CHAPTER 6

RESULTS AND COMPARISON

6.1 Set up time result

During doing this thesis, Time study was used to collect the set up time data of machine Ex-302 and Ex-303. The data of set up time of both main operator and sub operator in October and November 1997 of machine Ex-302 and Ex-303 were shown in Appendix F,G,H and I respectively. All data were used to comparing the activities results before improvement in July 1997 and after activities implementation in November 1997 (because in October operator had to trial run) in order to check that collective actions which was purposed in chapter 5 was effected to reduce set up time for machine Ex-302 and Ex-303 in power cable production.

The average of set up time of each type of product change for machine Ex-302 and Ex-303 comparing between before improvement in July 1997 and after improvement in November 1997 was shown in Table 6.1 and Table 6.2 respectively.

From the data of machine Ex-302 and Ex-303, the average of set up time type "A" which was collected on November 1997 was 23minutes and 20 minutes respectively. It showed that the set up time reduced after improvement from 57 minutes to 24 minutes for Ex-302 and the set up time for Ex-303 was 20 minutes which was nearly same as set up time of machine Ex-302.

The average of each step of set up time type "A" after improvement on November'97 of main operator and sub operator for machine Ex-302 and Ex-303 were shown in Table 6.3 and Table 6.4 respectively.

Table 6.1 : Average of set up time of each type of product change for Ex-302

Type of product change	Average of set up time (min)		
	July'97	Oct'97	Nov'97
A	57	31	24
B	59	32	24
C	39	30	22
D	25	31	20
E	49	27	23
F	35	26	20
G	25	20	14

Table 6.2 : Average of set up time of each type of product change for Ex-303

Type of product change	Average of set up time (min)	
	Oct'97	Nov'97
A	32	20
B	24	25
C	25	21
D	23	20
E	23	23
F	23	19
G	15	15

Table 6.3 showed the result of the average of each step of main operator set up time type "A". The data of this table had been plotted in Figure 6.1 and Figure 6.3 for machine Ex-302 and Ex-303 respectively. The step 1-4 which concerned cross-head took about 9 and 5 minutes, step 5 was about 2 and 2 minutes, step 6 which concerned pull out conductor and pass-line had also taken about 4 and 5 minutes and step 7 concerned start adjust also took high set up time which was about 5 and 4 minutes and step 8 was about 4 and 4 minutes for Ex-302 and Ex-303 respectively. It was total 24 minutes.

Table 6.4 showed the result of the average of each step of sub operator set up time type "A". The data of this table had been plotted in Figure 6.2 and Figure 6.4 for machine Ex-302 and Ex-303 respectively. Step 1 was about 2 and 6 minutes, It was without step 2 and step 3 because it was removed to be preparation step. Step 4 was about 9 and 6 minutes, step 5 which was concerned adjust centering was about 8and 3 minutes and step 6 was about 5 and 5 minutes for Ex-302 and Ex-303 respectively

The comparing average of each step of set up time type "A" between before improvement on July 1997 and after improvement on November1997 of main operator and sub operator for machine Ex-302 were shown in Table 6.5 and Table 6.6 respectively. The result showed that the average set up time of each step of set up time type "A" was reduced which resulted in average of total set up time type "A" was reduced from 57 minutes to 24 minutes.

The average of each step of set up time type "A" after improvement on November'97 of main operator and sub operator for machine Ex-303 were shown in Table 6.3 and Table 6.4 respectively. This data showed that the total of set up time of product type "A" was about 20 minutes which was nearly same as set up time of machine Ex-302.

Table 6.3 : Average of each step of set up time type "A" of main operator for Ex-302 and Ex-303 on November'97

Step of product change	Average of set up time (min)	
	EX-302	EX-303
1	2	2
2	3	1
3	2	1
4	2	1
5	2	2
6	4	5
7	5	4
8	4	4
Total	24	20

Table 6.4 : Average of each step of set up time type "A" of sub operator for Ex-302 and Ex-303 on November'97

Step of product change	Average of set up time (min)	
	Ex-302	Ex-303
1	2	6
2	0	0
3	0	0
4	9	6
5	8	3
6	5	5
Total	24	20

Table 6.5 : Comparing the average of set up time of each step of product change type "A" for main operator of machine Ex-302 between before improvement in July'97 and after improvement in November'97

Type of product change	Average of set up time (min)	
	Before improvement	After improvement
1	5	2
2	4	3
3	6	2
4	4	2
5	3	2
6	19	4
7	10	5
8	6	4
Total	57	24

Table 6.6 : Comparing the average of set up time of each step of product change type "A" for sub operator of machine of machine Ex-302 between before improvement in July'97 and after improvement in November'97

Type of product change	Average of set up time (min)	
	Before improvement	After improvement
1	18	2
2	1	0
3	10	0
4	5	9
5	8	8
6	10	5
Total	57	24

