

**NEW PROCEDURE TO COMBINE CAD MODELING FEM
SIMULATION AND BARKHAUSEN-NOISE STRESS
ANALYSIS IN SHEET METAL FORMING**

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Abstract

The industrial applications of the computer aided design and simulation necessitates a simplified and trusted data transfer. It needs to worked on an interface software which is able to handle CAD geometries and export them into FEM systems, also has to be able to export those surfaces which was created during the FEM simulation process to an intelligent CAD system. Also these interfaces have to be easy-to-use and working without any data or information loss. This article gives information one of these gateways which is connect the Unigraphics NX CAD system and the AutoForm FEM software efficiently and gives the best way to data and information transfer. Applying this gateway we are able to reduce the CAD modeling and FEM simulation time, especially when we compare it with the conventional method. The basic Barkhausen-noise (BHN) measuring techniques are well known by the physical sciences. As usual a technique without any industrial application is not enough. There are various BHN measuring techniques which are applied in industrial field and we would like to introducing another field of application which can be useful and developable. The basic structure of this technique is the usually applied BHN measuring

method. The difference from the other techniques that we created a totally direction dependent stress control system, and we can change the physical stresses in different directions or combine them. Using the BHN measuring techniques by a rotating measurement – this means that we rotate the measuring head in 10° steps – we can measure the stress changing and the remaining stress in the material. Using this method we can compare the measured stresses with those stress distribution that was calculated by Finite Element Method systems. Besides we can use the measured data to the reverse engineering or as input in the deep drawing tool designing or redesigning procedure. Using this method the “circle of deep drawing tool design” could be more efficient and using the accurate data from the BHN measuring – later it can built a database for similar applications – the designing process will be more productive.

I. Introduction

Introduction of the interface

Currently the AutoForm prefers two CAD systems (they are applied at the market maker automotive industries like AUDI, Mercedes, Volkswagen, and Ford) which could be integrated with an efficient interface which guarantees data and information transfer. These CAD systems are:

- CATIA (Dassault systems) and
- Unigraphics/NX (UGS solutions)
- Today the most applied CAD system is Unigraphics NX. The working method of the interface between computer aided design system (UG/NX) and the finite element method based system (AutoForm) shown on Figure 1

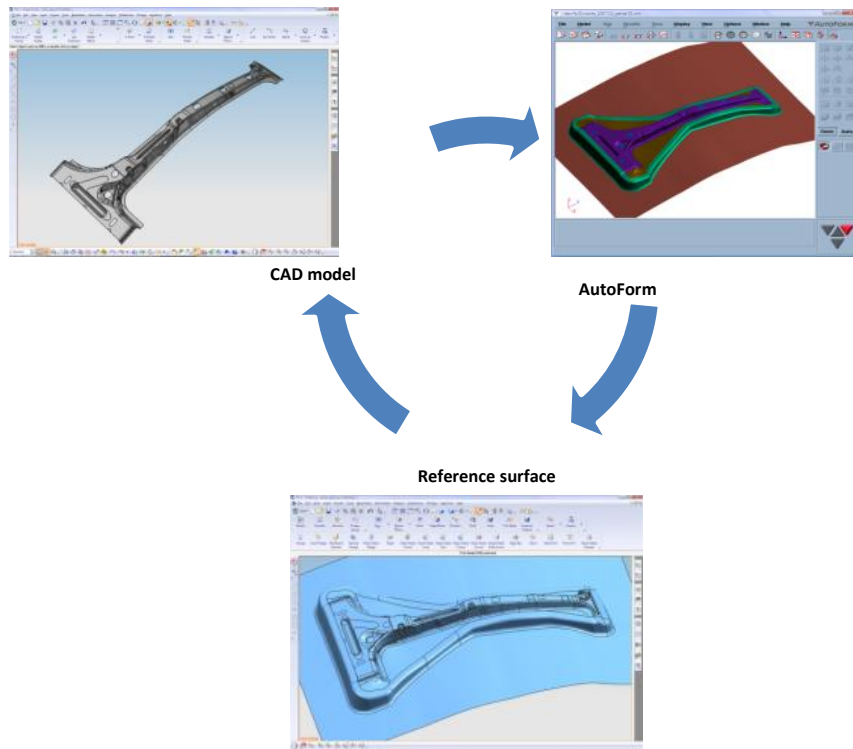


Figure 1: Working structure of the interface

I.1. Integration of UG-AF interface [1]

The Unigraphics-AutoForm (AF-UG) interface modul can be licensed separately. When we installed the interface and integrated it, we have to activate this modul. After the activation of the interface modul we can handle the interface with a menu bar which is shown on Figure 2.



