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ІМІТАЦІЙНЕ МОДЕЛЮВАННЯ В ПРОЕКТУВАННІ ОСНАЩЕННЯ ДЛЯ ФОРМУВАННЯ ЛИСТОВОГО МАТЕРІАЛУ

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SIMULATION MODELING IN DESIGNING APPLICATIONS FOR SHEET METAL FORMING

The forming simulation in sheet metal forming technology and its industrial applications have greatly impacted the sheet metal product design, die developments, die construction and tryout, and production stamping in the past decade. It led to significant progresses not only in fundamental understanding of sheet metal formability, forming mechanics, numerical methods, but also to the fruitful industrial applications in a wide range of industrial production.

The automotive die and stamping industry benefit most from the stamping simulations. The technology advancement speeds up the historical transition in automotive die development and stamping from a tryout-based workshop practice to a science-based, technology-driven engineering solution. The applications and benefits may be summarized as follows [1]:

- die engineering tool in stamping die developments;
- tryout tool to shorten production die tryout and thus to significantly reduce die cost and lead-time;
- production tool to provide production stamping conditions (beads, lube, binder and press forces, etc.);
- problem solving tool for production troubleshooting to reproduce manufacturing problems, and to provide solutions for process control improvements;
- simulation-based manufacturing guide to use the simulation output to drive consistency among die engineering, die construction, and production stamping;
- learning tool to explore and gain new knowledge and application guidance for new forming techniques and new materials.

In today's die and stamping industry, the simulation for virtual validations of die developments before production trials is a critical business for lead-time reduction, cost reduction and quality improvements. The global competitions drive higher quality requirements, lower cost, and shorter lead-time. The competitions also drive the industry to use more new designs, new materials, and new forming processes. These trends in automotive stamping can be summarized as follows increasing:

- part size and shape complexity such as whole body side panels, and multiple attached parts formed in one die to improve productivity and reduce die cost;
- material diversity to meet different needs such as using light weight material (aluminum) for fuel economy, using stronger material for safety (dual phase steel, TRIP steel, and ultra high strength steels), using laminated metal-plastic-metal sheets for noise- and vibration reduction, and using tailor-welded blank to reduce the number of parts for better structure integrity;
- use of unconventional forming processes such as hydro-forming for extra deep drawn panels, superplastic forming for complicated parts, and forming with intermediate annealing for materials very difficult to form.

All these new trends create new challenges for stamping simulation from fundamental research to software development and to production applications.

One of the main drawbacks in industrial practice hindering the even more wide application of simulation techniques that the output results of simulation packages are not usually directly and easily usable for computer aided die design. Obviously, there are tremendous efforts to successfully link CAD and FEM systems, however, still there are a lot to do in this field [2]. This solution requires a fully integrated approach of computer aided product design, process planning and die design, as well as the finite element simulation of the forming processes. It means that simulation tools should be efficiently used throughout the whole product development cycle.

This concept will be illustrated through the examples of automotive part production. In our practice, we use Unigraphics NX 4 as a CAD system for supporting the Process Planning and Die Design tasks and the AutoForm 4.05 is used as the numerical simulation tool, however, the principles applied here can be similarly adopted by using different CAD and simulation packages, too. Before analyzing this integrated solution, let's summarize the main features of forming process planning and die design in so-called conventional CAD environment.

Stamping industry applies CAD techniques both in the process planning and die design already for many years. However, in a „traditional" CAD environment, these are practically stand-alone solutions, i.e. for example a knowledge based process planning solution is applied for the determination of the necessary types of forming processes, even in some cases, the forming sequences can be determined in this way together with the appropriate process parameters, too. After determining the process sequences and process parameters, the forming dies are designed using sophisticated CAD systems, however, still we do not have any evidence whether the designed tools will provide the components with the prescribed properties. Therefore, before it goes to the production line, usually a time- and cost consuming try-out phase follows, as it is shown on Fig.1.

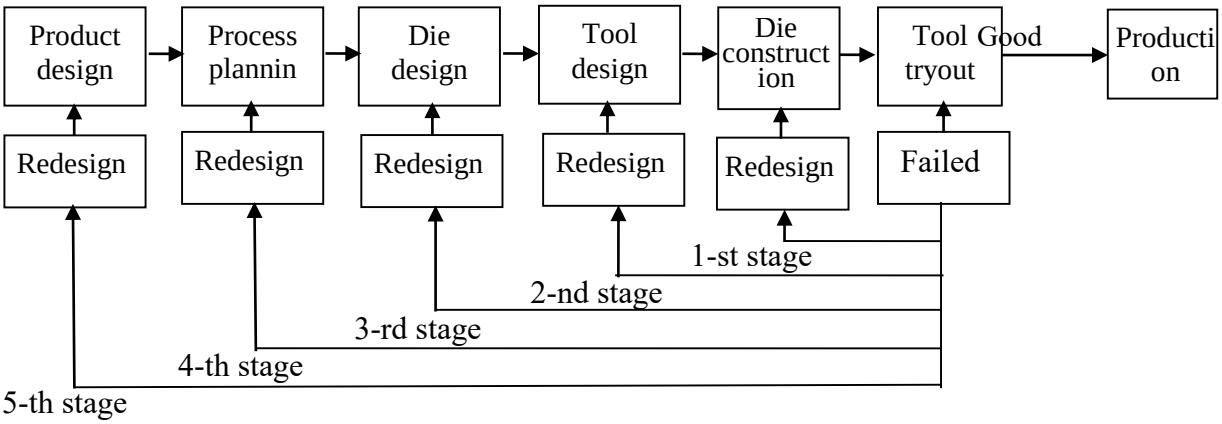

Figure 1 – Workflow of process planning and die design in „traditional" CAD environment

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