CHAPTER 4

CRITICAL SUCCESS FACTORS FOR THE IMPLEMENTATION OF INTEGRATED AUTOMATION SYSTEM

4.1 INTRODUCTION

Manufacturing companies are compelled to seek advanced technologies by integrating manufacturing facilities and systems in an enterprise through computers and its peripherals, communication networks to transform islands of enabling technologies into a highly interconnected manufacturing system (Lin 1976). Figure 4.1 shows the drivers for the change management. Furthermore, non-price factors, such as quality, product design, innovation and delivery services are the primary determinants of product success in today’s global arena (Shaw 2000). When necessary, enterprise decides to change their manufacturing systems, because of changing market requirements, business objectives, business requirements, improved manufacturing concepts or available technologies. The decision to manufacture new products might for example result in change in the existing CIM system. The manufacturing systems that are in operation today will be re-engineered at some point of time to turn into next-generation manufacturing systems, so that current integrated systems become future heritage systems (Arian et al 1995).
It is important to recognize that little of the previous research has sought to identify the CSFs specific to the development of integrated automation solutions for the manufacturing industries. Technology alone is only a piece of solution. Significant benefits will be achieved only when technology and processes are integrated and the key success factors are considered, as utility requirements become more and more complex. This chapter describes the CSFs for the implementation of IAS.

4.2 MOTIVATION FOR THE IDENTIFICATION OF CSF FOR IAS

The development of the personal computers and subsequent quality improvements have fuelled the explosion in information processing equipment
(Anitesh and Byungtae 1997). Based on the observation that not every firm that tried CIM was successful and the fact that many manufacturing concerns are significantly declining in their expectations about CIM (Gupta 1996) leads us to the possibility that the success of integrated CIM requires some critical factors. The primary objective of this research is to provide some key factors on the key technologies of information technology, managerial and communication issues that must be addressed for designing and implementing integrated CIM systems that lead to the concept of totally Integrated Automation System and to identify a set of CSF for the development of totally integrated flexible automation systems (Dhinesh et al 2002a). In the present context, these are the key factors that influence successful implementation of totally integrated automation systems.

4.2.1 The approach

The factors that are critical to the successful implementation of IAS are identified and discussed based on a review of literature, a field study that surveyed different types of manufacturing firms and series of interviews with a number of working professionals and managers in three leading automation and system components exhibition, held in Europe. Studies were carried in an automation and system components exhibition, where 690 exhibitors from almost 20 countries exhibited their product development and solutions. In another exhibition over 8,000 companies from 60 countries in attendance with an impressive array of trends, innovations and future markets in information technology, telecommunications and automation, embracing almost every type of equipment, as well as systems, stand-alone solutions, integrated solutions and concepts projected the supply and demand of the global market. In one more exhibition on Machine Building and Automation where nearly 28,000
visitors flocked through the aisles to see 750 exhibits of machine building and automation system.

These factors were then summarized and compared to similar findings and theoretical formulations, reported in similar literature. These factors are compared to four specific sets of CSFs developed for related topics. These studies assess the impacts of the identified factors on the benefits of IAS and develop a conceptual framework for measuring success and shows the relationship among the success factors in the development and implementation of IAS.

A field study that surveyed different types of manufacturing firms to investigate implementation success and the factors that may affect implementation success were identified and summarized as a tool for the successful development and implementation of integrated automation systems. The study consists of an interview instrument. Within each firm, a plant manager was identified as target for the questionnaire. The study variables are the type of industry, the relationship of the project to organizational structure, the criteria used to measure the success, and the factors related to the project, project manager, project team members, organization, and the environment. Success is measured by indicators as better return on equity, reduced cost, improved quality, enhanced competitiveness, better control and quick response.

Emphasis is given to grouping of success factors and explaining the interaction between them. It is important to recognize that very little previous research has sought to identify the key issues and the CSFs specific to integrated automation and control. Due to the fact that control and automation systems are characterized by constant technological change and that CSFs in
integrated automation system development have not been published, the chosen research strategy is ideally suited to the defined problem.

4.3 CSFS FOR THE IMPLEMENTATION OF INTEGRATED AUTOMATION SYSTEM

Several authors have identified CSFs that deal with subjects related to manufacturing automation. For example, CSFs have been identified for new product development (Lynn 1998), IT planning and requirements determination (Farrell 1996), enterprise wide information management system projects (Sumner 1999), the alignment of IS plans with business plans (Teo and James 1999) factory automation (Takanaka 1991), and software maintenance issues (Ettlie and Getner 1989) . A set of CSFs for the development/implementation of IAS was identified.

Discussion of CSFs: The following is a summary of the identified CSFs. Each CSF is accompanied by a short description and compared to similar findings reported in related literature.

Critical Success Factor 1: Formulate a simplified and standardized project plan prior to the design of Integrated Automation System.

The effective integration of available advanced manufacturing technologies starts with project planning. Before introducing new technologies, a company must assess whether these technologies will direct the organization to a specific goal, primarily to improve the competitive position. This assessment should lead to the development of a master plan that directs the allocation of resources and day-to-day operation of the company as it strives to
implement IAS. This CSF is supported by Aggarwal (1995) and Takanaka (1991).

