AFDEX Newsletter Winter 2016

MFRC
Tel: 82-55-854-7529 Fax: 82-55-854-1837
www.afdex.com, mfrc@afdex.com

1. New Enhanced Functions

1.1 New functions

AFDEX 70 version will be released in the 1st quarter of 2016. New and revised functions are listed below in Table 1.1.

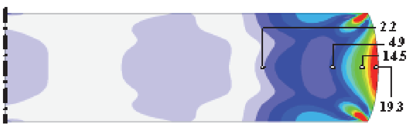
Table 1.1 List of new and revised functions.

No.	Title	Contents
1	Material library improved	Temperature ranges were expanded and 40 materials were added
2	Extended functions on the graph	Printing of current values at the graph New setting of axis information
3	Visualization of cross section improved	Status visualization on an arbitrarily inclined section
4	Version selection of a specific solver in execution	Tools → Options → Solver
5	Vector representation type added.	Vector off, Relative vector and Absolute vector
6	New press types added	Screw press and Knuckle press
7	Background screen improved	Grid on/off , Style and colors controllable
8	New functions related to FEM	Enhanced speed and utilities for 3D metal flow line 3D contact and friction routines improved Enhancement in coupled analyses Die convergence criteria improved and visualized
9	Upgraded visualization of 3D metal flow lines	See 1.2.2.
10	2D/3D analysis with elastic die deformations	See 1.2.5.
11	An improved analysis model for CWR process	See 1.2.6.
12	An improved analysis model for self piercing riveting (multi-body)	See 1.2.7.
13	An improved analysis model for roll forging	See 1.2.8.
14	FLD function implemented	See 1.2.9.
15	Ultrasonic vibration and periodic speed function	See 1.2.10.
16	Unloading function	See 1.2.11.
17	Development of steady-state extrusion analysis	See 1.2.12.
18	Spring force calculation routine improved	See 1.2.14.
19	Development of detailed and efficient analysis capability in a long slender member drawing	See 1.2.15.
20	UI development for ring rolling	See 1.3.1.
21	UI development for shape rolling	See 1.3.2.
22	UI development for super plastic forming	See 1.3.3.

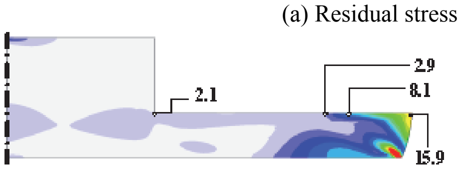
1.2 AFDEX research results and schedule

1.2.1 Prediction of residual stress changes after machining process

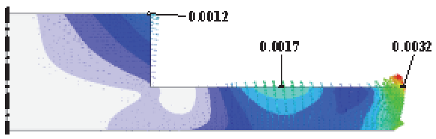
It predicts the amount of elastic recovery based on residual stresses and modified boundary conditions for the material which was initially input for the machining after elastoplastic simulation. Figure 1.1 shows the residual stress and shape change in a material which was axi-symmetrically upset and followed by lathe-machining.



(a) Residual stress after upsetting (MPa)



(b) Residual stress in the material after turning (MPa)



(c) Displacement due to turning (mm)

Fig. 1.1 Predictions of the residual stress and shape change in the material through upsetting and turning

1.2.2 Enhanced visualizations of 3D Metal Flow Lines (available now)

Visualization function of AFDEX metal flow lines has been greatly improved. The visualization of 3D metal flow lines, based on MFRC's inherent know-how, furtherly makes the forming simulator advance a step further to be quite useful. Figure 1.2 shows tracking result of metal flow lines in a analysis of forging and ring rolling combined process. The importance of metal flow lines is fully treated in the October issue of AFDEX newsletter last year.

