CHAPTER VI

CONCLUSIONS AND SCOPE FOR FUTURE WORK

6.1 CONCLUSIONS

The dynamic job shop manufacturing systems require new organisational structures and technologies which support the development of autonomous functions performing concurrently. Fifth generation management principles appreciate flexible infrastructures and realises the importance of human creativity in combination with technological solutions to support the tasks and decision making.

Based on the generic system classification of manufacturing systems, a self contained integrated manufacturing layout consisting of demand, design, process planning, manufacturing and delivery cells is suggested for make-to-order job shop manufacturing units. Restructuring into the integrated manufacturing layout provides:

(i) better coordination between marketing and production planning activities.

(ii) opportunity for shop floor decision makers to involve in integration of production planning and process planning functions.

(iii) elimination of idle time at all stages of processing an order.

(iv) opportunity to identify measures for continuous improvement in reducing the throughput time for processing all orders.

After identifying the demand for a manufacturing order the demand cell will generate detailed macro process plans for the
order. The processing times for all the operations are included in the process plan.

The set up factor and quality factor are identified as significant lead time factors in job shop manufacturing. Considering the constraints of processing a specific make-to-order demand, within the available manufacturing resources, a linear programming problem has been formulated with the objective of minimising the lead time factors. Solution for LPP has been obtained through LINDO package.

The manufacturing lead times have been estimated as a multiple of processing times and optimal lead time factors. A simulation program was developed to further analyse the behaviour of manufacturing lead time estimates. The simulation trials were conducted with alternative values of input lead time factors and detailed analysis of the results were carried out for better insight.

While submitting the quotations for accepting a manufacturing order the status of backlog jobs available in the manufacturing system is very important. The lead time estimated for backlog job is called backlog length.

The total time required for processing a manufacturing order from the demand generation to delivery is termed as order lead time. Order lead time has been estimated based on the backlog length in the system and manufacturing lead time for the specific manufacturing order.

To accommodate the dynamic status of the manufacturing system dynamic process plans have been generated whenever alternate feasible processing facilities are available. Based on dynamic
process plans the order lead times for all the feasible facilities were estimated. A dynamic programming problem has been formulated with the objective of minimising the order lead time of all the stages of the integrated manufacturing layout.

Due dates were assigned to the endogenous demands by adding order lead time with release time.

Feasibility of deadlines were assessed for exogenous demands considering the estimated minimum order lead time.

In order to avoid delay in delivery of the jobs, the jobs can be processed much earlier to the due date or deadline. This earliness in job completion before due date or deadline is identified as a disadvantage for strategic objectives of a dynamic job shop manufacturing system. Therefore the jobs are to be sequenced resulting in minimum earliness in an integrated schedule. To solve this problem a priority dispatching heuristic based on a deadline factor as priority index has been developed. The application of heuristics has been illustrated and the results were analysed by comparing with a well established heuristic and its expected case performance ratio.

The manufacturing orders will be infeasible when the order lead time is higher than the deadline lead time. This problem can be solved by reducing the order lead time by replacing a traditional manufacturing system by implementing an Advanced Manufacturing System having reduced processing times.

The traditional accounting methods will not be justifying the investment proposals for implementing AMS. Intangible benefits of AMS are quantified by relating them with the order opportunity cost. Then the order opportunity cost has been used
in the order lead time based justification model to justify the investment proposals for implementing the AMS.

The above methodologies necessitates generation of complex manufacturing plans and schedules handling and manipulating large amount of data describing general capabilities of an operation. A prototype KBES is developed to solve this problem.

The main program 'Knowledge Based Integrated Manufacturing Scheduler' (KBIMS) is compiled as a project including the following modules:

- **MACro Process Planner (MAPP)** for developing macro process plans for new orders. The process plans include estimated processing times for all the operations.

- **DYnamic Process Planner (DYPP)** for developing dynamic process plans for alternate facilities in a dynamic job shop.

- **PRIority DEspatcher (PRIDE)** for sequencing the jobs according to a priority dispatching heuristic based on a priority index according to deadline lead time and order lead time.

- **INVestment EXpert (INVEX)** system for preparing justifications based on opportunity cost and order lead time for capital investments on advanced manufacturing systems in order to arrange the delivery times as per the customers requirement. Fig. 6.1 shows the flowchart for the KBIMS project.

With the concept of integration of process and production planning the manufacturing operations can be effectively controlled. Consequently the throughput will be increased at a lower level of inventory. This will achieve increased flexibility and reduced lead time with increased reliability.

The issues such as product quality and traceability (ISO
9000 aspects are to be analysed with the integrated systems, because the same product can be manufactured in many different ways.

It is evident that an integrated approach to scheduling problems provides a methodology for changing traditional job shop manufacturing systems to be more competitive and dynamic with increased flexibility and reduced lead time.

6.2 SCOPE FOR FUTURE WORK

The methodologies developed in the present work with an integrated approach to scheduling problems are applied to a job shop manufacturing system for managing the operations of make-to-order jobs. In order to make them more realistic the following areas are suggested for further research.

(i) In the present work it was assumed that operations are carried out without suffering any breakdown or disruption. Models with breakdowns and disruptions can reflect better shop floor realities.

(ii) The required capacity and materials are assumed to be available in the system in the present work. Capacity constraints and material constraints are to be considered for more realistic solutions.

(iii) Robustness of these models can be verified by applying it to the service industries where make-to-order job demands are increasing with strict delivery schedules.

(iv) The solutions in the present work are mainly for tactical and operational levels of decision making. These concepts can be extended and integrated with strategic decision support systems.
Present work is basically designed to study the lead time planning problem. Statistical controls are to be designed to achieve effective lead time control.

Fuzzy logic and influence of chaos in the manufacturing system can be applied to accommodate the shop floor realities in the model.

IMPORTANCE OF PROPOSED RESEARCH

Integrated approach to the scheduling problems will open many future research directions. However the two most critical research areas are small scale manufacturing industries and service sectors. Small scale manufacturing industries play a dominant role in the manufacturing sector. Hence competitiveness can only be achieved by increasing the efficiency, economy and effectiveness of all operations in the small scale manufacturing industries. Similarly it is imperative to make the service sector more productive by adhering to prompt delivery of the demands and requirements of the customers.

It is hoped that the heuristics and models developed in this study would provide an effective decision support system for managing operations of manufacturing industries, particularly developing nations like ours, to enable them to be successful in highly competitive international markets.
Input order specifications
Prepare MAcro Process Planner (MAPP)
Calculate manufacturing lead time
Calculate backlog length
Calculate order lead time
Estimate deadline lead time

Start

Is DLT < OLT?

Yes
Prepare DYNamic Process plan (DYPP)
Calculate revised OLT

No
Is alternate process available?

Yes
Accept offer
Arrange sequence (PRIDE)

No
Propose new AMS

Is the investment justified? (INVEX)

Yes
No

Yes
Regret offer
Stop

Stop