**Critical Success Factor 2:** Develop an organization structure with effective interface for communication, coordination, monitoring, and documentation.

One of the most critical factors for the successful implementation is top management support. Such a support can be achieved if the organization structure is so organized in such a manner to provide an effective interface for effective communication, coordination, monitoring and feedback, and documentation. This CSF is supported by Pinto and Slevin (1987) and Sayles and Chandler (1971).

**Critical Success Factor 3:** Assemble personnel teams with the necessary experience and motivation to properly implement Integrated Automation solutions.

A well-organized and properly managed team is necessary to properly coordinate implementation activities. Personnel with the experience necessary to effectively utilize the available resources and technology are needed to design and build Integrated Automation (IA) systems. A well-defined work breakdown system should be developed to allow project teams to function effectively. Team behavior with regard to performance and information sharing should be emphasized. Team members responsible for the implementation of IA must have a clear understanding of the goals and needs of company management. Communication between group members must be dynamic and able to relate both the goals of management and the results and progress of their
implementation. Documentation that details these plans and their results should be available to all members of these projects so that they can understand their responsibilities and see the results of the project development. This factor is described by the work of Aggarwal (1995) and that of Pinto and Slevin (1987) and the work of Gupta (1996).

**Critical Success Factor 4:** The functional structure of both manufacturing and management should be developed as modular units.

It is necessary to divide processes and projects into manageable, autonomous operating units called modules. Modules should be constructed independently by individual teams and should be tested independently. This reduces the cost of on-site commissioning. Alfieri and Brandimarte (1997) stress the importance of this concept. Their work is also supported by that of Cho et al (1996).

**Critical Success Factor 5:** The manufacturing and management system modules developed previously must be integrated in a hybrid of both bottom-up, and top-down approach.

A well-defined development plan is essential for successful implementation of IA. This approach must be accompanied by a clearly defined vision for the system that is communicated to not only management, but also to the individual project members who will ultimately be responsible for the successful implementation of the plan. Alfieri and Brandimarte (1997) and Takanaka (1991) discuss this factor in their work.
Critical Success Factor 6: The performance of the finished system should be evaluated and modifications based on the evaluation should be made to keep the system operating efficiently.

Once implemented, the system should be subjected to evaluations that will allow the effectiveness of the system to be gauged. After evaluations have been completed, modifications must be made that will allow the system to be maintained properly. Future evaluations should take updated software, new manufacturing technology, and personnel changes into account. Aggarwal (1995) also discusses this factor as does Takanaka (1991).

4.4 STUDY OF CSFs IN RELATED AREAS OF IAS

In this section, the six CSFs for IAS development are studied in the related areas: project management, factory automation, managing large systems and new product development. These four areas are closely related to integrated automation system development. This study is used to support the CSFs identified in this chapter which are used to identify issues that are unique to integrated automation system development.

Table 4.1 displays six CSFs of project management as determined by Pinto and Slevin (1987), six CSFs of factory automation determined by Takanaka (1991) and five CSFs for managing large systems (Sayles and Chandler 1971) and five CSFs for new product development (Lester 1998).
Table 4.1 A comparative study of CSFs in project management, factory automation, managing large systems and new product development

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<td>1. Clearly defined goals</td>
<td>1. Strategy for systematic integration with clearly defined objectives</td>
<td>1. Project managers competence</td>
<td>1. Senior management commitment</td>
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<tr>
<td>2. Competent project management</td>
<td>2. Analysis and evaluation of resource requirements</td>
<td>2. Scheduling</td>
<td>2. Organizational structure and processes that support the venture</td>
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<td>3. Top management support</td>
<td>3. Establish milestones and inform the people involved</td>
<td>3. Control systems and responsibilities</td>
<td>3. Attractive new product concepts being available for development</td>
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<td>4. Competent project team members</td>
<td>4. Standardization and simplification of parts, modules and products</td>
<td>4. Monitoring and feedback</td>
<td>4. Venture teams with appropriate staffing and resources</td>
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<td>5. Sufficient resource allocation</td>
<td>5. Evaluation: identify advantages and disadvantages</td>
<td>5. Continuing involvement on the project.</td>
<td>5. Project management able to focus on reducing uncertainties</td>
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<td>6. Adequate communication</td>
<td>6. Change the management accounting system.</td>
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These particular CSFs were chosen for their comprehensiveness in scope and for their project-level focus. A study of these four lists with the six CSFs for IA system development identified in this study is summarized below:

CSF 1: Takanaka’s (1991) CSF (4) identifies the need to standardize and simplify parts, modules and products which may lead to simplification of the process as well as broader issues such as plant layout. Pinto and Slevin
(1987) CSF (1) address the need of clearly defined goal. The simplification of the mechanical components and processes of an IAS is particularly important.

CSF 2: Lester’s (1998) CSF (2,5), and Sayles and Chandler’s (1971) CSF (3,4,5) suggests the need for well defined organizational structure showing control and responsibilities, monitoring and feedback system, and address the need for effective interface with top management, for effective communication and coordination. This will improve the shared vision of the project and due reorganization of the individual.

