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CEGRIS II

Centreless grinding simulation part II

STREP

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24 months publishable executive summary

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Revision [draft]

1 Publishable executive summary

1.1 Summary description of project objectives

The industrially applied centreless grinding and especially centreless through-feed grinding process is characterised by its complexity and sensibility. This process is mainly used for mass-production of rotationally symmetrical workpieces such as valves and piston rods.

The aim of the project CEGRIS II is to minimise the long set-up times of the centreless grinding process in order to enhance manufacturing productivity of European companies employing the discussed technology by at least 40%. Next to reduction of the centreless grinding system set-up time, higher process flexibility can be obtained which again increases the productivity potentials.

Realisation of the industrial goal is based on the 3D simulation model of the complex centreless through-feed grinding process, which is being developed for this project. The model is computer-aided with a software tool that will enable not only to help set-up the machine-tool, but will also be able to simulate the process outputs at particular grinding system set-up. Finally, the 3D model and the software tool will be embedded in a CAVE environment for a VR (virtual reality) visualisation of the workpiece movement through the set-up grinding gap. This can be used for process demonstration and also for identification of specific centreless grinding related problems. Developed software tool with belonging 3D model embedded in CAVE VR environment represent the state-of-the-art in centreless grinding technology.

Another very important goal of CEGRIS II is the significant reduction of water-pollution by about 80%. Employment of newly designed filtering system will yield significant ecological benefits that are also aimed within this project.

1.2 Contractors involved

The consortium of the CEGRIS II Project consists of three different end-users TORUNSA S.A., SUSPA Holding GmbH and INA Schaeffler KG, who use the centreless through-feed grinding process in their production (**figure 1**). Two universities participate in the project. UNIVERSITY OF LJUBLJANA is qualified for the analytical approach to the simulation of the process and the WZL from RWTH Aachen, with numerous years of experience in centreless grinding process application. GRINDAIX Aachen GmbH is dealing with development of simulation software and was additionally involved in the project. Studer Mikrosa GmbH as a machine-tool manufacturer is a coordinator of the consortium as well as two machine-tool components suppliers. MARPOSS S.p.A is very experienced in process control, especially for centreless grinding operations. AWAS-Systemy SP.Z o.o. is an expert in the environmental conditioning of waste water, who provides its knowledge for the treatment of the water based coolant used in this process. The consortium is carefully selected and composed with experts of the respective sectors, to gain a maximum benefit for the project.

figure 1: CEGRIS II Consortium

figure 2: Official CEGRIS II logo

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The official project website is linked by www.cegris.de

1.3 Work performed and achieved results

In order to enhance the centreless grinding manufacturing technology by at least 40%, the long set-up times have to be minimised by simulating the grinding process. For this, different geometries of the wheels, workpieces and the grinding gap set-up have been analytically described with a 2D model. Investigations and calculations on geometrical stability have been carried out. By combining the analytical description of the grinding gap with process stability criterion, first calculations of process stability with regard to geometrical rounding effect could be conducted.

Beside the geometrical set-up of the grinding gap also the process parameters have an influence on the rounding effect. For the 2D centreless plunge-cut grinding process calculations for the kinematical stability were conducted. Comprehensive analytical modelling of the centreless grinding has to bring together separate descriptions of the workpiece centre displacement due to material removal and workpiece dynamics. Furthermore it has to incorporate geometrical mechanism of workpiece forming process. The structure of the analytical 2D centreless grinding model can be represented with the block diagram, which is shown in **figure 3**.

