CHAPTER 6

SYSTEM EVALUATION

This chapter evaluates the system after implementation on an ESEC die attach machine model 2007. While the Die attach machine error detection system is working automatically, current process of down time record is still used simultaneously. This is to compare between both processes and evaluate the die attach machine error detection system. In order to prevent an error of evaluation, total duration of both systems is the same. However, the data during September 24th – 26th, 1999 is used as representative of the system evaluation, by comparison between data from the error detection system and down time card during the same period. In additional, the data validation is done at the end of section in order to measure the accuracy of the error detection system.

6.1 Down time card record analysis

Based on the information on down time card, machine state transition during the date of September 24th-26th, 1999 will be shown as below. This machine state transition refers to the information on down card during evaluated period. Figure 6.1 illustrates the down time card and its records during that period.

Date	Time	State	Duration (minutes)
Sep.24,99	**14.45**	**Start evaluation**	
Sep.24,99	14.45	Utilised	40
Sep.24,99	15.25	Down	10
Sep.24,99	15.35	Utilised	135
Sep.24,99	17.50	Down	20
Sep.24,99	18.10	Utilised	75
Sep.24,99	19.25	Idle	15
Sep.24,99	19.40	Utilised	110
Sep.24,99	21.30	Idle	50
Sep.24,99	22.20	Utilised	15
Sep.24,99	22.35	Down	50

Sep.24,99	23.25	Utilised	75
Sep.25,99	00.40	Down	15
Sep.25,99	00.55	Utilised	155
Sep.25,99	03.30	Idle	5
Sep.25,99	03.35	Utilised	80
Sep.25,99	04.55	Idle	15
Sep.25,99	05.10	Utilised	110
Sep.25,99	07.00	Down	10
Sep.25,99	07.10	Utilised	260
Sep.25,99	11.30	Idle	60
Sep.25,99	12.30	Utilised	60
Sep.25,99	13.30	Idle	35
Sep.25,99	14.05	Utilised	205
Sep.25,99	17.30	Idle	50
Sep.25,99	18.20	Utilised	185
Sep.25,99	21.25	Down	10
Sep.25,99	21.35	Utilised	85
Sep.25,99	23.00	Idle	30
Sep.25,99	23.30	Utilised	60
Sep.26,99	00.30	Idle	60
Sep.26,99	01.30	Utilised	90
Sep.26,99	03.00	Down	10
Sep.26,99	03.10	Utilised	80
Sep.26,99	**04.30**	**Stop evaluation**	

MACHINE DOWN TIME REPORT									
DATE	SHIFT	PT NUMBER	STATE / PROBLEM	TIME START	TIME FINISH	TOTAL D/T	TOTAL R/T	ACTIONS	E/N
Sep.24,99	O	FSCP9H806.1	Set up host communications	14.40	14.45	-	-	Start error detection system	134400
Sep.24,99	C	FSCP9H806.1	Down / Die orientation problem	15.25	15.35	10	10	Set camera and ejector	155849
Sep.24,99	C	FSCP9H806.1	Down / Skip good die	17.50	18.10	20	20	Learn chip	155849
Sep.24,99	C	FSCP9H808.1	Idle / Change epoxy	19.25	19.40	15	15	Change and set epoxy	144831
Sep.24,99	C	PSTP94157.1	Idle / Change device number	21.30	22.20	50	50	Change device and set epoxy	144831
Sep.24,99	B	PSTP94159.1	Down / Die placement problem	22.35	23.25	50	50	Set bond head and teach PRS	143116
Sep.25,99	B	PSTP94158.2	Down / Insufficient poly	00.40	00.55	15	15	Change epoxy	143116
Sep.25,99	B	N/A	Idle / Material short	03.30	03.35	5	5	Material short	
Sep.25,99	B	PSTP94159.2	Idle / Machine set up	04.55	05.10	15	15	Machine set up for new lot	164328
Sep.25,99	D	PSTP94179.8	Down / Die placement problem	07.00	07.10	10	10	Learn new chip	158215
Sep.25,99	D	ICGP90316.1	Idle / Change device	11.30	12.30	60	60	Change device / buy-off / set BLT	137278
Sep.25,99	D	ICGP90316.1	Idle / Change epoxy	13.30	14.05	35	35	Change epoxy	158275
Sep.25,99	C	ACSP97235.1	Idle / Change device and epoxy	17.30	18.20	50	50	Change device and set epoxy	144612
Sep.25,99	C	ACSP97233.2	Down / Skip good die	21.25	21.35	10	10	Learn new chip	155847
Sep.25,99	B	ACSP97234.1	Idle / Change epoxy	23.00	23.30	30	30	Change epoxy	143116
Sep.26,99	B	FSCP9H929.1	Idle / Change device	00.30	01.30	60	60	Change device	143116
Sep.26,99	B	FSCP9H929.1	Down / Insufficient poly	03.00	03.10	10	10	Fill epoxy	143998
Sep.26,99	B	FSCP9H929.1	Stop host communications	04.30					134400

