Chapter 8: Conclusion, Limitations and Scope for Further Work

8.1 Conclusion

Traditionally when designing a new product, different steps in the initial design stage such as choosing the material, determining the process to make the part, designing the tool to make the part etc., are carried out sequentially by different people or work groups in numerous iterations. This leads to long lead time to come out with satisfactory results in designing the product and process. An IPPPIS have been developed for a machine tool manufacturing firm with integrating domain knowledge of various departments in the manufacturing industry.

This research has presented an integrated manufacturing application framework to link design stage to the other stages in the manufacturing systems, more specifically the manufacturing process design stage. The IPPPIS developed provides a computer-based method for the concurrent design of a part, the tool to make the part design, and finalize the processes to be used in making the part. Using this research, unlike in prior systems, the part design, the tool design and the process design can be carried out concurrently, which will reduce the time and cost of part design significantly.

To enable correct part design, the IPPPIS provides the part designer with all relevant information affecting the part design (such as information about the processes and materials used to make the part) while the part is being designed. With information models and IPPPIS developed in this research, the relevant information supplied to the part designer, the tool designer and the process designer. Designers can share information concurrently using the IPPPIS. Design decisions made by each designer can be included as a factor in the design decisions by other designers. As such, the functions of
part designer, tool designer and process designer often merge and overlap when the IPPPIS is used.

Using the above framework a prototype of an IPPPIS has been developed using object-oriented technology. This was done after studying the design process in a lathe manufacturing company and examining all information and factors necessary for modeling manufacturing and process planning used for collaborative design and manufacturing. A systematic information modeling technology was used to represent the information relationships and associations from a system perspective.

For development of the model for collaborative design and manufacturing in a machine tool manufacturing factory, Oracle tools such as Oracle 9i, Forms6i, Report 6i, has been used. The main components of this model are - process-planning model (PPM), manufacturing activity model (MAM), manufacturing resource model (MRM) and manufacturing cost and time model. In order to reduce the turn-around time and improve the response time to customer’s needs, modularity analysis in the design stage can be applied to the manufacturing planning stage to finish total tasks by using interrelated modules.

IPPPIS developed was able to meet the following objectives:

- Integration of part, tool and process design
- Deploying the concept of reuse by designing part-coding mechanism suitable for a machine tool company, this is kept in a part database.
- The reuse of planning methodologies and 'best of practice' (BOP) to reduce engineers’ workload and increase their planning efficiency.
- Design classifying and coding system for tools to keep in a tool database
- Collect and encode available machine data and process that can be carried out on them
This IPPPIS if adapted and implemented will benefit manufacturing units, by giving them an extra edge, in today’s cost and time competitive market by:

- Providing a set of feature data records, including shape information, tool information and process information corresponding to the respective primitive object. Each feature data record corresponding to a respective primitive object having a predefined function.
- Concurrently designing a product drawing and a process specification to make the product as a function of the form information, the tool information and the process information in the selected feature data record.
- Automating concurrent engineering, and more particularly, to provide a method for concurrent design of parts, tools and processes, that can quickly and accurately generate feasible manufacturing plans in mass customization situation based on existing BOP. This enhances the production efficiency, eliminates waste and reduces cost of the product by minimizing product variety.
- Providing a process by which a product may be produced with minimum cost, highest quality, highest consistency, while reducing the time to market (Being Agile to market).
- Designer can select design features in initial stage of design in such a way that standard machines and tools can be used (Encourage design for manufacture).
- Improved interrelationships among design and manufacturing as well as overall economics of the operations, which leads to Lean manufacturing.

The workability of this approach was tested in a machine tool manufacturing firm. The case study demonstrates the benefits from such an approach. Furthermore, this model provides software developers with the
information foundation for developing new process planning systems so that development time can be significantly reduced.

8.2 Limitations

In this research, the scope of IPPPIS development was for realisation of mass customization and batch production of machine tools. Design of the system was done keeping in mind the organization taken for the case study, which is a machine tool manufacturer, which manufactures lathes. Basing the design on a specific manufacturer and their process could have created a bias in system design, and therefore limited the applicability of the work presented in this thesis.

The process and stages in design though general in most machine tool manufacturing organizations, work allotment to group and work flow could be different in different organizations. This system was developed with, the stages and grouping of work and workflow, of the company studied in the case in mind. Hence, fine-tuning of the IPPPIS may be required to meet the requirements and work grouping of some other organization.

In this research, object-oriented technology with related tools and databases (free downloadable database software - Oracle 9i) has been used, which has its own advantages and disadvantages. Use of other technologies and tools such as Java, Dot Net etc. were also possible but were not attempted in this work.

The case study and trials were carried out with small parts design section of the machine tool manufacturing company. However, the same can be extended covering broader areas the same has not been done in this study.

8.3 Scope for Further Work

In this research, an integrated manufacturing application framework to link design stage to the other stages in the manufacturing systems has been developed. An IPPPIS has been developed to have a computer-based
method for the concurrent design of the part design, the tool design and the process design. Some directions for further work are given below:

- Only the limited aspects of fixture issues were considered here. However, fixture planning and fixture design is indispensable in setup planning which requires more attention. Multi-spindle machine tools are widely used in mass production. They can execute multiple processes at the same time, which can greatly increase productivity and reduce cycle time. The machine tool capability model can be extended to multiple spindle machine tools in future studies.

- In the part coding area, coding was restricted to 19-digit code in the design and process area. This is to reduce the time for coding and overall prototype model development. This can be further extended to more number of digits to enhance the accuracy of the retrieval. Some of the attributes such as tolerance, tools, fixtures, etc., can be elaborated further in this context, according to the requirement of the industry on which it is to apply.

- In this research domain, knowledge in the setup planning and fixture design area is restricted with more focus being given on process and design. This can be further elaborated with details of fixtures design and setup planning depending upon the type of machine tools that are being used, which can be linked with the framework of the IPPPIS developed.

Future research work can be planned for the improvement of the proposed framework, for creation of a model for evaluation of productivity improvements, in order to quantify time and cost reduction. Enhancement of the model through a workflow perspective, using the object-oriented approach used here, will help extending the use of the model for the entire production system.
The recommendations for future work also include:

- Incorporating the supplier’s process capability, in the framework, this will be useful where the processes are off loaded or subcontracted.
- Development of methods to integrate additional organizational strategies and goals (profitability, market share, technological leader, etc.) into design decisions.
- Investigation of the use of Living Systems Analogy (LSA) to model entire organizations at multiple levels of abstraction to facilitate the inclusion of organizational concerns in design decisions.
- Investigation of methods to include organizational goals at other points in the product realization process (in addition to configuration design addressed here).