CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS

- Schemes were developed to suppress tool vibration to improve the effectiveness of the process of turning of hardened AISI 4340 steel with minimal fluid application using multcoated hard metal inserts with sculptured rake face.
- Fluid delivery parameters were investigated and their optimum levels were identified for minimizing tool vibration.
- The effect of semisolid lubricants (silicon grease impregnated with graphite) on tool vibration during hard turning with minimal fluid application was investigated and it was found that the application of semisolid lubricants at critical locations can reduce tool vibration and bring forth better cutting performance. A pneumatic semisolid lubricant applicator was developed that has got a very good potentiality for commercialization. Introduction of semisolid lubricant brought about 44% reduction in tool vibration, 80% reduction in surface roughness and 25% reduction in tool wear.
- An impact damper was developed which is simple in construction, robust, comparatively less expensive and can operate in environments that are too
harsh for other traditional damping techniques. It was observed that there was 50.15% reduction in tool vibration, 15% reduction in surface roughness and 7.69% reduction in tool wear when compared to conventional minimal fluid application scheme when the tool holder was fitted with an impact damper during hard turning with minimal fluid application when the operating and the fluid application parameters were kept at their optimum levels. But impact damper is a damper with fixed stiffness and the size and the location of the damping mass is to be designed for each tool-work combination.

- A magnetorheological fluid damper was developed for suppressing tool vibration and improving cutting performance during hard turning with minimal fluid application. Parameters controlling the damping capability of the magnetorheological fluid damper were investigated and a set of levels of the controlling parameters were arrived at for achieving maximum damping. Introduction of an MR fluid damper could reduce tool vibration by 89%, tool wear by 70%, main cutting force by 29% and surface roughness by 50% during hard turning with minimal fluid application and a cost analysis indicated that the investment on the magnetorheological fluid damper can be recovered in a very short payback period.

- A tool with in-built sensors that can sense and transmit main cutting force, average cutting temperature and tool vibration signals was designed, developed and tested. This research work can form a basis for developing intelligent cutting tools that can predict tool wear online by fusing signals of cutting force, cutting temperature and displacement of tool vibration using sensors embedded on them.

- A sensor fusion model was developed that synthesized tool vibration, cutting force and cutting temperature based on Artificial Neural Network and Regression analysis and it was found that better tool wear prediction was possible when cutting temperature, main cutting force and tool vibration signals were considered collectively and a fusion model based on ANN predicted tool wear better than a model based on regression analysis.
9.2 SCOPE FOR FUTURE WORK

➢ As an extension of this work, a correlation may be developed between the magnitude of tool wear and the damping capabilities needed to suppress the resulting tool vibration and to keep the surface finish at a predefined level. During the beginning of turning the tool will be sharp and comparatively less damping is sufficient to maintain the cutting performance at its optimum level. But as the cutting progresses, tool wear increases and the cutting tool needs more damping. Hence a control system may be developed that automatically varies the damping capability as necessitated by the magnitude of tool wear. Such a package will be highly useful in maintaining the cutting performance throughout the life of the cutting tool as needed in high precision turning operations.

➢ A tool with in-built sensors that can sense and transmit signals of cutting force, cutting temperature and tool vibration to a remote location in the wireless mode during turning operation may be developed so that cutting tools in a number of machine tools on the shop floor or a number of cutting tools on the same machine tool can be monitored in wireless mode using a centralized tool wear monitoring system.