

Selection of Forging Machine using Design and Simulation Software

By:
Dr. Vijay Nagpal
Metal Forming Systems, Inc.
Canton Michigan USA
www.nagform.com

Introduction

In the past, cold forging processes have been developed through trial and error experimentation and experience gained on the forging machine. In today's environment, this trial and error approach is not a cost-effective solution. We now have software, such as NAGFORM and NAGSIM, to cut down the time it takes to perform any cold forging related task and thereby reduce the cost and time to develop any new product.

In this article, we are going to look at a specific task of selecting the forging machine for cold forged parts. We would discuss what is involved in the selection and the software that is available for this purpose.

Selection of Cold Forging Machine

There are two possible scenarios. The first is where a new forging machine has to be selected for a part or a number of parts in hand. The other scenario is that a new part must be formed in one of the available machines. This is normally the case at the time of quoting or feasibility evaluation of cold forging a part.

For selecting a new machine, the following steps are involved

1. Create an 'ideal' Progression Design for cold forging the part
2. Define if part would need be rotated in between stations
3. Create the Tooling Design based on the progression
4. Predict the forging load and energy that would be required
5. Determine the type of machine and its size that would meet the requirements
6. Validate the design through machine trials and simulation

For the second scenario where one of the existing machines is to be selected, following steps are involved

1. Determine the machines that would be available
2. Create a Progression Design that would suit one or more of the available machines
3. Predict the Load requirement
4. Based on the above information, select the machine that would be most suitable

For this case, the tool design and simulation may or may not be done based on the experience with similar designs.

Software Relevant to Machine Selection

Regarding software, there are two types of software that are available to assist the effort required to select a forging machine. First there is the process design software such as NAGFORM. Hand calculators specific for forging are also available. The other software is the FEA Simulation Software (such as NAGSIM) which helps predict the metal flow, part strain and tool stresses during forming.

The process design software such as NAGFORM can help in the following

1. Progression Design
2. Load estimation
3. Preliminary selection of the forging machine
4. Default tooling for the simulation.

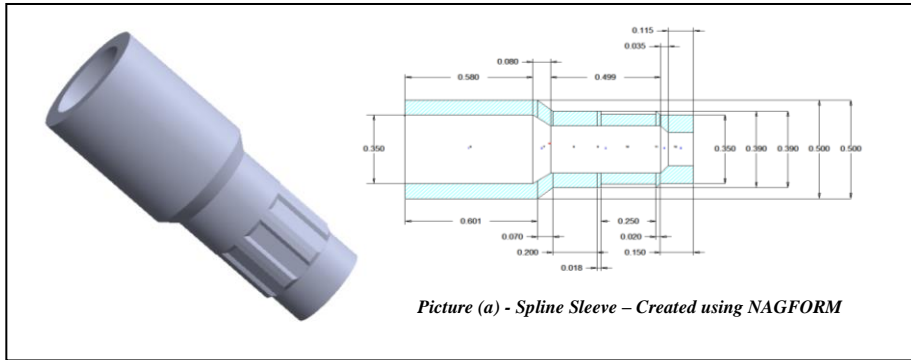
The NAGSIM simulation software can do the following

1. Predict the forging load very accurately
2. Validate the progression design by animating the material flow based on the tool drawings
3. Determine part quality and tooling issues that the design may have
4. In selection of new equipment, reduce the actual trials needed on the machine

There is no software in the market for designing the tools around the progression design, other than the 2D and 3D CAD systems. Here the design requires the experience of the designer.

Example

In this example we will take a typical part as shown in Picture (a). We will show how our software can help in reducing the effort, time and cost of selecting a suitable forging machine.