Figure2: Toolbar of AF-UG interface

Applying the features of the menu we can manage the data and information transfer between the CAD and FEM systems.

The Figure 2. shows the basic function of the AF-UG interface. Applying the tools of this menu effecting efficient data and information transfer, between the CAD and FEM systems. The basic tools are the follows:

- Creation of new AutoForm project
- Open AutoForm project, modification, update, and results exportation
- Detachment of AutoForm, closing of the interface
- Start/Stop AutoForm
- Update AutoForm
- Update NX
- Manage curves (import/export).

Thereinafter will show the information and data transfer between the CAD and FEM systems. To describe this procedure we will show it on a specific example. It will represent the designing and simulation process of an automotive part. The manufactured part is – as eventually in automotive design – right and left hand implementation. The CAD models of the manufactured part shown on Figure 3

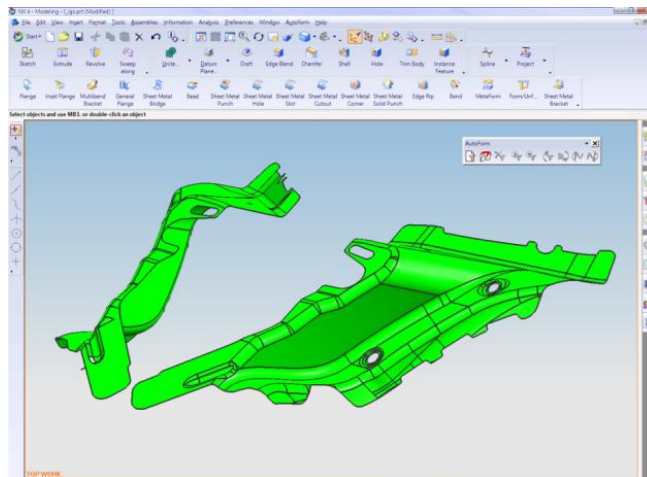


Figure 3: The manufactured parts (left/right)

II. Simulation of sheet metal forming process of the manufactured parts

After importation of the CAD model of the manufactured parts, we use Input generator and DieDesigner modul, and we define the binder surface and the addendum which connects binder ring with the manufactured parts. The results of this procedure shown on . We get a reference surface from which we can define the binder ring, die and punch. Positioning of the active elements before sheet metal forming procedure shown on Figure 4.

