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Winter 12-5-2005

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Jer-Wen Chen

Chin-Yua Ho

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# Using Adaptive Structuration Theory to Study the Implementation of CIM Systems: A case study of TFT-LCD Companies

Jer-Wen Chen, Dr. Ho, Chin-Yuan, Dr. Su Bo-chiuan  
Institute of Information Management, National Central University  
No. 300, Jung-da Rd, Chung-Li City, Taoyuang, Taiwan, 320, R. O. C.  
TEL : (886-3) 426-7251-6500 ,FAX : (886-3) 426-7251-6500  
[jerwen01@ms13.hinet.net](mailto:jerwen01@ms13.hinet.net), [ncu6500@ncu.edu.tw](mailto:ncu6500@ncu.edu.tw)

**Abstract:** CIM (Computer Integrated Manufacturing) is like a strategic weapon that helps industries increase their capacity for competing. Case study by interviewing enterprise is the main technique applied in this research. Base on AST (Adaptive Structuration Theory) introduced by multiple case analyses, in the process of implementing CIM the interaction between CIM and organization of two TFT-LCD industries whose business operation characteristics are different will be discussed. The research result can be treated as a reference for enterprises to perform their CIM system more effectively and promote their core competency.

In the paper, some discoveries are found as follows: the enterprises that have higher degree of automation always pay more attention to the operation standard of manufacturing and system, and consider the correspondence between them for need of process automation. On the other hand, the enterprises that have lower degree of automation always pay more attention to the rationalization of production lines, the convenience of adjusting operation process after the system is implemented, division of labor among the related organizations and their responsibility as well. The reason why causes the difference is the former thinks both the system functions and information linking techniques are two most important key points in the CIM project, so the employee rate of the staff related with IT must be increased in the project organization.

## I. Introduction

Many researches are proposed to mention about the successful key factors of introducing information technology system. In the recent years, however, observing the interaction between information system and organization in a view of sociology is one of academic research directions. The research motivation is to try to understand operation planning, introduction process, system performance and organizational performance of introducing information system through the interview analysis of the study case.

As information technology (IT) popularizes, in addition to semi-conductor industries, other high technology industries such as TFT-LCD industries, are also introducing manufacturing execution system (MES) gradually. In view of business owner, the introduction cost of MES is about

5~10% of whole plant construction cost. However, the success or failure of MES introduction deeply influences the operation condition of production lines. Therefore, most managers of manufacturing industries pay lots of attention to the MES introduction. Not only planning of automatic production lines has to be managed by MES, but also the case company introduced MES based on customer requirements.

Therefore, through the case study on the high technology manufacturing industry with different models of production operation management, this paper discusses the following questions to help enterprises with different planning of production lines introduce CIM related project.

1. Which factors will influence the selection consideration to the introduction of CIM in an enterprise organization? How?
2. How do CIM and the fitness of organization influence the process automation?
3. How does the introduction of CIM influence the performance of enterprise?

The research purposes is to use theoretical structure in Adaptive Structure Theory (AST) to observe the interaction between CIM system and organization in the introduction process of CIM, base on the case study on the different types of production operations. The discovered relations in the paper can help enterprises to effectively use CIM system to enhance the enterprise competence.

## II. Literature Review

Roach [5][6] proposed the phenomenon of "Productivity paradox". Strassman [7] also stated there is nothing which can prove that his investment in 1980 had got returned. However, other researches such as Marri et al. [4], depicted the introduction of CIM could obviously raise production efficiency, quality of product, and lower inventory as well.

Giddens [2] proposed the duality of structures and in an agile point of view claimed individual activities are not only purely obeying rules or doing routines but also make social structure changed by the applications of knowledge concepts. Gregor and Johnston [3] thought that theory which can be applied in developing a cross-organizational information system should equip with the process of multiple-level analysis, be able to explain the organizational behaviors in different time, and support the theory of emergence.