CSF 3: Pinto and Slevin’s (1987) CSF (2, 4) and Lester’s CSF (4) suggest that effective teams are critical. This study identified the need for a specific method to design teams, which is directly related to the design of the system. In addition, communication is improved and conflicts reduced due to cross-functional membership. Lester's (1998) CSF (2) and Takanaka’s (1991) CSF (3) suggest that effective communication between team members can promote a common understanding and can reduce conflicts within personnel. It is also important in providing a shared vision of the project. Performance measures are the feedback mechanisms to take corrective actions if they are needed.

CSF 4: Takanaka’s CSF (4) deals with the need to design automation systems that utilize standard modules. This standardization allows for new parts, tools, and processes to be incorporated rapidly into product development. Standardized modules of the entire management and manufacturing system within a company will allow for similar benefits to be realized as new techniques and technologies can be rapidly integrated without causing major downtime in corporate activities.
CSF 5: This factor is identified in Takanaka's (1991) CSF (1) for the effective integration of the modules into the proposed system. Initial automation is implemented with controllers in a stand-alone fashion, and then integration and higher-level control is established through communication networks. This is a specific strategy for systematic integration with clearly defined objectives.

CSF 6: Takanaka's (1991) CSF (5) identifies the need for critical evaluation of the finished system. One cannot gauge the effectiveness of a finished solution without standards by which it can be measured. Advantages that are found should be spread throughout the system and disadvantages should be corrected in a timely fashion to maintain system efficiency.

The study of five sets of CSFs (integrated automation, project management, factory automation, managing large systems and new product development) indicates that some of the CSFs identified for IA are common with other similar fields of application. Common CSFs tend to deal with the need for simple communication and planning within a company, proper team building and management, and resource allocation. However, the CSFs appear to address a larger field of applicability. CSFs dealing uniquely with IA focus on the ability to treat individual manufacturing units and management processes as modules that must be standardized and integrated in order to achieve management goals.
4.5 A FRAMEWORK FOR MEASURING THE SUCCESS AND THE INFLUENCE ON OTHER FACTORS

This study assess the impacts of the identified factors on the benefits of IAS and develop a conceptual framework for measuring success and shows the relationship, influence among the success factors in the development and implementation of IAS. The factors are grouped into:

- The factors related to the project
- The factors related to the Organization.
- The factors related to the project team
- The factors related to the functional structure of the Manufacturing system.
- The factors related to the System Integration
- The factors related to the Performance Evaluation.

A research model developed as a framework for empirically evaluating the successful integration, the Critical Performance Indicators (CPIs), and Critical Performance Measures (CPMs) is shown in Figure 4.2. Its success is a multidimensional attribute that may be expressed through various measures such as assessment of the success of the integration process and integrated systems, the ability to exploit opportunities arising from the merger, the ability to avoid problems, stemming from the merger and the end user satisfaction with the integration process and integrated system. This results in effective planning and scheduling, effective communication and coordination, effective use of managerial skills, technology, effective control and monitoring, and availability of resources.
Figure 4.2 A framework showing the CSFs, CPIs, and CPMs

**Indicators of successful implementation** of IA solutions include: an increase in product quality, employee productivity and a decrease in equipment downtime, collection of new customers, widespread usage of IA procedures within the company. Some indicators of unsatisfactory IA implementation are: an inefficient communication structure marked by frequent breakdowns in communication systems between management and manufacturing, the integration of new modules or technology is excessively time-consuming and expensive, failure to produce meaningful reactions and lack of reductions in production lead-time. In order to successfully implement IA, management must
have a strong commitment to the design process and the ability to overcome inter organizational barriers, and must also exercise effective program execution to ensure that management's implementation plan is successfully carried out.

**Neglected imperatives:** The points that are ignored by many enterprises are lack of long term goal, failure to carry out feasibility study, technical and behavioral uncertainty, lack of real vision, cost justification, vendor selection, and insufficient employee training. A company must establish long and short-term goals and standards against the goals are measured. A detailed analysis of the current manufacturing process and supporting operations is needed to understand better, how automation and integration will achieve both business and manufacturing goals. The ability and technical know how should be analyzed before selecting the right vendor. There must be an initiative for people to update their technical and management skills. This is particularly important when new computers and communication technology is introduced.

### 4.6 SUMMARY

As every factor will not be of equal importance to an enterprise, it follows that a relatively limited number of factors will be critically important for the successful implementation of IAS and is derived from the enterprise's internal and external operating environments, and arise from a wide variety of events, circumstances, conditions of activities which require special attention of the enterprise management. The knowledge and understanding of these factors will assist firms in successful implementation of IAS and enable them to further improve their confidence and competitive ability to maximize their services and
returns. The pitfalls in implementation come from neglecting CSFs and making unrealistic assumptions. The characteristics of these factors shows that these CSFs are clearly actionable, measurable and controllable through the use of CPIs and associated CPMs. These findings add to our academic understanding the functional relationships among variables that affect the innovation adaption decision. These factors also reveal the fact that system integration should be achieved in a cohesive manner to provide a complete and intelligent solution to the manufacturing industries.