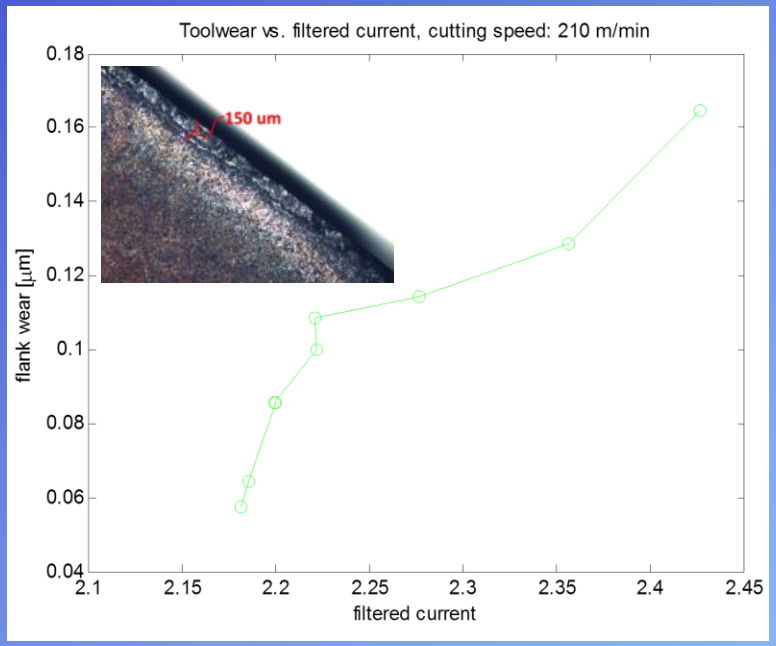
Manufacturing Processes Modelling and Energy Efficiency

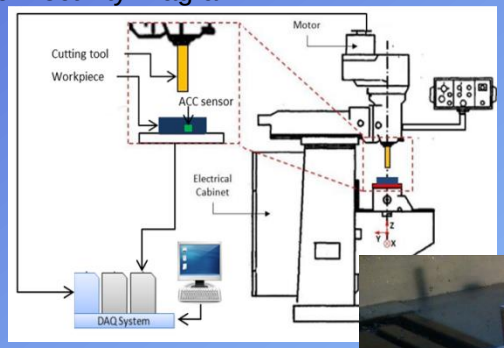
Online Tool-wear Monitoring

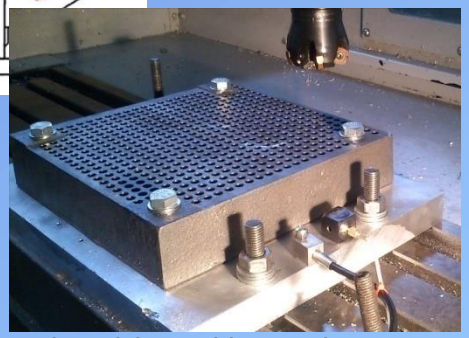
Correlation of tool-wear measurements during milling using:
•Spindle torque measured through inductive measurement of the motor elec. current
•Vibration signals obtained by accelerometer



[A]

Connectivity Diagram:





Configuration of the tool-insert-piece system

Conclusions:
•The RMS value of the electrical current signal could be used for the assessment of the wear level
•A frequency domain analysis is required for a useful indication of tool wear levels through the accelerometer signals

REF: Doukas C., Stavropoulos P., Papacharalampopoulos A., Foteinopoulos P., Vasiliadis E., Chryssolouris G. (2013) "On the estimation of tool-wear for milling operations based on multisensorial data", *(CIRP CMMO) Procedia CIRP, 14th CIRP Conference on Modelling of Machining Operations*, Turin, Italy

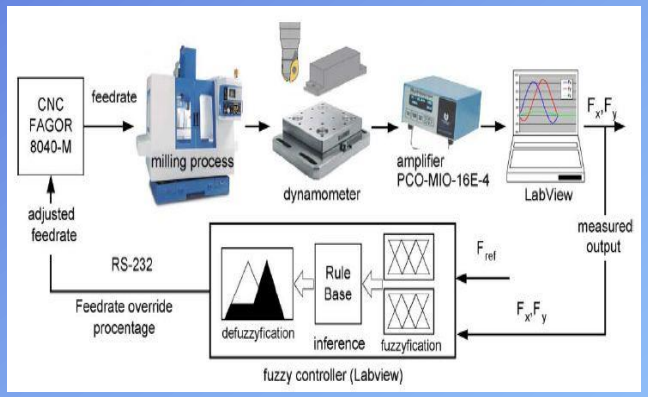
Manufacturing Processes Modelling and Energy Efficiency

Adaptive Control (AC) of manufacturing processes

The future enhancement of machining systems will essentially depend upon the development and implementation of innovative AC systems.

