รายการอ้างอิง

ภาษาไทย

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- เฉลิมพล ลีลาผาติกุล. การวิเคราะห์และควบคุมปัจจัยที่มีผลกระทบทางคุณภาพสำหรับอุตสาหกรรมผลิตยางรถยนต์. วิทยานิพนธ์ปริญญามหาบัณฑิต ภาควิชาวิศวกรรมอุตสาหการ คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, 2540.

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ภาคผนวก

ภาคผนวก ก.

แสดงตัวอย่างผลที่ได้จากการจำลองผลการรีดโดย Program rolling simulation

แสดงตัวอย่างผลที่ได้จากการจำลองผลการรีดโดย program rolling simulation

```
WELCOME TO LPN PLATE MILL ROUGHING OFFLINE MODEL
               ======= == === ===== ==== ======== ======= =====
Help : press RETURN wish to use default file name
       Enter Schedule File Name [8 MAX]:
 mill constants initialized: MCTEST =   1234567890
 mill constants size:        MILSIZ =         1920
 MILCOM copied to MILLOC [        1920]
Test LPN Models Utility
=======================
Help : press RETURN for menu detail
       Enter Option :
 1 = Enter PDI Data
 2 = Enter Shape Model Parameters
 3 = Enter Mill Configuration Parameters
 4 = Enter Family Data Parameters
 5 = Update Material Hardness
 6 = Enter Edger Configuration Parameters
 9 = Display Model Results
10 = Do Model Calculation
11 = Calculate Schedule for Given Drafts
20 = Create Product Data from Schedule Data
30 = Read mill setup from MSUOFF.FIL file
40 = Get PDI Data from PRS
50 = Run Head/Tail End Temperature Calculation
99 = Exit


Help : press RETURN for menu detail
       Enter Option :
 1 = Enter PDI Data
 2 = Enter Shape Model Parameters
 3 = Enter Mill Configuration Parameters
 4 = Enter Family Data Parameters
 5 = Update Material Hardness
 6 = Enter Edger Configuration Parameters
 9 = Display Model Results
10 = Do Model Calculation
11 = Calculate Schedule for Given Drafts
20 = Create Product Data from Schedule Data
30 = Read mill setup from MSUOFF.FIL file
40 = Get PDI Data from PRS
50 = Run Head/Tail End Temperature Calculation
99 = Exit

Help : press RETURN for menu detail
       Enter Option :

Help : press RETURN for menu detail
       Enter Option : 1
*** Enter PDI Data ***
dataok =  T
 GDACOM read from grade file [  1234567890]
 FAMCOM read from family file [  1234567890]

Help : Enter uppercase grade type 8 digits
       Slab      Grade (A8)  [a0360000]:
Slab  Thickness (mm)  [   250.0000    ]:
Slab      Width (mm)  [   1550.000    ]:
Slab     Length (mm)  [   2300.000    ]:
Slab   Temp. (Deg-C)  [   1180.000    ]:
Target Thickness (mm) [   7.700000    ]:
Target     Width (mm) [   1568.000    ]:
Target Temp. (Deg-C)  [   850.0000    ]:
Shape Bias             [   1.500000    ]:
Width Bias            [  0.0000000E+00]:
```

```
Help : Input 0 = Do not Care  1 = Odd Pass  2 = Even Pass
       Sched End Direc Flag  [                1]:
Flow Stress Eqn #     [              1]:
Help :  1 = long  - trans - long
        2 = trans - long  - trans
        3 = trans
        4 = long
        5 = trans - long
        6 = long  - trans
        Broadside Roll Code   [               1]:
First pass turn Code   [              0]:
Help : 0 = Plate           1 = Steckel coil
       2 = Quench Plate    3 = Coil Plate
       Product Flag          [              0]:
Flat Steckel Passes   [              1]:
CR Stage 1 Hold Thick (mm)[  0.0000000E+00]:

Enter Option : 2
*** Enter Shape Model Parameters ***
Enter grinding  crown (mm) [  0.3000000    ]:
Enter min shape draft (mm) [  0.2000000    ]:
Shape Target Tolerance(mm) [   2.500000    ]:
Maximum force change (MT)  [   815.7729    ]:
Minimum force change (MT)  [   30.59148    ]:
Min last pass force (MT)   [   509.8581    ]:
Enter max. # shape passes  [             10]:
Enter min. # shape passes  [              1]:
BETA                 bias % [  0.0000000E+00]:
 MILCOM copied to MILLOC [        1920]

Help : press RETURN for menu detail
       Enter Option :

Help : press RETURN for menu detail
       Enter Option : 3
*** Enter Mill Configuration Parameters ***
Set STKMIL flag (T)       [Y/N:D=Y]:
Use Cluster Method (F)    [Y/N:D=N]:
Do Clustr Learning (F)    [Y/N:D=N]:
Create PMDCLC.LOG     (T) [Y/N:D=Y]:
Create PMLRN.LOG      (T) [Y/N:D=Y]:
Trim Schedule     Mode    [Y/N:D=N]:
Trim Temperature  Mode    [Y/N:D=Y]:
Trim Shape        Mode    [Y/N:D=Y]:
Permit TAPERED rolling    [Y/N:D=N]:
Inhibit SHEAR passes      [Y/N:D=N]:
Inhibit SHAPE passes      [Y/N:D=N]:
Use RX strategy           [Y/N:D=N]:
Inhibit EDGER passes      [Y/N:D=Y]:
Add crown to target       [Y/N:D=N]:
REDRAFT after each pass   [Y/N:D=N]:
Set TMCTRL flag           [Y/N:D=Y]:
Set OUTLOG flag           [Y/N:D=Y]:
Set TBLFIT flag           [Y/N:D=Y]:
Enter safety for trim entry thick. [   1.000000    ]:
Enter draft bias  [1.00]:
Enter speed bias  [1.00]:
Enter flow stress temperature gain [   1.000000    ]:
Enter flow stress error deadband   [  0.1000000E-01]:
Enter temp. error deadband         [  0.5000000E-01]:
Enter temperature deadband         [  0.0000000E+00]:
Enter temperature learning gain    [  0.1000000    ]:
Enter force error learning gain    [  0.8000000    ]:
Enter bside safety margin (torque) [   1.000000    ]:
Enter front stk fce distance  (M)  [   9.850000    ]:
Enter back  stk fce distance  (M)  [   9.850000    ]:
Enter front table length      (M)  [   55.00000    ]:
Enter back  table length      (M)  [   110.0000    ]:
Enter backup roll diameter (mm)    [   1436.100    ]:
```

```
Enter work roll diameter (mm)       [   808.7000    ]:
Enter thread speed (mpm)            [   90.00000    ]:
Enter tailout speed (mpm)           [   90.00000    ]:
Enter STK thread speed (mpm)        [   72.78300    ]:
Enter STK tailout speed (mpm)       [   72.78300    ]:
Enter base torque (n-m)             [   1281248.    ]:
Enter maximum torque (n-m)          [   2593552.    ]:
Enter maximum mill force (MT)       [   3597.559    ]:
Enter operator force limit    (MT)  [ 0.0000000E+00]:
Enter broadside sizing width (m)    [   3.325000    ]:
Enter last pass speed (MPM)         [   298.4103    ]:
Enter base speed (rpm)              [   50.03831    ]:
Enter maximum speed (rpm)           [   104.0873    ]:
Enter maximum torque ratio          [2.00 1.75 ]:

Enter mill descale pattern        [      40     400]:
Enter mill reversal time (sec)     [   6.000000    ]:
Enter STK reversal time (sec)      [   10.00000    ]:
Enter fce to dscl box time (sec)     [   20.00000    ]:
Enter dsc box to mill time (sec)     [   15.00000    ]:
Enter shear delay   time (sec)     [   30.00000    ]:
Enter turn delay    time (sec)     [   15.00000    ]:
Enter torque calculation factor    [ 0.0000000E+00]:
 MILCOM copied to MILLOC [        1920]

Help : press RETURN for menu detail
       Enter Option :


Help : press RETURN for menu detail
       Enter Option : 10
*** Do Model Calculation ***
 work rolls initialized to ambient temp.
 roll stiffness data initialized: STFXTM=  7.8125000E-02
 GDACOM read from grade file [  1234567890]
 FAMCOM read from family file [  1234567890]
 MILLOC copied to MILCOM [        1920]

Starting Schedule calculation for ingot     1 beginning with pass
1
Safe Production (MTons per Hr):   131.895
Peak Production (MTons per Hr):   131.895
 schedule(s) run
Test LPN Models Utility
=======================
Help : press RETURN for menu detail
       Enter Option : 9
*** Display Model Results ***
```