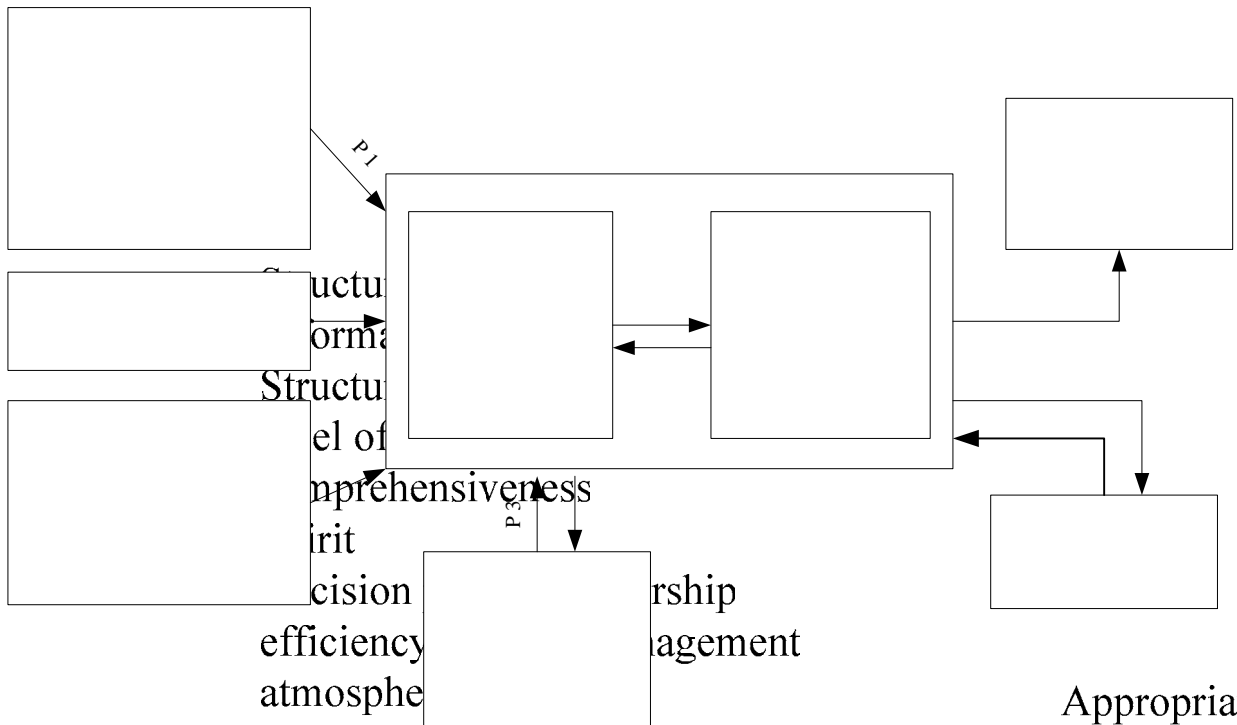


Fig. 2.1 AST theory architecture

(Source: DeSanctis and Poole, 1997)

Among these theories, Giddens' structural behavior theory is the most appropriate to be applied in the research on cross-organizational information system.

DeSanctis and Poole [1] proposed Adaptive Structure Theory: AST. It was used to discuss the interaction between the introduction of advanced information technology and organization in an enterprise. The structure is as the above figure 2.1.

The research implements the empirical study by making use of AST, and try to understand what the staffs think and their concepts in different organizations and enterprises while the information system is being introduced. Moreover, the difference of interaction among organizations in an enterprise will be discussed when CIM system is introduced.

### III. Research Structure

#### III.1 Assumptions

The research adopts multiple-case-multiple-interview method to realize the concepts and the thoughts of all kinds of staffs in the organizations in the introduction process of CIM system through the comparison of interviewing information. In the paper, two TFT-LCD manufacturing companies with different degrees of automation are selected as the subjects of the case study. The introduction performance of CIM will be compared, base on the description of those staffs in the

organization.

There are seven assumptions proposed as follows:  
The structural characteristics and the design concept of CIM system always influence the process of social interaction while introducing CIM system.

Because when the function and the reliability of CIM system have been upgraded, the system stability will be more important to production lines.