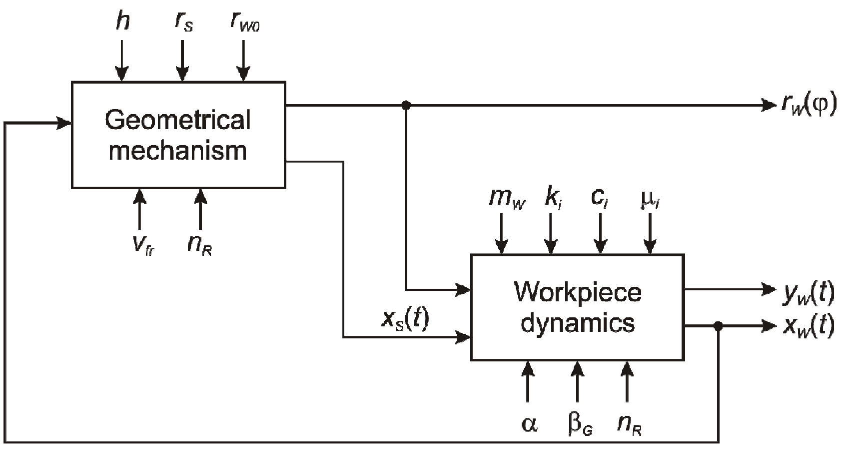

figure 3: Block diagram of the 2D centreless grinding model

By the use of the software model a virtual workpiece shape after grinding process can be calculated. In **figure 4** the virtual workpiece shape is calculated for two different infeed speeds and same frame boundaries. This shows the additional influence of kinematical stability to the geometrical stability. Stability calculations have been verified by grinding tests.

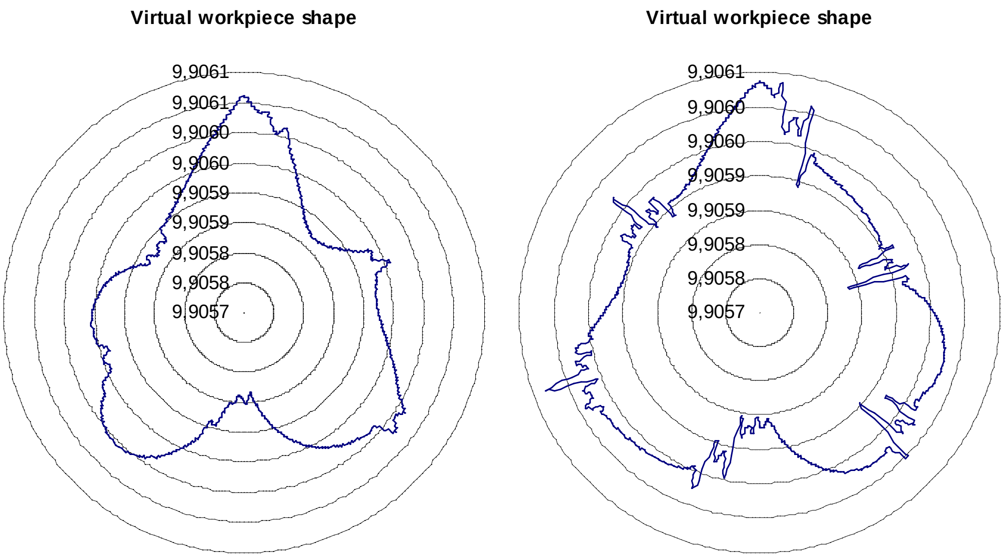

figure 4: Virtual workpiece shape depending on infeed speed

Concerning the geometry of a 3D grinding gap, analytical display of the control wheel has been developed. In the next steps of the project, the geometrical and kinematical stability calculations will be extended to the 3D model and visualised in a CAVE environment. A software tool for stability calculations will also be implemented into the machine-tool CNC system in order to reduce set-up times and to monitor the process. This simulation software will also be connected to a measurement system in the grinding gap, which monitors the polygon order. By an adaptive workrest blade it will be possible to adjust the grinding gap set-up automatically and to reduce the roundness error.

For reducing the water pollution by coolant, research on coolants, coolant filtering and coolant conditioning has been done. Analysing different possibilities of coolant filtering systems, a new system has been designed. This new floatation system has been implemented into the test machine-tool and first examinations have been realised. The floatation system could reduce the amount of bacteria from 17.000.000 per gram to less than 1.000 per gram, which is outstanding. This big effort in coolant conditioning leads to better working environment for the machine-tool operators as well to enhancement of coolant life-cycle.