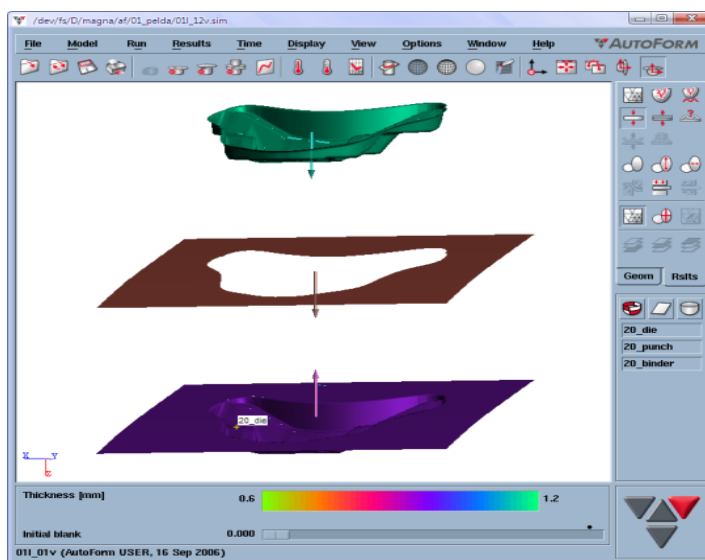


Figure 4: Positioning of the active elements

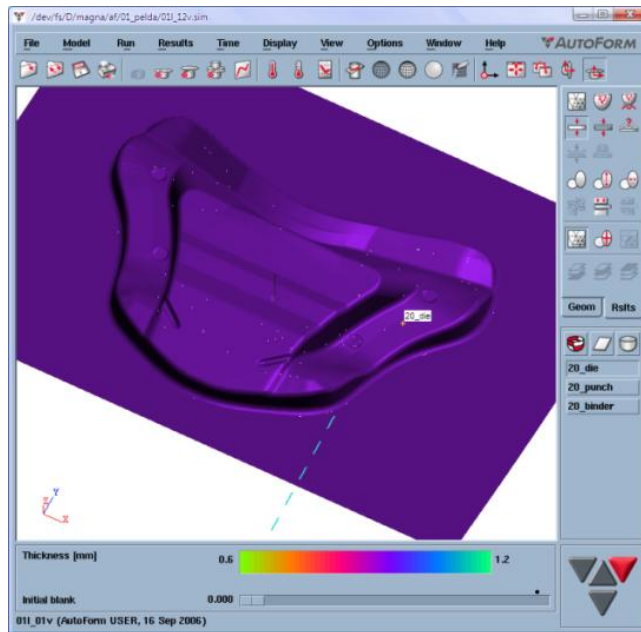


Figure 5: Reference surface for active element

Applying the previously described active elements (punch, die, binder surface) and defined technological parameters we have to run a finite element simulation of the sheet metal forming process. The results of this simulation shown on Figure 6. (The left side of the figure represents the exact results of the finite element method simulation after drawing. The right side of the figure shows the manufactured parts (left/right) after cutting)

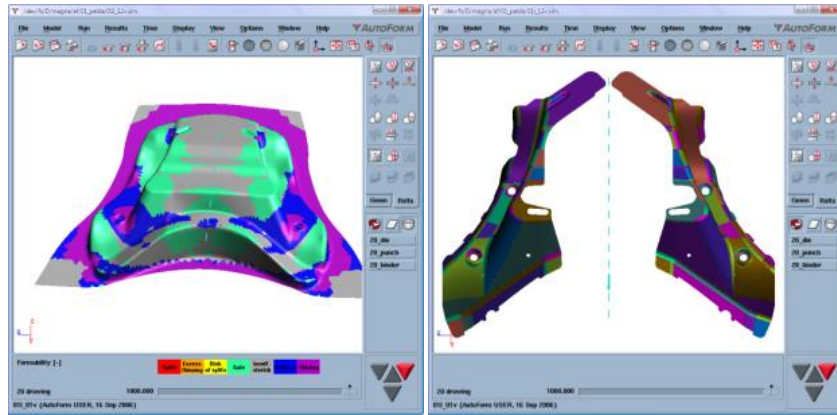


Figure 6: Utilization of reference surface

Utilization of these solid bodies the total progressive die can design in CAD applying the conventional steps of sheet metal forming tool design.

II. 1. Importing reference surfaces

In that case if our simulation was successfully finished, and during the forming process we didn't see any cracks or not permissible splitting we can continue with CAD modeling. Design of the tool surface based on reference surface. We have to import it into Unigraphics NX CAD system from AutoForm FEM system. We can do it with the previously described tool *'update unigraphics'*. We have to define on which layer we want to import this reference surface and then we are able to import this surface to Unigraphics NX CAD system. Applying AF-UG interface the imported reference surface shown on Figure 7.