Fig 6.1 EX302 Lot change time analysis for main operator

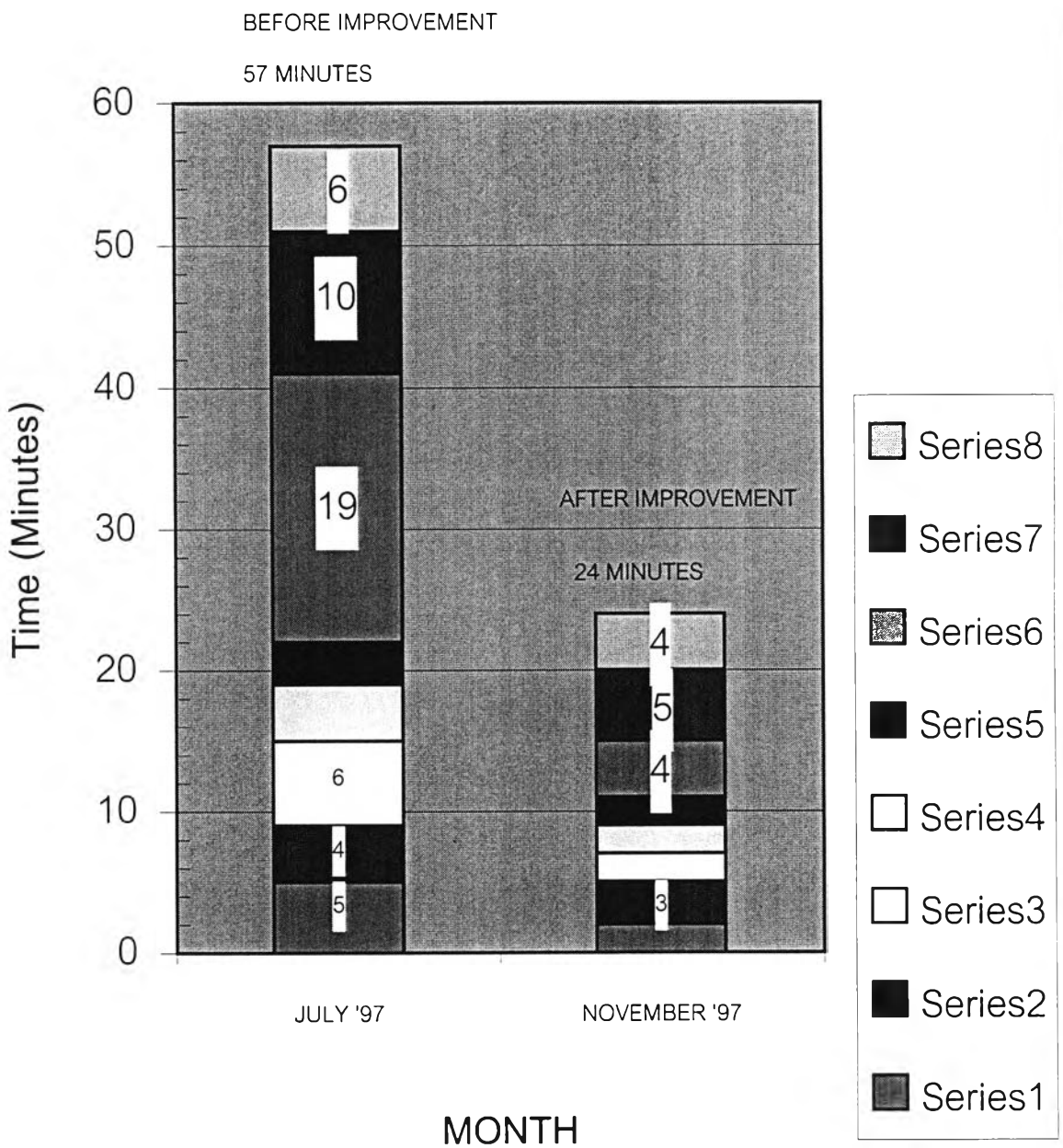


Fig 6.2 EX302 Lot change time analysis for sub-operator

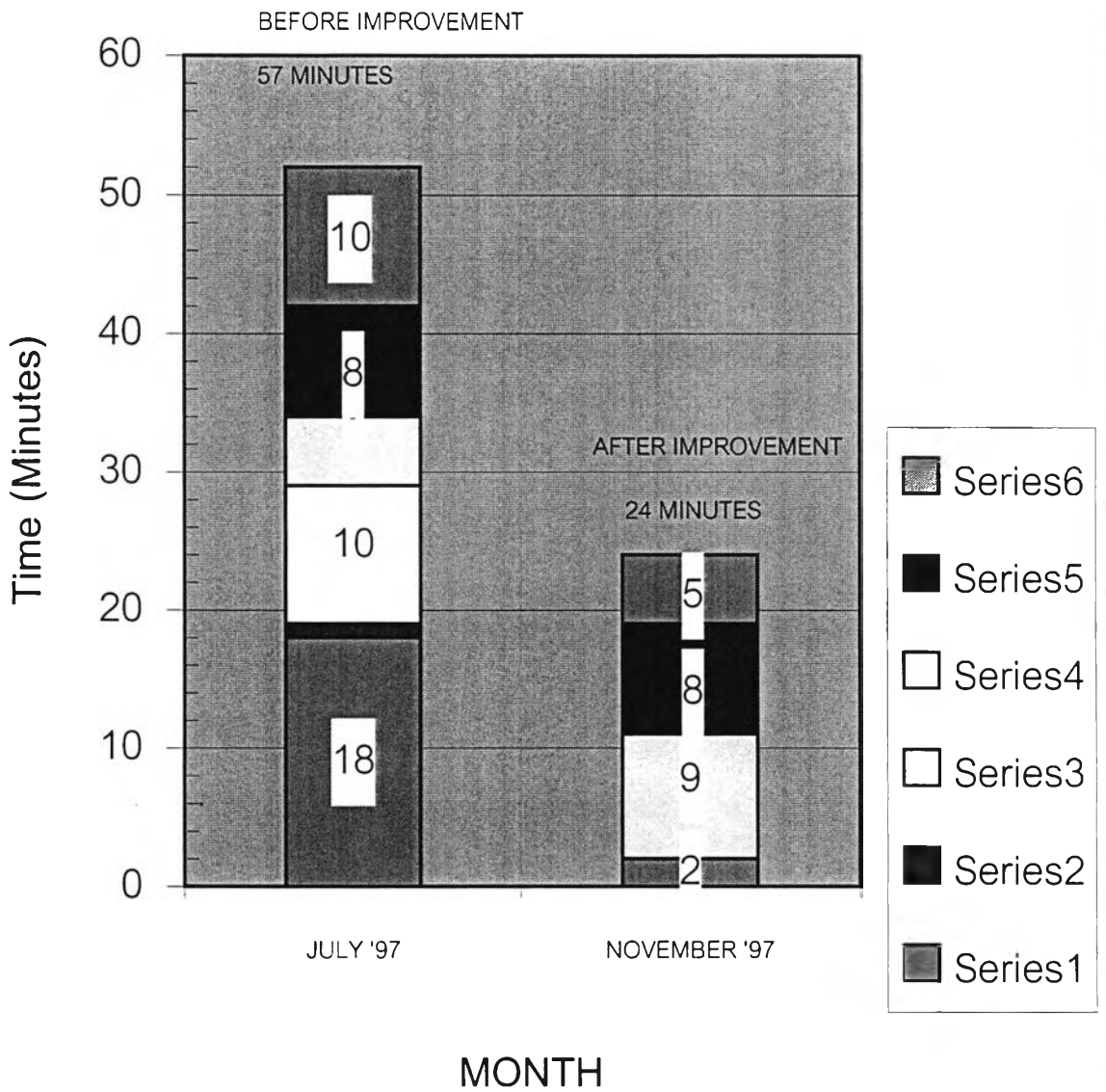


Fig 6.3 EX303 Lot change time analysis for main operator

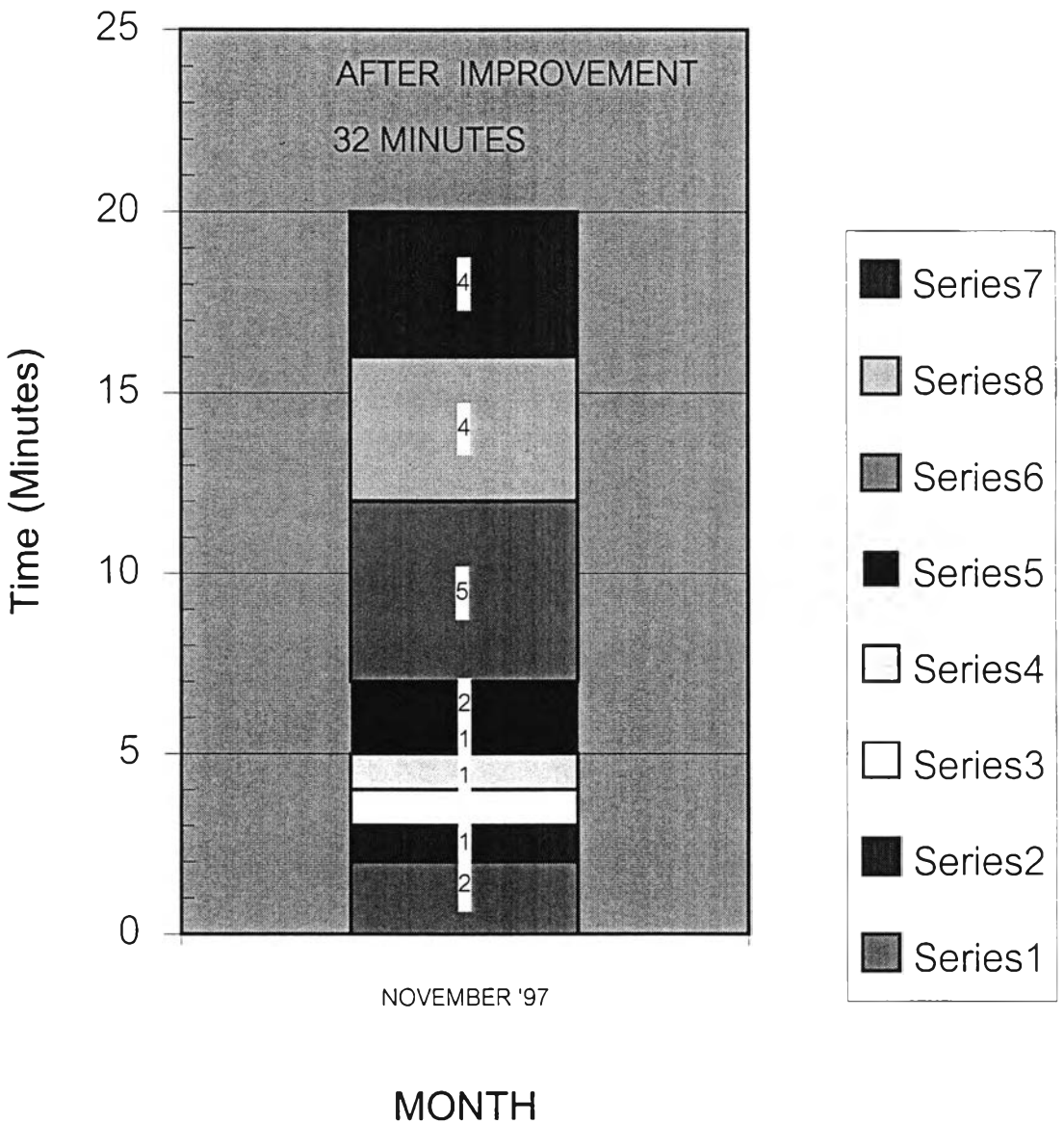
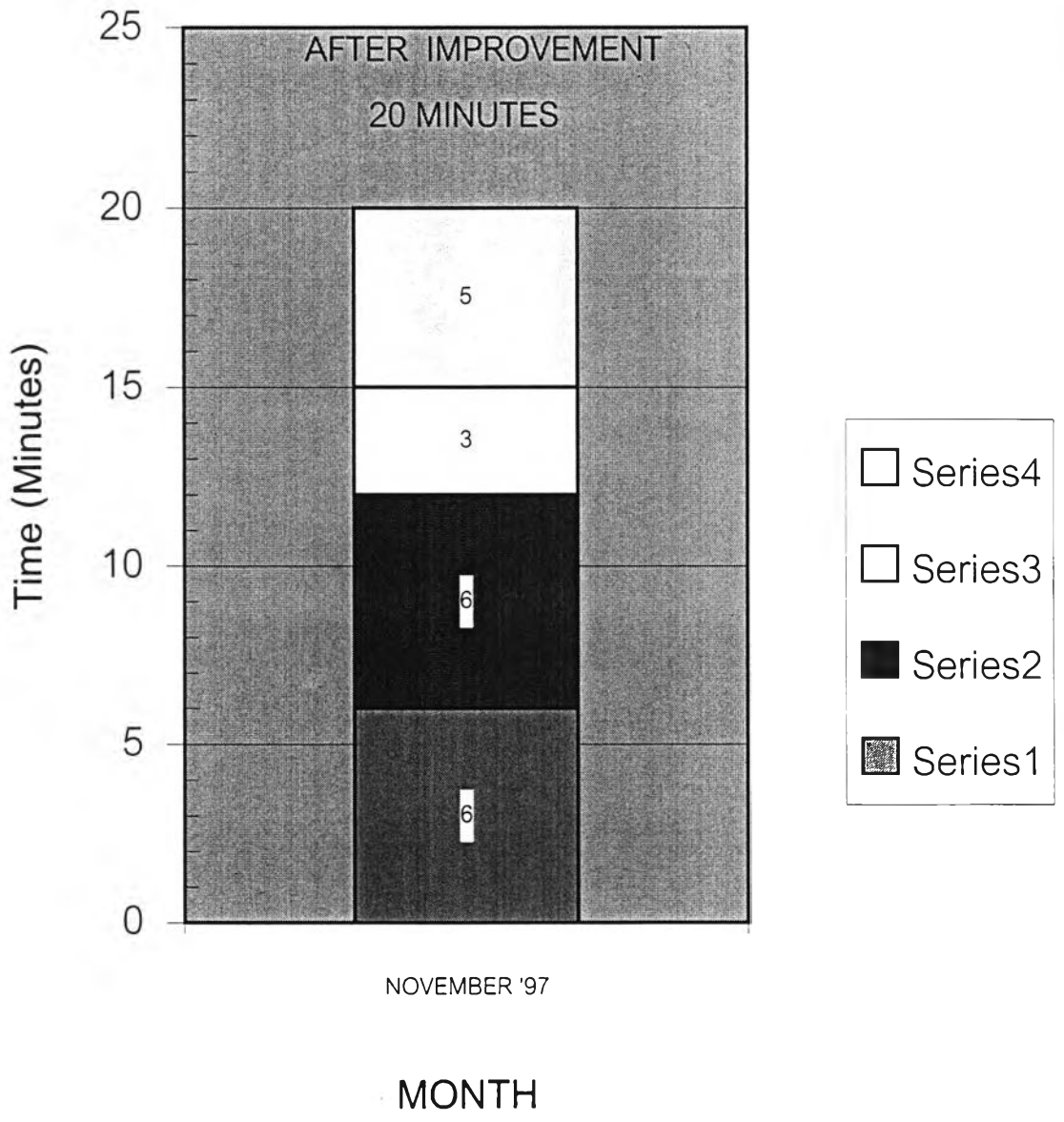


Fig 6.4 EX303 Lot change time analysis for sub-operator



6.2 Counter action result

After counter actions were implemented, The results showed for each stages in the jacketing machine process which were (1) Talc bath (2) Pay off (3) Take up (4) Printing unit (5) Water tank (6) Extruder (7) Hopper in Table 6.7 - 6.13 respectively and the comparing status of operation time between before implement counter action and after implement counter action was shown in Table 6.15.

6.2.1 At Talc bath

The total status of operation time at talc bath was reduced with 0.8 minute due to relocate air valve.

6.2.2 At Pay off

The counter action results at pay off showed that the total status of operation time was reduced with 2 minutes preparing tooling box near production area resulted in reduce transportation time and training conductor joint skill to operators and the conductor quality checking operation was changed to be the preparation in 6 minutes.