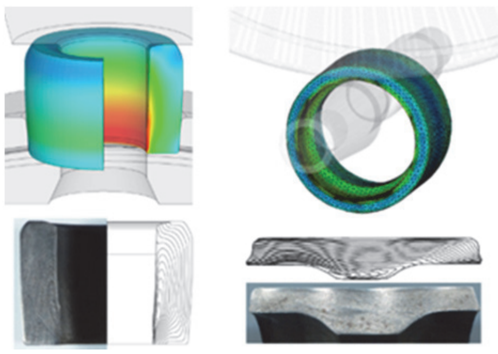


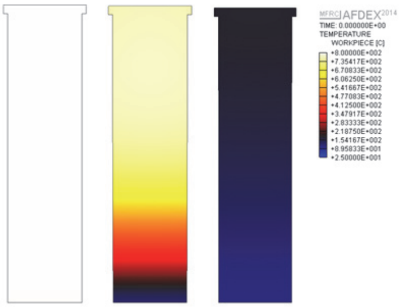
Fig. 1.2 Visualization of 3D metal flow line

1.2.3 Heat treatment function (to be released in the last quarter of 2016)

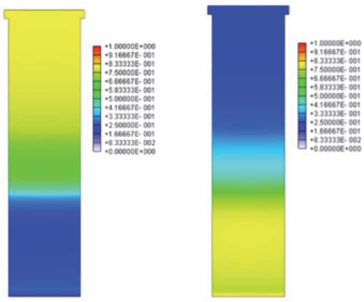
Core mechanical parts generally require durability so that heat treatment is necessarily involved. Microstructure influenced by heat treatment process effects on material strength, and it makes an additional change of durability. If strength might be predicted after metal forming process and the following heat treatment process, it is also possible to anticipate the lifetime of product and its replacement period.

Heat treatment module for AFDEX is recently developed and furtherly applied to the Jominy test, which enables the measurement of fraction data in the metal's microstructure according to the temperature and time elapsed followed by the heat treatment process and its resulting temperature change (Figure 1.3).

This module is supposed to be effective to 2D AFDEX first at the late 2016 after rigorous internal tests and researches for commercialization. This module is also anticipated to play an intriguing role in the technology advancement of heat treatment and parts material.



(a) Temperature distribution



(b) Ferrite fraction (c) Bainite fraction

Fig. 1.3 Temperature distribution in Jominy test

1.2.4 Microstructure prediction (to be published in the first quarter of 2017)

MFRC is currently carrying on the pilot research project with BRIMET, the only integrated research institute in china specialized in the fields of general plastic forming and heat treatment technology, for the purpose of utilizing the advanced material core technology in China. Meanwhile BRIMET is known to work so hard, indulging itself to secure the elemental technologies of those related modules. It also developed an independent prediction model based on the related microstructure researches performed by other professional material research institutes in China, continuing with MFRC to apply those outcomes to the field application. Presently the basic algorithm came to a completion and the project is at an application research stage.

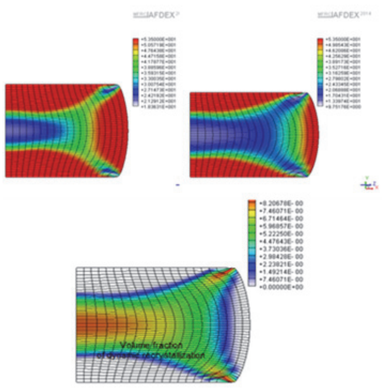
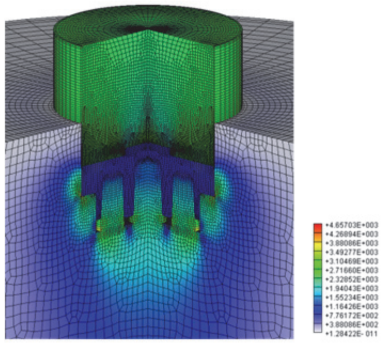


Fig. 1.4 Pre-study results about the microstructure prediction

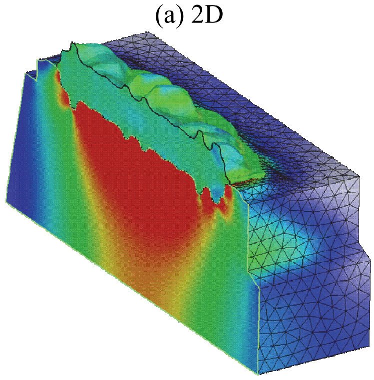
1.2.5 AFDEX 2D/3D with consideration of elastic die deformation (to be published in the second quarter of 2016)

Processes and materials are sometimes greatly influenced by the die deformation during the metal forming process so that demand for the related technique which may fruitfully handle those situations is steadily uprising. With the fact in mind MFRC has developed a stable solution method based on their inherent technique. Figure 1.5 shows a typical example of an axisymmetric cold forging process in which an elastic die deformation has great influence on the process. Material can be assumed elastoplastic or rigid-plastic, whereas the die is set to be an elastic body.