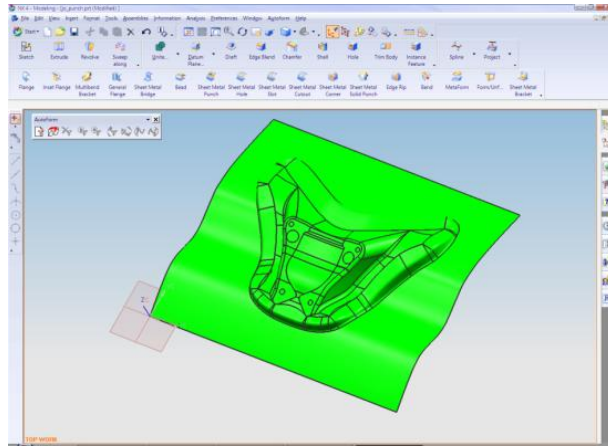


Figure 7: Imported reference surface in Unigraphics

Utilization of the imported and sewed reference surface we created the solid bodies of the active elements of sheet metal forming represents the sheet metal forming tools. Left side of the figure shows the solid body of the punch, right side of the figure shows the solid body of the die.

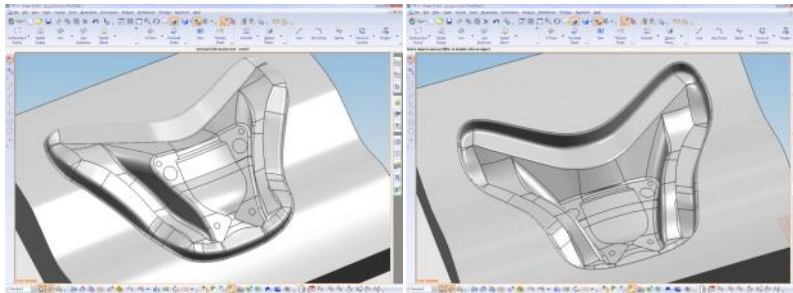


Figure 8: Utilization of reference surface

Utilization of these solid bodies the total progressive die can design in CAD applying the conventional steps of sheet metal forming tool design.

III. Barkhausen noise

III.1. Barkhausen effect

The Barkhausen effect is a name given to the noise in the magnetic output of a ferromagnet when the magnetizing force applied to it is changed. This effect was discovered by German physicist Heinrich Barkhausen in 1919, nowadays we know the reasons of this effect. It is caused by rapid changes of size of magnetic domains (similarly magnetically oriented atoms in ferromagnetic materials). Barkhausen's work in acoustics and magnetism led to the discovery, which provided evidence that magnetization affects whole domains of a ferromagnetic material, rather than individual atoms alone. The Barkhausen effect is a series of sudden changes in the size and orientation of ferromagnetic domains, or microscopic clusters of aligned atomic magnets (spins), that occurs during a continuous process of magnetization or demagnetization. The Barkhausen effect offered direct evidence for the existence of ferromagnetic domains, which previously had been postulated theoretically. Heinrich Barkhausen discovered that a slow, smooth increase of a magnetic field applied to a piece of ferromagnetic material, such as iron, causes it to become magnetized, not continuously but in minute steps.

III.2. Barkhausen noise

A coil of wire wound on the ferromagnetic material can demonstrate the sudden, discontinuous jumps in magnetization. The sudden transitions in the magnetization of the material produce current pulses in the coil. These can be amplified to produce a series of clicks in a loudspeaker. This sounds as crackle, complete with skewed pulses which sounds like candy being unwrapped, Rice Krispies, or a pine log fire. Hence the name Barkhausen noise. Similar effects can be observed by applying only mechanical stresses (e.g. bending) to the material placed in the detecting coil.