6.2.3 At Take up

The results showed that the total status of operation time at take up was decreased with 1 minute due to prepare calculator in production area which was resulted in reduce transportation time and the operation of preparing bobbin, check sample and input data in check sheet were changed to be the preparation about 15 minutes.

Table 6.7 : Counter action results at Talc bath

Step operation	Operation	Problem	Counter action	Existing Time (min)	Impro. Time (min)	Saving Time (min)	Finish date in 1997
reparation	Check talc bath condition	-	-	-	-	-	-
Operation	open air valve for hot jet and pull out conductor	take long time because the valve located near floor therefore it is difficult to operate	valve is removed to near hot jet panel	1.0	0.2	0.8	Sep.2
Total time (min)				1.0	0.2	0.8	

Table 6.8 : Counter action results at Pay-off

Step Operation	Operation	Problem	Counter action	Existing Time (min)	Improv. Time (min)	Saving Time (min)	Finish date in 1997
Operation	Check quality of conductor	take long time due to many checking points	do it at preparation step	6	6	0	Aug.13
Operation	conductor cut and set bobbin	take long time due to no tooling at operation area	prepare tooling box near operation area	3	2	1	Aug.13
Operation	Conductor joint	take long time due to no skill	Training and make skill to operator	2	1	1	Aug.13
Operation	Conductor pull out and pass line	take long time due to wire breakage	Improve drawing process and wire stranding process.	-	-	-	-
Operation	Pull out conductor	-	-	5	5	0	-
Adjustment	Check pass line	-	-	-	-	-	-
Total time (min)				16	14	2	

Table 6.9 : Counter action results at Take-up

Step operation	Operation	Problem	Counter action	Existing Time (min)	Impro time (min)	Saving Time (min)	Finish date in 1997
Operation	Prepare bobbin	Take time	do it at preparation step	1	1	0	Aug.13
Operation	Check sample	Take long time due to many points to check	sample check should do after completed product changed	6	6	0	Aug.13
Operation	fill data in check sheet	Take long time due to many data need to fill in check sheet	data should be filled in check sheet after completed product changed	8	8	0	Aug.13
Operation	Calculation data	Take long time due to no calculator near production area	prepare calculator in production area	2	1	1	Aug.10
Operation	Pull out wires	-	-	1	1	0	-
Adjustment	Adjust wires	-	-	2	2	0	-
Total time (min)				20	19	1	

6.2.4 At Water tank

The counter action results could reduced set up operation time 2 minutes due to improve the method of taking sample.

6.2.5 At Printing unit

The results showed that the total time at printing unit was reduced 9 minutes caused from connect automation between machine speed and printing roller speed and improve the way to take out and setting printing unit and some operation of cleaning and setting printing unit were changed to be the preparation about 11 minutes.

6.2.6 At Extruder

The counter action results showed that the total time at extruder was reduced for 13 minutes. Because of the improvement of cleaning and setting extruder such as utilize impact wrench, prepare tool box in production area, remove air gun and change some parts such as breaker plate, master core and screw.

6.2.7 At hopper

The counter action results showed that the total time at hopper was reduced for 1 minute because of hopper modification and the operation was changed to be the preparation.

6.3 Process flow result

Flow process chart of main operator and sub operator were shown in Table 6.16 and Table 6.17 respectively. The comparing process flow chart of main operator and sub operator were shown in Table 6.18 and Table 6.19 respectively.

Table 6.10 : Counter action results at Water-tank

Step operation	Operation	Problem	Counter action	Existing Time (min)	Improv time (min)	Saving Time (min)	Finish date in 1997
Operation	take sample from tank	take long time due to difficult to do and need skill operator	install stainless steel plate on the water tank in order to make it easy.	2	1	1	Aug.21
Operation	peel jacket from lead wire	take long time due to difficult to do by cutter	utilize stripper instead of cutter	3	2	1	Aug.28
Adjustment	pass line cord	take long time due to need to adjust twist cord	install more guide rollers to hold cable	-	-	-	Aug.11
Total (min)				5	3	2	

Table 6.11 : Counter action results at Printing unit

Step operation	Operation	Problem	Counter action	Existing Time (min)	Improv Time (min)	Saving Time (min)	Finish date in 1997
Operation	take off printing unit	take long time due to difficult to lock and adjust by hexagon wrench	Modify fixing bolt, do not use hexagon wrench.	1	0.5	0.5	Aug.15
Operation	clean washing plate	take long time	do it at preparation step	1	1	0	Aug.21
Operation	clean printing roll	take long time due to difficulty	Make work bench and dipping bath for roll and roll is cleaned during operation by Ultrasonic cleaning machine	1	1	0	Sep.28
Operation	clean roll shaft	take long time due to difficulty	make work bench and dipping bath for roll and roll is cleaned during operation by Ultrasonic cleaning machine.	1	1	0	Aug.28
Operation	clean docto blade holde	take long time due to difficulty	prepare spare and do it at preparation step	1	1	0	Aug.28

Table 6.11 : Counter action results at Printing unit (cont)

Step operation	Operation	Problem	Counter action	Existing Time (min)	Improv Time (min)	Saving Time (min)	Finish date in1997
Operation	change ink	take long time due to cleaning ink pot is difficulty.	Prepare spare ink pot and do it at preparation step	7	7	0	Aug.28
Operation	setting printing unit	take long time due to blade holder design is not good	modify blade holder to easier to set	2	1	1	Aug.14
Operation	Set printing unit	take long time due to difficult to lock and adjust by hexagon wrench	modify fixing bolt, do not use hexagon wrench.	2	1	1	Aug.15
Adjust	Adjust roller speed to be same as machine speed	take long time due to difficult	connect automation interlock between machine and roller speed automatically, no need to adjust.	6	0	6	Sep.30
Total (min)				22	13.5	8.5	

Table 6.12 : Counter action results at Extruder

Step operation	Operation	Problem	Counter action	Existing Time (min)	Improv Time (min)	Saving Time (min)	Finish date in 1997
Preparation	set extruder temperature	no instruction to set so it is up to operator skill	make instruction sheet for extruder temperature setting	-	-	-	Aug.28
Operation	take out bond heater from cross head	take long time due to difficult to turn the screw	change screw to one touch type	1	0.5	0.5	Aug.28
Operation	take out bolt and nut from cross head	take long time due to tool keeping panel is too far	make tool box in production area	2	1	1	Aug.2
Operation	take out bolt and nut from cross head	take long time	utilize impact wrench	2	1	1	Sep.2
Operation	take out nipple holder	take long time	utilize impact wrench	1	0.5	0.5	Sep.2
Operation	take out master core	Take long time	utilize impact wrench	2	1	1	Sep.2
Operation	cramp of sub extruder open and close	Take long time	utilize impact wrench	1	0.5	0.5	Sep.2

Table 6.12 : Counter action results at Extruder (cont)

Step operation	Operation	Problem	Counter action	Existing Time (min)	Improv Time (min)	Saving Time (min)	Finish date in 1997
Operation	cleaning breaker plate, die and nippple	Take long time	prepare spare and do it at preparation step by cleaning equipment	4	4	4	Sep.2
Operation	cleaning cross head and master core	Take long time due to inconvenience to use air gun because its keeping place is too high	air gun keeping place is moved to 1m high	2	1.5	0.5	Aug.12
Operation	cleaning master core	Take long time due to many compound burn remaining in master core cause from master core worn out	change new master core	-	-	-	Sep.31
Operation	set die and nipple	Take long time due to die and nipple no good quality made wire breakage	set incoming inspection and periodically inspection of die and nipple to keep the good condition	-	-	-	Aug15

Table 6.12 : Counter action results at Extruder (cont)

Step operation	Operation	Problem	Counter action	Existing Time (min)	Improv Time (min)	Saving Time (min)	Finish date in 1997
Operation	set die and nipple	Take long time due to die and nipple no good quality made wire breakage	2)improve cleaning method by using cleaning equipment	-	-	-	Aug15
Operation	overflow compound	take long time due to air bubble problem cause from screw worn out	change new screw	-	-	-	Sep.31
Operation	overflow compound	take long time due to contamination cause from breaker plate worn out	change new breaker plate	-	-	-	Sep.5
Operation	Pull out conductor	-	-	9	9	0	-
Adjustment	adjust center	take long time	utilize double head and job sharing between main and sub operator	21	19	3	Aug,30
Total time (min)				45	35	10	

Table 6.13 : Counter action results at Hopper

Step operation	Operation	Problem	Counter action	Existing Time (min)	Improv Time (min)	Saving Time (min)	Finish date in 1997
Operation	check compound	take long time due to many item to check	do it at preparation step	2	2	0	Aug.1
Operation	Cleaning	take long time due to difficulty to do	modify hopper	3	2	1	Sep.21
Adjustment	check compound overflow	overflow compound had many air bubbles due to screw worn out and fish-eye problem due to breaker plate worn out	change screw and breaker plate	-	-	-	Oct.5
Total time (min)				5	4	1	

Table 6.14 and Table 6.15 showed that after improvement operator had reduced set up time operation for operation and adjustment from 57 minutes to 24 minutes because some elements of operation and adjustment were moved to be preparation step which should done in external activities before set up operation time and some elements were reduced timing due to each improvement activities.

Table 6.14 : Summalized status of step operation time before improvement

M/C Stage	Step Operation							
	Main Operation				Sub Operation			
	Preparation	Operation	Adjustment	Total	Preparation	Operation	Adjustment	Total
Pay-off	0	5	0	5	6	3	0	9
Talc bath	0	0.2	0	0.2	0	0	0	0
Take up	0	1	0	1	15	1	2	18
Water tank	0	3	0	3	0	0	0	0
Printing unit	0	0	0	0	11	2.5	0	13.5
Extruder	5	11	2	18	0	0	14	14
Hopper	0	0	0	0	2	2	0	4
Total	5	20.2	2	27.2	34	8.5	16	58.5

Table 6.15 : Comparing status of step operation time between before improvement and after improvement for main operator and sub operator

M/C Stage	Step Operation							
	Main Operator				Sub Operator			
	Preparation	Operation	Adjustment	Total	Preparation	Operation	Adjustment	Total
Pay-off								
After	0	5	0	5	6	3	0	9
Before	0	5	0	5	0	11	0	11
Talc bath								
After	0	0.2	0	0.2	0	0	0	0
Before	0	1	0	1	0	0	0	0
Take up								
After	0	1	0	1	15	1	2	18
Before	0	1	0	1	0	17	2	19
Water tank								
After	0	3	0	3	0	0	0	0
Before	0	5	0	5	0	0	0	0
Printing unit								
After	0	0	0	0	11	2.5	0	13.5
Before	0	0	0	0	0	16	6	22
Extruder								
Before	5	11	2	18	0	0	14	14
After	0	24	21	45	0	0	0	0
Hopper								
Before	0	0	0	0	2	2	0	4
After	0	0	0	0	0	5	0	5
Total Before (B)	5	20.2	2	27.2	34	8.5	16	58.5
Total After (A)	0	36	21	57	0	48	9	57
Saving time (B)-(A)	5	(15.8)	(19)	(29.8)	34	(39.5)	7	1.5

6.3.1 Process flow chart of main operator

Flow process chart of main operator comparing before improvement and after improvement activity was shown as Table 6.18. It showed that time of operation was reduced from 49 minutes to 19, number of transportation was reduced from 3 times to 1 times resulted in transportation time was reduced from 5 minutes to 2 minutes and total set up time was reduced from 57 minutes to 24 minutes.

