NAGFORM[Sheet]

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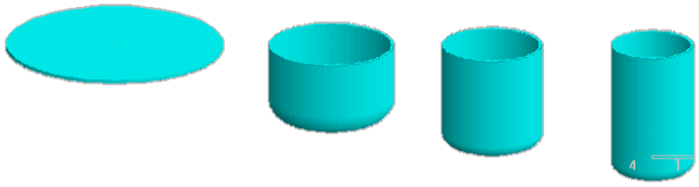
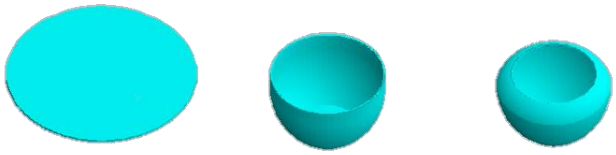
Overview

NAGFORM[Sheet] is a knowledge based software program for designing forming sequence of sheet metal parts. It allows the user to capture manufacturing knowledge and use it to design forming progressions for similar parts in minutes. The sequence designs created in NAGFORM[Sheet] can be quickly validated in NAGSIM.2D / NAGSIM.3D FEA simulation programs. NAGFORM[Sheet] is available as a stand-alone software or as an add-on module with NAGFORM software program. The advantage of NAGFORM program with this module is that the user can compare the manufacturing steps for parts that can be cold forged from solid as well as formed from sheet. This can help in converting sheet metal parts to cold forged parts and vice versa.





Uses

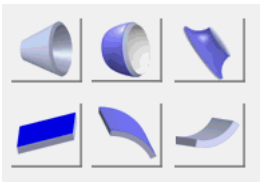
- Determine material required, surface area and weight of formed part.
- Create sequence design for forming a part, in minutes.
- Save any automatic design as a reusable design template.
- Optimize and standardize designs.
- Search for knowledge on similar parts in design database
- Help reduce number of operations required to form a part.
- Obtain estimated forming loads and pressures.
- Create analysis file for NAGSIM.2D / NAGSIM.3D for design validation
- Teach forming design to new personnel.

Limitations

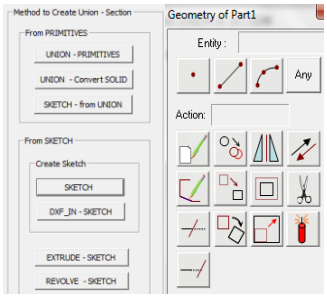
NAGFORM[Sheet] is not a FEA simulation program. It cannot predict metal flow defects and stresses in tools.

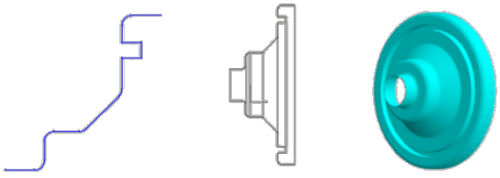
Create Part Model

In NAGFORM[Sheet], Geometric model of a part is constructed by joining simple building blocks called primitives. All primitives are defined by certain dimensions.



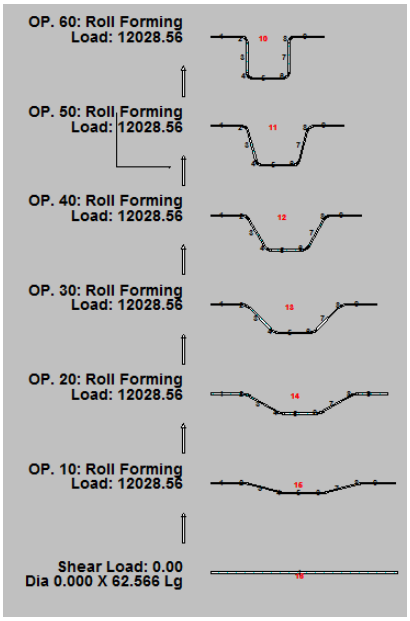
Based on the part dimensions and material, the program determines the Volume, Surface Area, and Weights. Complex parts can be created and designed using these primitives. The user can also create a sheet metal part model from a sketch created within NAGFORM or imported from a 2D Dxf drawing.