The function for AFDEX 2D will be shown to the market in the second quarter of 2016, while that for 3D is expected in the fourth quarter of 2016. However, the functions can be available at any time, if needed, before commercialization.



(a) 2D



(b) 3D

Fig. 1.5 Analysis result with die elastic deformation involved

1.2.6 Model improvement in the CWR process (to be published in the 2nd quarter of 2016)

A new model improvement is made in the analysis of cross wedge rolling process. The role of guide bar may be modeled as it is or replaced by the material's simple revolution, whereas the local sticking friction is aligned with its rolling direction. It is generally not plausible to depict theoretically or numerically the inevitable sticking area which is quite characteristic of rolling process. Hence, we have chosen the way of endowing the highly pressured surface with the sticking condition along the rolling direction, whereas those existing friction conditions are imposed along the other directions. Meanwhile the guide bar is modeled to possess the role of preventing the simply revolving area from any kind of fluctuating motion, then rendering the analysis more stabilized.

1.2.7 Self-piercing riveting process model

The analysis of self-piercing riveting process is categorized as very hard to solve. It is basically because the analysis shows the peculiar features embedded in the multi-body problem. The version to be published in the 1st quarter of 2016 is going to carry some enhanced functions.

Of crucial importance is the deformation in the tip area of rivets for the analysis of self-piercing process. In order to reflect those characteristics such an optimization over the mesh density is being made during the re-meshing stage. Together with solution convergence greatly improved, by the way, one failure in solution convergence might be observed out of every 5 cases. Improving the failure criterion at the tip region and its continuous execution of the analysis may successfully resolve those impending problems in almost all the cases, and material failures at the rivet tip area are based on the allowable thicknesses. As the dense mesh region may track the rivet tip area sequentially, the critical areas can be discretized by the selective and densified mesh configuration.

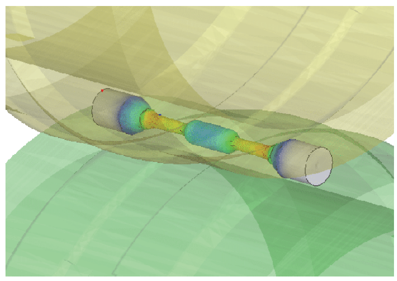


Fig. 1.6 Revised cross wedge rolling

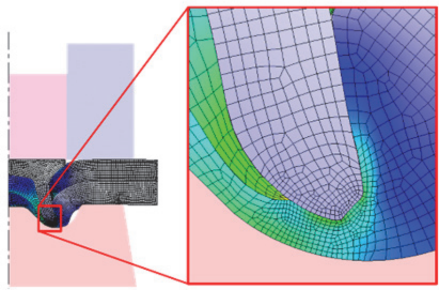


Fig. 1.7 Enhanced self-piercing riveting process

1.2.8 Revised roll forging process model

A proper modelling of a grip is one of the long standing problems in the analysis of roll forging process. As material separate intermittently from the die during the process, the existing analysis used to transfer it with a uniform speed, while the revised model additionally pertains to a moderate tensioning over the material through the grip.

This provides the noticeable ways of controlling any slippery motion of material and empirically resolving some notable discrepancy between theoretical and experimental outputs imposed by the limitation of current friction models. Depending on the amount of tensioning, the simulation results will be slightly different from each other, and for better solution accuracy there might be more necessities for further experiments which would enable us to compare them with the analytic ones under various conditions, leading furtherly to a higher level of application.