P	S	EXIT THK (MM)	EXIT LEN (M)	EXIT WID (MM)	DRAFT (MM)
R01 D	3	223.64	2.6229	1567.8	29.000
R02	3	194.64	3.0106	1569.3	29.000
R03	3	165.64	3.5341	1570.9	29.000
R04	3	136.64	4.2797	1572.4	29.000
R05	3	107.64	5.4272	1573.9	29.000
R06	3	78.902	7.3961	1575.5	28.736
R07	3	54.306	10.735	1576.9	24.596
R08	3	34.149	17.052	1578.4	20.157
R09	111	22.445	25.913	1579.6	11.705
R10	818	15.234	38.165	1579.0	7.2109
R11 D	818	11.474	50.626	1577.7	3.7594
R12	818	9.1917	63.154	1576.6	2.2826
R13 D	818	7.7520	74.792	1574.7	1.4397

```
Continue [CTRL_Z = No]?
```

P	S	FORCE	TORQUE	ENTRY TEMP	EXIT TEMP

		---- MTons ---	---- MT-M ----	--- Deg C ----	--- Deg C ----
R01 D	3	1553.6	229.05	1164.9	1165.1
R02	3	1509.7	217.28	1162.6	1163.1
R03	3	1480.2	207.93	1160.3	1160.8
R04	3	1490.8	204.40	1157.4	1158.0
R05	3	1582.9	211.84	1153.6	1154.7
R06	3	1802.3	234.49	1148.6	1150.5
R07	3	1934.1	228.75	1141.3	1144.1
R08	3	2141.9	225.78	1128.4	1133.1
R09	111	1844.0	147.20	1105.3	1109.0
R10	818	1749.5	109.16	1065.0	1068.9
R11 D	818	1657.2	74.832	972.15	974.79
R12	818	1566.6	55.384	898.84	900.01
R13 D	818	1352.6	38.129	767.41	766.64

Continue [CTRL_Z = No]?

ภาคผนวก ข.

ตัวอย่างผลลัพธ์การรีดแต่ละก้อนที่ถูกบันทึกด้วยคอมพิวเตอร์

ตัวอย่างผลลัพธ์การรีดแต่ละก้อนที่ถูกบันทึกด้วยคอมพิวเตอร์

First pass start: 5-MAR-2004 08:38:41.72 LPN Steel - Model Evaluation Log Last pass complete: 5-MAR-2004 08:42:46.27