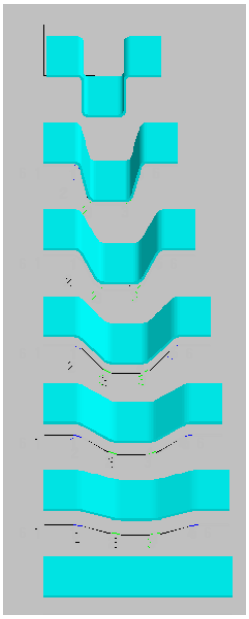




Automatic Designs of Forming Progressions

NAGFORM[Sheet] utilizes a combination of design logic, knowledge based rules and simplified analyses to determine a forming progression automatically in minutes. In general, there is more than one forming sequence by which a part can be formed. The number of designs depends upon part geometry and, material being formed. NAGFORM[Sheet] has its own design logic to determine various possible ways to form a part. Because the program looks for all possible designs and applies its logic without fail, NAGFORM[Sheet] can determine design concepts that even an experienced designer may overlook.





Design Helper

The "Design Helper" is a diagnostic tool that helps the user get a sequence design when no design can be found through standard forming rules. It determines the extent to which certain rules need to be modified to get a sequence design.

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Template Designs for 'Similar Parts' or 'Family of Parts'

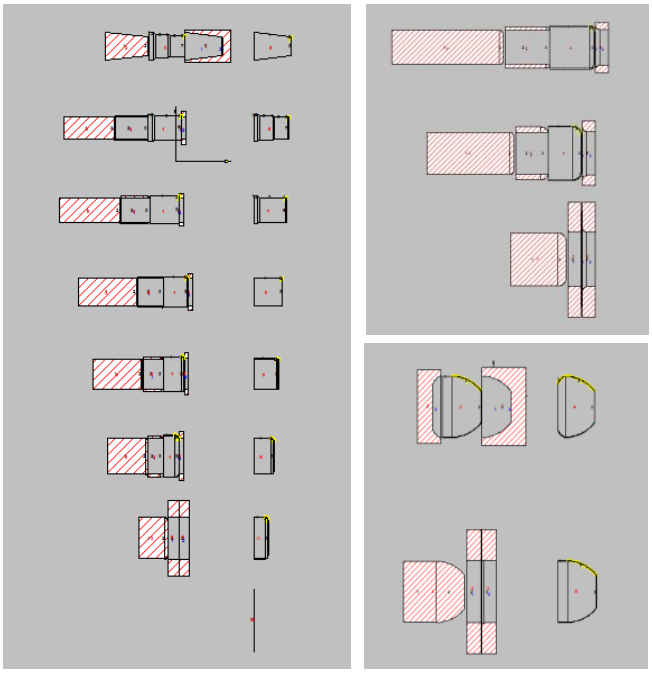
For any part that is similar to a template in the database, NAGFORM^Sheet can follow the template design files to create forming progressions in minutes. The users have the capability to create their own reusable template designs.

DXF Input and Output

In NAGFORM^Sheet, the geometry of parts can also be imported from DXF format from CAD systems such as AutoCAD, SolidEdge etc. The results of NAGFORM^Sheet sequence designs and 'Generic' tooling can be saved in DXF format for input to other CAD systems.

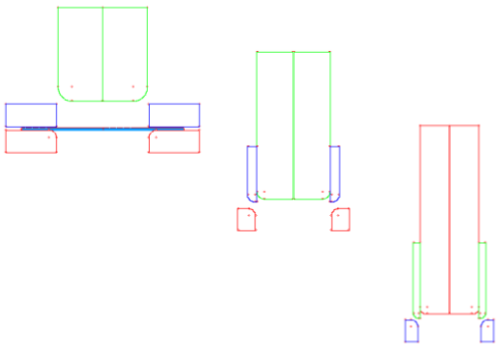
Generic Tooling for FEA Simulation

For the sequence designs obtained through NAGFORM^Sheet logic, 'Generic' tooling can be created automatically. This generic tooling can be used to simulate the forming operation in a FEA simulation program such as 'NAGSIM.2D' and 'NAGSIM.3D'.

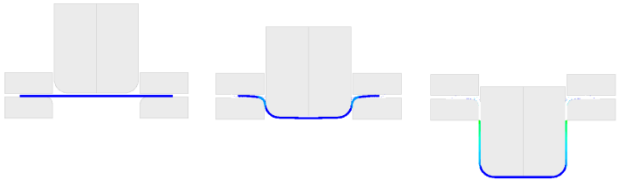


Integration with NAGSIM.2D

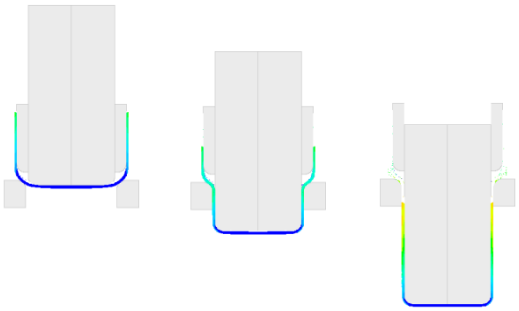
In NAGFORM^Sheet, simulation files for NAGSIM.2D can be automatically created for any selected part progression generated in Auto Design. To simulate, the user opens this file in NAGSIM.2D, meshes the parts and begins simulating. It takes only couple of minutes to go from NAGFORM's design concept to NAGSIM.2D simulation.