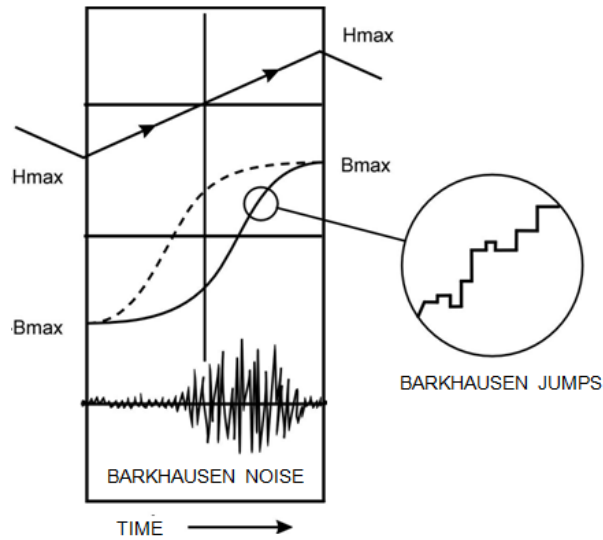


Figure 9: Barkhausen noise

III.3. BHN Stress measuring

Applying the BHN measure method we can measure the remaining stresses in different directions. During deep drawing process there are identified areas (by FEM calculations) which contains high amount of remaining stresses. Measuring of these stresses are not solved yet. There are different practical way to estimate these stresses, but these data not enough accurate. Applying the BHN technique combining with our newly developed system which can indicate controlled stress conditions, and we can use the same techniques during the forming process. This equipment shown on the figure 10.

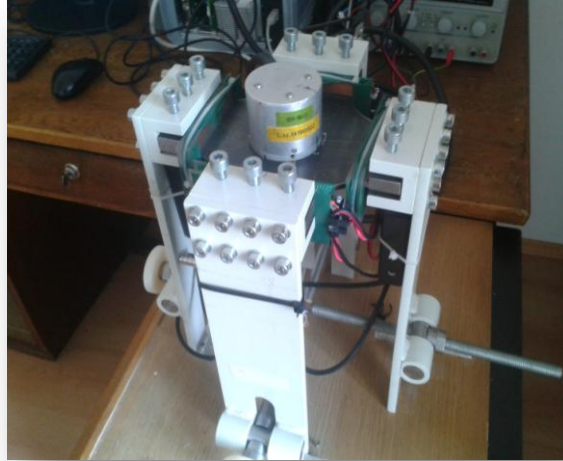


Figure 10: BHN combined with controlled stress

The next step was the solving of the rotation of the BHN measuring head to create the complete remaining stress (RMS) curve of the zone.

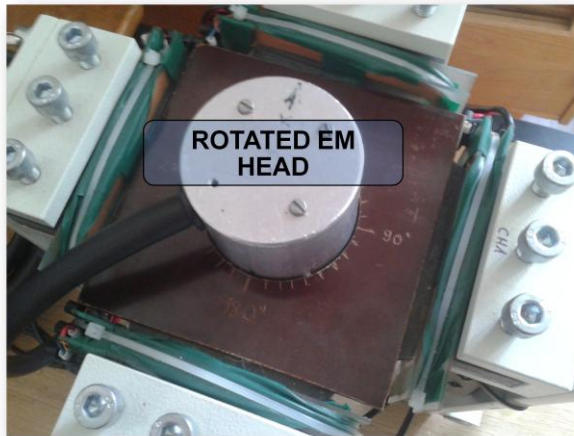


Figure 11: Rotated EM head

IV. Measuring software

After we created the measuring head and we have the method how to measure the RMS in different formed zones, we need to create a software which handles the data and all the input to get the most accurate results. The basic requirements of the software:

1. Dynamic instrument control and signal display
2. Automated measurement sequences
3. Data storage, presentation
4. Noise measure evaluation and comparison

IV. 1. Dynamic instrument control

We were built a hardware from different modules which handles different tasks. To combine and control the data inputs for different tasks eg. bending moment of the sheet metal specimen, amplified noise handling, air gap, and voltage and sign control.

IV.2. Automated measurement sequences

Measuring and combining different parameters needs different and parallel controlled measuring methods. To control these tasks we have to create different automated sequences to get the best results. On the Figure 12 can seen the control panel for this process.

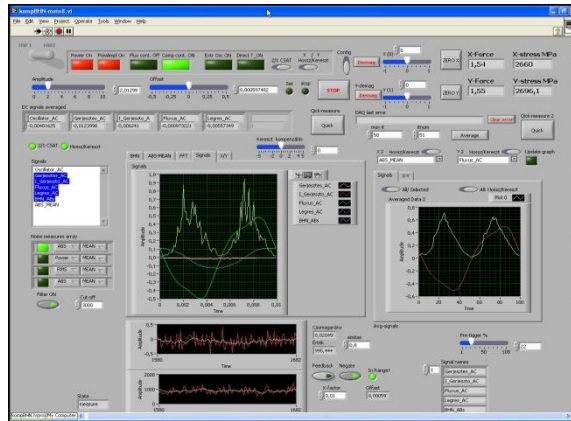


Figure12: Control panel

IV. 3. Data storage, presentation

Certainly if we measured with combined process we have to handle and save these data to the future use. We also made a data handler part. This part of the software can be seen in Figure 13.