SLAB DATA PRODUCT DATA WORK ROLL BACKUP ROLL

Piece Id : V4A177B Gauge (mm): 244. Ordered Gauge (mm): 7 Top Bottom Top Bottom
Cast Number : Width (mm): 1556. Ordered Width (mm): 1574. Diam. (mm): 793.8 803.6 1436.1 1443.9
Grade : 03600 Length (m): 1.950 Ordered Length (m): 61.1 Crown (mm): 0.300 0.300 0.000 0.000
Model Grade : 03600001 Weight (kg): 5812. Product Weight(kg): 5812. Len Rolled: 22558 22558 839173 839173
Rolling Code : 3 Density (kg/m^3): 7850.0 Target Gauge (mm): 7.70 Target Width (mm): 1574.
Furnace Column: NORTH Slab Temp. (Deg C): 1269. Model Target Gauge: 7.70 Model Target Width: 1555.
Roll Status Flags : 40000007 Meas. Final Gauge: 7.78 Meas. Final Width: 1574.
Family Number : 2 Product Type : COIL Meas. Final Length: 58.300 Sched Mode: CALC - TIPPINS Shape
Clst Prd : 0360_12_01_25 Schedule Id: Prod Name : 03600001_0770_1600_**
Lineup | Seq : 11 | 14 Updated Id: Prod File:

P|---------- SCHEDULE VALUES ----------|
A R DTS ------ Hot Exit ------ Head Body Exit Stp Dely Mill Flow AGC AGC Cls ---------- REPREDICTED ----------

S S SRH Draft Gauge Width Len Forc Forc Trq Temp Spd Time Time Stres HFor BFor Sts Gauge Width Len Body Trq CFor CTq Temp
S TCNR mm mm mm m MT MT MT-m ^C mpm s s kg/mm2 MT MT FT mm mm m MT MT-m MT MT-m ^C

1R 3D 26.10 220.67 1575 2.2 1194 1194 172 1254 97 15.0 1.4 5.6 0 1194 00 220.62 1575 2.2 1180 147 0 0 1257
2R 3 23.71 196.97 1577 2.5 1105 1105 147 1253 97 6.0 1.5 5.7 1118 1105 00 196.95 1577 2.5 1094 143 0 0 1256
3R 3 23.71 173.26 1578 2.8 1011 1086 138 1252 97 6.0 1.7 5.7 1011 1043 00 173.27 1578 2.8 1046 144 0 0 1254
4R 3 23.71 149.55 1580 3.2 1111 1078 134 1250 128 6.0 1.6 6.4 1111 1084 00 149.54 1580 3.2 1087 136 0 0 1252
5R 3 23.71 125.84 1581 3.8 1170 1096 140 1249 136 6.0 1.9 6.9 1170 1120 00 125.84 1581 3.8 1124 145 0 0 1249
6R 3 23.71 102.13 1583 4.7 1300 1166 134 1246 142 6.0 2.5 7.7 1300 1233 00 102.12 1583 4.7 1239 135 0 0 1245

7R 3 23.71 78.42 1584 6.2 1456 1325 156 1244 161 6.0 3.0 8.6 1456 1408 00 78.44 1584 6.2 1415 160 0 0 1241

8R 3 21.36 57.06 1586 8.5 1611 1457 155 1241 176 6.0 3.9 9.6 1611 1585 00 57.08 1586 8.5 1636 156 0 0 1227

9R 6 S 19.06 38.00 1588 12.7 1730 1598 200 1238 167 6.0 5.5 10.0 1730 1730 00 38.03 1587 12.7 1746 199 0 0 1220

10R818 17.86 20.14 1588 23.9 2575 2499 201 1175 150 36.0 10.8 13.3 2575 2707 00 20.18 1587 23.8 3137 200 0 0 1121

11F818 8.11 12.03 1587 40.0 2252 2285 147 1114 106 10.0 22.7 15.5 2252 2357 00 12.07 1587 39.9 2252 158 0 0 1084

12F818 3.26 8.77 1587 54.9 1865 1534 57 1074 139 10.0 28.4 17.6 1865 1700 00 8.80 1586 54.6 1686 63 0 0 1052

13L818 1.00 7.77 1586 61.9 1143 791 22 1017 102 10.0 36.4 21.4 1143 987 00 7.78 1586 61.8 984 20 0 0 1001

M P|---------- M E A S U R E D V A L U E S ----------|

O A SDT Roll G A U G E Entry Exit --- Forces --- Pyro Stp Delay Mill Flow -- Repredicted -- -- #Pts ---

D S ESR Gap X-ray GM Width Len Head Body Tail Trq Curr Temp Spd Time Time Strs Ini Fin Ini Fin Avg Beg End Steer

