Dynamic Index for a Versatile and Diverse Pilot Production Fab

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Abstract

We report how to establish the dynamic index for production control in a pilot fabrication over versatile and diverse production environments. We used dynamic index provided by a simulation model to monitor production performance. When production control is abnormal, the information system prompts administrators to classify these abnormal situations. In addition, the trend over the operation index is continuously reviewed in short-term and long-term. This simulation model is handy at setting goal for a versatile and diverse pilot production fab.

1. Introduction

It is difficult to evaluate production performance in the experimental fabrication that involves diverse LCD products. Single production index is not enough to solve complex situations in the fabrication. When low capacity is happened on the equipment factors, we must make sure that low production capacity is reasonable or not. In this study, we create a model to simulate fabrication by eM-Plant software, which verified and validated with the attributes in the real fabrication. We apply the output attributes in this verified and validated model to design the Operation Index Line that monitors production capacity in the fabrication every day.

Based on this line, we collect all abnormal conditions and ways to solve these problems, classifies these by the factors that happened in the fabrication, and established the intellectual database from gathering data every day. Moreover, we continually monitor these data how to drift against this line in short-term and long-term and modify periodically whether it conform with the operation in the fabrication.

2. System

We estimate production capacity of the fabrication In advance based on a simulation model of the fabrication. This model developed by the eM-Plant software isn't the optimal model, but the estimated model. Furthermore, we supply the physical operations and attributes in this model. The system is input and output as follows.

The input attributes are operators, a working-hour, the types of the products, MTBF (Mean Time Between Failure) and MTTR (Mean Time to Repair) in the equipment, warming-up time in the equipment, routine table in the productive processes. The output attributes are WIP (Work In-Process), Pass Stage that the per product pass the amount of the stages (a stage includes some steps which are the entire productive process.), MS (Move Speed) that is how many stages to pass per WIP for a day.

Eventually, to guarantee the accuracy of this model still needs to test it. Testing model can be divided into two parts, model verification and validation. Model verification confirms whether the model and the real fabrication are the same. We must check the following attributes whether they are the same as the basic components of the real fabrication. These attributes are as follows: Equipment number and type, MTTR/MTBF, Process Flow for PVGA Baseline Product, Standard Working Time (SWT), 2 shifts, Operators, 3 locations …etc., Above-mentioned attributes are fundamental elements which composed of the real fabrication. Model validation confirms the eM-Plant model's behavior whether it represents operation conditions of the real fabrication. We need to set up four key indexes, such as Move speed (Turn ratio), WIP (Work in Process), Pass Stage and Bottleneck machine. And we put recently historical data from the database of the information system into the model and than repeatedly observe above-mentioned four key index values. When the results of four indexes are the same as operation results in the real fabrication, model validation of this model is successful. **Table 1** shows these results between simulation model and in the real fabrication.

	Real	Simulation	Same
Bottleneck	Machine #6	Machine #6	Yes
WIP	30	30.22	Yes
Pass Stage	45	45.04	Yes
Move speed	1.56	1.4~1.7	Yes

Table 1. Validation Result

3. Simulation for Dynamic Index

According to the demand of the plan, there are three indexes of WIP, Pass Stage, and MS that close relate to the throughput of the product line. However, the abnormal factors caused to low throughput, are always happen in the experimental fab. Dynamic Index is therefore defined as low (L) and normal (N) mode. Two modes determine the curve line which is a productive datum line.

3.1 Low and Normal Modes

The low and normal mode is two points that determine the Operation Index Line. There are five indexes in two modes, respectively, which are WIP, Pass Stage, MS, the rate of the productive utilization(PUR), and the maximum production capacity (WIP(max)). Their relations represent four formulas as follows.

Normal mode:

$WIP(N) = (PUR) * WIP(max)$

$MS(N) = PassStage / WIP(N)$

Low mode:

$WIP(L) = (PUR)*\{(1/2)\ WIP(Max)\}$

$MS(L) = PassStage / WIP(L)$

3.2 Operation Index Line

The two modes are two points that draw Productive Operated Control Line composed of Y1, Y2, and Y3, respectively.

$Y1=WIP(L)$

$Y2=MS(L)+(X–WIP(L))*\{(MS(L)–MS(N))/\ (WIP(L) – WIP(N))\},\ WIP(L) < X < WIP(N)$

$Y3=MS(N),\ X > WIP(N)$

This line is adapted to estimate production capacity every day. We define tolerance limits, ± 15% of the centerline. The region between the tolerance limits is a normal production situation. In addition, **Figure 1** shows three regions, A, B, and C, which are divides by WIP(L) and WIP(N). Region A implies that production capacity is seriously insufficient in the fabrication. Region B shows that production capacity cannot fulfill the rate of productive utilization. These points located on region B are considered WIP-dependent in the fabrication. Region C is normal to located points in the fabrication.

