Visions and Latest Developments in Dynaform

Arthur Tang and Jeanne He*

Engineering Technology Associates, Inc.
1133 E Maple Rd. Suite 200
Troy, MI 48083, USA

*Corresponding author: qhe@eta.com

Abstract

DYNAFORM has been evolved from a Draw Die analysis tool to a Die System analysis tool kits. As the simulation technology and computer resources have been growing rapidly, more demands emerges from different stage of the product and process development sector. Stamping simulation technology is facing more challenges. Based on LS-DYNA ® implicit and explicit solver, DYNAFORM provide simulation tools that support not only the incremental analysis for validation of Draw Die face design, also provides an one-step analysis based cost estimating tool (BSE), Die
Face Design tool (DFE) and Die structure analysis, motion transfer and scrap shedding Analysis. DYNAFORM helps the product and process development cycle and makes them more efficient and reliable. Evolving into a process based simulation tool is the future of DYNAFORM. Upgrading the user interface to be flexible for customization and supporting script function are the focus of the next generation DYNAFORM. This paper will also discuss our visions and the future development of DYNAFORM.

Introduction

After the initial engagement of the forming simulation technology from 1983, ETA has released the first version of DYNAFORM in 1997, developed from a general finite element pre/post processor, the earlier version was focused on the application of Finite Element Analysis for stamping application; mostly focused on Draw Die analysis only, users at that time were mostly OEM customers who are highly educated FEA Engineers. 11 Eleven years later, with the growing challenge of the manufacture demands, DYNAFORM has transformed from a LS-DYNA based incremental solution package for mainly Draw Die simulation and validation tool to a LS-DYNA based, Die System Analysis package. DYNAFORM modules cover from the cost estimating and material saving for early product design stage to Die Face design creation, Die Face design validation, Die Structure analysis, Motion Transfer analysis and early stage Trim Die analysis. Today, DYNAFORM users nowadays are product design engineers, process engineers, die design engineers, FEA engineers and Die makers. With the rapid growing computer resources, optimization is become feasible to support many aspects of the stamping applications. DYNAFORM is moving to a newer level and covering more spectrums of the applications in stamping sector.

Blank Size Engineering Module

Blank Size Engineering (BSE) was initiated to support the incremental analysis by providing an initial blank size from a product or a Die design. With a one-step solver embedded in this module, BSE also supports trimline development, where you can project the trimline onto the designed addendum or curved binder (Fig.1). BSE also provides blank nesting capability to help engineers evaluate cost saving options, makes the quotation process much less time consuming. BSE also provide One-step solutions for crash engineers to provide forming effect into the crash analysis.
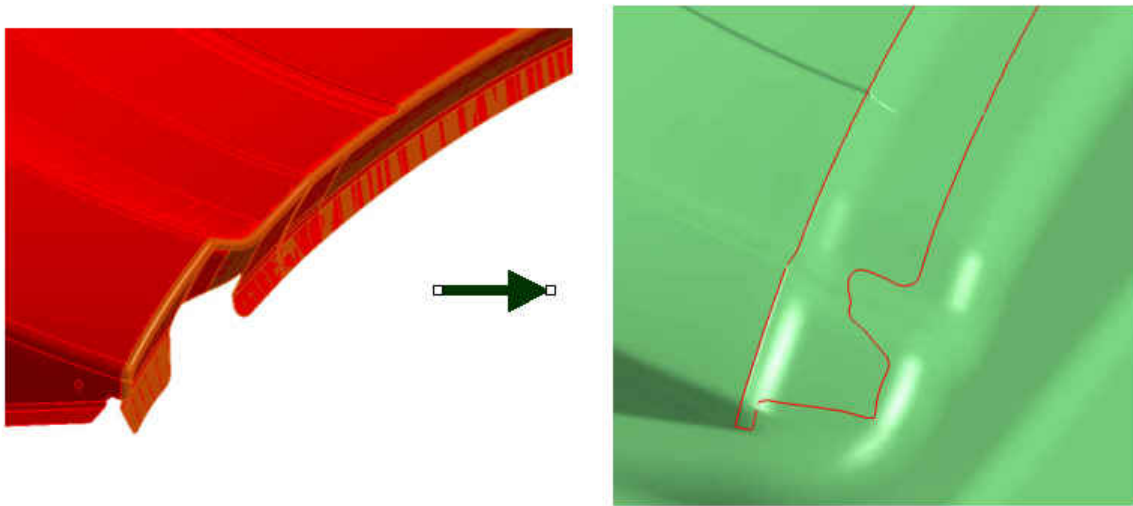

Figure 1: Trimline Development, product flanges project onto the addendum surfaces.

