AFDEX Newsletter
Q2 / 2019

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1. AFDEX_V19R01 Release

1.1 Features in the latest version

AFDEX_V19R01 will be released on the third week of April for general users and is expected to get released on the first half of May for Altair users. The latest version has been improved to extend its application to a wider range (See Chapter 2), including large scale problems, complete analysis, multi-body problems or processes, high speed calculation of large-scale processes, die-less forming processes, etc. Some functions need user's intervention in terms of editing the input files, which can be guided by specific tutorial manuals.

Major improvements are shown in Tables 1.1 and 1.2. Much of the contents of Table 1.1. and Table 1.2 are consistent with those described in 2019 Q1.

Table 1.1 New functions or improvements of AFDEX_V19

	Functions or improvements
2D and 3D	-Simulation of large-scale processes with high speed -Larger scale process solving for coining, etc. -Microstructural evolution prediction -Heat treatment and carburization simulation -Spring back analysis -New shearing, piercing, trimming and blanking -Added total strain and its components in post-processor -Added a function for visualization of thinning in post-processor -Function for skin element generation -Quantification of grain flows -Multi-body simulation for isothermal analysis -Sophisticated material models -Improved structural analysis of assembled dies -Improved complete simulation -3D local remeshing -Damage coupled flow stress -Non-penetration die-gap treatment -Process design optimization with HyperStudy -Two-step motion of dies (Loading and unloading)
3D	-Increased the maximum number of elements -Added new function for 3D multi-body simulation -Improved spring-attached die -Improved function for imposing boundary conditions -Improved contact treatment at the interface of two dies -Improvement in metal flow control through small gaps or clearance in dies
GUI	-Introduction of a new binder function to select the activation type (Delayed / Initial) -Added function for definition of shearing process simulation in GUI -Added advanced functionalities in die structural analysis -Added visualization function for total strain in post-process -Added new function for 3-dimensional multi-body simulation -Added new function for visualization of thinning of GUI -Added new function for friction definition between workpieces in multi-body simulation -Added new function for opening simulation files edited using AFDIC(AFDEX Input Convertor) -Added new function for adjusting the coordinate transformation of the geometry. This function helps the user to automatically orient their input geometry as per the required coordinate transformation in AFDEX.

1.2 Improvement plans during this year

Improvements or plans for the latest version during this year are summarized in the following table. Pre-processing functions are not currently supported for some of these functions.

Table 1.2 Plan for adding new functions or conducting improvements for AFDEX_V19 during this year

	New functions or improvements
2D or/ and 3D	-Anisotropy of material -Multi-function of blanking holding die or binder -Treatment of non-separation boundaries of multi-body problem -Dieless forming (Problem type 290)

2. Some extreme or special cases of AFDEX application

Here are some special applications made with the latest version of AFDEX. The related research works will be presented in this upcoming KSTP Spring Meeting 2019, held in Kyungbuk National University in Daegu, Korea. Other topics will be also presented or introduced in the conference, including optimization of TTT curves for precision simulation of heat treatment process, treatment of flow stress at small strain and strain-rate, a new concept of critical surface strain for friction modeling, precision analysis of combined hot and cold forging process of a bevel gear, contact analysis of a pair of bevel gears, causes of crack generated in tube drawing, etc.

2.1 Complete analysis of crankshaft hot forging process with much reduced computation

Complete analysis, that is, fully coupled analysis between die-material deformation as well as flow and heat transfer problems of a hot forging process of a crankshaft was conducted using rigid-thermo-viscoplastic finite element analysis function of the latest version with die deformation coupled with plastic deformation of material. Note that the computational time was reduced drastically by a factor of 5, compared with the previous version. Fig. 2.1 shows some predictions of the complete analysis.