E S QCN mm mm mm mm m MT MT MT MT-m A ^C mpm s s kg/mm MT MT MT-m MT-m mm

---

C 1R SF 218.16 0.00 220.62 1579 2.1 1039 1020 1043 137 10088 0 91 23.0 1.3 4.8 1180 1181 170 171 12 2 13 -.20

C 2R S 194.44 0.00 196.95 1569 2.4 1106 1062 1031 146 10733 0 92 7.8 1.5 5.5 1094 1094 148 148 14 2 15 -.19

C 3R S 170.67 0.00 173.27 0 2.7 1116 1091 1120 141 10338 0 92 7.8 1.7 6.0 1078 1078 140 140 16 2 17 -.20

C 4R S 146.92 0.00 149.54 0 3.1 1141 1102 1153 144 10555 0 97 7.6 1.9 6.5 1074 1075 134 134 7 7 13 -.19

C 5R S 123.11 0.00 125.84 0 3.7 1197 1159 1226 132 9691 1038 98 7.9 2.3 7.1 1095 1096 131 131 8 9 16 -.20

C 6R S 99.28 0.00 102.12 1587 4.5 1281 1242 1291 138 10129 0 106 8.0 2.6 7.8 1172 1172 135 135 9 9 17 -.19

C 7R S 75.20 0.00 78.44 0 5.9 1448 1441 1477 151 11409 0 135 8.1 3.2 8.8 1337 1338 148 148 9 12 20 -.20

C 8R SF 53.63 0.00 57.08 0 8.3 1579 1594 1573 153 12657 0 151 7.6 4.0 9.6 1516 1517 154 154 12 14 25 -.19

C 9R S S 34.32 0.00 38.03 0 12.4 1753 1723 1715 155 13645 1088 164 8.2 5.6 10.0 1704 1702 202 201 16 19 34 -.20

C10R SF 14.96 0.00 20.18 0 22.6 2847 2686 2988 240 17876 0 147 45.6 10.7 13.2 3098 3062 278 277 32 35 66 -.19

C11F S 7.03 0.00 12.07 0 37.9 2585 2542 2937 138 10138 977 99 6.4 22.0 16.7 2628 2604 148 148 77 71 147 -.19

C12F S 4.86 0.00 8.80 0 53.2 2279 1879 2056 72 5390 0 137 6.4 25.4 19.5 1675 1672 60 61 74 101 174 -.18

C13L S 5.52 0.00 7.78 0 58.3 1004 894 1233 31 2297 856 101 7.0 34.1 19.4 871 873 20 21 114 113 226 -.21

M P |---------- A G C V A L U E S ----------||--- M E A S D A T A ---|

O A SDTS ----- Confirmed ------ Calc Gap Screw Stretch Gap H_Taper T_Taper FS Cls FS Tm --- Std Dev ----

D S ESRH Gauge HFor BFor Gap Gap Error Pos Meas Antic Stif Trim Amt Len Amt Len Corr Corr Thk Frc Trq

E S QCNR mm MT MT mm mm mm mm mm mm % mm mm m mm m % ^K % % %

C 1R SF 220.67 0 1194 218.09 218.34 0.18 218.62 2.28 2.58 99 0.19 0.00 0.0 0.00 0.0 0.0 0 0.05 2.81 20.36

C 2R S 196.97 0 1105 194.55 194.62 0.18 194.94 2.33 2.42 99 0.19 0.00 0.0 0.00 0.0 0.0 11 0.02 2.19 11.56

C 3R S 173.26 0 1043 170.95 170.86 0.19 171.05 2.41 2.31 99 0.19 0.00 0.0 0.00 0.0 0.0 -4 0.02 1.67 13.18

C 4R S 149.55 0 1084 147.16 147.14 0.22 146.55 2.40 2.39 99 0.19 0.00 0.0 0.00 0.0 0.0 -9 0.01 0.51 8.11

C 5R S 125.84 0 1120 123.39 123.32 0.21 123.83 2.53 2.45 99 0.19 0.00 0.0 0.00 0.0 0.0 -19 0.02 1.61 4.39

C 6R S 102.13 0 1233 99.49 99.48 0.20 99.48 2.64 2.64 99 0.19 0.00 0.0 0.00 0.0 0.0 -19 0.02 1.88 9.99

C 7R S 78.42 0 1408 75.47 75.41 0.21 75.66 3.03 2.95 99 0.19 0.00 0.0 0.00 0.0 0.0 -24 0.01 0.66 19.76

C 8R SF 57.06 0 1585 53.81 53.84 0.21 54.67 3.24 3.25 99 0.19 0.00 0.0 0.00 0.0 0.0 -16 0.03 1.93 16.03

C 9R S S 38.00 0 1730 34.48 34.51 0.20 35.42 3.51 3.52 99 0.19 0.00 0.0 0.00 0.0 0.0 -3 0.06 0.60 5.53

C10R SF 20.14 0 2707 15.01 15.16 0.20 16.11 5.01 5.13 99 0.19 0.00 0.0 0.00 0.0 0.0 40 0.08 0.77 2.10

C11F S 12.03 0 2357 7.42 7.23 0.20 8.25 4.84 4.61 99 0.19 0.00 0.0 0.00 0.0 0.0 9 0.16 1.74 3.84

C12F S 8.77 0 1700 5.25 5.07 0.21 6.44 3.73 3.52 99 0.19 0.00 0.0 0.00 0.0 0.0 -50 0.20 2.64 11.21

C13L S 7.77 0 987 5.25 5.72 0.19 6.44 2.06 2.52 99 0.19 0.00 0.0 0.00 0.0 0.0 -10 0.21 3.02 7.96

Ave Xray Gauge: 0.00 Xray Gauge Within Tolerance: 0.00 % Tol: +/- 0.100 Operator Speed bias : 1.0000

Operator Width bias (mm): 0.0

Model Last Pass Force Tgt (MT): 793. Operator Draft bias (%): 0.9000 Operator Shape bias : 0.8500

	Initial	Final	Initial	Final	Initial	Final
GRADE						
1st Coefficient	1: 0.14488E+07	0.14488E+07	2: 0.96491E+06	0.97860E+06	3: 0.10689E+08	0.10007E+08
2nd Coefficient	1: 56614.	56614.	2: 57567.	57150.	3: 30039.	30718.
3rd Coefficient	1: 0.37597	0.37597	2: 0.71251E-01	0.51277E-01	3: 0.00000E+00	0.00000E+00
4th Coefficient	1: 0.00000E+00	0.00000E+00	2: 0.00000E+00	0.00000E+00	3: 0.00000E+00	0.00000E+00
5th Coefficient	1: 0.00000E+00	0.00000E+00	2: 0.00000E+00	0.00000E+00	3: 0.00000E+00	0.00000E+00

Steel Resistivity : 0.00000E+00 0.00000E+00

	Calculated	Actual
RMS Time :	96.7 s	92.2 s
Mill Time :	235.2	244.6
Interval :	20.0	18.3
Mill + Interval :	255.2	262.8
MT/Hr :	82.0	79.6

Ave coil temp: 0

ภาคผนวก ค.