Die Face Design Module

Die Face Design (DFE) module in DYNAFORM provide a quick way for feasibility study for both a product design and a die face design, to evaluate a product formability., Tthe limitation of the one-step analysis can be overcome by utilize the DFE module. DFE allows user create a complete die face design from a specific product design, then anthe incremental analysis can be performed, therefore, accurate information can be obtained for Die design decision making. With the increasing accuracy demand for crash analysis, for key components affect the crash simulation accuracy; user can incorporate stamping effect by obtaining LS-DYNA stamping simulation results by creating the Die Face with DYNAFORM DFE module.

DFE module mainly consists three main steps, preparation, binder creation and Addendum creation.

Preparation functions

The first challenge when starting a die face design is to smooth the product edges, including inner cut off area or concave area along the outer boundary. Maintaining the tangency and providing sufficient editing tool are keys to accomplish this task; DFE provides extensive

smooth and fill functions, with various of options allow user create control lines, keep tangency with the neighboring geometry. Equipped with variety of surface functionalities, DFE provides high quality surface based on those patched area, this reduce the surface creation work for CNC process in production. Generic element, line, surface creating/editing/morphing tools provide an efficient and effective tool for DYNAFORM customer even before the release of DFE.
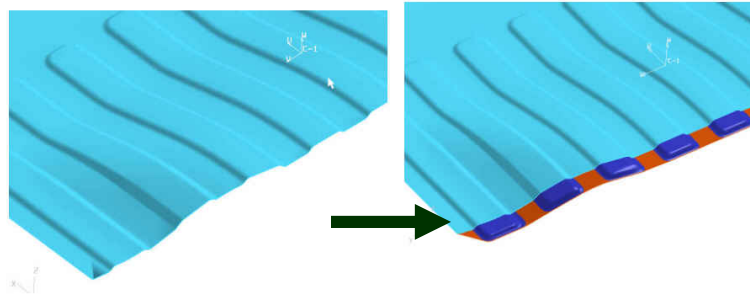

Figure 2: Complete geometry, smooth product edge for addendum creation preparation.

Binder Creation

Binder creation and editing functions have been successfully improved in DYNAFORM5.6. Binder creation features includes free form binder which allow user define a binder shape on a snap point plane; two line binder option allows user start the binder shape with two selected feature lines from the product; conical binder allows user select to radius to build the initial binder shape; part on binder is also available in DYNAFORM5.6. Extensive surface editing functions are available to allow user modify the binder shape. Section line can be created and user can edit the binder section line detail from a 2-d window as shown bellow (Fig 3).
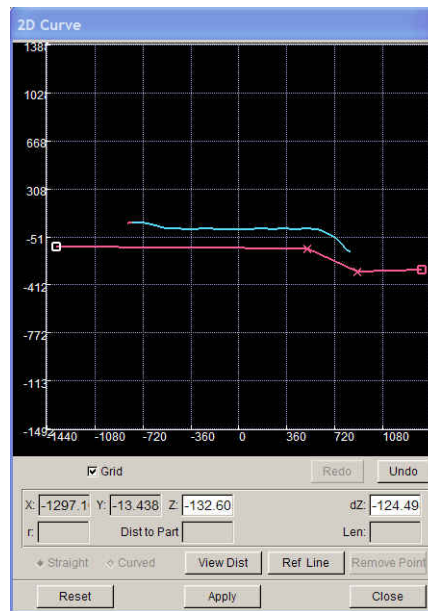