6.3.2 Process flow chart of sub operator

Flow process chart of sub operator comparing before improvement and after improvement activities was shown as in Table 6.19 No. of operation was been reduced from 10 times to 6 times which resulted in reducing operation time from 38 minutes to 18 minutes, number of transportation was reduced from 7 times to 2 times so transportation times was reduced from 17 minutes to 4 minutes and total set up time was reduced from 57 minutes to 24 minutes.

6.4 Step of operation result

After preparation steps were provided, It resulted in changing the step of cross-head cleaning and setting and the step of printing unit cleaning and setting.

6.4.1 Step of cross-head cleaning and setting

Table 6.20 showed the comparizon of step of Cross-head cleaning and setting before improvement and after improvement. Step no.5, 8 and 15 which were cleaning die, nipple and breaker plate respectively had non operated after improvement.

Table 6.16 : A Flow chart of maim-operator after improvement

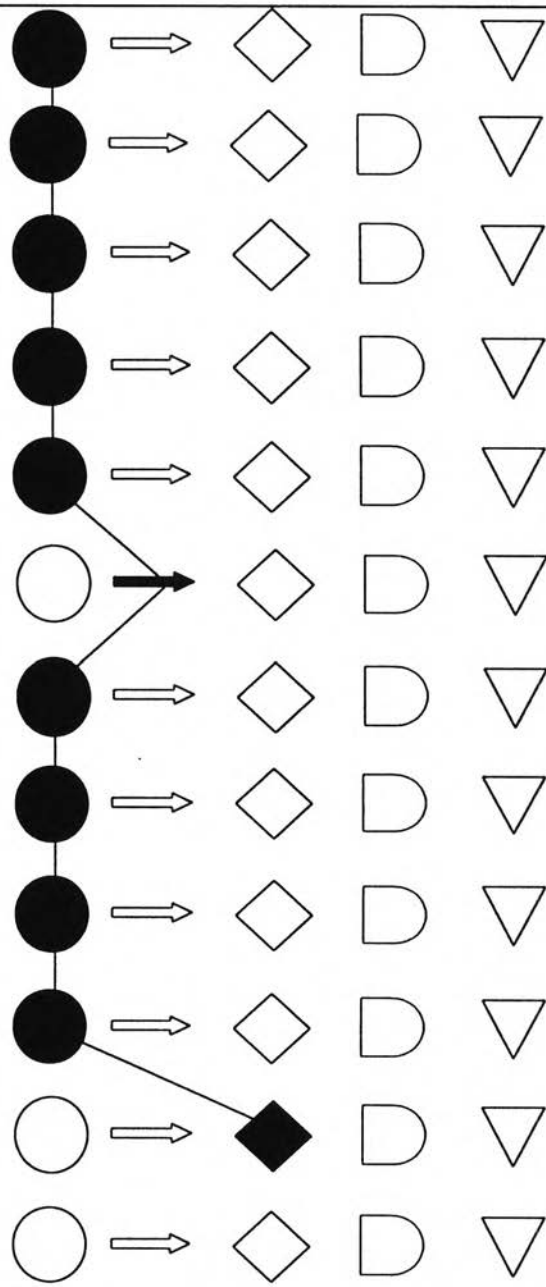
Distance (m)	Time (min)	Chart symbols	Process Description
	10		Cross-head cleaning and setting
	1		Open overflow compound
	1		Change pay-off bobbin
	1		Joint conductor
	1		Pull out conductor
10	2		Transportation to cross-head
	1		Start machine
	2		Adjust center
	1		Speed up machine
	1		Adjust center
	3		Check product quality

Table 6.17 : A Flow chart of sub-operator after improvement

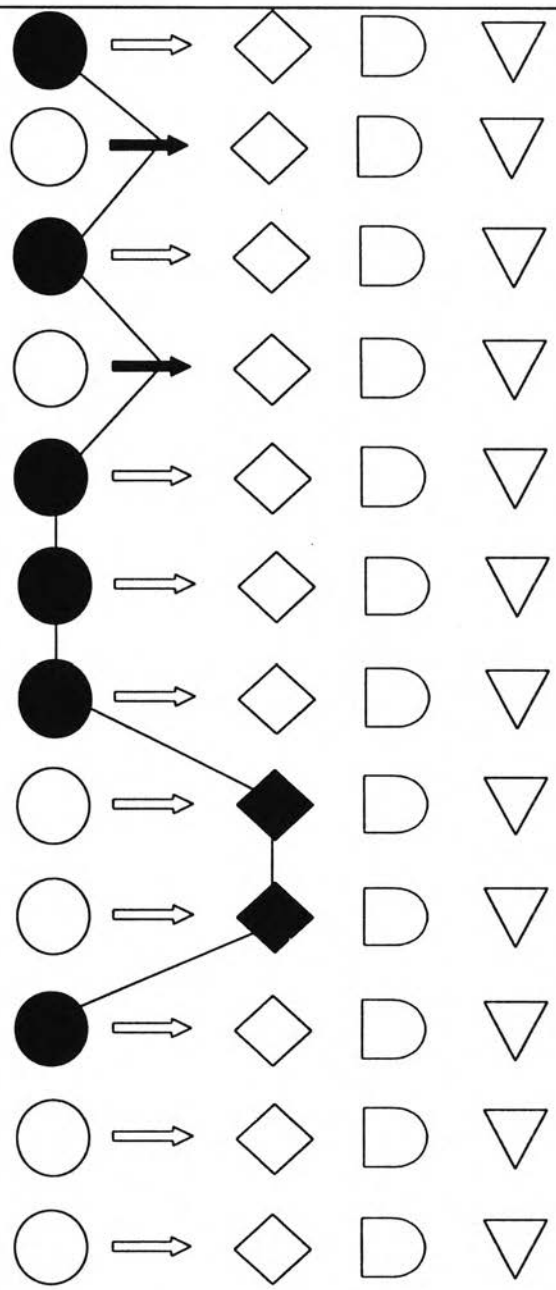
Distance (m)	Time (min)	Chart symbols	Process Description
	2		Printing unit setting
6	1		Transportation to take up
	1		Change take up bobbin
25	3		Transportation to pay-off
	3		Hopper cleaning and setting
	2		Counter setting
	4		Pull out conductor
	1		Check product center
	1		Check product center after speed up
	6		Input data in check sheet

Table 6.18 : Comparing process flow chart of main operator between before improvement and after improvement

Item	Before Improve		After Improve	
	No. of Operation (times)	Time (min)	No. of Operation (times)	Time (min)
Storage	1	0	0	0
Transportation	3	5	1	2
Operation	9	49	9	19
Inspection	1	3	12	3
Delay	NO	NO	NO	NO
Total	14	57	11	24

Table 6.19 : Comparing process flow chart of sub operator between before improvement and after improvement

Item	Before Improve		After Improve	
	No. of Operation (times)	Time (min)	No. of Operation (times)	Time (min)
Storage	1	0	0	0
Transportation	7	17	2	4
Operation	10	38	6	18
Inspection	2	2	2	2
Delay	NO	NO	NO	NO
Total	20	57	10	24

Table 6.20: Show the compare of step of Cross-head cleaning and setting before improvement and after improvement

Before Improvement	After Improvement
1). Switch off die heater	1). Switch off die heater
2). Remove die heater by wrench	2). Remove die heater by wrench
3). Remove die holder and clean	3). Remove die holder and clean
4). Remove die from die holder	4). Remove die from die holder
5). Clean die with steel brush	5). Non-operation**********
6). Set new die into die holder	6). Set new die into die holder
7). Remove nipple from nipple holder	7). Remove nipple from nipple holder
8). Clean nipple with steel brush	8). Non-operation**********
9). Remove nipple holder	9). Remove nipple holder
10). Set new nipple into nipple holder	10). Set new nipple into nipple holder
11) Remove master core and clean	11) Remove master core and clean
12). Remove overflow value and clean	12). Remove overflow value and clean
13). Remove clamp lock	13). Remove clamp lock
14). Remove breaker plate and clean	14). Remove breaker plate ad clean
15). Clean breaker plate	15). Non-operation**********
16). Set screen mesh	16). Set screen mesh
17). Install overflow value	17). Install overflow value
18). Set clamp lock	18). Set clamp lock
19). Set master core into cross head	19). Set master core into cross head
20). Set nipple holder and nipple	20). Set nipple holder and nipple
21). Set die holder and die	21). Set die holder and die
22). Spacing measuring	22). Spacing measuring
23). Center adjusting	23). Center adjusting
24). Lock hold nut	24). Lock hold nut
25). Lock neck	25). Lock neck

Table 6.21 : Show the compare of step of printing unit cleaning and setting before improvement and after improvement

Before Improvement	After Improvement
1). Take out printing roller, front & side blade, front & side blade holder, shaft roller	1). Take out old ink bath and set new ink bath instead of old ink bath
2). Cleaning printing roller, front & side blade, front & side blade holder, shaft roller	2). Non-operation**********
3). Cleaning ink bath	3). Non-operation**********
4). Set front blade and side blade with blade holler	4). Non-operation**********
5). Set marking roller fit with shaft roller	5). Non-operation**********
6). Set ink viscosity	6). Non-operation**********

6.4.2 Step of printing unit cleaning and setting

Table 6.21 showed the comparizon of step of printing unit cleaning and setting before improvement and after improvement. Step no. 2-6 were moved to be preparation step so there were non operated after improvement.

6.5 Man-machine chart

After study man-machine chart again, the man and machine chart after implement improvement activities was written as in Table 6.22. and the summary of man and machine chart was shown in Table 6.23.

Table 6.24 was compared man and machine chart between before improvement and after improvement which was reduced machine idle time about 33 minutes from 57 minutes to 24 minutes.

6.6 Over flow and start adjust scrap result

Table 6.25 and Table 6.26 showed the data of scrap of compound and copper analysis of production line Ex-302 and Ex-303 respectively for Power Cable in Jacket process in September,1997- June,1998. These data in Table 6.25 and Table 6.26 were ploted in Figure 6.5 and Figure 6.6 respectively.