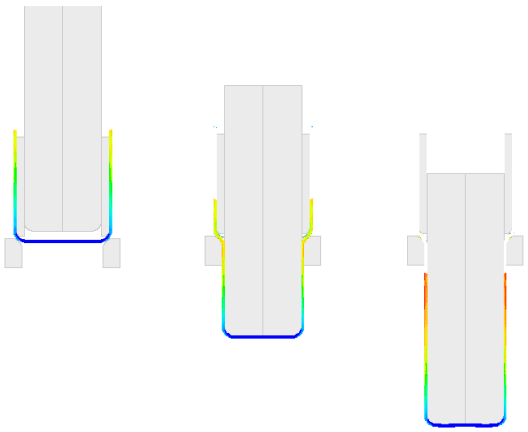
Default Tooling generated by NAGFORM^Sheet



Simulation Results Station 1 – NAGSIM.2D



Simulation Results Station 2 – NAGSIM.2D



Simulation Results Station 3 – NAGSIM.2D

Manual Design

In addition to automatic design, NAGFORM^Sheet has a separate module for creating a forming progression manually. Using computer aided techniques, the user can quickly and easily construct a forming sequence according to his/her concept. The designer can also start from a NAGFORM^Sheet generated design and modify it.

NAGFORM Sheet

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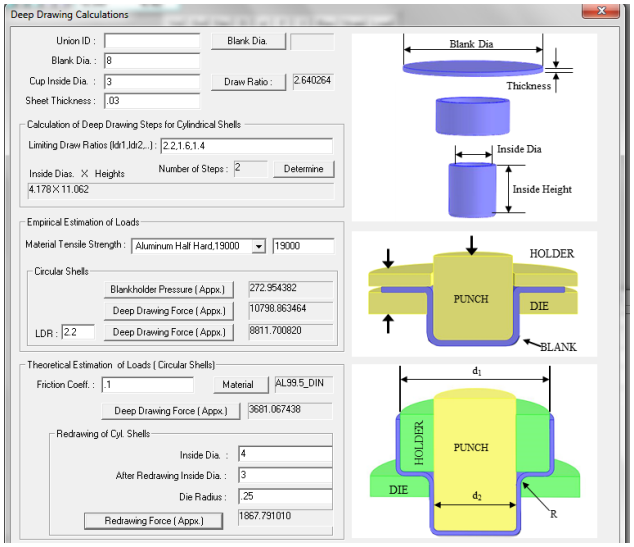
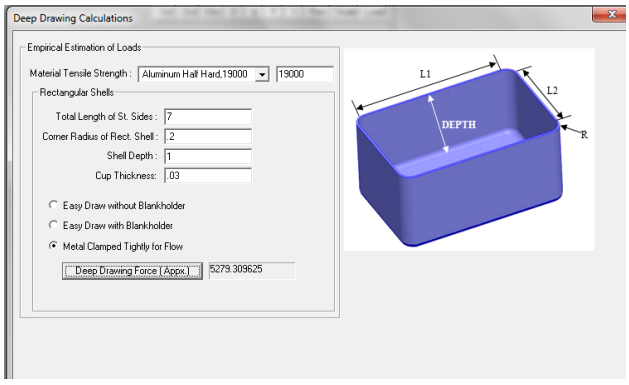
Sheet Metal Process Calculator

NAGFORM Sheet contains a calculator to help design the forming sequence. Following calculations can be performed:

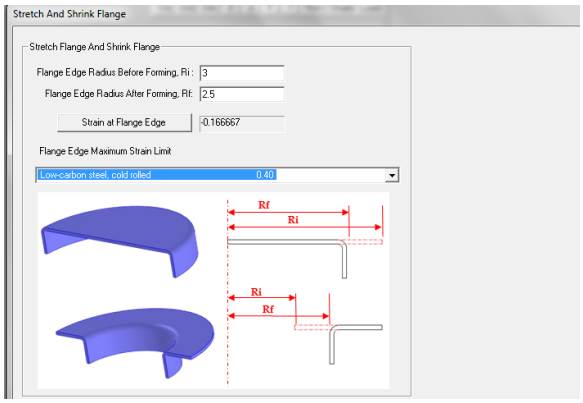
- Deep Drawing of Circular Shells –
  - Given circular cup inside diameter, height and material, the calculator determines the number of deep drawing operations needed to form the cup.
  - Cup dimensions at each deep drawing operation are also calculated.
  - Determines the deep drawing force, redrawing force and blank holder pressure required.