Figure 3: Binder section line edit 2-d window

Addendum Creation

Able to create a smooth addendum shape is the most challenge work in the addendum creation. Dynaform5.6 provides several approaches for the addendum generation. User can use segmented addendum with the patch function smoothly connecting the segmented addendum parts. User can also use the control profile approach where user can edit profile shapes by defining and editing the control profile shapes, a desired addendum shape will be created (Fig.4), both surfaces and mesh are generated for analysis and machining use.
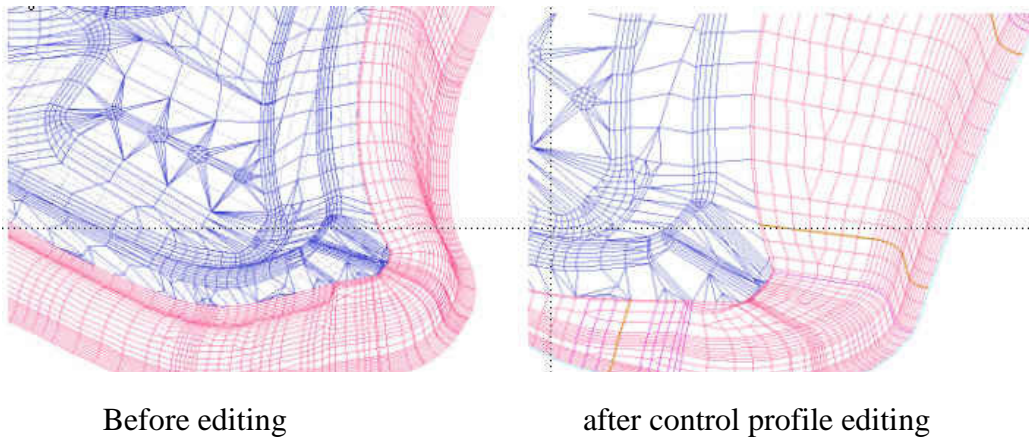

Before editing   after control profile editing

Figure 4: Addendum editing using control profile approach

Multi-stage Setup Module

Simulation is no longer focused on Draw Die face design validation only, supporting the whole Line Die design become a daily production needs. Commonly simulation analysis needs to cover gravity loading, binder wrap, draw, redraw, trim, flange, and hamming operations. Setting up those process seamlessly without manually setup each step after the completion of the previous is a challenge work for preprocessor development. DYNAFORM5.6 Autosetup has successfully designed and implemented for this challenge.
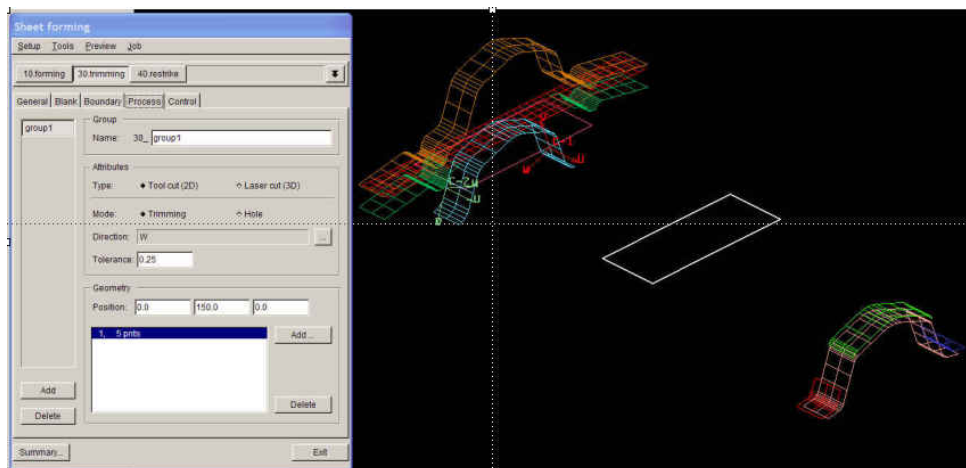

Figure 5: Multi stage Setup for a Draw, Trim and Redraw analysis(courtesy to SUZUKI)

Autosetup in Dynaform5.6 also includes features listed bellow:

1. Supports the new LS-DYNA implicit static method for gravity loading analysis, implicit static method has been widely tested by OEM users. This method has been used on daily production simulation work successfully.
2. Supports LS-DYNA Selective mass scaling feature, which reduce the kinetic energy significantly to improve the springback predictions, also allows further conventional scaling to shorten the simulation run time without introduce excessive numerical noise.
3. Supports LS-DYNA Super Plastic Forming material: material 64.
4. Supports LS_-DYNA material model 125, which is Kinematic hardening material model from Dr. Yoshida, this material provides promising springaback results as the material hardening behavior is being incorporated in this material model.
5. Supports LS-DYNA hot forming features for hot stamping simulation applications.
6. Supports LS-DYNA "Case" card that allows user to submit multiple input files automatically, ETA job submitter gives an alternation from using the "Case" card and driver.

Die System Analysis Module

Die System Analysis (DSA) has three parts:
1. - Die Structure Strength and Durability
2. - Sheet Metal Handling and Transferring
3. - Scrap Removal / Shedding

Based on LS-DYNA implicit and explicit solver. Die Structure analysis provides static and dynamic loading analysis solutions, for dynamic loading, user can either transfer the loading distribution from the rigid tool draw simulation, with the assumption of linear loading. Users can also modeling the tool as a flexible tool instead of rigid. With the current growth rate of the computer power, draw simulation with all the flexible tools is become a reality.

Sheet Metal Handling and Transferring Analysis provides a baseline study for the transfer system design, whether the system is a robot transfer system, ducking system or suction cups, the panel quality needs a to be carefully preserved. Unlike the rigid motion simulation, with LS-DYNA, Sheet Metal Handling and Transferring analysis provides more realistic study with the blank modeled as a deformable body.

Scrap Removal/Shedding problem is a widely common problem in every stamping plant. Very high percentage of the plant down time was cased by scrap problem. Scrap Removal/Shedding module provides an effective study for the Trim Die design at very early stage, a detailed description about this module is provided in a separate paper.

Visions and Future Direction

DYNAFORM will continue supports new features provided by LS-DYNA which relatedrelating to sheet metal forming applications., Iimplicit flange simulation, roll hamming and new material model will be supported and implemented in DYNAFORM.

With the rapid growth of computer power, optimization become feasible for stamping analysis, Optimize the drawbead design, which includes identifying the sensitivitiesy of specifica drawbead design and providing solution for an optimized drawbead design configuration. Drawbead configuration designs are in great demand to shorten the production cycle as for both simulation analysis and tryout., Ddrawbead adjusting is a timing consuming work that can be improved dramatically through optimization analysis.

Optimization can also provide possibility to optimize die structure designs. A, as the increasing material cost and the decrease of the production volume for each car model, building an efficient Die instead of over designing Die becomeis feasible with optimization analysis.

Process oriented tool for tooling process design with a synchronized cost estimating tool kits is the direction of next generation DYNAFORM. Engineers can Sstarting from a finished product design to layout die lines., wWithin each die process, a matching components library will be incorporated., fThese component libraries could includeor example, nitrogen cylinder Draw Die binder support; trim steel for trim die, cam components for the flange die, and etc. Those entire sub-libraries are provided for cost calculation, this willwhich could lend to provide a parametric cost estimation for any design alternation.

BSE will continue developed for progressive strip layout. This will provide a more advanced cost-estimating tool for progressive Die designers. Further more, with the strip layout, DYNAFORM DFE can provide a quick way of generating the progressive tooling for incremental analysis with LS-DYNA.
Just like an old model computer turn obsolete as the technology advanced, software also under goes continuous technology updates, DYNAFORM6.0 will be builtd on aan entire whole new platform with up to date technology platform, providinges high performance on super-large models supports multiple model, multiple view, plug-in modules, and centralized options. It will ; also support scripts, session files, batch processing, and user functions.

Simulation software is advancing with the fast growing simulation industry. Design and analysis package is undergoing unification. A process based stamping analysis incorporated with detailed cost estimation, strong CAD features is the goal for LS-DYNA based DYNAFORM, a Die system solution package.