Assumption 1: system characteristics

<b>P1b</b>	<b>The higher stability of CIM system and the higher instantaneity information processing will be more helpful to process automation.</b>
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The operational characteristics of organization will influence the selection and introduction of CIM system. Once the system got sophisticated, it is easily found that there is a proportional relationship between the participation degree among information staffs to CIM system and the leading selection degree of system.

Assumption 2: organizational characteristics

<b>P2b</b>	<b>The higher degree of production automation is, the higher leading selection degree of CIM system the information staffs have.</b>
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The personality of users will influence the selection of CIM system. In the paper, the attitude of system users who take part in the project of CIM system was observed to realize whether the process automation is proportional to organization after the introduction of CIM system.

Assumption 3: characteristics of users

<b>P3b</b>	<b>The more positive attitude of system users who take part in the introduction of CIM system, the more possible the goal of the process automation will be achieved.</b>
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The assessment and selection of a system is a kind of interaction among systems and organizations. Moreover, the way to design the system is a key factor in the process of assessment and selection. The content of design should be followed the need of organization, and process automation is one of the main purposes in the introduction of CIM system. Hence, P4b also became another assumption proposed in the research.

Assumption 4: the assessment and selection of system

<b>P4b</b>	<b>If the design of CIM system is more fit to the need of organization, then the degree of process automation is higher.</b>
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The difference of the participation degrees and application methods of the project-related staffs will influence the project much.

Assumption 5: emergent structure

<b>P5b</b>	<b>The higher degree of process automation usually comes after a large portion of information staffs in the project of CIM system.</b>
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	<b>It helps on achieving the final goal of process automation.</b>
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The introduction of CIM system will affect the current organization, so the collaboration degree of organization in charge of the system maintenance will be higher.

Assumption 6: new organizational structure

<b>P6b</b>	<b>The degree of process automation and the collaboration degree of organization in the information department will be higher after the introduction of CIM system. The stability of CIM system can be maintained or increased through the maintenance operation of information department.</b>
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As managers demand the facilities be used effectively, a organism which increases the usage of facilities and production yield of production lines can be constructed through systematically monitoring management of production process.

Assumption 7: organizational performance

<b>P7b</b>	<b>The introduction of CIM can improve the performance of production lines; the higher degree of process automation will bring higher system efficiency.</b>
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Base on the above assumptions, the research structure is arranged as the figure 3.1 shows.