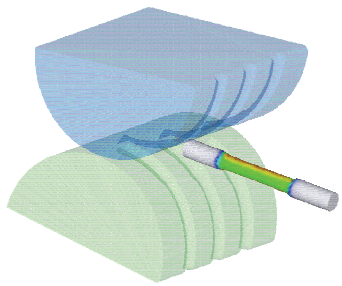
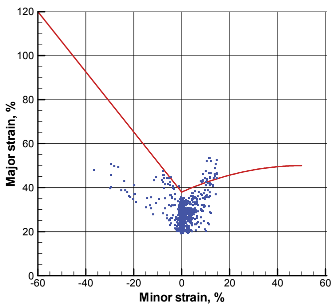


Fig. 1.8 Revised roll forging process

1.2.9 Fracture prediction in clad plates using FLD technique

In the case of sheets or thick plates the FLD (Formability limit diagram) curves are more generally used to check the fracture initiation rather than those damage models for the analyses of bulk plastic processes, whose experimental data should be ready for actual applications. And AFDEX now provides such a function of FLD from the latest version in the market.



(a) A typical FLD curve

(b) Predicted results for clad metals

Fig. 1.9 Sheet metal forming and FLD diagram

1.2.10 Development of a function of ultrasonic vibration and periodic speed

Due to the rare occasions of application the speed parameter in a periodic function has not been considered in AFDEX 2D. Recently AFDEX is loaded with such a useful capability as utilizable in the USRP (ultrasonic surface rolling process) analysis. This was meaningfully applied to the surface hardening process by ultrasonic vibration, in which the ultrasonic vibration is supposed to leave the residual stresses on the surface of high quality products under static loading condition. And that's why the elastoplastic finite element analysis is most indispensable.

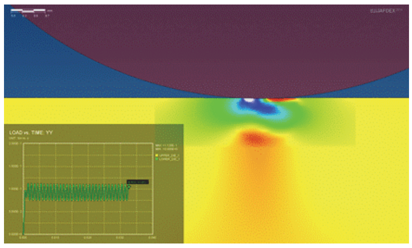


Fig. 1.10 Analysis of USRP process

1.2.11 Development of separation function after an elastoplastic analysis

Frequently observed in real applications are the problems of separation of material from dies during unloading.

MFRC currently carries a research on the analysis of unloading process caused by the backward motion of a punch and also the spring-back phenomenon in a die, especially seen in the 2D cold forging applications. Most applications are in fact met now when users are utilizing the elastoplastic analysis functions, while all the relevant functions including 3D analysis capabilities are expected to be ready in the last quarter of 2016.

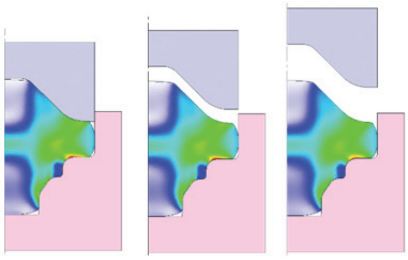


Fig. 1.11 Results from the pre-study in the case of unloading

1.2.12 A new function for the steady state extrusion analysis (to be published in the 1st quarter of 2016)

When analyzing the processes of rolling, extrusion, and drawing based on the steady-state assumption, there are usually some areas on the simulation domain whose results fit quite well with real phenomena. Depending on the problems under such a steady state assumption, moreover, those analyses are expected to frequently enhance any deteriorated solution accuracy from frequent remeshing procedures, furtherly enabling users to enjoy an economic approach to the real application with elastic die deformation involved. Presently, the analysis function for steady-state extrusion process is expected to be soon on the verge of completion.

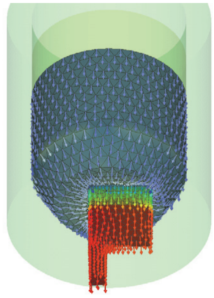


Fig. 1.12 A steady state extrusion process and its analysis

1.2.13 Analysis of rolling process with an elastic roll deformation

Every roll has its own peculiar mill constant, so called. And it is defined by the roll force to incur the unit separation between upper and lower rolls. When the material is in a rolling process and experiences the required roll separating force, the roll stands are supposed to experience an elastic deformation, which inevitably leads to the roll gap increase, while the roll gap is known to be proportional to the very mill constant. There has been such a continuous demand for describing the roll deformation from the users' side that AFDEX now provides the analytic capability with due consideration of roll stand deformation characteristics.