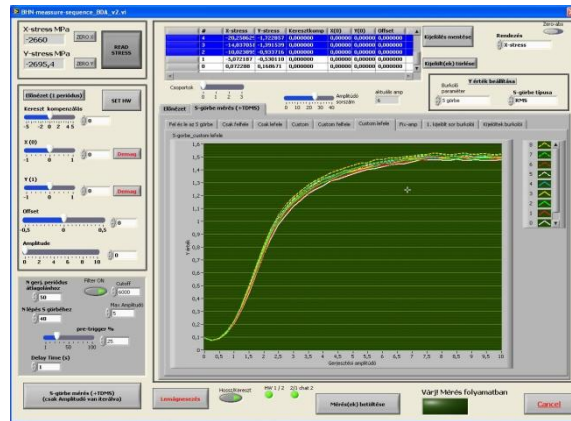


Figure13: Data handle&storage

IV.4. Noise measure evaluation and comparison

When we made the measuring we can indicate the stress dependencies from the mechanical stress with the last module. This module can seen on the Figure14.

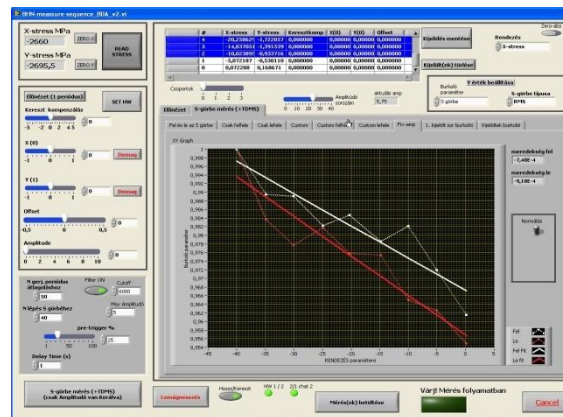


Figure14: Noise measure evaluation and comparison

IV.5. Future & industrial application

Combining of this BHN based measuring method with the CAD/FEM interface we can create a database from this measuring and later using of this database in similar forming processes during the tool design procedure can be the next step to get better deep drawing tools in the future. This process diagram shown on the Figure 15.

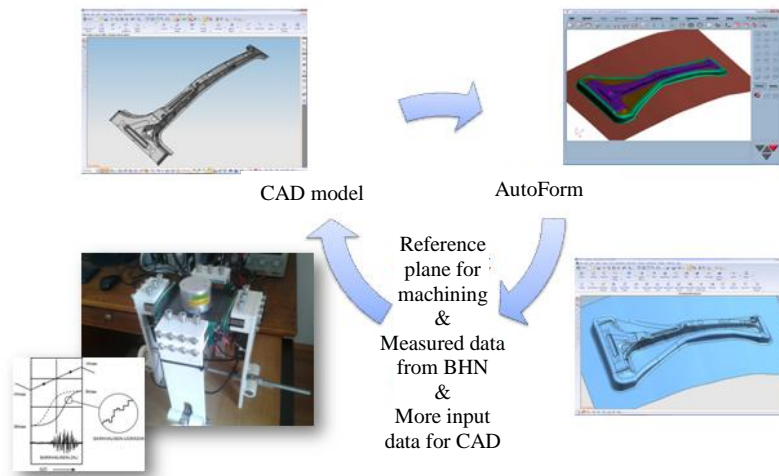


Figure 15: New process circle

V. Acknowledgements

We would like to express our gratitude to the Department of Solid State Physics of University of Debrecen and Metal Elektro Ltd. for the financial background for our research.

VI. References

- [1] G. Balogh, M. Tisza Dr., An intelligent gateway between cad modelling and fem simulation in sheet metal forming – Slovenian-Hungarian mini symposium 2007, University of Miskolc