การเขียน Laddle diagram เพิ่มเติมในโปรแกรม PLC เพื่อคำนวณค่า Gap trim

แสดงการเขียนLaddle diagram เพิ่มเติมในโปรแกรม PLCเพื่อคำนวณค่า Gap trim

```
|
| << RUNG  208 >>
|
| Total          342415
| Roll           PLC2OIS
|Length          Global
| R12592          R06021
+[   A     MOVE      B ]-                                          (  )
|
| << RUNG  209 >>
|
|035508
| Slab
| ID 2
| R03201  R12118
AO0298
+[  A EQUAL B  ]-------------------------------------------------(  )
|
| << RUNG  210 >>
|
|035508
| Slab
| ID 3
| R03202  R12119
AO0299
+[  A EQUAL B  ]-------------------------------------------------(  )
|
| << RUNG  211 >>
|
|
Reset
|
Loop
|
LastPas
|
|AO0298
AO0294
+--]/[--+-----------------------------------------------------(OS)
|       |
|       |
|       |
|AO0299 |
+--]/[--+
|       |
|       |
|       |
|AO0364 |
+--]/[--+
|
| << RUNG  212 >>
|
| Reset  035508
| Loop    Slab
|LastPas  ID 2
|AO0294   R03201          R12118
```

```
    +--] [---[   A      MOVE       B ]-
    |                                                                    (  )
    |
    | << RUNG  213 >>
    |
    | Reset  035508
    | Loop    Slab
    |LastPas  ID 3
    |AO0294   R03202
    +--] [---[   A      MOVE      R12119
    |                              B ]-
    |                                                                    (  )
    |
    | << RUNG  214 >>
    |
    | Reset
    | Loop                          Exit
    |LastPas                        Gauge
    |AO0294     Const               Pointer
    +--] [---[   A      MOVE        R12100
    |          +08231               B ]-
    |                                                                    (  )
    |
    | << RUNG  215 >>
    |
    | Know     Exit
    |LastPas   Gauge                Exit
    | Latch    Pointer              Gauge
    |AO0295    R12100               Pointer
    +--]/[---[   A ADDX  B  =  Const R12100
    |                          +00015   C ]-
    |                                                                    (  )
    |
    | << RUNG  216 >>
    |
    | Know
    |LastPas                        Exit
    | Latch                         Gauge
    |AO0295  IR12100                R12101   Const
    +--]/[---[   A  MOVE TBL EXT   B        LEN ]-
    |                                          001                       (  )
    |
    | << RUNG  217 >>
    |
    | Know     Exit
    Know
    |LastPas   Gauge
    LastPas
    | Latch
    Latch
    |AO0295   R12101   Const
    AO0295
    +--]/[---[  A EQUAL B  ]-------------------------------[LATCH]---( L)
    |                +00000
    (  )
    | Reset
    (  )
    | Loop
    (  )
    |LastPas
    (  )
    |AO0294
    (  )
    +--] [-------------------------------------------------------------(UL)
```

```
|
|
| << RUNG  218 >>
|
|035504          Utility
|Current
|Pass #
|                  Ua[
| R09100   Const  R02133
AO0250
+[   A SUBX  B  =    C ]----------------------------------------(  )
|         +00001
|
| << RUNG  219 >>
|
| Know
Know
|LastPas
LastPas
| Latch
OS
|AO0295  AO0250
AO0297
+--] [-----] [-------------------------------------------------(OS)
|

| << RUNG  220 >>
|
| Know    Exit            Force
|LastPas  Gauge          LastPas
|  OS    Pointer         Pointer
|AO0297   R12100   Const  R12102
+--] [---[   A SUBX  B  =    C ]-                                (  )
|                 +00014
|
| << RUNG  221 >>
|
| Know                    Check
|LastPas                  Force
|  OS                    LastPas
|AO0297  IR12102          R12103   Const
+--] [---[   A  MOVE TBL EXT  B    LEN ]-                        (  )
|                                    001
|
| << RUNG  222 >>
|
| Know   Check
Dummy
|LastPas  Force
Pass
|  OS    LastPas
OS
|AO0297   R12103   Const
AO0296
+--] [---[  A EQUAL B  ]-----------------------------------------(OS)
|                +00000

| << RUNG  223 >>
|
| Know    Dummy   Force          Force
|LastPas  Pass   LastPas        LastPas
```

```
|  OS      OS    Pointer          Pointer
|AO0297  AO0296   R12102   Const  R12102
+--] [-----] [---[   A SUBX  B  =    C ]-                          (   )
|                          +00015
|
| << RUNG  224 >>
|
| Know    Force            Gauge
|LastPas LastPas          LastPas
|  OS    Pointer          Pointer
|AO0297   R12102   Const  R12104
+--] [---[   A SUBX  B  =    C ]-                                  (   )
|                  +00001
|
| << RUNG  225 >>
|
| Know    Gauge           GaugeB4
|LastPas LastPas          LastPas
|  OS    Pointer          Pointer
|AO0297   R12104   Const  R12105
+--] [---[   A SUBX  B  =    C ]-                                  (   )
|                  +00015
|
| << RUNG  226 >>
|
| Know                    Force
|LastPas                  Last
|  OS                     Pass
|AO0297  IR12102          R12106   Const
+--] [---[   A  MOVE TBL EXT  B    LEN ]-                         (   )
|                                   001
|


| << RUNG  227 >>
|
| Know                    Gauge
|LastPas                  Last
|  OS                     pass
|AO0297  IR12104          R12108   Const
+--] [---[   A  MOVE TBL EXT  B    LEN ]-
(  )
|                                   001
|
| << RUNG  228 >>
|
| Know                    Gauge
|LastPas                 Before
|  OS                    LastPas
|AO0297  IR12105          R12120   Const
+--] [---[   A  MOVE TBL EXT  B    LEN ]- (  )
|                                   001
|
| << RUNG  229 >>
|
| Know    Gauge   Gauge   Draft
|LastPas Before   Last    Last
|  OS    LastPas  pass    Pass
|AO0297   R12120  R12108  R12122
+--] [---[   A SUBX  B  =    C ]-                                  (   )
|
```

```
| << RUNG  230 >>
|
| Know
|LastPas
| Latch
|AO0295  IR12105          R12126   Const