Figure 6.1: Information on down time card during September 24th-26th, 1999 on ESEC# 13.

The data analysis based on the information on the down time cards are as follows.

Total time	:	2,265 minutes
Machine down time	:	125 minutes
Machine idle time	:	320 minutes
Machine utilisation time	:	1,820 minutes

The percentage of each machine state is as follows:

Machine down	:	5.52%
Machine idle	:	14.13%
Machine utilisation	:	80.35%

6.2 Error detection system records analysis

As mention in Chapter 5 that all machine activities are recorded in an electronic text file in order to use for further analysis. APPENDIX F illustrates the data of machine activities that are recorded by the die attach machine error detection system during the same period as the previous section (down time record). The text file will be loaded and converted to worksheet file by Microsoft Excel. The Microsoft Excel has the function to facilitate for data analysis. The data can be sorted and calculated for duration of each machine state.

Figure 6.2 illustrates the total time that is calculated by Microsoft Excel based on data from the die attach machine error detection system. Moreover, time can be separately calculated by date.

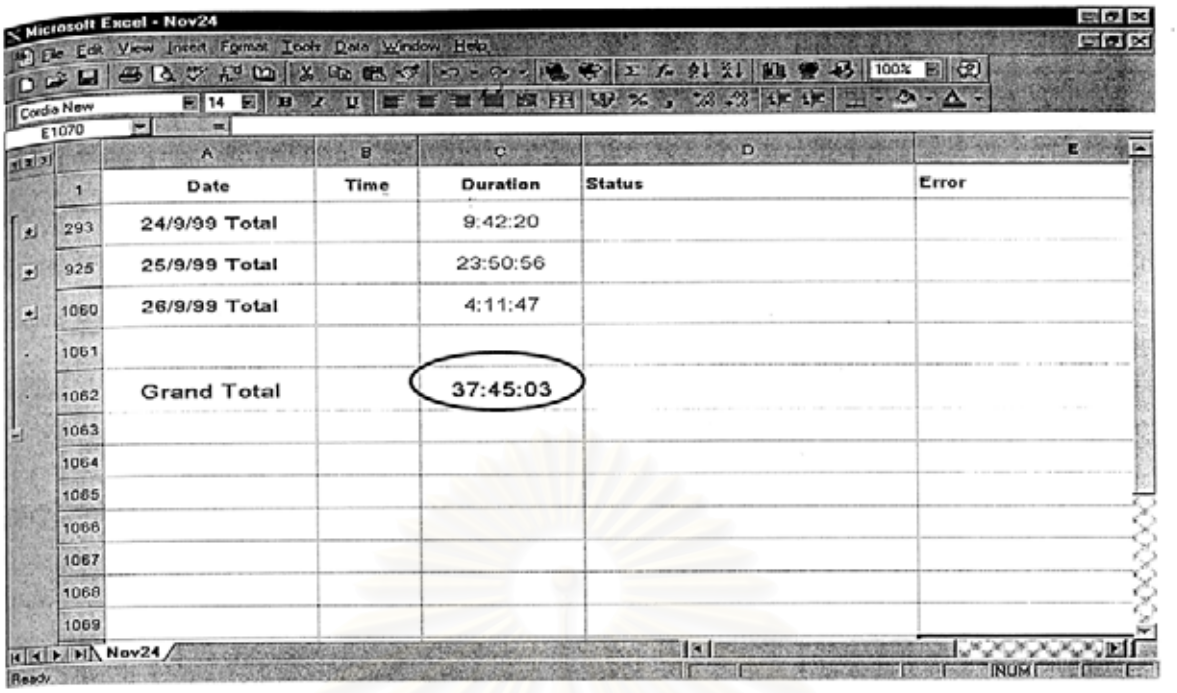

Figure 6.2: Total time based on the die attach error detection system that is calculated by Microsoft Excel.