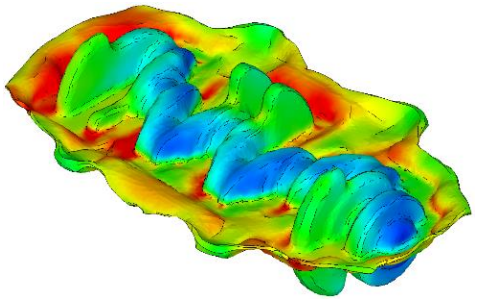


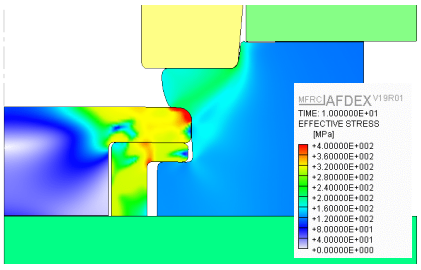
Fig. 2.1 Selected predictions of the complete analysis

2.2 Multi-body forming process

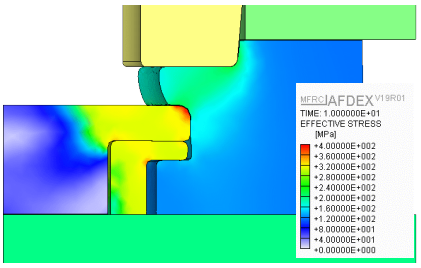
Multi-body plastic deformation problems are hot issues in metal forming simulation. AFDEX started to be applied for several multi-body forming processes since last year. AFDEX V19 has experienced more complicated and actual processes than before, as can be seen in Fig. 2.2 and Fig. 2.3

Fig. 2.2 shows elastoplastic FE predictions of a forming process for assembling three parts. The comparison between 2D results in Fig. 2.2(a) and 3D ones in Fig. 2.2(b) shows good similarity.

Fig. 2.3 shows another example of multi-body simulation for assembling hub bearing unit by rotary forging process. Two taper-roller bearing inner races were treated as separate bodies which have no constraints. In this simulation, no artificial constraint was assumed, i.e., all bodies were assumed elastoplastic while the bearing inner races were dealt with elastic dies as per the previous simulation introduced in the Q4 2018 newsletter. Elasto-plastic finite element method was employed. It is shown that the bearing inner races stay in elastic region during the entire process of assembly process.



(a) 2D



(b) 3D

Fig. 2.2 Joining process of three bodies

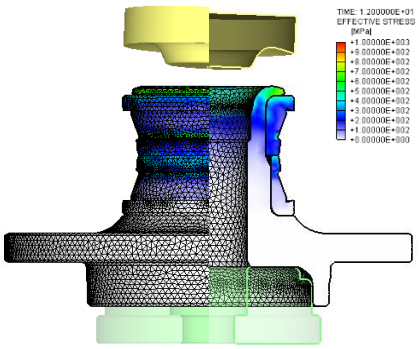


Fig. 2.3 Residual stress of a hub bearing assembly

2.3 Complete analysis of springback analysis

Springback is getting more and more important for precision metal forming to minimize machining cost, to save global environments and to improve product quality. Springback is caused from thermal load as well as mechanical load. A complete analysis, that is, fully coupled analysis between die-material deformation as well as flow-temperature analysis is conducted.

Unloading process and ejection process were all analyzed, and the predictions are shown in Fig. 2.4. The predicted distances just after unloading process, after ejection process and after cooling down were 30.58 mm, 30.48 mm and 30.43 mm, respectively. The experimental distance between two measurement points was 30.53 mm, implying that the predicted springback of 0.92 mm is close to the experiment of 0.82 mm.

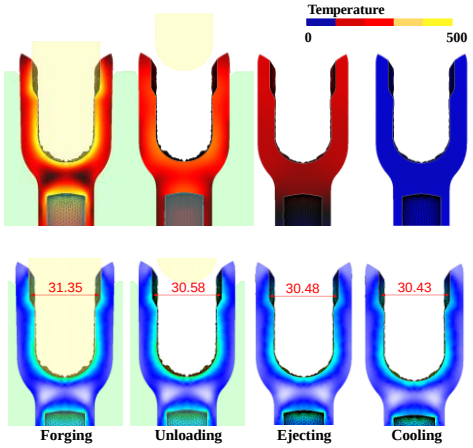


Fig. 2.4 Springback analysis of a yoke forging process

2.4 Coining process

Coining process is one of an extreme case in terms of number of elements. Die surface is drawn by an artist and it is thus very delicate. Therefore, the material surface should be treated with very fine and intelligent surface mesh system which needs very high number of elements.