The over flow scrap was 9.64-11.63% and 11.26-19.26% for Ex-302 and Ex-303 respectively. And start adjust scrap was 18.73-32.39% and 20.24-33.02% for Ex-302 and Ex-303 respectively. The data also showed that start adjust scrap was increased since March'98 due to new product implementation started in March'98 and wire break scrap was also incrasing due to Drawing and Standing Process problem.

Table 6.22 : Man and machine chart of Jacket Extruder machine

Man-1 (Main operator)	Man-2 (Sub operator)	Machine	Time (min)
Take out die,die holder, nipple, nipple holder, breaker plate and set die, die holder, nipple, nipple holder and breaker plate	Set printing unit	Idle	2
Change pay-off bobbins and joint conductor and pull out conductor	Hopper cleaning and put compound into hopper, counter setting and pull out conductor	Idle	10
Start and adjust center	Check product centering	Idle	8
Speed up and adjust center	Check product centering and change take up bobbin	Idle	4
Check product quality	Input data in check sheet	Idle	5
Check product quality	Write down check sheet	Working	20
Check product quality	Preparing new POM and new check sheet for new product	Working	5
Check machine and controller at extruder and pay-off... ..... , if it did not have the abnormal condition..... ..., Preparing conductor for new product by checking diameter of conductor and count no. of conductor after that record in new check sheet.	Check machine and controller at printing unit and take up .. , if it did not have the abnormal condition..... , Cleaning die and nipple	Working	20
Check product quality	Write down check sheet	Working	5

able 6.22 : Man and machine chart of Jacket Extruder machine (cont.)			
Man-1 (Main operator)	Man-2 (Sub operator)	Machine	Time (min)
heck machine and controller at xtruder and pay-off... ..... f it did not have the abnormal ondition....., reparing compound for new roduct by check compound ame from label, lot no. of ompound before record in new heck sheet	heck machine and controller at rinting unit and take up....., f it did not have the abnormal ondition....., leaning nipple holder and reaker-plate,	Working	20
heck machine and controller at xtruder and pay-off... ..... , if t did not have the abnormal ondition....., reparing die and nipple and hecking diameter and ppearance. , nipple holder, reaker plate(both main extruder nd sub extruder) for new roduct.	heck machine and controller at rinting unit and take up..... if t did not have the abnormal ondition....., leaning ink-pot and printing oller	Working	20
heck product quality	rite down in check sheet	Working	5
heck machine and controller at xtruder and pay-off... ..... , if t did not have the abnormal ondition..... ..., reparing nipple holder and reaker plate(both main extruder nd sub extruder) for new roduct.	heck machine and controller at rinting unit and take up... . if it id not have the abnormal ondition....., reparing printing unit for new roduct	Working	20

Table 6.22 : Man and machine chart of Jacket Extruder machine (cont.)			
Man-1 (Main operator)	Man-2 (Sub operator)	Machine	Time (min)
Check product quality	rite down in check sheet	Working	5
Check machine and controller at extruder and pay-off.....,	Check machine and controller at printing unit and take up... ,	Working	20
Check product quality	Write down in check sheet	Working	5
Check machine and controller at extruder and pay-off .....,	Check machine and controller at printing unit and take up.....	Working	20
Check product quality	Write down in check sheet	Working	5
Check machine and controller at extruder and pay-off..... ,	Check machine and controller at printing unit and take up.....	Working	20
If it had been reached customer order quantity.....			
Stop all buttons for stop machine	Prepare new bobbins	Working	1

Table 6.23 : Summary of Man and machine chart of Jacket machine after improvement

Man (Main and sub operator)	Machine	Time (min)
Do set up machine	Idle	24
Check product quality, Check machine and controller and write down check sheet If it has not been found any problem, Operator will do the preparation step for next order.	Working	Until finished

Table 6.24 : Comparing man and machine chart of Jacket machine between before improvement and after improvement

Man (Main and sub operator)		Machine		Time (min)	
Before improvement	After improvement	Before improvement	After improvement	Before improvement	After improvement
Do set up machine	Do set up machine	Idle	Idle	57	24
Check product quality, Check machine and controller and write down check sheet	Check product quality, Check machine and controller and write down check sheet If it has not been found any problem, Operator will do the preparation step for next order.	Working	Working	Until finished	Until finished

Table 6.27 and Table 6.28 showed data which comparing causes of scrap in Over flow and Start Adjust for Ex-302 and Ex-303 before improvement in February-April 1997 with after improvement in September 1997-June 1998.These data in Table 6.27 and Table 6.28 were plot in Figure 6.7 and Figure 6.8 respectively.

After set up operation time was reduced, the average of over flow scrap was significanted to reduce from 15.69% to 10.93% for Ex-302 and from 24.09% to 13.74%% for Ex-303 and the average of start adjust scrap was also singnificanted to reduced from 36.50% to 24.29% for Ex-302 and from 31.09% to 27.17% for Ex-303..

6.7 Down time result

Table 6.29 and Table 6.30 showed data of down time analysis of production line Ex-302 and Ex-303 for Power Cable in Jacket process in September 1997-June 1998.These data in Table 6.29 and Table 6.30 were plot in Figure 6.9 and Figure 6.10 respectively.

The product change down time was 41.12-57.49% and 45.38-55.66% for Ex-302 and Ex-303 respectively.

Table 6.31 and Table 6.32 showed data which comparing down time caused from product change which concerning set up operation of Ex-302 and Ex-303 before set up improvement in February-April 1997 with after set up improvement in September 1997-June 1998.This data in Table 6.31 and Table 6.32 were plot in Figure 6.11 and Figure 6.12 respectively.

After set up operation time was reduced, the average percentage of product change time was increased from 44.58% to 48.80% for Ex-302 and it was increased from 47.76% to 50.25% for Ex-303.

Table 6.25 : Percentage of compound and copper scrap analysis of production line Ex-302 for Power cable in Jacketing Process in September,1997-June,1998.

Percentage of compound and copper scrap of M/C EX-302 (%)										
	Month									
Type of scrap	Sep' 97	Oct' 97	Nov' 97	Dec' 97	Jan' 98	Feb' 98	Mar' 98	Apr' 98	May' 98	Jun' 98
Over flow	9.64	11.16	10.22	11.03	11.55	11.04	10.39	11.63	11.33	11.26
Start	21.65	31.45	18.73	21.37	23.52	19.17	22.05	22.43	30.15	32.39
Wire break	23.65	26.66	19.72	16.65	21.75	21.11	21.11	20.41	16.87	25.02
Appearance	0	0	2.61	0.48	0	1.76	12.77	3.51	3.44	5.62
Printing	12.28	11.02	12.25	21.0	24.22	23.10	20.31	17.33	28.32	18.66
Diameter	2.23	3.53	3.36	3.19	2.30	5.10	1.35	3.69	2.75	0
Others	30.55	16.19	33.11	26.28	16.67	18.71	12.02	21.00	7.13	7.04

Table 6.26 : Percentage of compound and copper scrap analysis of production line Ex-303 for Power cable in Jacketing Process in September,1997-June,1998.

Percentage of compound and copper scrap of M/C EX-303 (%)										
	Month									
Type of scrap	Sep' 97	Oct' 97	Nov' 97	Dec' 97	Jan' 98	Feb' 98	Mar' 98	Apr' 98	May' 98	Jun' 98
Over flow	19.26	12.9	16.42	12.66	11.63	14.87	13.06	14.00	11.33	11.26
Start	24.18	23.17	27.94	20.24	22.43	26.09	32.09	33.02	30.15	32.39
Wire break	20.33	11.96	11.32	6.08	20.41	18.23	27.70	22.65	16.87	25.02
Appearance	0.51	11.95	2.69	6.54	3.51	15.27	1.62	4.31	3.44	5.62
Printing	16.59	24.78	27.87	39.28	17.33	9.98	18.29	15.51	28.32	18.66
Diameter	2.52	3.22	3.14	2.91	3.69	4.36	0.39	1.47	2.75	0
Others	16.6	12.01	10.61	12.29	21.0	11.20	6.86	9.04	7.13	7.04

Table 6.27 : Comparing Over flow scrap and Start Adjust scrap for Ex-302 before set up improvement and after set up improvement.

M/C EX-302							
Over flow				Start Adjust			
Before improvement		After improvement		Before improvement		After improvement	
Month	% of scrap	Month	% of scrap	Month	% of scrap	Month	% of scrap
Feb'97	15.16	Sep'97	9.64	Feb'97	42.03	Sep'97	21.65
Mar'97	20.79	Oct'97	11.16	Mar'97	42.01	Oct'97	31.45
Apr'97	11.13	Nov'97	10.22	Apr'97	25.47	Nov'97	18.73
		Dec'97	11.03			Dec'97	21.37
		Jan'98	11.55			Jan'98	23.52
		Feb'98	11.04			Feb'98	19.17
		Mar'98	10.39			Mar'98	22.05
		Apr'98	11.63			Apr'98	22.43
		May'98	11.33			May'98	30.15
		Jun'98	11.26			Jun'98	32.39
Average	15.69	Average	10.93	Average	36.50	Average	24.29

Table 6.28 : Comparing Over flow scrap and Start Adjust scrap for Ex-303 before set up improvement and after set up improvement.