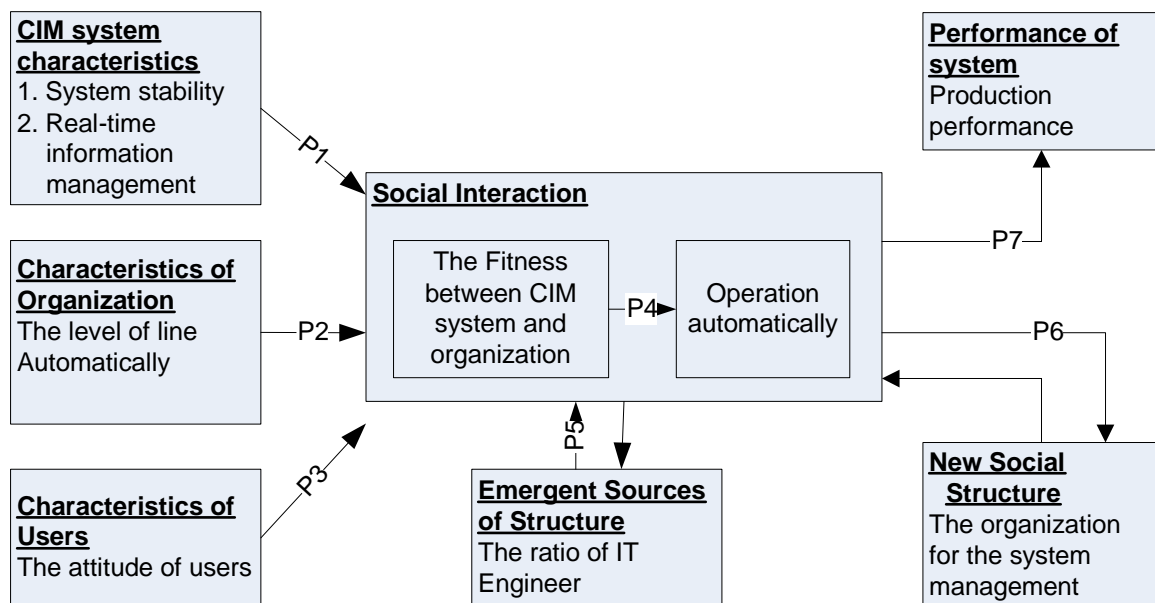


Fig. 3.1 research structure

### III. 2 Planning of Interview Subject and Operation Model

To enrich the interviewing content of cases and collect the information of related research issues more completely, the interviewing subjects should be the most important roles really devoted to the introduction of CIM system, and they also can process the data collection in different points of view, such as the view of enterprise managers (Business unit managers, information system managers, production line managers), the view of system maintaineners (information managers, information system engineers), the view of system users (production line managers, production line operators). The occupational structure of the interviewing subjects is as figure 3.2.

## IV. Case Study

The purpose of this research is to compare the processes and results of the introduction of CIM system in the two different operation-based companies. The comparison can be the following two ways:

#### ☆ Assumption-based analysis:

The aim of is to investigate every occupational role in a company to know their idea and their thoughts of a series of assumptions, and then find out the same and the different depictions in theses tow companies. Through the results of assumption-based analysis, it might be found the interaction among systems and organizations in the introduction process of CIM system in the different operational base companies.

#### ☆ Occupation-based analysis:

The aim of occupation-based analysis is to ask every occupational role in different companies for knowing their idea and their thoughts of each question, and then analyze the reasons of these descriptions. Finally, the effect of every occupational role on CIM project will be known.

According to the arrangement of the interviewing content, some conclusions are found as follows:

#### (1) Which factors will affect the selection consideration of the introduction of CIM system in an enterprise? How?

This question can be illustrated from three aspects, namely, characteristics of system, characteristics of organization, and characteristics of users:

##### Characteristics of system:

The characteristics of CIM system are a series of processes of assisting the automation of production operations and the treatment of engineering data. Both the stability of system and the demand of real-time information processing are proportional to the degree of operation automation.

##### Characteristics of organization:

In the automated operation based enterprise, the information department is in charge of the CIM system project. Also, the first consideration for the system selection is mainly the information department, and the selection standard is based on the performance of system introduction.

##### Characteristics of users:

In the semi-automated operation based enterprise, the participation attitude of users is more positive, and they are the managerial core of operational process and system function.

#### (2) How CIM system and organizational fitness affect the process automation?

The case company A is based on operational automation, its organizational and operation process have had clear definition, and its system feature is to provide the managerial function of operation process; the main purpose of the case company B is to enhance the efficiency and the quality of operation, so the organization need to adjust or reconstruct the operation process during the process of system introduction.

As the cross-analysis of cases shown, the staffs in the enterprises with different degrees of automation have varied concepts and thoughts for CIM system so that the degrees of impact to organization are also different. For instance, the staffs in a production line with high degree of automation are more willing to pursue automation because of the standardization of production process and high unit price of each product. Therefore, the developing core tend to be placed on information department.

#### (3) After the introduction of CIM system, how it affect the performance of the enterprise?

Generally speaking, the introduction of CIM system usually helps enterprises to raise their performance. An enterprise with automated production operation will try to improve the level from operational automation to managerial automation, and implement more advanced appliance based on the data of CIM system. An enterprise with manual production operation will take advantage of the transparency of production data to make benefit from real-time management and quick response, especially for those who have more complicated manual production. The introduction of CIM system does affect the reconstruction of operation process a lot.

## V. Conclusions and Future Works

Some conclusions are remarked here base on the arranged information of cross analysis of cases.

1. As the interview information shown, the interviewers all thought CIM system can improve the performance of production. The managers proposed the information

transparency of production lines will be helpful to managerial communication. Concerning about the benefit return of system, surprisingly, semi-automated operation based company B has more concrete cognition to benefit earning. Therefore, the research claimed the benefit return after the introduction of system is related with the profit-making business model but the degree of automation.

