Virtual Set-up of Multi-stage Presses Integrated with the Design of the Forging Process

Prof. Paolo F. Bariani, Prof. Dr. Ing. Guido A. Berti, Dr. Ing. Jungjiang Yang

DIMEG, University of Padova

Abstract: *In the current practice the set-up of multi-stage transfer presses results to be an intensive-labour and time-consuming activity which considerably contributes to the increase of non operational time of the press. Considering the high production rates of these machines when equipped with automatic transfer devices, as well as the high investments for equipment and tooling, a reduction of non operational time of the press can lead to an appreciable increase of production efficiency.*

A Virtual Environment has been developed and implemented for the design and test of the forging process. It consists of a set of software modules specifically devoted to assist the process designer in a set of tasks including (i) design of the forging sequence, (ii) design of components and assembly of the tooling system, and (iii) timing and setting up of the press.

By this approach, the setting up of a press is moved from the operative level of the shop floor to the more decisional level of process planning, where preforms and tooling are designed.

The present paper is focused on the module for timing and setting up of the press. This module assists the process designer in the off-line determination of press parameters for a specific forging task. It is based on 3D parametric models of the objects and their animation in the working area of the press according to the kinematics of the machine. It allows a correct timing of movements of punches, ejectors, grippers and blanks without collisions and blank dropping.

The virtual set-up has been applied in industrial environment and has demonstrated advantages summarised as follows: (i) easy generation and test of alternative sets of adjustment parameters, (ii) reduction of modifications of the tooling system, and (iii) considerable reduction of the time for setting up and timing of the press and, therefore, of the total lead time to manufacture.

Keywords: Multi-stage presses, Timing, Virtual Set-up.

Timing and the Timing Module

Modern multi-stage forging machines(Fig. 1), with automatic mechanical transfer between stations, permit very high production rates to be reached and are widely used in cold and warm automobile forging industry. Process planning for such machines, including forging operation sequencing and grouping, tool sets design and machine timing, together with tool manufacture and machine setting, take up a significant proportion of the total manufacturing lead time. Furthermore, process planning functions require the skills of experienced personnel.

Timing the press consists essentially in assigning stroke lengths and stroke positions to the transfer system and workstation actions in order to co-ordinate their sequence. The actions to be timed are ejection of the cut-off at the push-out station, the die-side and punch-side

ejection of slugs, their gripping and transfer. The stroke length and position are controlled usually by steplessly and individually adjustable cams.

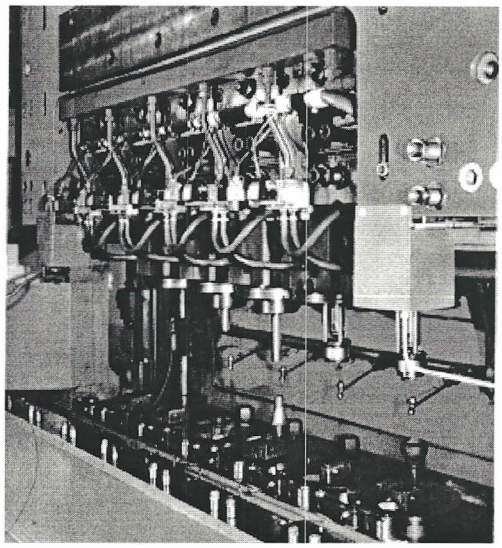

Fig. 1 Multi-stage vertical press.

Therefore reduction of the lead time to manufacture, as well as effective deskilling of critical tasks, are typical benefits expected from the implementation of computer aided procedures in the production departments, including. machine timing activity. The timing model is aimed to simulate the press movements with the tooling and transfer system as a virtual working cell. The 3D timing model of the press and tooling presents the advantage that the module can be used for both axisymmetric and non axisymmetric components and the working area of the press can be checked for collisions. Adopting a parametric CAD system allows an easier modification of components of the tooling and transfer system.

The press movement adjustment parameters can be changed according to the forging timing simulation. In this way the machine setting up can be simulated and animated on the computer screen.

The module's capabilities include: (i) interactive simulation and animation of movements of the machine with relevant punch, die, ejectors and transfer grippers, (ii) automatic proving of the timing plan against collisions, (iii) modification of both press setting parameters and tool sets. A complete error-free timing table can be obtained as a final printout.

A central CAD database has been created to store the standardised tool components, special dies and punches, as well as the assemblies. The procedures for timing consists of three steps: i) tooling envelops creation, ii) timing module setting up, iii) timing simulation (Fig. 2); it can be summarised as follows:

- Definition of the envelops and their assembly with the two slugs and the two grippers (precedent and current at this station).
- Retrieval of press database and parameters for positioning punch-, die- and ejectors-envelops, slugs and grippers, according to the mechanism of the press. Some parameters and relations are passed from the tool set design, according to the product dimension.
- Simulation of the motions in the working area of the press.

Collision among punch, die, punch- and die-ejectors, slugs and grippers are continuously checked. If the setting up can not be achieved correctly, the user can modify press very easily by menus. All positions of the parts can also be adjusted according to the modification of press parameters. If the modification of the tool sets is required, the designer can activate the tool design module to perform required changes.

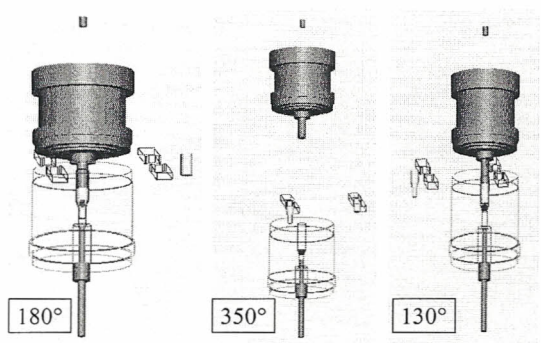

Fig. 2 Examples of timing simulation.

Final results of timing module include i) detailed design, ii) tool documentation (drawings of assemblies and parts, bills of materials), and iii) press setting up parameters.