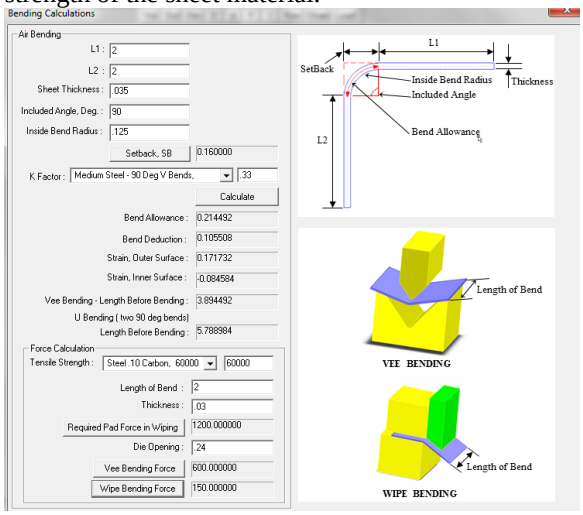
- Deep Drawing of Rectangular Shells - Given dimensions of rectangular shell and material, the calculator determines the deep drawing force required with different types of blank holders.



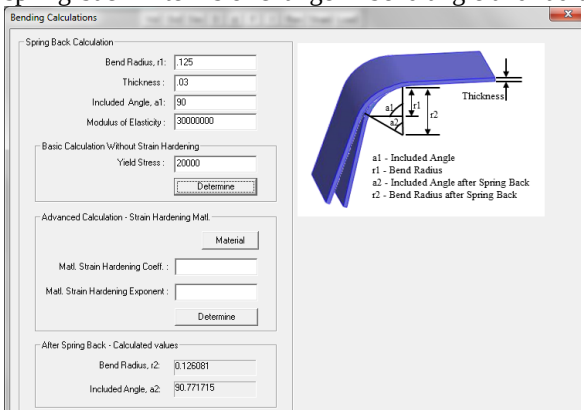
- Stretch and Shrink Flanging - Given the dimensions before and after flanging, the program calculates the edge strains for shrink and stretch flanging processes. The edge strain can be compared with limiting strains for various materials to determine feasibility of flanging.



- Bending Calculations – Given dimensions of the bend including sheet thickness, angle and K Factor of material, the program determines the bend allowance and setback for Vee Bending. The program also calculates the Vee bending and Wipe bending forces based on the tensile strength of the sheet material.



- Spring Back Calculations - Given the material properties, bend angle and bend radius, the program calculates the spring-back in terms of change in bend angle and radius.