Fig. 2.5 is one of artificial coining processes which needs more that one million elements for a precise description of side wall and letters.

Fig. 2.5 Artificial coining process

2.5 Dieless forming process

Dieless forming is one of the special forming processes in terms of die or tool motion. Most previous research works employed shell or plate elements. However, the tool-material contact area is so small that pure stretching assumption cannot be applied to the dieless forming process. Therefore, solid element approach has some strong points because local deformation of thickness can take place by lateral contact force. Fig. 2.6 shows an example of dieless forming process.

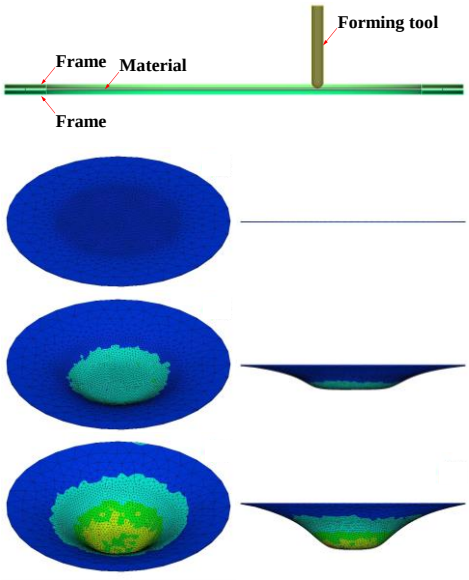


Fig. 2.6 Dieless forming process simulation

2.6 Sheet metal forming simulation

Sheet metal forming process was simulated by solid element approach. One of hottest issues in the field of sheet metal forming simulation is the FE analysis using solid elements which can solve the inherent defects of traditional sheet metal forming simulation technology based on shell or plate elements, for example, local thinning phenomena.

Fig. 2.7 shows an example of applying solid-element based FE approach to a sheet metal forming process of oil pan.

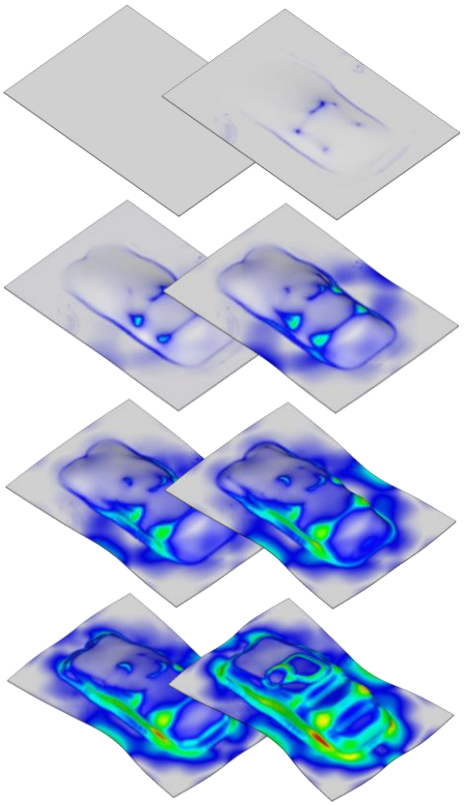


Fig. 2.7 FE simulation of oil pan forming process

2.7 Open-die forging of larger slab

An open-die forging process of larger slab was simulated to conduct process design optimization to increase product quality as well as yield rate. Fig. 2.8 shows a typical example, which consists of about 300 blows. The simulation was conducted in semi-automatic way, i.e., user-intervention is made only when material adjustment is needed, for example, rotating and initializing it.

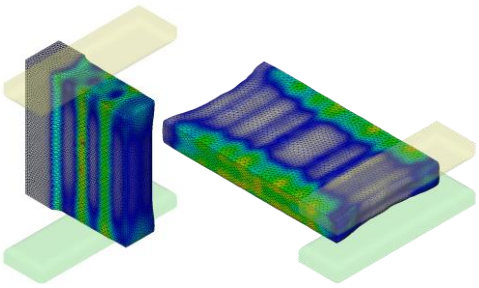


Fig. 2.8 Open-die forging of larger slab

2.8 Plastic deformation of a bundle of wires

Elastoplastic finite element analysis of stretching a bundle of wires was conducted which belongs to a kind of extreme multi-body plastic deformation problem in terms of generality in contact treatment. Fig. 2.9 shows predictions of plastic deformation of a bundle of fine wires for medical use.

