Virtual engineering and planning process in sheet metal forming

Nowadays the and in sheet metal forming is fundamentally supported by CAD and CAE systems. Beside the full 3D design of parts and tools the simulation of sheet metal forming has established itself in the last 15 years within standard industrial practises. Nevertheless the and consists of more than just CAD and CAE tools. For a coordinated and effective it is recommended to make use of the so-called chain model. Therewith the interactions between different technologies or single es can be taken into account. The chain “Painted Car Body” consists of geometry and functionality development as well as forming, joining and coating es. The backbone of a chain is generally called “Synchroplan” where the main technical and business milestones for the different technologies and development es are fixed. The challenges for the are response time and accuracy with respect to the Synchroplan milestones. In the early phase of product development it is helpful to make use of standards. These standards give guidelines for the product design with respect to feasibility and robustness without restricting “freedom” which will enable new styling and technical innovations. These standards are sometimes much more than just single numbers. For
repeatable geometry details (door entrance, rear lights etc.) one can define so called meta models if these details can be represented by few parameters. The benefit of these meta models is the quick assessment of parameter combinations with an adequate accuracy. With this argumentation it is clear that an effective and efficient and consists of three major components: - standards for geometry and technology - fast CAD tool for creation of geometry proposals - effective CAE tool for fast and accurate assessment enabling definition of improvements The more standards are defined and accepted over the whole chain the less detailed simulations and CAD loops are necessary. Nevertheless realisation of new styling ideas and technological improvements (new materials, improved crash worthiness etc.) always require CAD and CAE support. The backbone of the CAD at BMW Group is currently the CAD system CATIA V5. All geometry information in the chain has to be finally delivered in native CATIA V5 data. But especially in the early or so called concept phase of a project it is not necessary for sub es that all CAD work is done in the backbone system. A typical example is the concept die face for the geometry definition of a forming simulation. With this geometry no physical tool is built and therefore no native CAD data is required. It is more important to realise the ideas and proposals of the engineer as fast as possible with a sufficient accuracy for FE-simulation. Nevertheless the geometric proposals after the loop should be finally available in the CAD system. For the definition of a concept die face several working steps are (typically) necessary: - import of part geometry (ideally with native CAD data) - flange unfolding and lay out of geometry details from following operations - definition of the basic production idea (double part, symmetry, ...) - definition of drawing direction - part preparation (filling of holes, smoothening of boundary, ...) - creation of blank holder - design of addendum - preparation for simulation All these working steps beside the preparation for simulation can obviously be realised also in the standard CAD system. The most time consuming work is the creation of the addendum in comparison to specialised alternative solutions. This is the main reason why currently the concept die faces are not generally designed in CATIA V5. The accuracy and necessary design work for concept die faces strongly depends on the examination objectives. Especially the prediction of surface quality of outer skin panels necessitates much work for the blank holder. Therewith the first contact of the blank with the forming tools is determined which causes sometimes unacceptable skid or impact lines. For the FE-simulation of concept die faces a powerful CAE tool is necessary. Beside of short calculation times an easy applicability is of high interest. Nevertheless one has need for well described complex material models and powerful user interfaces to solve extraordinary boundary value problems, e.g. for the assessment of new forming technologies. LS-DYNA fulfils most of these demands and has a high application rate in research work at universities. In the past, the main objectives of forming simulations were only the assessment of feasibility (e.g. occurrence of necking and wrinkles). Nowadays additional and more complex examinations are possible due to improvements of the simulation systems. Some examples are press force calculation, multi stage forming, spring-back, surface quality, failure prediction for complex strain paths. Many of these applications need an accurate stress calculation. For new material grades like ultra high strength dual phase steels the classical material description is not sufficient anymore. The advantage in competition for automotive companies is the controllability in the and even without having experience of series production. The more accurate the material description in the simulation tools the less problems and scrap rate occur in the production. Normally the first simulation of a concept die face will not lead to a feasible part geometry. In an effective and it is necessary to show the way to feasible and robust production es. The fast translation of simulation results in geometric proposals is an essential step. The handling of geometry updates is a big challenge for the work with concept die faces. An easy and robust parametric design of the concept die faces is still one of the biggest problems in this context. Even for specialised systems for the creation of concept die faces there is still much room for improvements. Due to this problem we should not restrict ourselves to single software systems from the general viewpoint of BMW Group. It is necessary to define useful interfaces and data formats. Therewith a fruitful competition and a market also for smaller software companies or university spin offs can exist. An example for such an interface is the description of a forming based on a concept die face. It is necessary to define links on the tool geometry and sheet material, the forming direction and additional information like cam positions and directions. Tool meshes and detailed material data should not be included in this interface. The big advantage of intelligent interfaces is the possibility to combine different CAD and CAE systems as well as the possibility for fast modification loops. We expect a higher innovation velocity with widely accepted interfaces due to a wider market and more competitors.