NAGFORM^{Sheet}

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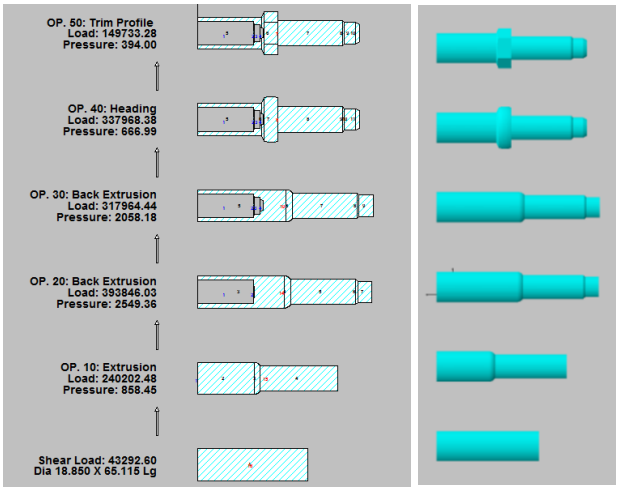
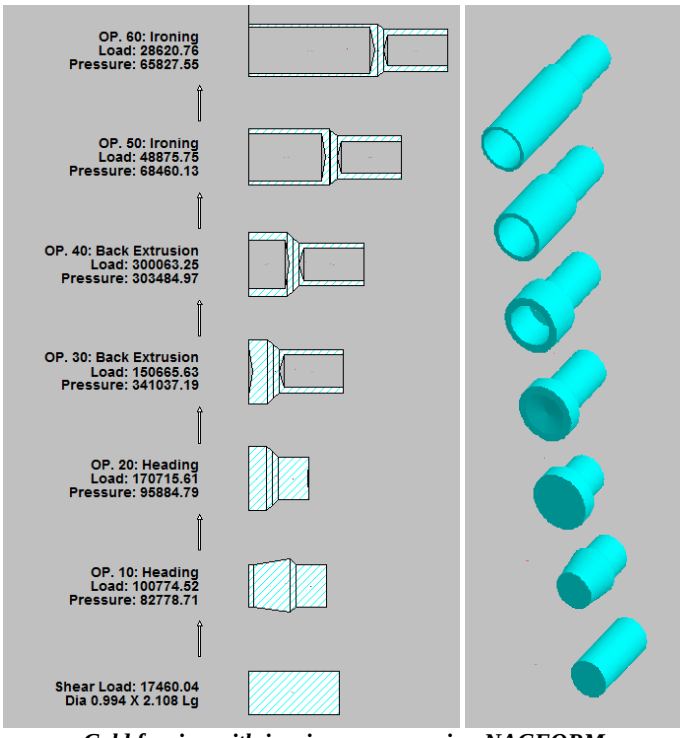
NAGFORM + NAGFORM^{Sheet} Module

This option allows full capabilities of NAGFORM program with additional capabilities of NAGFORM^{Sheet} module. User can design forging sequence for cold forged part as well as design forming sequence for sheet metal parts.



Cold forged progression design using NAGFORM

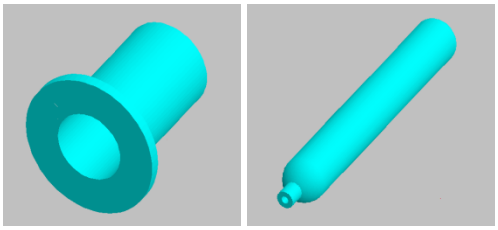
In certain cases, sheet forming processes such as 'Ironing' to reduce part thickness and 'Drawing' to reduce outside diameter of thin section can be combined with cold forging processes to manufacture parts with thick and thin sections. Examples of such parts are ammunition shells and high pressure cylinders.



Cold forging with ironing process using NAGFORM

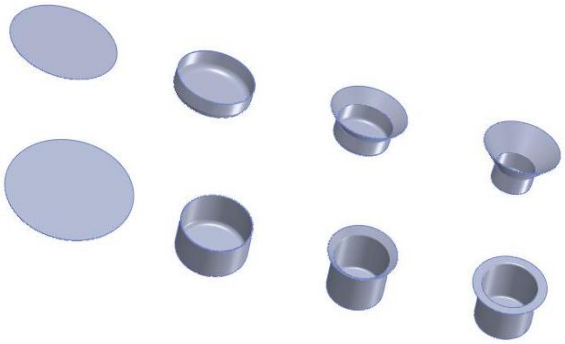
Additional features of NAGFORM + NAGFORM^{Sheet} program:

- Perform comparative study of parts that can be made from sheet metal as well as wire/rod
- Help in converting sheet metal parts to cold forged part and vice versa
- Help in eliminating welding in assembly of sheet metal part with thick / solid parts

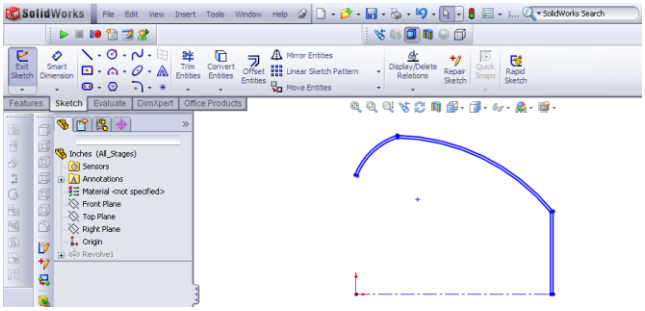


NAGFORM^{Sheet} SolidWorks Interface

The **'NAGFORM-SolidWorks Interface'** toolbar allows the user to automatically generate '3-D SolidWorks' drawings of NAGFORM Sheet metal parts and progression results.



Sample NAGFORM progressions generated in SolidWorks



Sample Sketch exported into SolidWorks