Control of the External Cylindrical Grinding Process Using an In-Process Gage and Open Architecture Control

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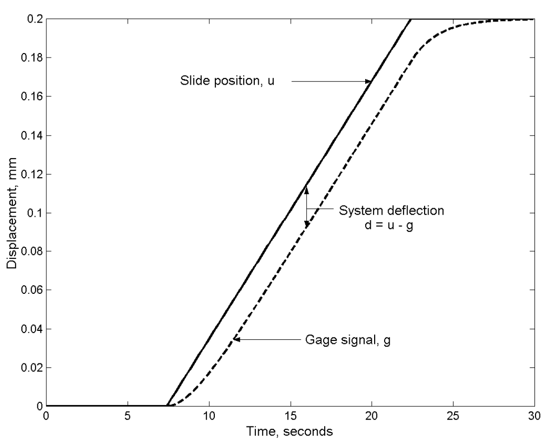
The purpose of this research is to reduce the part diameter variation and cycle time of a high volume dedicated grinding machine process. The automotive and bearing industries use these processes extensively to produce components expected to last the life of a product. Grinding machine manufacturers are constantly trying to increase the capabilities of their machines to produce better quality parts.

Current machine control technology includes a spindle power monitor and in-process diameter gage. The power is directly related to the tangential force of the process. In-process gages are intended to improve quality by signaling the machine to transition to different stages based on the part diameter and a series of set points. The disadvantage of this current control technology is the reliance on grinding parameters that change based on the current health of the process. Variations in the sharpness of the grinding wheel change the coefficient of friction between the normal and tangential forces. Therefore, at the end of a cycle the same spindle power may result in a different normal force and system deflection. The final diameter of the part is affected by this force and deflection.



Simulation of the external cylindrical grinding process showing the relationship between the plunge axis slide position input and the in-process diameter gage output.

A system was developed to improve the part diameter variation by adjusting the feedrate of the machine tool to maintain a constant system deflection at the end of the process. The control uses the best attributes of power control and in-process gage set point control. The system consists of a heavily modified machine tool fitted with a Delta Tau PMAC and a dSpace DS1102 real-time DSP development system. The dSpace implements the custom control algorithms and varies the infeed of the plunge axis using the external feedrate override of PMAC. Models were developed to verify algorithms and methods prior to implementation. Results are benchmarked against existing algorithms by implementing them on the machine.

Picture of the external cylindrical grinding process and in-process gage setup in the PMRC lab at Georgia Tech.

David Longanbach is a Ph.D. candidate working on improving the grinding process using metrology and advanced control algorithms. He received his BSME degree from Virginia Tech in the Spring of 1996 and started graduate studies at Georgia Tech in the Fall of 1996. He received his MSME from Georgia Tech in 1997, and plans to graduate with his Ph.D. in the Fall of 2001. He has recently accepted a position with Caterpillar as a Senior Development Engineer in the Advanced Production Technologies Division located in Mossville, Illinois.

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