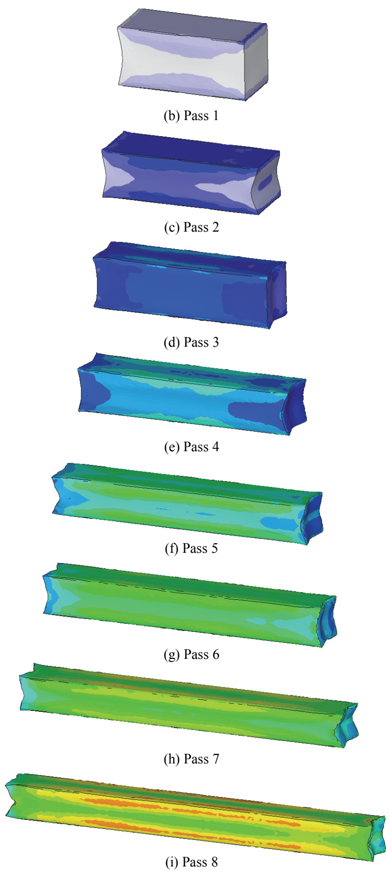


Fig. 1.13 A rolled bloom and its simulation

1.2.14 Revised routine for spring force

As shown in the example of Fig. 1.14 the material at an initial stage with spring die attached as in Fig. 1.14 (a) undergoes no forming activities until it attains to the configuration in Fig. 1.14 (b) It is notable that only the spring is compressed while the upper punch, material, and the spring die experience their own rigid-body motion, respectively. By the way such motions influence so sensitively the plastic region involved that it is not easy to reflect correctly the effect on the simulation result. As the cases similar to those in Fig. 1.15 are frequently reported, we came to revise the corresponding routine and the resulting simulations are shown in the Fig. 1.15.

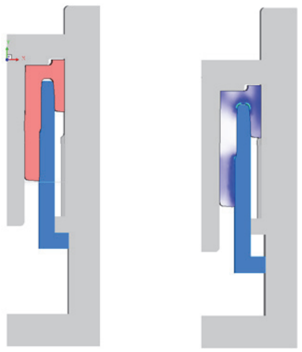
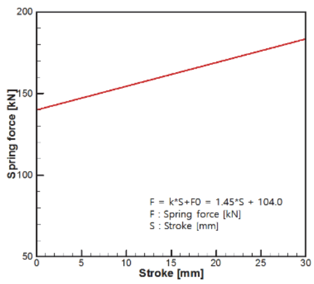
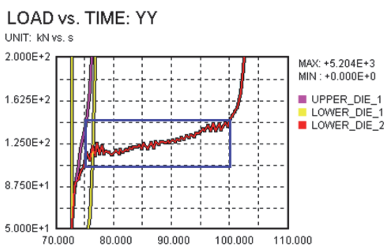


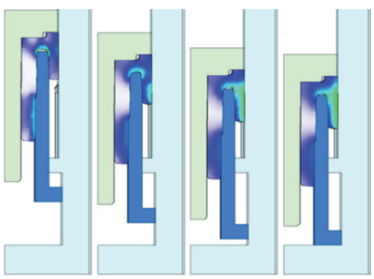
Fig. 1.14 A spring production process: (a) initial stage (left), (b) an analysis ready to go



(a) Input data



(b) Simulation result



(c) Deformation history (effective strain)

Fig. 1.15 Input of spring force and the result

1.2.15 Drawing analysis of a long slender material

In the drawing process of a long and slender member there are instances to calculate the temperature of the die and plug. And one may obtain a high quality simulation result by maintaining a uniform length of material and also using a relatively fine mesh density in the vicinity of material-die interface region. Fig. 1.16 shows an applicative example of the tube drawing process where temperature in the plug displays a sharp rise from 25℃ to 50℃. During the application of this model a sufficient mesh density is maintained in the plastic range. If one wants to analyze such a slender member with a full model of length 6,000 mm, it would be actually impossible to use such a big number of nodes in the discretization procedure of the model.