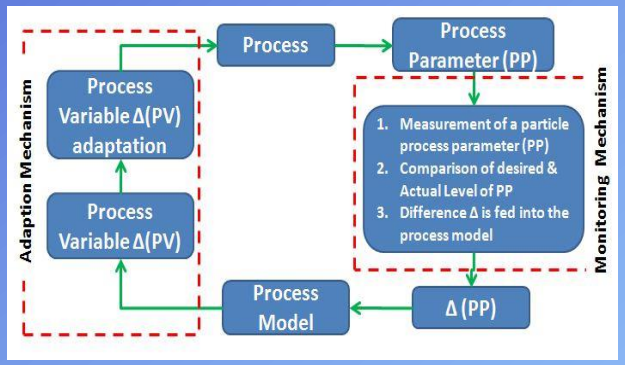
These novel systems will have to be robust, reconfigurable, reliable, intelligent and inexpensive in order to meet the demands of an advanced manufacturing technology.

Example of Online Adaptive Control System

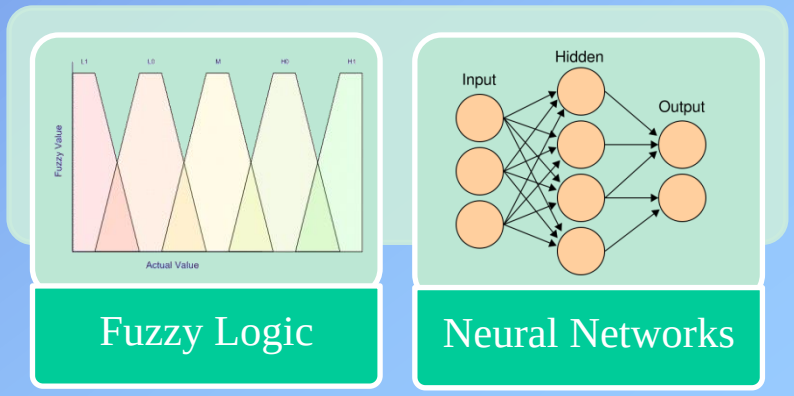


Control Categories:

- **ACC: Adaptive Control with Constraints**
- **ACO: Adaptive Control with Optimization**
- **GAC: Geometry Adaptive Control**



Modeling Methods to include measurements:



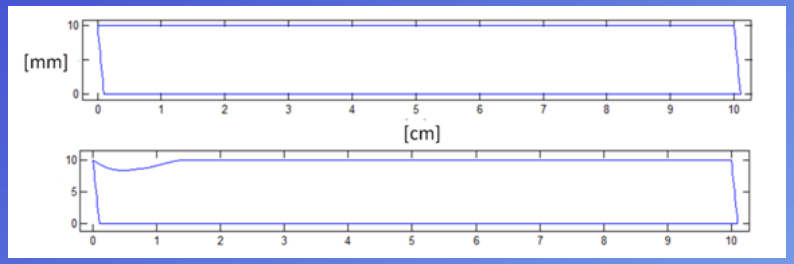
REF: Stavropoulos P., Chantzis D., Doukas C., Papacharalampopoulos A., Chryssolouris G. (2013) "Monitoring and control of manufacturing processes: A review", *(CIRP CMMO) Procedia CIRP, 14th CIRP Conference on Modelling of Machining Operations*, Turin, Italy

Manufacturing Processes Modelling and Energy Efficiency

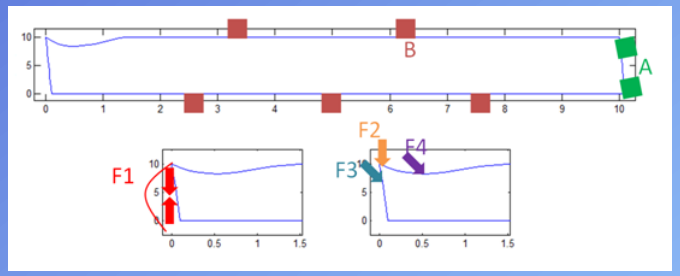
Study of Acoustic Emission signals within structures (i.e. tools)

Computational study of the effects of the tool configuration on propagated signals.

•Different Geometries (due to toolwear)



•Different Configurations (A-B for clamping, F1-F4 for various forces excitation) & Microstructure



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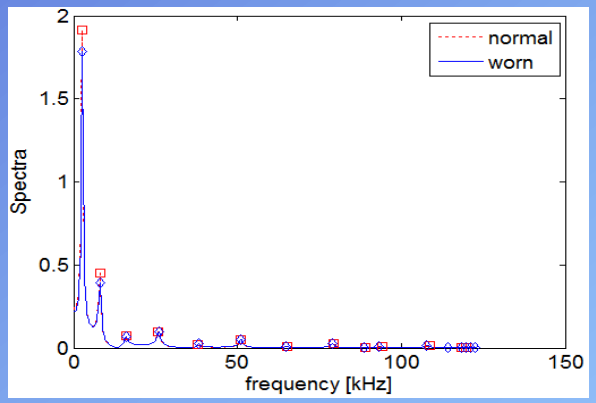
Example of a frequency response:



Conclusions:

•Excitation: changes the phase of the AE signal spectrum

•Clamping: makes higher frequencies of the AE dominant

•Micro-Structure: lowers the extrema of the AE spectrum

•Wear: changes the distribution of energy across dominant frequencies at relatively low frequencies.

REF: Papacharalampopoulos A., Stavropoulos P., Doukas C., Foteinopoulos P., Chryssolouris G. (2013) "Acoustic emission signal through turning tools: A computational study", *(CIRP CMMO) Procedia CIRP, 14th CIRP Conference on Modelling of Machining Operations*, Turin, Italy