+--] [---[   A  MOVE TBL EXT  B    LEN ]-                              (  )
|                                    001
|
| << RUNG  231 >>
|
|
|AO0364   R12126          R12124
+--]/[---[   A     MOVE      B ]-                                       (  )
|
|
| << RUNG  232 >>
|
|
| R12126  R12124
AO0364
+[  A EQUAL B  ]-------------------------------------------------------(  )
|
|
| << RUNG  233 >>
|
| Total                    Roll   Utility
| Roll                    Length
|Length                   1=100M
|                                  Uc[
| R12592           Const  R12110  R02137
+[   A    DVD       B     QUO     REM ]-                                (  )
|                 +00100
|
| << RUNG  234 >>
|
|         Roll   Utility
Roll
|        Length
Length
|        1=100M
> 10 KM
|                 Ua[
|  Const  R12110  R02133
AO0362
+[   A SUBX  B  =    C ]-------------------------------------------------(  )
| +00100
|
| << RUNG  235 >>
|
|         Roll   Utility
Roll
|        Length
Length
|        1=100M
> 20 KM
|                  Ub[
|  Const  R12110  R02135
AO0363
+[   A SUBX  B  =    C ]-------------------------------------------------(  )
| +00200
```

```
|
| << RUNG  236 >>
|
| Force           Force
| Last            Last
| Pass           PassFP
|
| R12106          R12112
+[ INTEGER  TO  FLOATING POINT ]-                                    (  )
|
| << RUNG  237 >>
|
| Draft           Draft
| Last            Last
| Pass           Pass FP
| R12122          R12114
+[ INTEGER  TO  FLOATING POINT ]-                                    (  )
|
| << RUNG  238 >>
|
| Roll    Force                              Utility
|Length   Last
|> 10 KM PassFP
|                                           Ua[
|AO0362   R12112          Const            R02133
+--]/[---[  A    FMULT      B       =        C          ]-          (  )
|                        +3.109000-04
|
| << RUNG  239 >>
|
| Roll    Draft                              Utility
|Length   Last
|> 10 KM Pass FP
|                                           Ub[
|AO0362   R12114          Const            R02135
+--]/[---[  A    FMULT      B       =        C          ]-          (  )
|                        +7.769001-03
|
| << RUNG  240 >>
|
| Roll   Utility         Utility            Utility
|Length
|> 10 KM
|          Ua[                             Uc[
|AO0362   R02133          Ub[              R02137
+--]/[---[  A    FADD      R02135   =        C          ]-          (  )
|                          B
|
| << RUNG  241 >>
|
| Roll   Utility                             Gap
|Length                                      Trim
|> 10 KM                                     Calcul
|          Uc[
|AO0362   R02137          Const            R12116
+--]/[---[  A    FSUB       B       =        C          ]-          (  )
|                        +1.310000-01
|
| << RUNG  242 >>
|
| Roll    Roll    Force                                Utility
```

```
|Length  Length   Last
|> 10 KM > 20 KM PassFP
|                                                    Ua[
|AO0362  AO0363   R12112          Const              R02133
+--] [-----]/[---[  A    FMULT      B       =         C          ]-(  )
|                                +1.220000-03
|
| << RUNG  243 >>
|
| Roll    Roll    Draft                              Utility
|Length  Length   Last
|> 10 KM > 20 KM Pass FP
|                                                    Ub[
|AO0362  AO0363   R12114          Const              R02135
+--] [-----]/[---[  A    FMULT      B       =         C          ]-(  )
|                                +1.219000+00

| << RUNG  244 >>
|
| Roll    Roll                    Utility            Utility
|Length  Length
|> 10 KM > 20 KM
|                                          Ua[       Uc[
|AO0362  AO0363    Const                   R02133    R02137
+--] [-----]/[---[  A    FSUB      B       =         C          ]-(  )
|                +6.000000-01
|
| << RUNG  245 >>
|
| Roll    Roll    Utility         Utility            Gap
|Length  Length                                      Trim
|> 10 KM > 20 KM                                    Calcul
|                    Uc[                  Ub[
|AO0362  AO0363    R02137                R02135     R12116
+--] [-----]/[---[  A    FADD      B       =         C          ]-(  )
|
|
| << RUNG  246 >>
|
| Roll    Force                                  Utility
|Length   Last
|> 20 KM PassFP
|                                                    Ua[
|AO0363   R12112          Const              R02133
+--] [---[  A    FMULT      B       =         C          ]-       (  )
|                        +4.401000-04
|

| << RUNG  247 >>
|
| Roll    Draft                                  Utility
|Length   Last
|> 20 KM Pass FP
|                                                    Ub[
|AO0363   R12114          Const              R02135
+--] [---[  A    FMULT      B       =         C          ]-       (  )
|                        +5.430000-01
|
| << RUNG  248 >>
|
| Roll                    Utility            Utility
```

```
|Length
|> 20 KM
|                          Ua[             Uc[
|AO0363    Const          R02133          R02137
+--] [---[  A    FSUB       B       =       C          ]-         (  )
|        +4.060000-01
|
| << RUNG  249 >>
|
| Roll   Utility         Utility           Gap
|Length                                    Trim
|> 20 KM                                   Calcul
|          Uc[             Ub[
|AO0363   R02137          R02135           R12116
+--] [---[  A    FSUB       B       =       C          ]-         (  )
|
|
| << RUNG  250 >>
|
|         030824  Utility
|          1=1%           Header
|          Draft
|                   Ua[   B030816
|  Const  R09019  R02133 O0-0141
+[   A SUBX  B  =    C ]---] [---[NO OP]-                        (  )
| +00133
```

