
0.3431	0.0940	3.5629	8.234461	2.25502	85.51051	2.08612	1.24060	2.79759	32.8888	35.6864	4
0.4302	0.1715	4.3983	8.260048	3.29262	84.44733	2.08612	1.24060	4.08484	22.8220	26.9069	5
0.5167	0.2820	5.2013	8.266556	4.51244	83.22100	2.08612	1.24060	5.59816	16.1329	21.7310	6
0.6016	0.4330	5.9654	8.251147	5.93797	81.81089	2.08612	1.24060	7.36667	11.3968	18.7634	7
0.6843	0.6323	6.6834	8.211326	7.58769	80.20098	2.08612	1.24060	9.41332	7.9036	17.3169	8
0.7636	0.8877	7.3486	8.145551	9.46899	78.38546	2.08612	1.24060	11.74727	5.2593	17.0066	9
0.8390	1.2053	7.9558	8.054038	11.57044	76.37553	2.08612	1.24060	14.35433	3.2251	17.5794	10
0.9097	1.5875	8.5027	7.939556	13.85477	74.20567	2.08612	1.24060	17.18829	1.6433	18.8316	11
0.9760	2.0320	8.9920	7.807853	16.25624	71.93591	2.08612	1.24060	20.16756	0.4008	20.5684	12
1.0383	2.5305	9.4313	7.667253	18.68644	69.64630	2.08612	1.24060	23.18248	-0.5896	22.5929	13
1.0977	3.0697	9.8326	7.527277	21.04950	67.42322	2.08612	1.24060	26.11410	-1.3980	24.7161	14
1.1557	3.6346	10.2096	7.396694	23.26167	65.34163	2.08612	1.24060	28.85853	-2.0792	26.7793	15

ศูนย์วิทยุโทรพยากรณ์  
จุฬาลงกรณ์มหาวิทยาลัย

# IDLE TIME COST OF LEAD BOND MACHINE

SINGLE SERVICE MODEL





ประวัติผู้เขียน

รายงานวิทยานิพนธ์ฉบับนี้เขียนโดยนายบุญเจิด ประภัสสรชัยกุล เกิดเมื่อวันที่ 25 มกราคม พ.ศ. 2507 สำเร็จการศึกษาระดับปริญญาตรี สาขาวิศวกรรมโยธา จาก มหาวิทยาลัยสงขลานครินทร์ เมื่อปีการศึกษา 2528 เคยผ่านงานเป็นผู้ช่วยผู้วิจัยของ สถาบันวิจัยและการพัฒนาแห่งประเทศไทย (TDRI) และเป็นผู้สำรวจเก็บข้อมูลให้แก่บริษัท Semico ปัจจุบันประกอบกิจการส่วนตัวที่ หจก.จินดาการทอภัณฑ์



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย