CHAPTER 3

CONCEPTUAL MODEL FOR IMPLEMENTATION OF ROBOTIC SYSTEM AND FORMULATION OF THE PRESENT WORK

3.1 DEVELOPMENT OF CONCEPTUAL MODEL FOR IMPLEMENTATION OF ROBOTIC SYSTEM

Review of the literature on implementation of robotic system suggests that implementation of robotic system is a complex activity. It also suggests that, while implementing robotic system it is important to remember that it is a system and therefore all the related aspects should be considered interactively. A considerable amount of research has been conducted concerning the various aspects of implementation of robotic system. However, much of the literature available is in isolation and componentwise without addressing the other aspects of robotic implementation. It spans from extremely theoretical to extremely practical approach, which makes it a challenge to develop a comprehensive methodology for implementation of robotic system. It also confirms that, there is a need to develop an integrated approach for implementation of robotic system. Fig 3.1 shows the conceptual model for implementation of robotic system.

![Diagram of Robotic Implementation](image-url)
The proposed conceptual model provides for integrating the various aspects of robotization concurrently. At the same time it also provides for coupling the knowledge-based approach and conventional analytical tools to make a well-informed decision regarding implementation of robotic system. Following section discusses each element of the conceptual model.

3.1.1 Conceptual Model for Robotic Implementation Planning

Proper planning for implementation of robotic system is imperative for maintaining a strong competitive position in today’s dynamic manufacturing environment. Thus, the greatest impact and benefits of robotization can be obtained by focussing at early stages of planning. There are three approaches to planning: analytical, heuristic, and procedural. The analytical solution is function of problem attributes that are well defined. These methods can be particularly useful for RTM analysis, cycle time calculations, etc. At the same time, planning related decisions are complex and multi attribute problems. Thus, multi attribute decision technique, like AHP, can provide a framework for strategic planning and vendor selection. Since, planning is an area requiring considerable amount of human expertise, knowledge-based systems can be of great use for robot selection, vendor selection, goal recommendation and strategy execution. The procedural methods can be successfully adopted for plant survey, initial feasibility, training etc. Thus, for proper planning of robotic implementation, what is required, is an approach that combines the three approaches of planning. Fig.3.2 shows the conceptual model for robotic implementation planning. The suggested approach integrates the features of Expert system, Analytical methods, and Procedural methods.

3.1.2 Conceptual Model for Financial Justification of Robotic System

Analysis of the literature suggests that the problems of justification of costs and benefits and strategic values of the investment in advanced manufacturing systems, like, robotic system are yet to be resolved by accounting procedures. Traditional financial analysis can be used for a precise economic justification as long as costs and savings can be accurately quantified. However, these methods do not work well for robotic system. Special characteristics of robotic system require several modifications in conventional financial justification techniques. At the same time, decision to invest in robotic system is difficult to make purely on monetary grounds. Other strategic and non-monetary factors are required to be considered in relation to decision of implementation of robotic system. Thus, the financial justification of robotic system must integrate the strategic benefits offered by the robotic system and economics of robotic system. The integrated approach must provide for simultaneous analysis of strategies and economic characteristics of robotic system to reach on investment decision. This will allow for many of the problems associated with traditional methods to be dealt with so that appropriate justification process can be developed.

The process of financial justification of robotic system can be made fast and accurate by use of computer-based system. But, for solving the problem of robotic justification by computer-based system, the important prerequisites include: incorporating heuristic.
incorporating analytical models and tools, explaining the results, and the like. Thus, the most suitable approach for financial justification of robotic systems would be to adopt a better balance between AI based systems and conventional computational methods. Fig 3.3 shows the proposed knowledge-guided financial justification approach.

