

## Overview

NAGSIM.2D is a finite element software program for the computer simulation of two dimensional metal forming processes. It can simulate large plastic deformation of the part as well as elastic deformation of the tools. It compliments NAGFORM, a knowledge-based program for obtaining alternative forming sequences to form a part. Using NAGSIM.2D, the user can verify and improve any sequence design through FEA simulation. Forming of thick or thin sheets can be simulated.

## Eliminate Trial & Error in Forming

NAGSIM.2D allows the user to simulate the part forming in a computer before running it in the machine. NAGSIM.2D provides quick information to:

- Reduce die trials and costly mistakes.
- Improve tool life.
- Predict and eliminate defects, such as necking or buckling
- Reduce scrap.
- Predict mechanical properties of formed part.
- Determine influence of lubricants.
- Determine effect of heat treatment of the blank.
- Shorten print-to-part time and improve part quality.

## A Complete and Easy-to-Use Solution

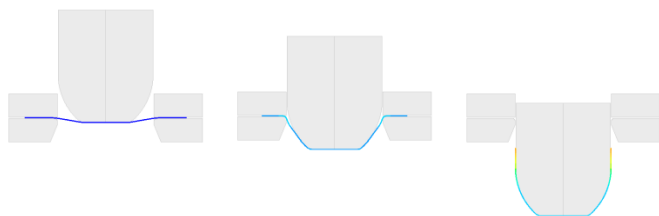
NAGSIM.2D provides a complete and easy-to-use solution from creating a model of the forming operation to post-processing of simulation results. NAGSIM.2D's graphical user interface is tailored specifically for simulating metal forming operations. NAGSIM.2D has its own CAD module to create geometry of the workpiece and the tools. The part geometry can also be imported in DXF format from other CAD systems such as AutoCAD, SolidEdge etc.

## Efficient and Robust Solver

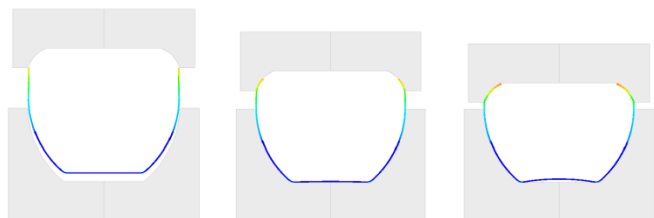
NAGSIM.2D uses an incremental finite element analysis solver that is specifically suited to metal forming operations with large plastic deformation. Two types of problems can be analyzed:

- Plane Strain - deformation of long parts.
- Axisymmetric - deformation of round parts.

## Simulation of Drawing and Nosing

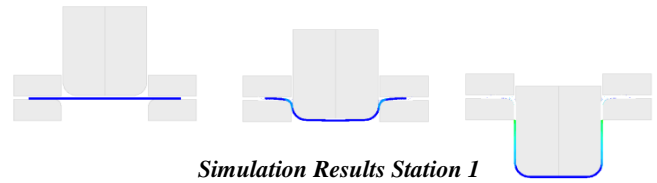


Simulation Results Station 1

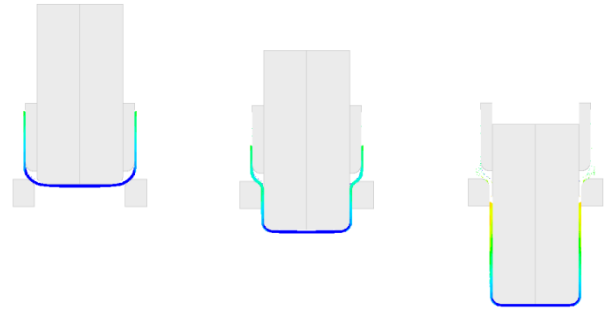


Simulation Results Station 2

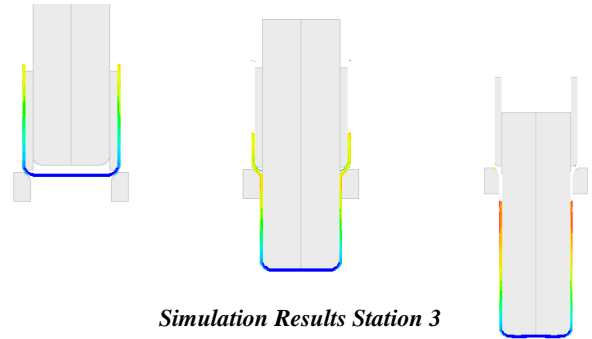
## Simulation of Deep Drawing



Simulation Results Station 1



Simulation Results Station 2



Simulation Results Station 3

## Material Database

NAGSIM.2D has a database of materials commonly used in cold forming. New materials can be easily created and stored in the database.

## Automated Meshing and Remeshing

NAGSIM.2D incorporates an automatic element mesher. The starting geometry of the part and the tools are meshed automatically. After the deformation process starts, the program automatically remeshes the part if the old mesh gets excessively distorted or if it is desired to mesh certain areas with finer mesh.

## Cold, Warm and Hot Forging

NAGSIM.2D can be applied to cold forming at ambient temperatures where material's flow stress is primarily strain dependent. For applications like warm or hot forging, where temperature changes cannot be neglected, NAGSIM\_Gen.2D can be used. NAGSIM\_Gen.2D is a special version of NAGSIM.2D program that includes thermal analysis during metal deformation.