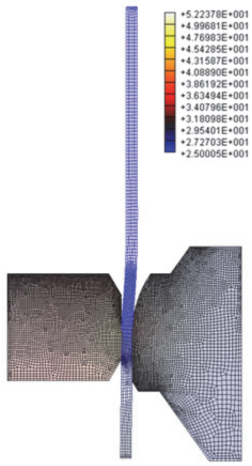


Fig. 1.16 A drawing analysis of a long slender material

1.3 Special purpose templates

Principally AFDEX is endlessly seeking for the solution accuracy and convenience in users' everyday use. For the latter AFDEX pre-processor has been developed focusing on various functions related to the basic forging operations, while additional templates may also enable one to conveniently input the information for several other special forming processes after setting-up procedure in the pre-processor. Fig. 1.17 shows the way how an additional UI imports the AFDEX project file and endows it with special set-up functions.

The UI's directly input information required through the dialog box rather than editing .scf and .sif files in the notepad. Among them under test a few templates are to be displayed below for the ring rolling, shape rolling, and superplastic forming.

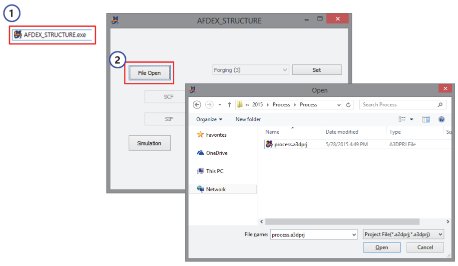
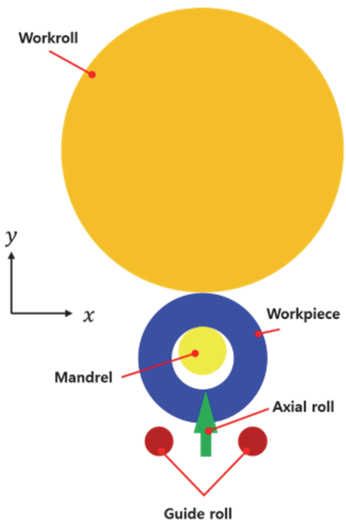


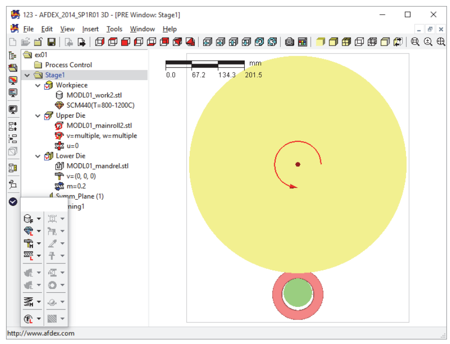
Fig. 1.17 Execution of AFDEX/Special UI with the pre-processed file imported

1.3.1 Ring rolling template

In order to set up ring rolling process one needs to generate a xy-plane CAD model as shown in Fig. 1.18 (a) , and then preprocess initial set-ups as depicted in Fig. 1.18 (b) . Ring rolling process is usually composed of workroll, mandrel, with (or without) the axial roll depending on the jobs at hand, while the geometry of guide roll is additionally specified in AFDEX/Special UI. It contains a dialog box where information indispensable for the ring rolling process can be input. SIF Dialog handles the information about Workroll, Mandrel, Axial roll and Guide roll, respectively. Those parameters in Fig. 1.19 are explained in detail in its users' manual to be released.