ภาคผนวก ง.

ผลการวิเคราะห์ทางสถิติด้วยโปรแกรม SPSS for Windows

ผลการวิเคราะห์ทางสถิติด้วยโปรแกรม SPSS for Windows

- ที่ค่า Wear Crown = 0.25 ม.ม.

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	Draft Last Pass, Force Last Pass [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: gap_trim

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.415	2	.207	137.297	.000[a]
	Residual	.471	312	1.511E-03		
	Total	.886	314			

a. Predictors: (Constant), Draft Last Pass, Force Last Pass

b. Dependent Variable: gap_trim

Coefficients[a]

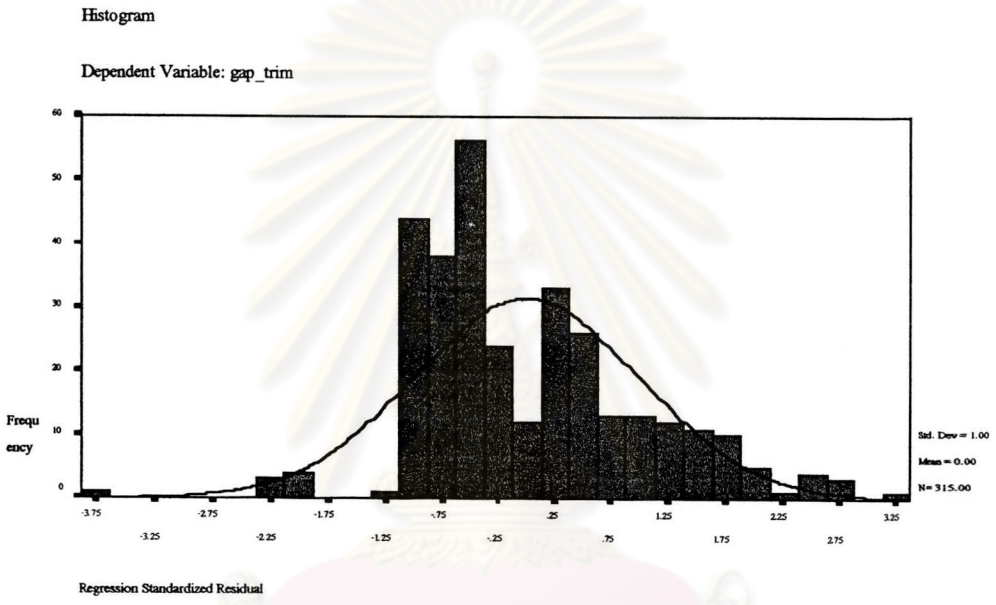
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-5.516E-02	.008		-7.297	.000
	Force Last Pass	9.348E-05	.000	.511	9.142	.000
	Draft Last Pass	2.115E-02	.005	.226	4.049	.000

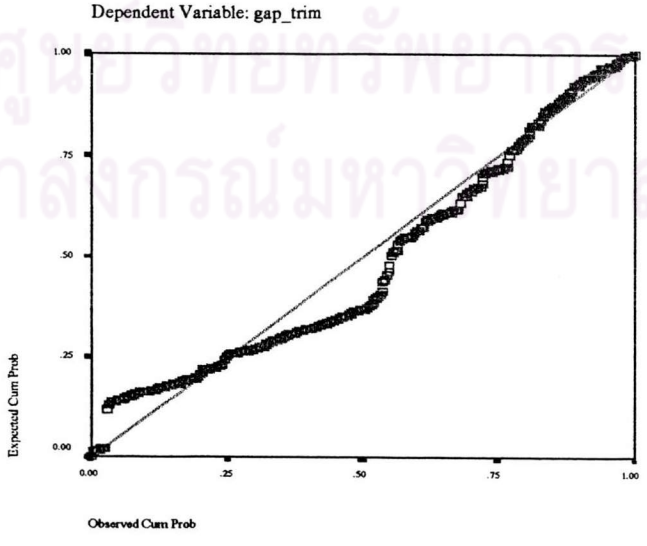
a. Dependent Variable: gap_trim

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-2.4189E-02	.1948	4.733E-02	3.635E-02	315
Residual	-.1448	.1242	-1.0001E-17	3.875E-02	315
Std. Predicted Value	-1.968	4.056	.000	1.000	315
Std. Residual	-3.724	3.195	.000	.997	315

a. Dependent Variable: gap_trim





- ที่ค่า Wear Crown = 0.15 ม.ม.

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	Draft Last Pass, Force Last Pass [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: gap_trim

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.075	2	.538	383.310	.000[a]
	Residual	.438	312	1.403E-03		
	Total	1.513	314			

a. Predictors: (Constant), Draft Last Pass, Force Last Pass

b. Dependent Variable: gap_trim

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.222	.012		19.113	.000
	Force Last Pas	-4.043E-04	.000	-1.620	-14.820	.000
	Draft Last Pass	.403	.019	2.268	20.747	.000

a. Dependent Variable: gap_trim

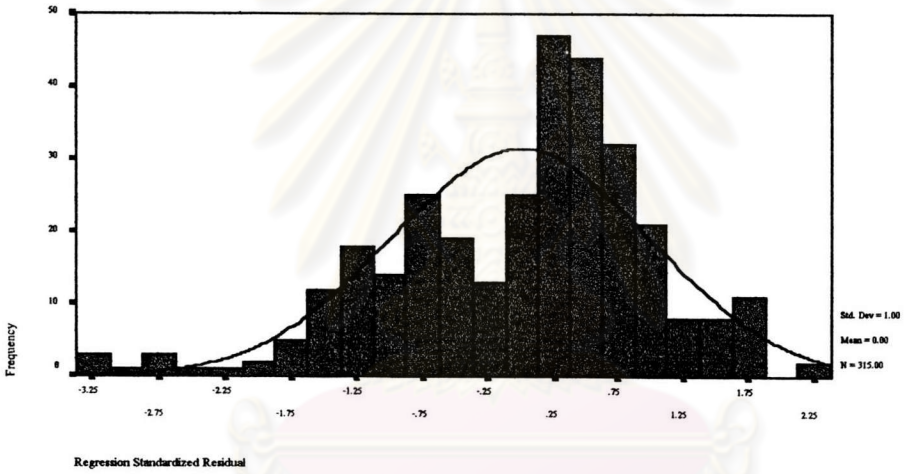
Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	8.276E-02	.3263	.1600	5.852E-02	315
Residual	-.1201	8.490E-02	-7.5513E-17	3.733E-02	315
Std. Predicted Valu	-1.320	2.842	.000	1.000	315
Std. Residual	-3.208	2.267	.000	.997	315

