2. X-CONCEPT

Fig. 1: X-concept tool box

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1. Introduction

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2.2 Strategy 4-Position

All four axes are position controlled. This strategy imposes a higher demand on the machine calibration because even a small position inaccuracy leads to high forces in the structure and no power reserve for the movement exists.

3. Predefined Torque Calculation

The predefined torque is composed of different individual values. It is possible to achieve each compensation on its own.

- Static Compensation
  A torque which generates a defined force on each strut in an axial direction. Only gravity and geometrical dimensions are taken into account.

- Dynamic Compensation
  Additionally to the static torque, the acceleration of the system is used.

- Friction
  The load dependent friction of the carriages is added.

- Lag Error Transfer
  At a force controlled axis, the force is independent of the position deviation of the axis. In order to achieve also a position dependent torque without the influence of structural inaccuracies, the position deviation of axes 1 and 2 are transformed to axes 3 and 4. This deviation is multiplied by a K-factor and added to the predefined torque. This corresponds to a simple P-Controller with a dead time element.

4. Experiments

For each predefined torque, experiments were performed on the machine with different parameters and paths. During the tests the driving torque and the lag error was logged by the control unit.

Fig. 4: Circle path – Torque axis 1

An example for the torque on axis 1 during a circular motion with 20 m/min feed rate is shown in figure 4.

5. Acknowledgements

In general the charge of each drive can be reduced by the predefined torques. Thereby higher feed rates and acceleration are possible. With the 2-Position/2-Force controlled strategy, oscillations are generated around the extended position of the position driven axes. This effect could be eliminated by a switch of the position dependent axes from one side-pair of struts to the other. The requirement of this change is dependent on whether the x/y-position of the TCP is close to the singularity point. With the 4-position control strategy, there is no oscillation, but the generated torques are greater to offset the restraining forces in the structure. With enhanced predefined torque algorithms it will be possible to divide the charge uniformly to all axes and increase the maximum feed rate, acceleration and accuracy.

6. References