FIG. 3.2 CONCEPTUAL MODEL FOR ROBOTIC IMPLEMENTATION PLANNING

FIG. 3.3 SIMULTANEOUS ENGINEERING KNOWLEDGE-GUIDED FINANCIAL JUSTIFICATION APPROACH.
The proposed approach provides for simultaneous analysis of strategies and economic characteristics of robots and combines knowledge-based systems and traditional analytical tools, like engineering economy models, sensitivity analysis, multi attribute analysis models, for performing deterministic and heuristic activities and aiding in decision making tasks.

The proposed knowledge guided justification approach is having three components : knowledge, justification process, and analytical tools. The justification process starts with guidance and suggestions of knowledge component. The justification process decides the justification model to be considered and analytical component analyses the justification model and provides appropriate result.

3.1.3 Conceptual Model for Maintenance of Robotic System

The high initial cost of robotic system makes it essential for a manufacturing unit to ensure its smooth operation for maximum possible time. However, the complexity associated with maintenance of robotic system and limited availability of experts in this area is a major hurdle in successful implementation of these systems in Indian industries. Though, the diagnostics has improved over these years, still no other factor has been as neglected, misunderstood and mismanaged as preventive maintenance, fault diagnosis, and repairs. This obviously results in poor quality products, disrupted production schedules, delayed deliveries and lost customers. However, preventive maintenance, fault diagnosis and repairs equipped with tools based on Artificial Intelligence(AI) techniques, like Expert system, can provide effective robot utilization and can minimize the maintenance cost. A consultation with user friendly knowledge_based system can shorten the time and skill required for preventive maintenance, fault diagnosis and repairs of robotic system. Fig. 3.4 shows the architecture of user friendly knowledge_based system for preventive maintenance and fault diagnosis of robotic system.

![Conceptual Model for Maintenance of Robotic System](image)

**FIG 3.4 ARCHITECTURE OF KNOWLEDGE_BASED SYSTEM FOR PREVENTIVE MAINTENANCE AND FAULT DIAGNOSIS OF ROBOTIC SYSTEM**
3.1.4 Conceptual Model for Robot Work-Station Safety

The robot work-station safety has become more complicated and a matter of extreme importance because of robot application in variety of situations and higher degree of sophistication. The increasing range of applications of industrial robots will create increased accident hazards. First, because of the wider use of small and medium sized mass production machines, the volume of programming work to be carried out will increase, implying more frequent contact between the person and the industrial robot. Secondly, the range of the functions will be extended so that manufacturing system as a whole becomes more complex and thus, in certain circumstances, becomes more prone to break down. Complexity will also arise from:

1. More complex programs.
2. Collaboration of several industrial robots.
3. Use of sensors.
4. Use of grippers and tool changing systems.

In addition, the energy potential available within the system will also increase through the use of:

1. Industrial robots with higher performance.
2. High speed tools.
3. Laser and waterjet cutting with industrial robots.

So far, in spite of differently oriented problems, conventional safety systems/procedures have been used. Because of this situation and complexity involved with manufacturing (CAM/ CIM/FM:), it is important that there be a user friendly knowledge-based system for robot work-station safety. Fig. 3.5 shows the architecture of knowledge-based system for robot work-station safety.

![Diagram of knowledge-based system for robot work-station safety]

**Fig. 3.5** Architecture of knowledge-based system for robot work-station safety
3.2 PROBLEM FORMULATION

It has already been stated that robotic technology is still very new to Indian industries and can affect every aspect of organization. Therefore, implementation of robotic system in Indian industries calls for expertise in various functional and economic fields of knowledge. At the same time, robotic implementation methodology should address to various technical, financial, personnel functions of the organization in a very integrated manner. This work, out of the various issues and methodologies suggested in conceptual model, concentrates on development of fairly generalized computer aided methodology for identification of work-station to be robotized in view of local conditions. The developed methodology consists of three inter-related stages.

Stage I: Development of methodology for robotic implementation planning and demonstration of its usefulness for Indian industries.

Stage II: Development of decision support system for strategic and financial justification of robotization.

Stage III: Development of guidelines and knowledge-based expert system for robot workstation safety.