2. After researching the information of cases, we found the high portion of information staffs and what corresponds with the assumption P6b is high degree of process automation contribute mostly to the accomplishment of process automation. According to the observation of the case company's experience, the project staffs in the case company A evaluated a CIM system set-up for new factory always needs 20~30 information managers and information engineers. Among the different departments, the proportion of the users representatives employed to make sure the system requirements and senior engineers or senior managers in charge of projects is about one to five in the case company A but five to one in the case company B. If the time consumed in the project meeting is considered, the proportion difference between these two case companies will be ten times of the former.

3. For the enterprise with high degree of process automation, the connection operation specifications and standards between the production facilities and system in each production process should be noticed for successful introduction of CIM system. The other companies must notice the operation rationalization of production lines, the adjustment of operational process after introduction, and the confirmations of related organizational collaboration and responsibility. Briefly, there are three conclusions for related enterprises as follows

- (1) Raise the leading awareness of users will improve the introduction performance of CIM system.
- (2) For semi-automated operation based enterprises, they should consider the process reconstruction after the introduction of CIM system and the impact that the

proceeding schedule of project brings.

- (3) The higher degree of automation the case company has, the more stable system they should own.

The research verified the interaction between the advanced information system and organization depicted by the AST model through the case interview information. Moreover, the cross analysis is also applied to realize what enterprises and the system integration industries should notice while introducing CIM system under different degrees of automation of production lines. However, more advanced interview information and comparison analysis is required to extensively apply the conclusions to other similar enterprises and industries. Meanwhile, to obtain the intact interview content, it is a good way to make the assumptions under the AST models the question items in the questionnaire to verify the acquired information, that can increase the reliability of the information.

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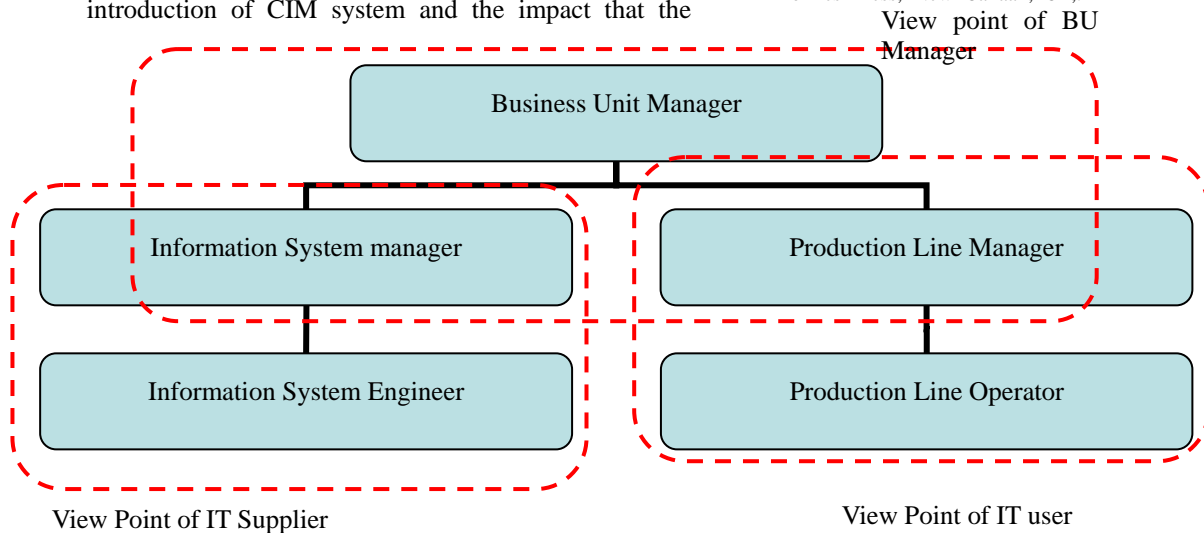


Fig. 3.2 occupational structure of the interviewing subjects