## Limitation

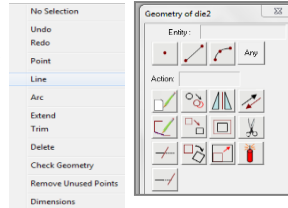
The current NAGSIM.2D program is based on Rigid-Plastic formulation. It cannot predict the elastic recovery of the material – spring back and residual stresses. A version of NAGSIM.2D based on Elastic – Plastic material which would predict spring back is under development.

## Special Features

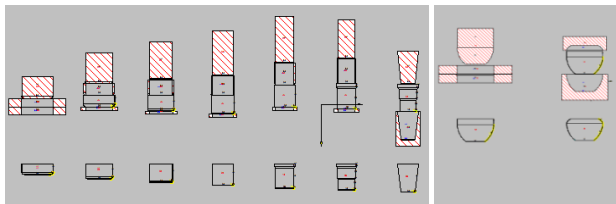
- Very user friendly
- Does not require extensive FEA background.
- Simulate multiple operations easily using templates.
- DXF interface to CAD systems.
- Stand-alone program.

## Other Features

- **Mini Cad System –** NAGSIM.2D program includes a user friendly mini 'CAD' system. Using this, the user can create the part and tool drawings or modify the imported drawings within NAGSIM.2D



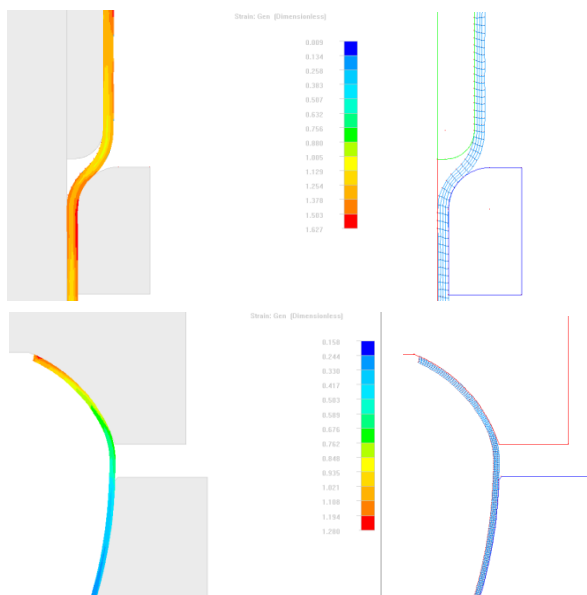
- **Integration with NAGFORM<sup>Sheet</sup>** NAGSIM.2D has the capability to import the default tooling generated by NAGFORM<sup>Sheet</sup>



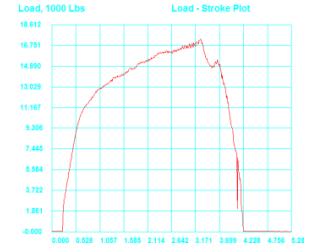
## Results

NAGSIM.2D provides a complete insight into the forming process. The results include: Material flow, stress distribution, strain distribution, formation of laps, material buckling, load displacement, tool stresses, and contact between the part and the tools. Animation of results presents a clear visual of the forming operation.

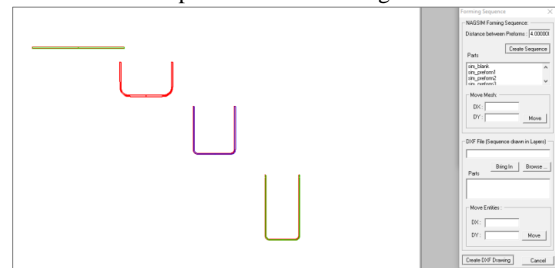
- **Part Strain & Thinning -** A part can fracture due to high Strains or Tensile Stresses. Based on the FEA simulation, the program determines the strain levels and part thinning that can be used to predict part failure.



- **Load Stroke Curve –** The program can predict the load required to deform the part in a particular station.



- **Tool Loads –** The program displays the contact points between the deforming part and the tools at each step. The graphics display shows the force vectors exerted by the deforming part on the tools at the contact nodes.
- **Grain Flow /Flow Lines Prediction –** Flow lines defines the path of material movement during the deforming process.
- **Lap and Necking Prediction –** The program has the capability to predict folds and necking in the part due to forming.
- **Progression Drawings –** Based on the simulation of the deforming part in various stations, NAGSIM.2D can create a progression drawing. The results can be exported to a DXF CAD file for comparison with the design.



- **Elastic Stress –** Using NAGSIM, the user can predict the principle stresses in the tool. The fatigue life of a tool is directly proportional to the numeric values of the stresses in a tool during a forming cycle.
- **Elastic Tool Deflection -** The program provides a magnified view of the deflection in the tools during the forming operation.
- **Animation of Velocity Vectors at Grid Points-** Velocity vectors show the instantaneous direction of the metal flow at the grid points. It is useful in studying the grain distortion.
- **Tracing a Point in Forging Sequence –** The user can trace a point on the part (cut-off or final part) throughout the simulation.

### Training:

- Regular training classes are held on NAGSIM software at the Canton MI office.
- In addition, web training and support is available through Web Conferencing System