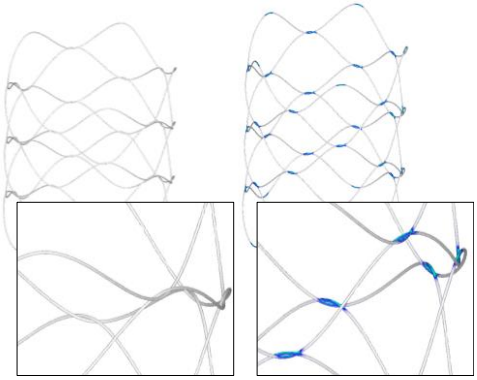


Fig. 2.9 Stretching a bundle of wires

3. Notice

3.1 Forge Fair 2019, USA

MFRC will participate in Forge Fair 2019, held at Cleveland, Ohio from May 21-23, 2019. Forge Fair is considered as North America's largest event exclusively dedicated to the forging industry and more than 1600 professionals from the forging fraternity, across the globe, are expected to visit and interact with each other. Please do visit us in booth number 130 to know more about the latest developments of AFDEX. MFRC would also be presenting "Intelligent metal forming simulation with emphasis on solution accuracy" on May 22, 2019 under the industrial presentation slots.

3.2 NUMIFORM 2019

Held once in every three years, NUMIFORM has grown to be a reputed platform for advancing the state-of-the-art in numerical simulations of metal forming processes. MFRC will be exhibiting AFDEX in NUMIFORM 2019, sharing the booth space with Altair. The event is scheduled for June 23-27, 2019 at New Hampshire, USA. Some of the researchers from MFRC would also be presenting their work in the conference which is attended by the field's top thought leaders. The main theme of MFRC's presentations in NUMIFORM will be process design optimization in metal forming processes. MFRC will also have a close Q&A time for Altair-AFDEX users or global users in our booth. Special or process-specific training program requests could also be obliged if informed in advance. Please contact our technical support team(r.sekar@afdex.com) for further details or requests.

3.3 ICMMPT and ICAME 2019

Prof. Joun, CEO of MFRC and Professor of GNU, will give invited plenary presentations in the 4th ICMMPT 2019 in Taiwan and ICAME 2019 in Malaysia. The titles are "Accuracy of Metal Forming Simulation" for ICMMPT and "Hot issues of metal forming simulation technology for automobile parts" for ICAME 2019. MFRC will conduct a one-day user-meeting as well as a hands-on practice session for the users in ASEAN and Oceanian countries at the ICAME venue in Kota Kinabalu, Malaysia after the conference.

3.4 GISPAM 2019

GISPAM 2019 will be held from July 22(Monday)-August 23(Friday). Happening for a period of 5 weeks, the program will be attended by distinguished students and scholars from Mexico, Malaysia as well as some undergraduate students from Gyeongsang National University. GISPAM started in 2014 based on an AFDEX training request from the Mexican government. 2019 will be the sixth year in which GISPAM has evolved into a program for training the attendees on different and important engineering software.

This training will be conducted in English. Week 1: CAD and Mathematical Background, Week 2: Mechanics and AFDEX, Week 3: AFDEX and AnyCast assignments, Week 4: Injection Molding and CAM, Week 5: Korean Culture Experience and Company Visit /Presentation evaluation. Gyeongsang University students and up to 10 AFDEX users are also allowed to participate in GISPAM education. If you would like to take part in this program, it's recommended to make a reservation in advance.

3.5 MFCAE 2019

MFCAE 2019 will be held on August 22(Thursday)-23(Friday) at the MBC Convention Center, Jinju. Users are encouraged to participate actively through oral/poster presentations to learn the simulation software as well as gain expertise. Their research activities can be presented in Korean. The location and date may be changed and will be announced to the users through our homepage and e-mail after further confirmation.

Venue	Date	City	Contents
MBC convention	Aug. 22-23, 2019	Jinju	-Theory and practice -Application