The following figure is the sum of Down time, Idle time and Utilisation time that is also calculated by Microsoft Excel which refers to the data from the die attach machine error detection system.

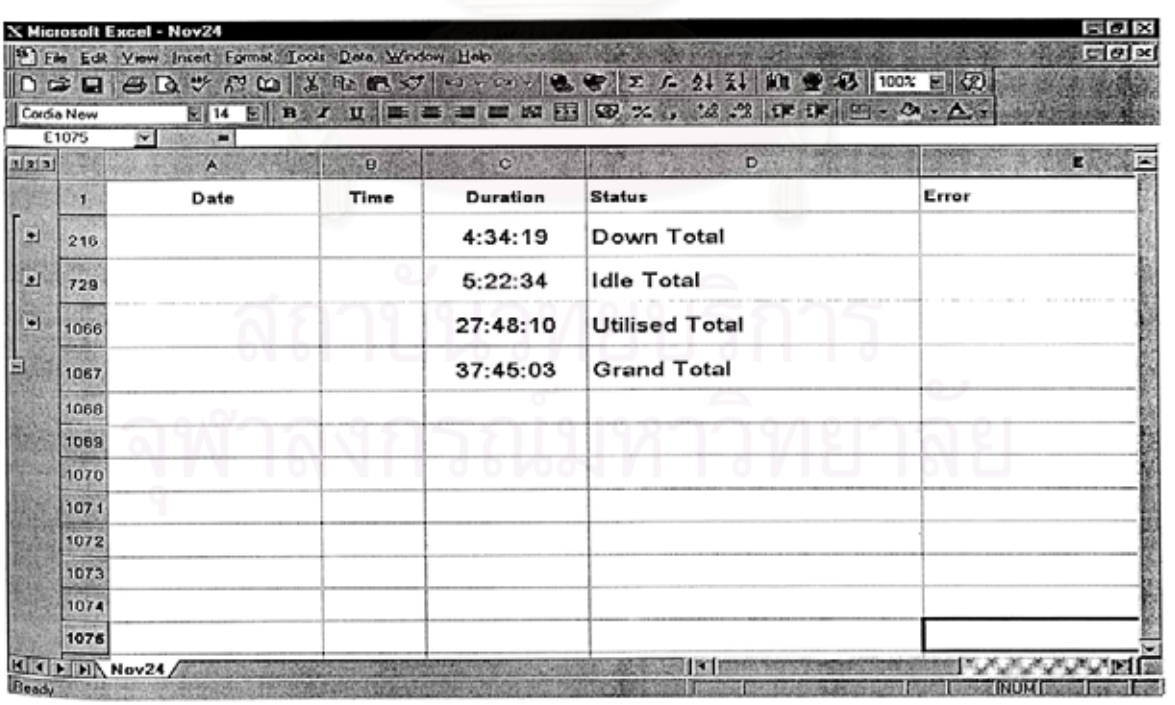

Figure 6.3: Sum of Down, Idle and Utilisation time calculated by Microsoft Excel

After using the Microsoft Excel to calculate the sum of duration for each machine state by refer to the information from the die attach error detection system, the result is below.

Total time	: 37 hours 45 minutes	= 2,265 minutes
Machine down time	: 4 hours 34 minutes	= 274 minutes
Machine idle time	: 5 hours 23 minutes	= 323 minutes
Machine utilisation time	: 27 hours 48 minutes	= 1,668 minutes

The percentage of each machine state is below:

Machine down	:	12.10%
Machine idle	:	14.26%
Machine utilisation	:	73.64%

6.3 Comparison between two systems

The following is a comparison of the analysis data between the down time recorded manually and the error detection system.

	Down time record	Error detection system
Total time	: 2,265 minutes	2,265 minutes
Machine down time	: 125 minutes	274 minutes
Machine idle time	: 320 minutes	323 minutes
Machine utilisation time	: 1,820 minutes	1,668 minutes
%Down time	: 5.52	12.10
%Idle time	: 14.13	14.26
%Utilisation	: 80.35	73.64

According the above data, it can be analysed the result of this evaluation as below.