M/C EX-303							
Over flow				Start Adjust			
Before improvement		After improvement		Before improvement		After improvement	
Month	% of scrap	Month	% of scrap	Month	% of scrap	Month	% of scrap
Feb'97	26.61	Sep'97	19.26	Feb'97	37.43	Sep'97	24.18
Mar'97	21.04	Oct'97	12.90	Mar'97	32.69	Oct'97	23.17
Apr'97	24.63	Nov'97	16.42	Apr'97	23.14	Nov'97	27.94
		Dec'97	12.66			Dec'97	20.24
		Jan'98	11.63			Jan'98	22.43
		Feb'98	14.87			Feb'98	26.09
		Mar'98	13.06			Mar'98	32.09
		Apr'98	14.00			Apr'98	33.02
		May'98	11.33			May'98	30.15
		Jun'98	11.26			Jun'98	32.39
Average	24.09	Average	13.74	Average	31.09	Average	27.17

Figure 6.5 Comparing percentage of Overflow scrap of Ex-302 before improvement in Feb'97-Apr'97 and after improvement in Sep'97-Jun'98

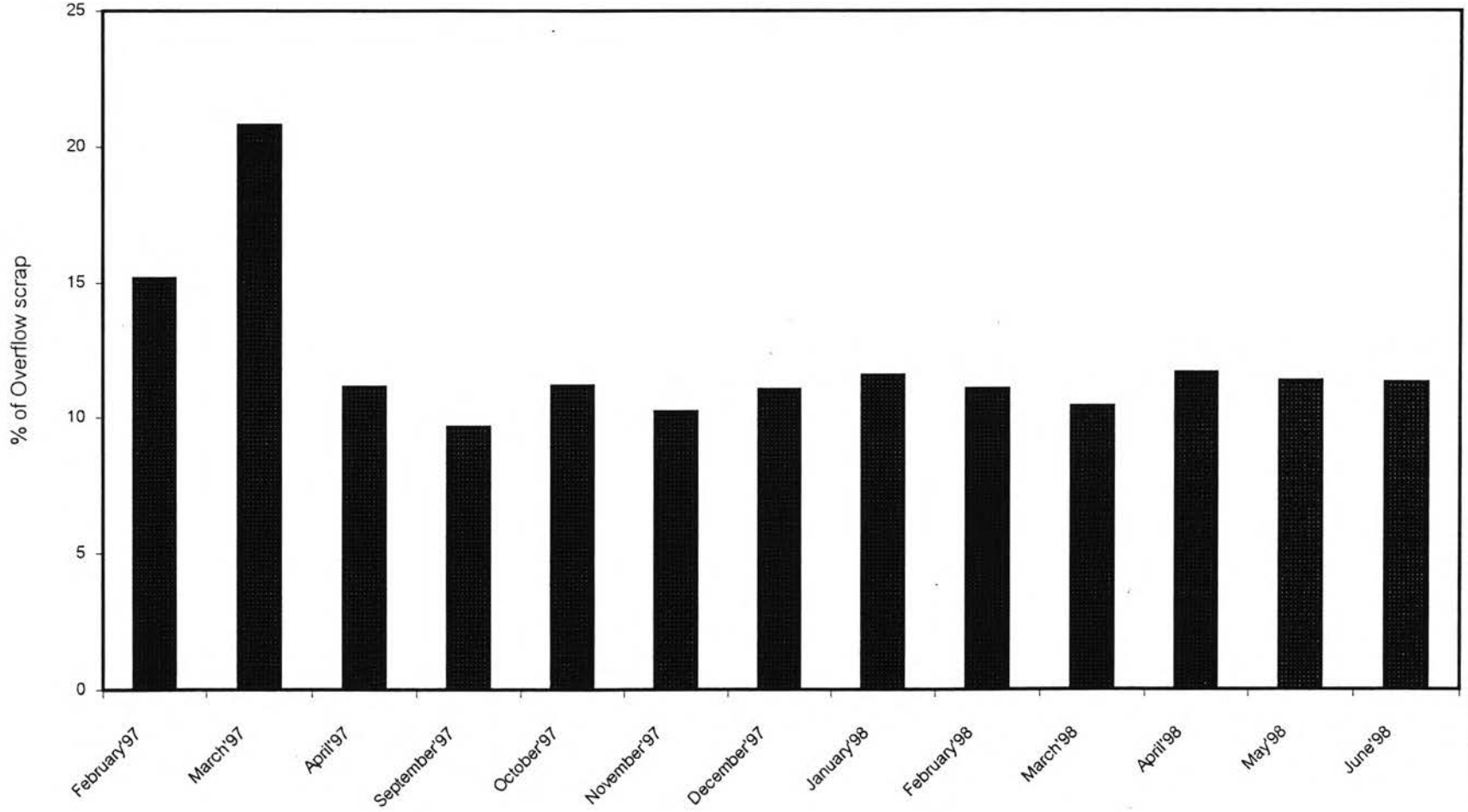


Figure 6.6 Comparing percentage of Start Adjust scrap of Ex-302 before improvement in Feb'97-Apr'97 and after improvement Sep'97-Jun'98

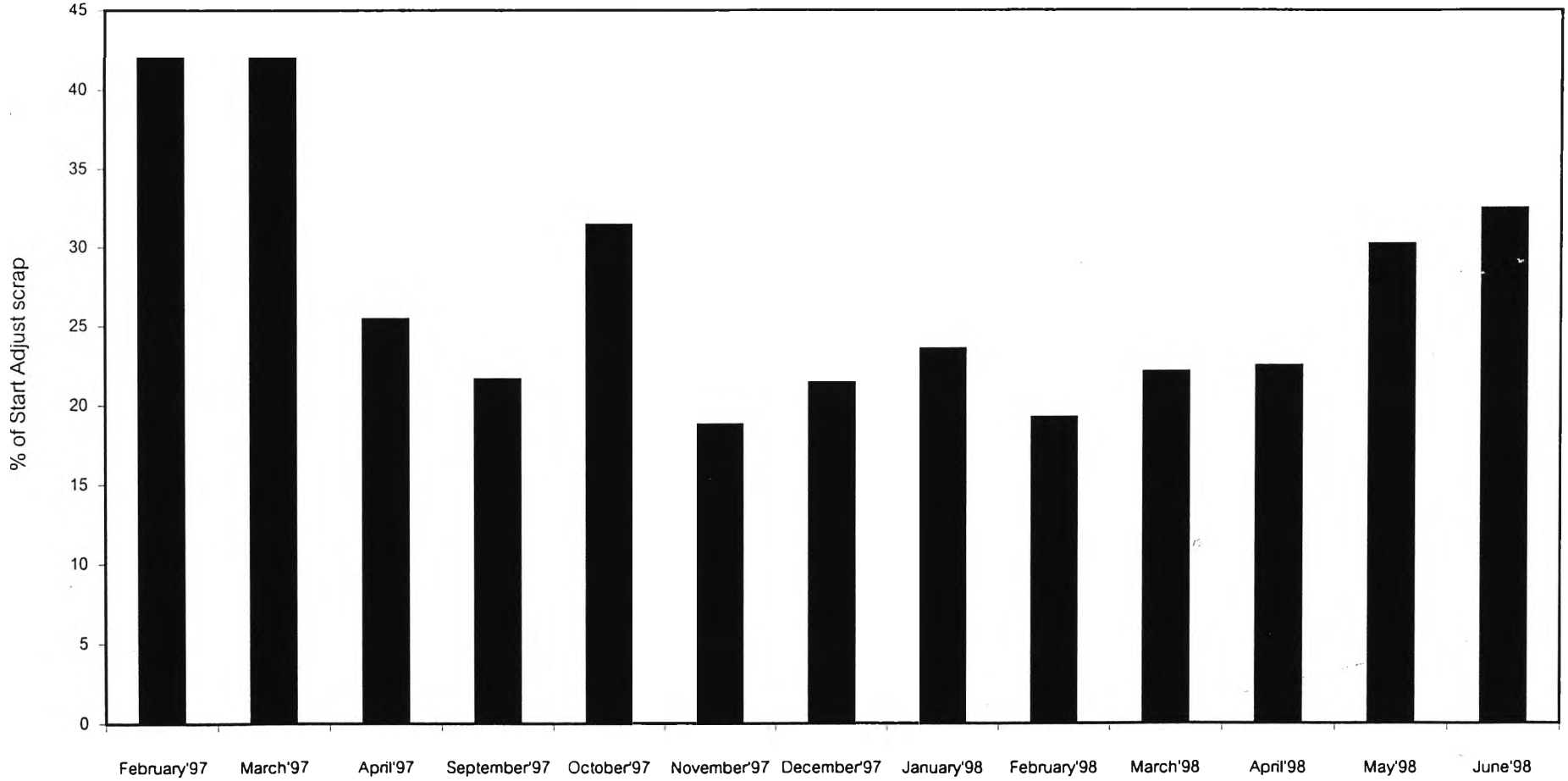


Figure 6.7 Comparing percentage of Overflow scrap of Ex-303 before improvement in Feb'97-Apr'97 and after improvement in Sep'97-Jun'98