a. Dependent Variable: gap_trim

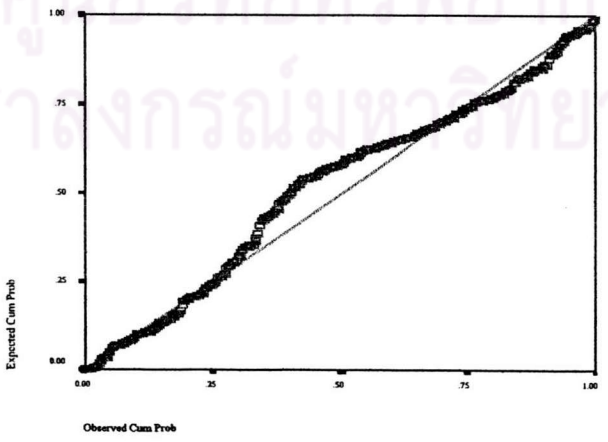
Histogram

Dependent Variable: gap_trim



Normal P-P Plot of Regression Standardized Residual

Dependent Variable: gap_trim



- ที่ค่า Wear Crown = 0.05 ม.ม.

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	Draft Last Pass, Force Last Pass [a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: gap_trim

ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.218	2	.109	38.459	.000[a]
	Residual	.884	312	2.833E-03		
	Total	1.102	314			

a. Predictors: (Constant), Draft Last Pass, Force Last Pass

b. Dependent Variable: gap_trim

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.352E-02	.014		6.139	.000
	Force Last Pass	1.005E-04	.000	.488	2.814	.005
	Draft Last Pass	-8.648E-03	.033	-.046	-.264	.792

a. Dependent Variable: gap_trim

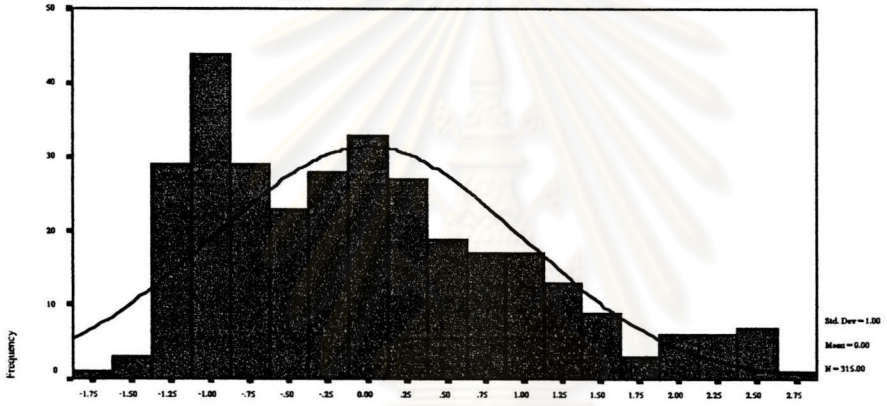
Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.1301	.2770	.1705	2.634E-02	315
Residual	-9.7002E-02	.1474	-3.7007E-17	5.306E-02	315
Std. Predicted Valu	-1.534	4.042	.000	1.000	315
Std. Residual	-1.822	2.769	.000	.997	315

a. Dependent Variable: gap_trim

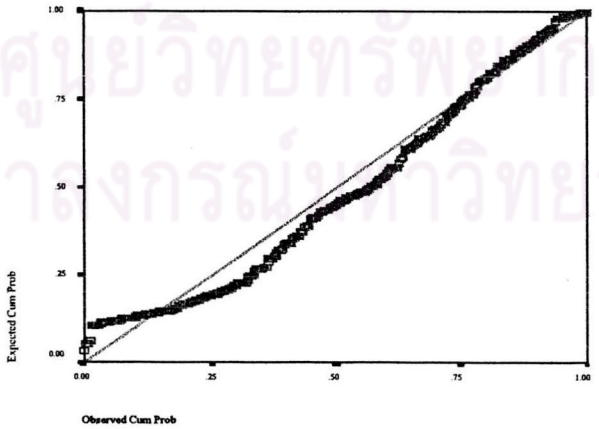
Histogram

Dependent Variable: gap_trim



Normal P-P Plot of Regression Standardized Residual

Dependent Variable: gap_trim



ประวัติผู้เขียนวิทยานิพนธ์

นายสุรศักดิ์ อ้นอุ่น เกิดเมื่อวันที่ 5 กรกฎาคม พ.ศ. 2512 ที่จังหวัด นนทบุรี สำเร็จการศึกษาระดับปริญญาตรี อุตสาหกรรมศาสตร์บัณฑิต สาขาวิชาเทคโนโลยีการผลิตจาก สถาบันเทคโนโลยีพระจอมเกล้าพระนครเหนือ ในปีการศึกษา 2539 หลังจากนั้นได้เริ่มเข้าทำงาน ในบริษัทอุตสาหกรรมผลิตเหล็กแผ่นรีดร้อน ตำแหน่งซุปเปอร์ไวเซอร์ควบคุมการผลิต และเข้า ศึกษาต่อในหลักสูตรวิศวกรรมศาสตร์มหาบัณฑิต สาขาวิศกรรมอุตสาหการ จุฬาลงกรณ์ มหาวิทยาลัยในปีการศึกษา 2543