1) Down time that is calculated by refer to information on the die attach machine error detection system is much higher than the down time card record.

2) The idle time is not significant different between using the information from down time card and the die attach error detection system.

3) When using the information on the error detection system for calculation of utilisation time, it provides less percentage than using information on down time card.

Based on the above summarisation, there are many differences between the analysis result of both processes especially utilisation and down time. It can be explained by the following reasons.

1) The error detection system records every time when the machine stops due to an error. While the machine is operating, if an error is detected, with some assists from the operator, an equipment error report will be sent to the host computer. After that, the machine processing state transits from EXECUTING to NOT READY state (refer to the processing state model). The host computer considers the duration of this state transition to be machine down time.

   In contrast, for the process of down time card record, if the operator considers that it is not important error or it can be solved in short period, this error will not be recorded into the down time card. Hence, some periods of machine error are not recorded into the down time card. Therefore, when using the information on down time card for analysis, it is still considered to be utilisation time while the error detection system considers every machine stop errors to be down time. Hence, duration of machine down time that calculated by refer to the down time card is then much less than the down time on the error detection system.

2) When the operator actuates "STOP" button, the machine stop and then transits from EXECUTING (Utilisation) state to READY (Idle) state. The machine sends an S6F11 with code of this state transition to the host. The host considers this stop to be IDLE time even if it is a short period. For the down time card record system, operator records on down time card for the long period stop only. While, the duration of short period stop is not recorded on the down card. Although it is short time stop but it should be considered to be idle time because it is non-productive time.

The operator usually does not stop the machine operation, so the duration of idle time on both systems is not much different.

3) The utilisation time on the error detection system is less than on down time card system because the host records every time of machine stop even if it is the short period. However, it indicates the actual utilisation time of the machine.

6.4 The system evaluation

In order to test the accuracy and validation of information on the die attach machine error detection system and down time card, the die attach machine is programmed to count the number of die that are attached by the machine during the evaluated period (September $24^{th} - 26^{th}$,1999)

Since the number of product that can be produced by the machine in an hour (UPH) has been known, the number of die that should be produced by the machine for a time frame can be calculated by the following formula.

Expected number of die = %Utilisation X Machine UPH (units) X Duration (hours)

During the evaluated period, the machine is used for production on 8L SOIC package. The standard machine UPH for this package is 5,208 unit per hour. The duration of evaluation is 37 hours 45 minutes. The machine utilisation based on the down time card and the error detection system is 80.35% and 73.64% respectively. Therefore, the expected number of processed die for both systems shall be as below.

Down time card system:

Expected number of processed die = 0.8035 X 5,208 X 37.75

= 157,970 units

The die attach machine error detection system:

Expected number of processed die = 0.7364 X 5,208 X 37.75

= 144,778 units

The counter is activated at the start of evaluation and then count number of die that is processed by the machine until finish the evaluation. At the end of evaluation, the machine can produce **146,279 units.** Therefore, the percentage of error is 1.0% for the die attach machine error detection system while the error is 8.0% for down time card record system. Hence, the die attach machine error detection system provides more accurate information than the down time card record system.

The advantage of the accurate information effect on the capacity planning. The company always calculates the machine capacity by refer to the information from down time card record. If the down time card system provide higher capacity than the actual machine capacity, the machine will not be able to actually achieve this number. Hence, it conducts to high in-process inventory and may effect to the lead-time of product because the exceeding numbers have to wait for production until the machine is available. If the die attach machine error detection is used for capacity planning, the number of product that is calculated is much close to the actual machine capacity. Hence, the company can improve the process of capacity planning to be more accurate when using the information from the die attach machine error detection system for calculation. Therefore, in-process inventory will not be created and the product can be sent to the customer on time.

Another advantage of the error detection system effects on the machine utilisation improvement. The company generally defines a target of machine utilisation. The improvement plans are required for any machines that have the percentage of utilisation less than the target. Hence, the accuracy of information is quite important. The down time card system provide less information than the error detection system. As previously mentioned, the operator does not record the short period stop so that such periods are not shown on the down time card. If the company wants to improve the machine utilisation, every records of machine activity are necessary. Although it is a short period, it may effect to the overall machine utilisation. Moreover, it may be useful for setting the improvement plans. The data analysis and improvement plans will not be effective if it is based on the in-accurate information. Therefore, every machine activities are very important for the machine utilisation improvement.