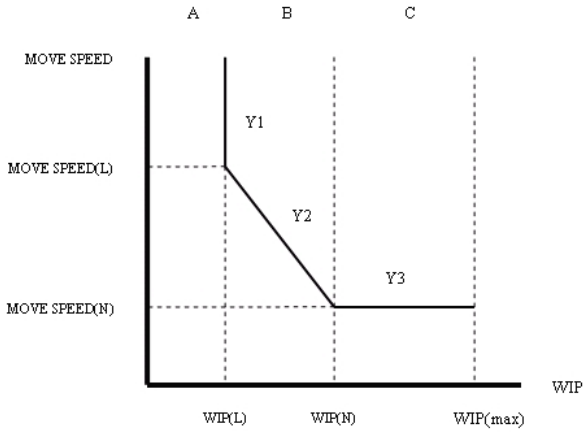

Figure 1. Operation Index Line

4. Results and Discussion

After setting up the Index Line, the manufacture information system notifies the product operation administers of the three indexes of WIP, Pass Stage, and MoveSpeed each day. They depend on these indexes to classify abnormal factors and conditions, the ways to solve these situations.

4.1 Data Collection

Analyzing the gathered data, there are total amounts of 173 points. **Figure 2** shows that values that higher than MoveSpeed(N) has 117 points. Between MoveSpeed(L) and MoveSpeed(N) has 45 points. Below MoveSpeed(L) has 11 points. These data centralize the normal operation.

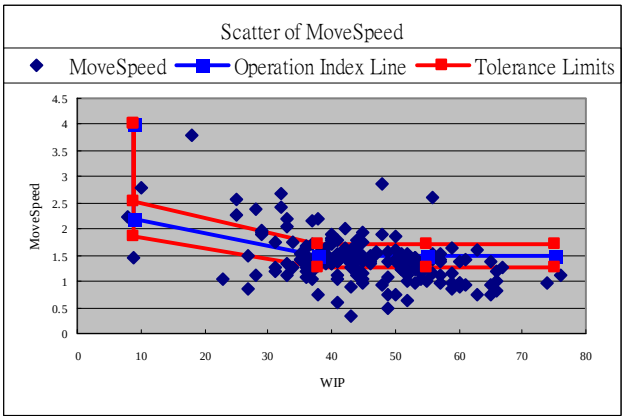

Figure 2. Scatter of Move Speed

4.2 Classification

Figure 3 shows 58% of the normal and 42% abnormal operation. In the abnormal operations, equipment and others factors are two most crucial factors for 37%.

Table 2 we classify the abnormal conditions in detail. Those factors affect the accuracy in this simulation model. Equipment Maintenance factor and Testing Equipment factor in Routine can be adjusted by modified this model. Equipment failure can select some historical data that were useful information to modify the model. However, new technology that is not considered in the first place always causes unpredictable situation.

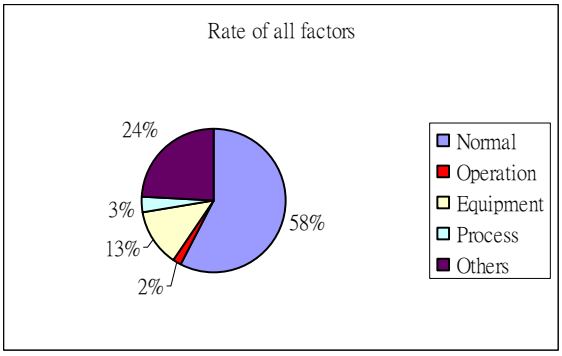

Figure 3. Rate of All Factors

Abnormal Classification	Abnormal Conditions
Operation	Training Operator
	Mal-operation
Equipment	Unscheduled Down
	Irregular Maintenance
Process	Testing New Process
Others	Testing Equipment in Routine
	New Technology Introduction

Table 2. Abnormal Classification

5. Conclusion

In general, we review simulation model each year and modify input attributes of this model to adjust to the physical circumstances on this fabrication. This simulation model will be used to create Operation Index Line.

Operation Index Line not only provides the administrators in product line to monitor production performance each day, but also shows production trend in short-term, per one-month, and medium-term, per one-year, whether production capacity in two interval periods drifts degree against the Operation Index Line. When production capacity shifts over the upper and low tolerance limits, we must take further steps to resolve difficult situation such as equipment factors and operations.

In addition, the upper and low tolerance limits is set to 15%, which is based on administrator's experience. In the future, the goal can adjust dynamically to sustain production capacity each day for rational number.

6. Acknowledgements

We are grateful to the related colleagues in Electronics Research Service Organization, Industrial Technology Research Institute for supplying us valuable information and experience to analyze and modify the results in this work.

7. References

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