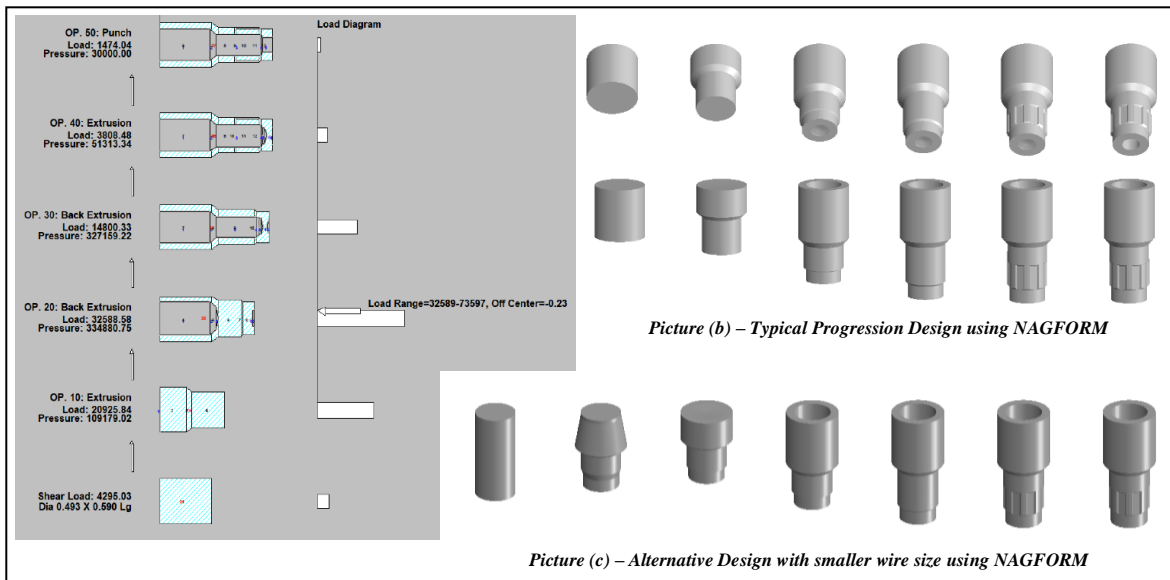
Progression Design

For a new machine or an existing machine selection, first the best progression design, from the point of manufacturing and tooling cost, needs to be determined. Without any software, it would all depend upon the experience of the designer as to how good his progression design is. Since a part can be made in many different ways, different designers would design it differently. For a designer to look at different forming options, with hand calculations, would take a lot of time.

On the other hand, if the designer uses progression design software such as NAGFORM, they can accomplish the following:

1. Get alternative progression designs for any part in a short period of time.
2. The software may give design concepts that the designer may not have thought of.
3. Designer can investigate designs with different wire sizes to look for the best wire size to use
4. Progression Design software give estimated forging loads. The designer can use load as criterion to select the design that requires the minimum forging load.
5. Progression Design Software gives an outline of the tooling for simulation purposes. The designer can use the tooling drawings from the software for the simulation.
6. It can provide a preliminary selection of the machines out of a group of machines that may be suitable to a selected progression design.

For the example part, these advantages are illustrated by the pictures shown.

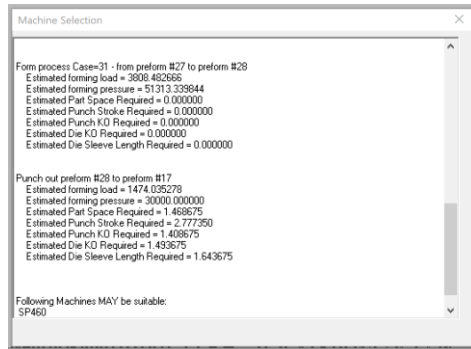


Load Calculations

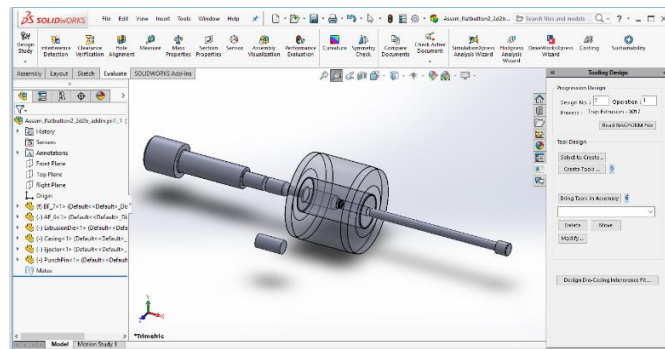
Most designers use a calculator type program or simple spreadsheets to estimate the forging loads. NAGFORM also uses the text book equations with material properties to estimate the approximate loads. The estimated loads may be good enough if the machine capacity is much more than the estimated loads. If the load estimates are close to the machine capacity, then load prediction using FEA simulation may be the only way to predict loads accurate enough for selecting the machine especially a new machine.

Machine Selection and Tool Design using NAGFORM

The machines selection toolbar of NAGFORM helps the user determine the machines suitable for their particular design. Based on the machine specs and NAGFORM designs, the user can create their default tooling in SolidWorks.



