# Abstract

## *Numerical simulation of sheet metal forming*

U. Wendt, K. Mattiasson, A. Samuelsson

Cold forming of thin metal sheets is a very important process in the automotive industry. Plane steel sheets is by so-called deep drawing by stamping plastically deformed into the different parts of the car body. The stamping is performed with almost stiff, heavy tools called punches that are forced to press a steel sheet into the form of the die.
The tool must have such a shape that the sheet does not become too thin anywhere or get wrinkles. Until the last decade the tool were manufactured by very skilled workers and engineers who by experience could get the right form of the tool. However, this tool manufacturing was very time consuming so there was a great need for a numerical simulation of the stamping. To make such a simulation code that is accurate but also fast enough has been a great challenge.
Mechanically the problem is a large deformation, elasto-plastic quasi-static one. The first attempts were made in 1978. In [1] a full elasto-plastic finite element simulation was proposed and in [2] and [3] the elastic property was disregarded so a plastic flow formulation was used. The latter approach was considerably faster but could not simulate either buckling nor spring-back when the punch was removed. On the other hand the full elasto-plastic continuation approach was very slow and often instable. In 1989 [4] Honecker and Mattiasson proposed to take inertia effects into the elastic-plastic model. The reason was that an explicit solution procedure then can be used meaning that no system of equations has to be solved. Even if the explicit method is only conditionally stable so very small time steps are needed, it was found that this procedure could be effective. As the inertia effects are very small in the stamping process no considerable errors were introduced by increasing the real stamping time with, say, a factor 100 so the computing time was kept reasonably low. Further, no instability problems appear with this method.
The explicit solution procedure has been implemented in almost all car factories around the world and has been found to be effective. The time for tool manufacturing is said to be reduced with up to 50%.

### References

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[4] A. Honecker, K. Mattiasson: Finite element procedures for 3D sheet forming simulation, NUMIFORM89, Balkema, 1989.