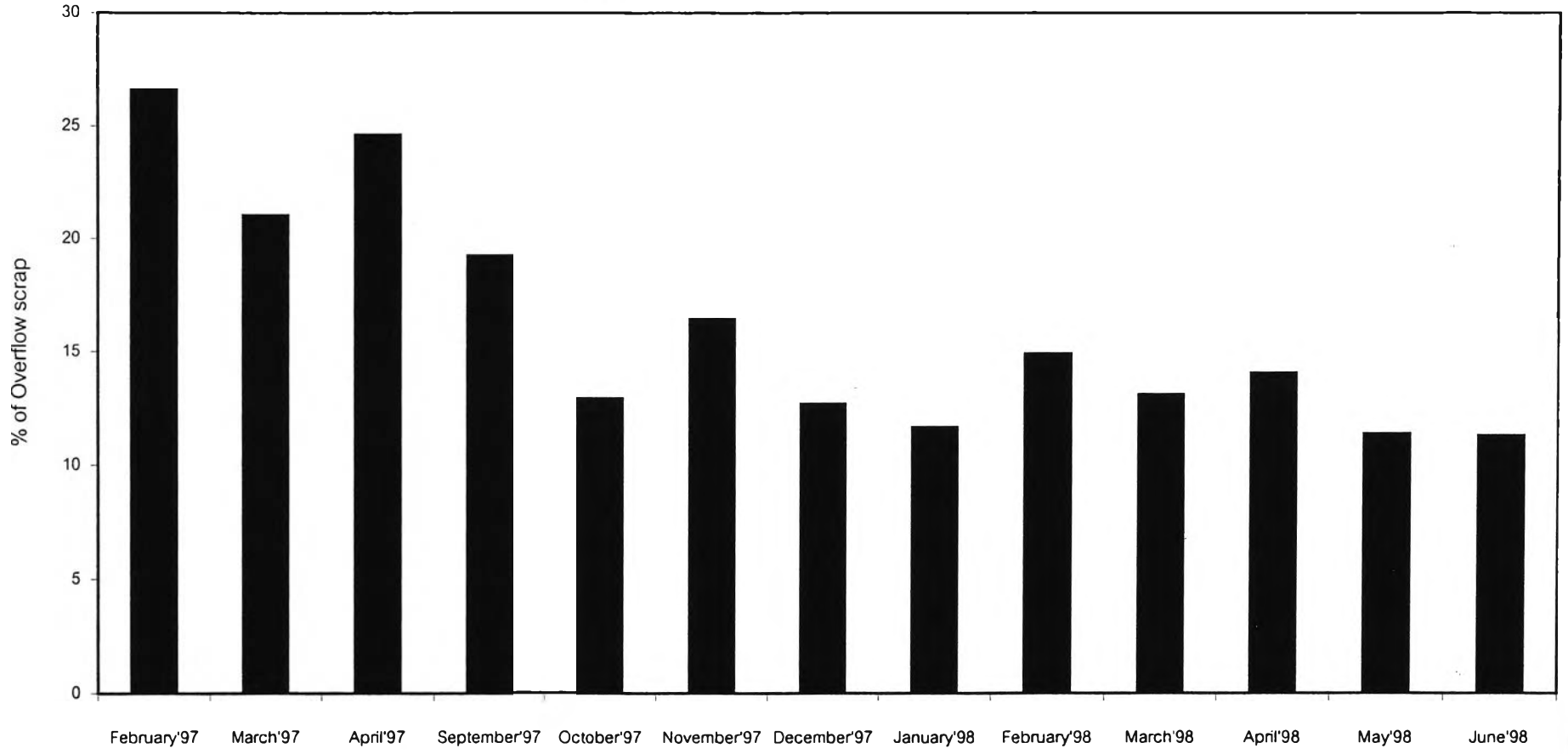
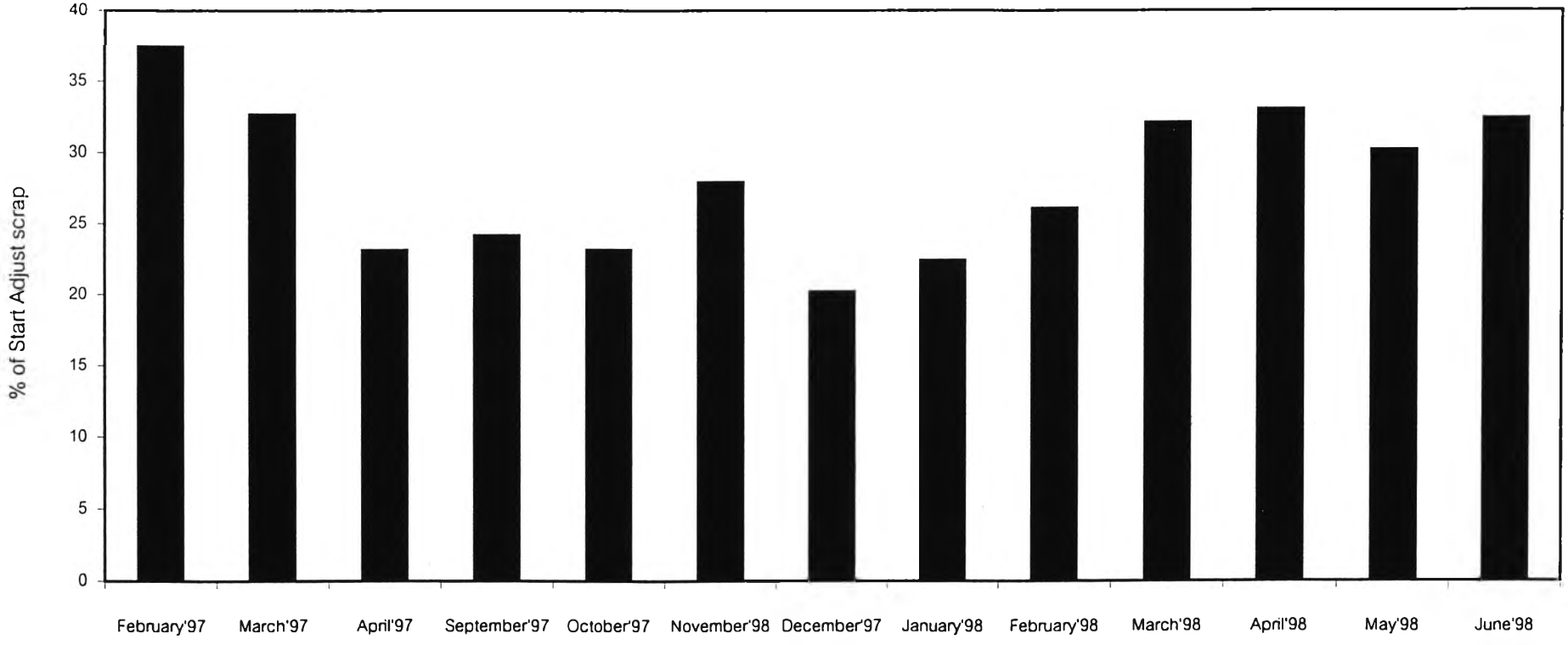


Figure 6.8 Comparing percentage of Start Adjust scrap of Ex-303 before improvement in Feb'97-Apr'97 and after improvement in Sep'97-Jun'98



It could be noticed that percentage of product change time was still high due to number of product change increasing.

Table 6.33 and Table 6.34 showed data which comparing amount of product change time of Ex-302 and Ex-303 before set up improvement in February-April,97 with after set up improvement in September,97-June,98.These data in Table 6.33 and Table 6.34 were plot in Figure 6.13 and Figure 6.14 respectively.

The average amount of product change times was increased from 54 times to 103 times for Ex-302 and it was increased from 63 times to 103 times for Ex-303. The reason of increasing amount of product change times was customer requirement because customer would like to change stock policy by reducing lot size of product.

After customer changed their stock policy, cable production would faced the delivery problem due to down time caused from product change increasing which was reduced the available time in production line. But it was not faced any deliver problem even though the amount of product increasing from 6000 km to 8000 km because of the result of set up time reduction activities. So it could be concluded that the result of set up time reduction activities was resulted in not only saving the scrap but also saving machine idle times especially the existing condition which increased the amount of product change times.

Table 6.29 : Down time Analysis of production line Ex-302 for Power Cable in Jacketing Process in September.97-Jun,98.

Percentage of down time of M/C EX-302 (%)										
	Month									
Type of Down time	Sep' 97	Oct' 97	Nov' 97	Dec' 97	Jan' 98	Feb' 98	Mar' 98	Apr' 98	May' 98	Jun' 98
M/C Problem	36.15	28.9	27.14	33.33	40.75	30.35	39.26	37.19	32.66	19.48
Product change	44.13	41.12	48.93	48.31	47.35	52.17	46.21	50.5	51.64	57.49
Quality	7.61	3.13	4.23	0.78	3.07	6.79	7.64	2.96	4.19	5.69
Planning Problem	8.39	5.61	2.21	0.78	0.94	3.14	1.7	2.26	4.22	3.15
Others	3.54	21.23	17.49	9.35	7.89	7.54	5.18	7.09	7.29	14.19

Table 6.30 : Down time Analysis of production line Ex-303 for Power Cable in Jacketing Process in September,97-June,98

Percentage of down time of M/C EX-303 (%)										
	Month									
Type of Down time	Sep' 97	Oct' 97	Nov' 97	Dec' 97	Jan' 98	Feb' 98	Mar' 98	Apr' 98	May' 98	Jun' 98
M/C Problem	25.74	19.15	34.17	24.2	37.24	22.66	24.15	28.54	32.54	22.53
Product Change	55.66	50.45	47.87	46.67	45.38	55.32	51.69	48.67	49.35	51.4
Quality	6.76	5.22	3.02	2.23	3.56	10.02	6.4	5.24	2.87	3.08
Planning Problem	4.74	15.02	2.06	4.24	3.9	3.15	6.17	7.78	6.28	5.51
Others	7.09	10.16	12.34	22.66	9.92	7.84	11.59	9.76	8.95	17.47

Table 6.31 : Comparing % of Product change Down time for Ex-302 before set up improvement and after set up improvement.

EX-302			
Before improvement		After improvement	
Month	% of product change time	Month	% of product change time
Feb'97	59.83	Sep'97	44.31
Mar'97	31.51	Oct'97	41.12
Apr'97	42.39	Nov'97	48.93
		Dec'97	48.31
		Jan'98	47.35
		Feb'98	52.18
		Mar'98	46.21
		Apr'98	50.5
		May'98	51.64
		Jun'98	57.49
Average	44.58	Average	48.80

Table 6.32 : Comparing % of Product change Down time for Ex-303 before set up improvement and after set up improvement.

EX-303			
Before improvement		After improvement	
Month	% of product change time	Month	% of product change time
Feb'97	34.72	Sep'97	55.66
Mar'97	44.67	Oct'97	50.45
Apr'97	66.89	Nov'97	47.87
		Dec'97	46.67
		Jan'98	45.38
		Feb'98	55.32
		Mar'98	51.69
		Apr'98	48.67
		May'98	49.35
		Jun'98	51.40
Average	48.76	Average	50.25

Table 6.33 : Comparing amount of Product change Down time for Ex-302 before set up improvement and afte set up improvement.

EX-302			
Before improvement		After improvement	
Month	No. product change (times)	Month	No. product change (times)
Feb'97	57	Sep'97	96
Mar'97	37	Oct'97	82
Apr'97	69	Nov'97	104
		Dec'97	106
		Jan'98	111
		Feb'98	112
		Mar'98	95
		Apr'98	100
		May'98	136
		Jun'98	92
Average	54	Average	103

Table 6.34 : Comparing amount of Product change Down time for Ex-303 before set up improvement and after set up improvement.

EX-303			
Before improvement		After improvement	
Month	No. product change (times)	Month	No. product change (times)
Feb'97	56	Sep'97	101
Mar'97	52	Oct'97	94
Apr'97	82	Nov'97	96
		Dec'97	115
		Jan'98	96
		Feb'98	130
		Mar'98	108
		Apr'98	109
		May'98	84
		Jun'98	99
Average	63	Average	103

Figure 6.9 Comparing percentage of Product Change Down Time of Ex-302 before improvement in Feb'97-Apr'97 and after improvement in Sep'97-Jun'98