Picture (d) –NAGFORM Machine Selection Summary



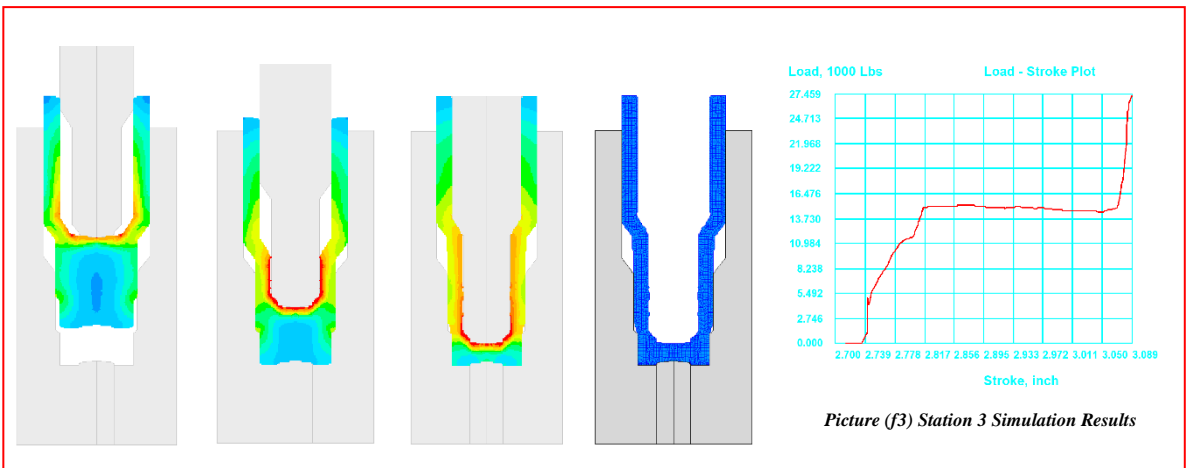
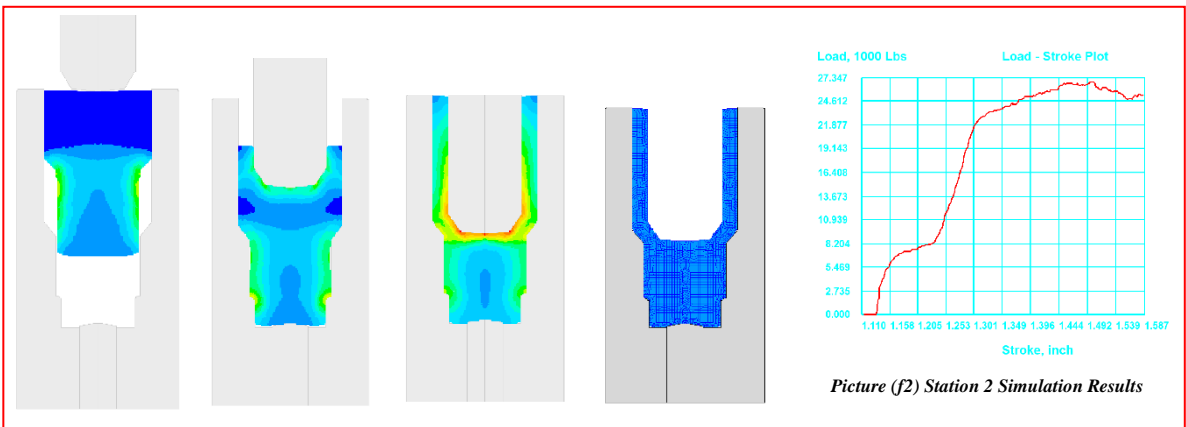
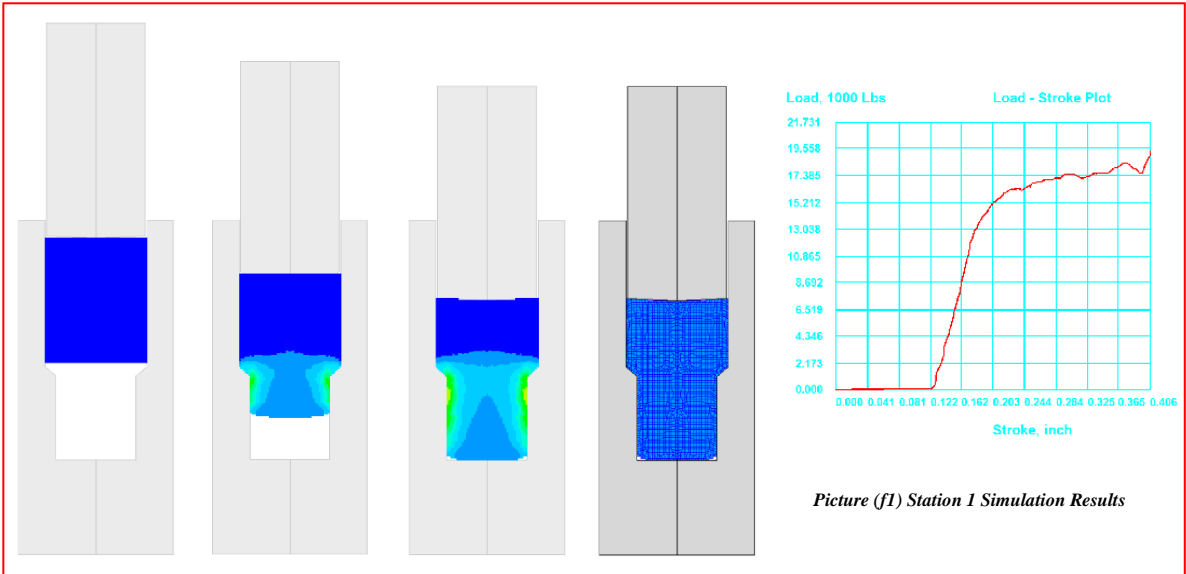
Picture (e) –Tool Design created in SolidWorks using NAGFORM Default tooling

