Plunge Grinding Process
Surface Roughness Model and Process Control

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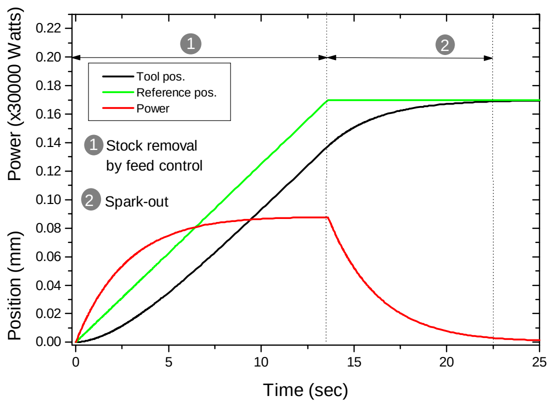
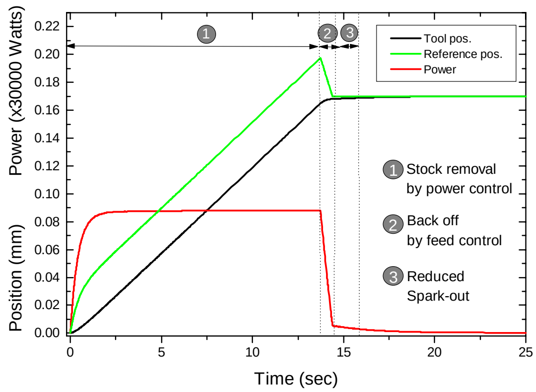
Grinding is an extensively used process to finish machined parts that require high surface quality and tight tolerances. Grinding is an abrasive process where the tool, composed by small abrasive grits bonded together, presents a very complex interaction with the workpiece, making the process difficult to predict. More than fifty years of research have been focused on the interaction between the process, machine and workpiece parameters related to the output variables such us surface roughness and residual stresses. The lack of a complete understanding of the process and the low practicality of these analytical equations has forced the use of purely empirical equation for the process optimization. These empirical equations are simple in structure but their reliability depends on the sensor technology and on-line parameter estimation techniques to count for the no modeled process variations.



Reference position, tool position and power response for a typical grinding cycle.

This research proposes the development of the surface roughness governing equations for plunge grinding that includes several physical mechanisms in grinding, such us wheel-workpiece overall deflection, local grit deflection and individual grit-workpiece interaction. This model takes into account the workpiece material properties, type of wheel, machine characteristics and machining parameters such as the tool feed per revolution, the dressing conditions and the wheel/workpiece tangential velocity. Also the time dependent behavior of the grinding process is considered.

The model is to be used in an optimization strategy composed of an accelerated spark-out process combined with a power controlled stock removal stage. Power control during stock removal stage presents the advantages over constant feed control in that it accelerates the spark-in, limits an excessive wheel wear and prevents surface burn if the right level of power is commanded. The accelerated spark-out has been studied to reduce the spark-out time subject only to final dimension requirements. The proposed research is to use the surface roughness equation to control the accelerated spark-out phase subject not only to part dimension but also to surface roughness requirements.



Commanded position, tool position and power for a power controlled grinding cycle combined with an accelerated spark-out phase.

Rogelio Hecker is a Ph.D Candidate working on research in the area of grinding process modeling and control. He received his Electromechanical Engineering degree from UNLP, Argentina, in 1995 and a Nuclear technology Specialization in 1996 from Balseiro Institute, Arg. After that he worked in robotics research until Fall of 1998 when he jointed the master program at Georgia Tech. He received his MSME in Spring of 2000, and plans to graduate with a Ph.D. in mechanical engineering by Fall 2002. He is currently looking for opportunities related to manufacturing process modeling and control.

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