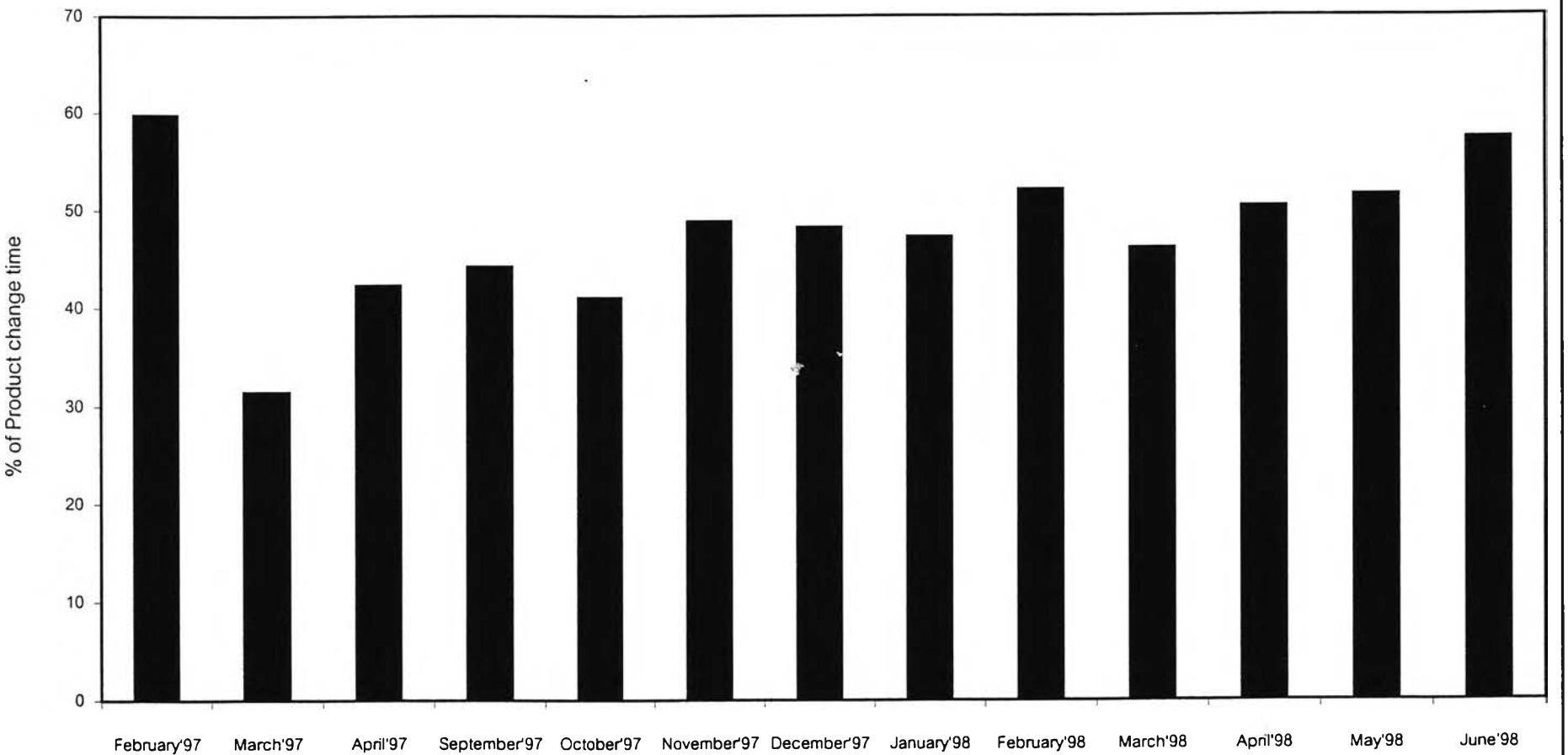


Figure 6.10 Comparing percentage of Product Change Down Time of Ex-303 before improvement in Feb'97-Apr'97 and after improvement in Sep'97-Jun'98

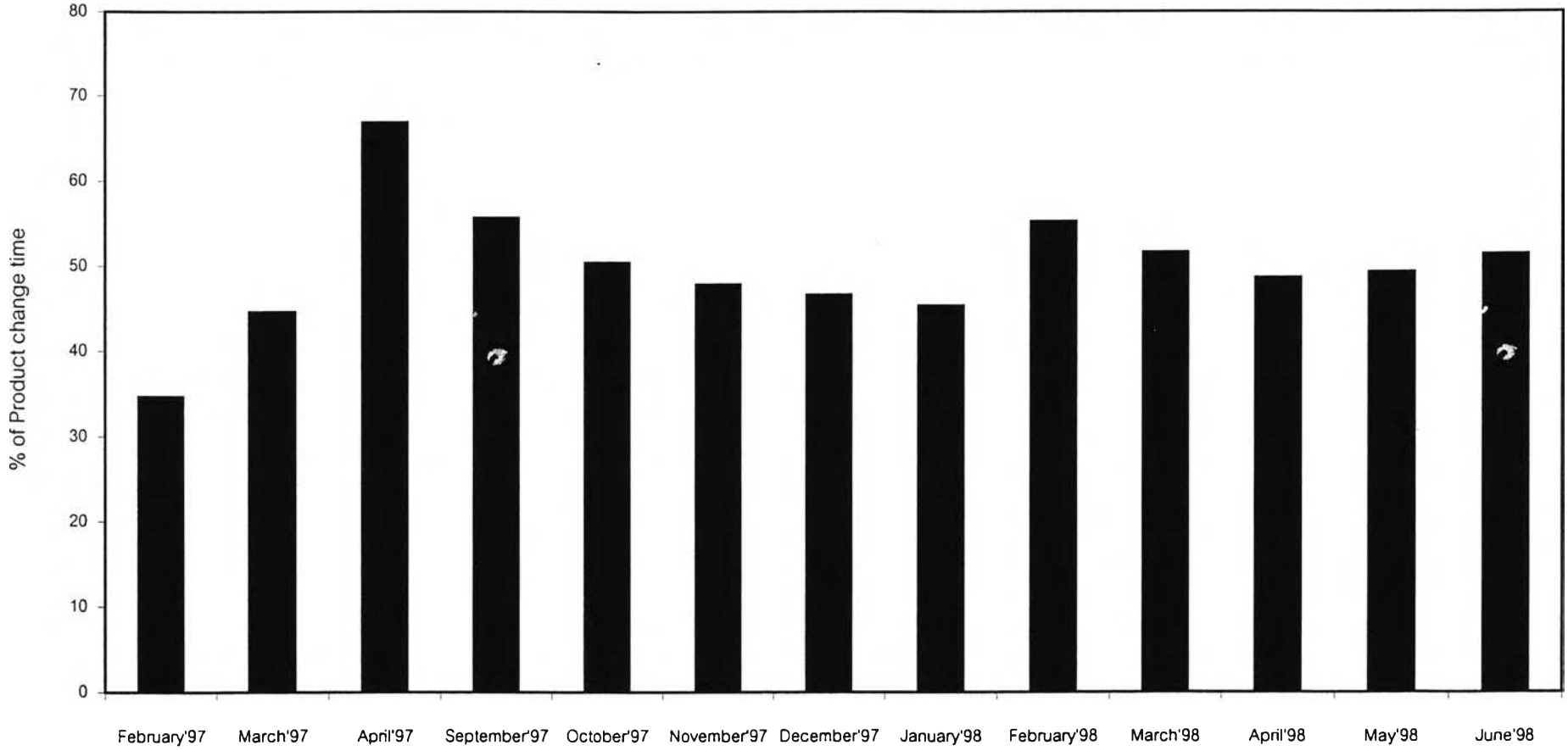


Figure 6.11 Comparing Amount of Product Change of Ex-302 before improvement in Feb'97-Apr'97 and after improvement in Sep'97-Jun'98

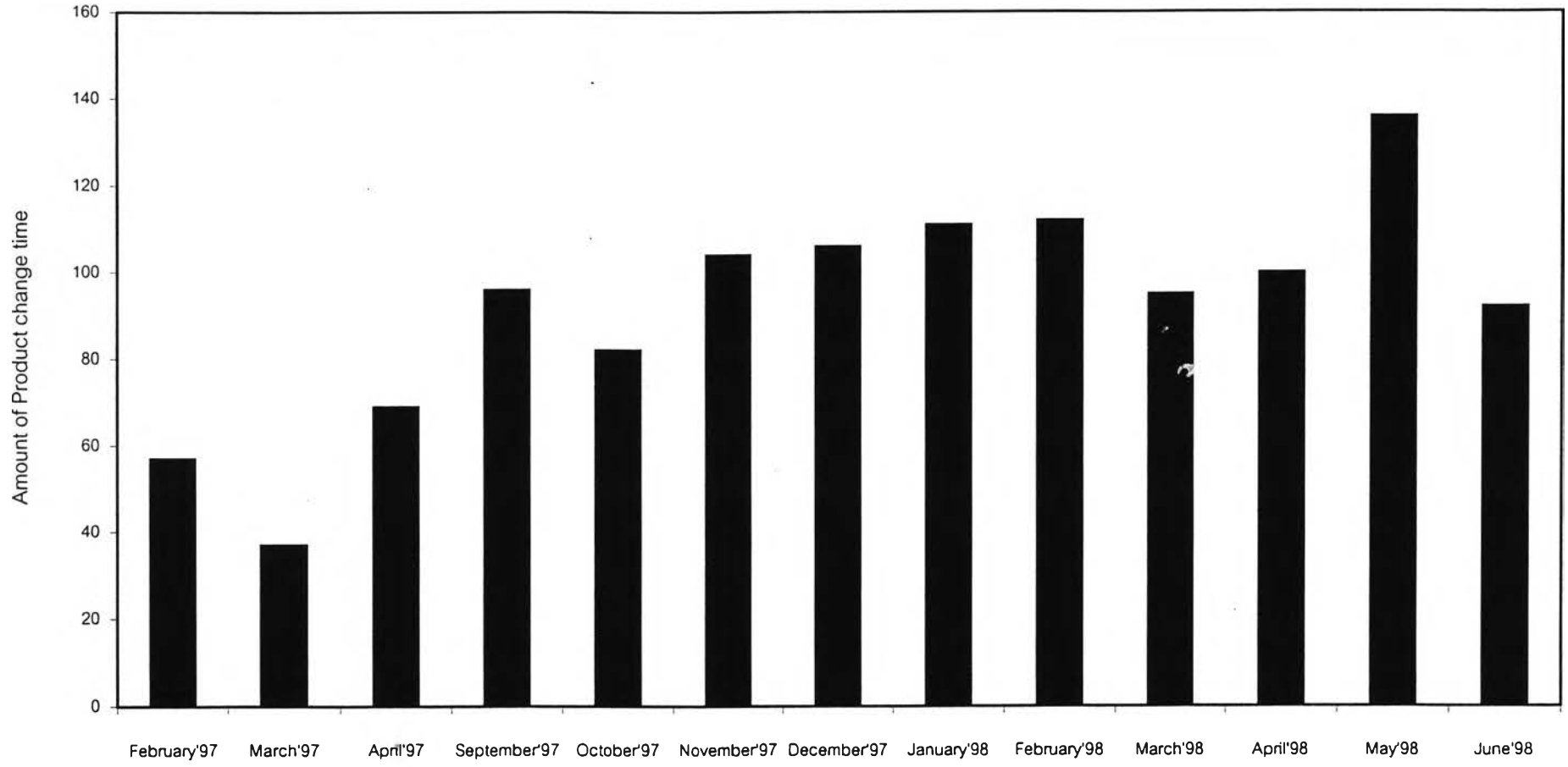


Figure 6.12 Comparing Amount of Product Change of Ex-303 before improvement in Feb'97-Apr'97 and after improvement in Sep'97-Jun'98