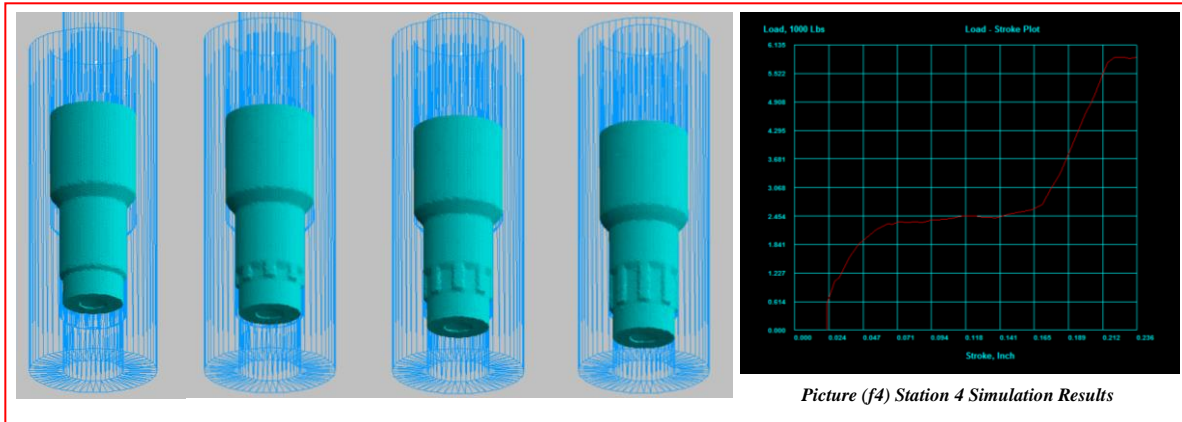
Validating design and tooling using FEA Simulation Software

When accurate prediction of load, strains in the part and stresses in tools is required, FEA simulation program is the only software that can meet the needs. So, to validate and debug the tooling design, simulation program (such as NAGSIM) is almost an essential tool. It can help reduce costly shop floor trials and breakage of tools. However, there is an effort and therefore a cost to perform FEA simulation. Accurate input of material property data, tooling geometry and process details is needed to get accurate results from simulation software.

At the quoting and feasibility stage, when the tooling drawings are not available, usually FEA simulation is not done due to the effort required to perform a simulation, unless there are serious questions regarding the design. However, in selection of a new machine, the cost of performing a simulation is justified.

The results of FEA simulation of a progression design for the example part are shown for illustration. Please note that the results of the FEA simulation are accurate only for the material data and process conditions that were used to perform the simulation. For example, if the material is not properly annealed but in simulation a fully annealed material was used, the load prediction would not be accurate. Other data and conditions such as friction, tool geometry, sliding tool motions, and clearances, all affect the simulation results. The simulation must be set up so it accurately represents the actual process otherwise the results would not be accurate.





Other Factors in Machine Selection

There are other factors that influence the machine selection such as knock-out on die side and punch side, type of transfer needed, punch stroke, use of sliding tools, part rotation between stations and special operations to be done within the machine.

Concluding Remarks

Process design and simulation software such as NAGFORM and NAGSIM, significantly reduce the time, effort and cost of developing the manufacturing process for cold forged parts. The software makes decision making much simpler and effective. Our company, Metal Forming System, Inc., continually strives to design software that improves the productivity of our customers. We also put lot of effort on training and education so our customers can achieve expertise in Cold Forging Technology in a much less time than the norm.

For more information about our products and services, please visit our website www.nagform.com