(a) Ring rolling concept



(b) Initial ring rolling set-up in AFDEX preprocessor

Fig. 1.18 A ring rolling process

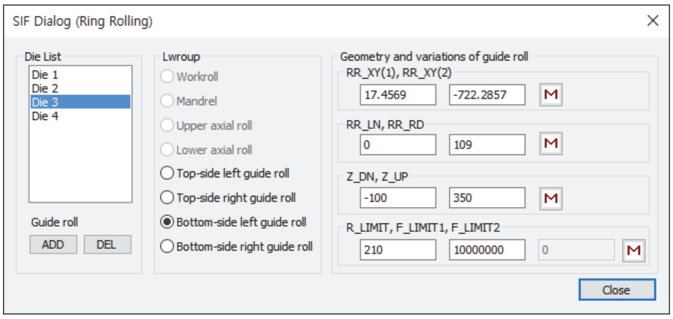


Fig. 1.19　SIF Dialog for a ring rolling process

1.3.2 Rolling template

AFDEX/Special UI contains a dialog box where information indispensable for the rolling process can be input. SCF Dialog (Shape Rolling) handles the information about rolling directions at each stage, pusher and puller conditions and boundary conditions as well. SIF Dialog (Shape Rolling) handles the information about mill constant. Those parameters in Fig. 1.20 are explained in detail it its users' manual to be released.

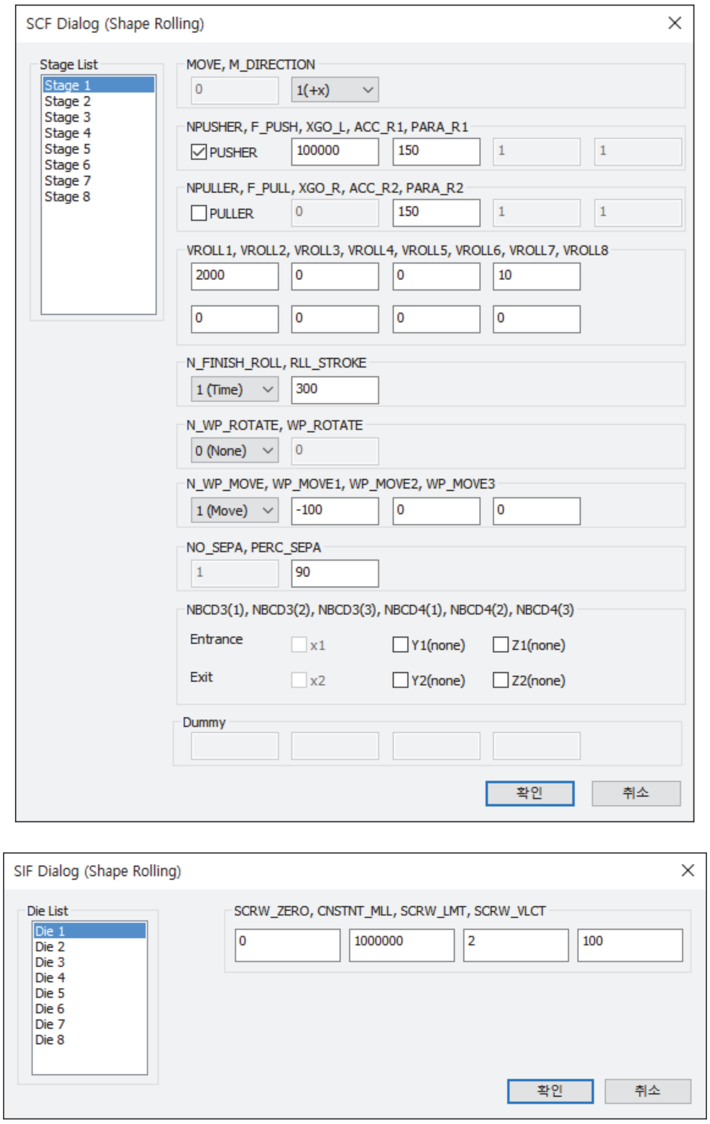


Fig. 1.20　SCF and SIF Dialogs for rolling process

1.3.3 Template for superplastic forming

AFDEX/Special UI contains a dialog box where information indispensable for the superplastic forming process can be input. SCF Dialog (Superplastic Forming) expresses pressure as function of time, while SIF Dialog (Superplastic Forming) also handles the information about the involvement of pressurizing dies and sticking conditions. Those parameters in Fig. 1.21 are explained in detail in its users' manual to be released.

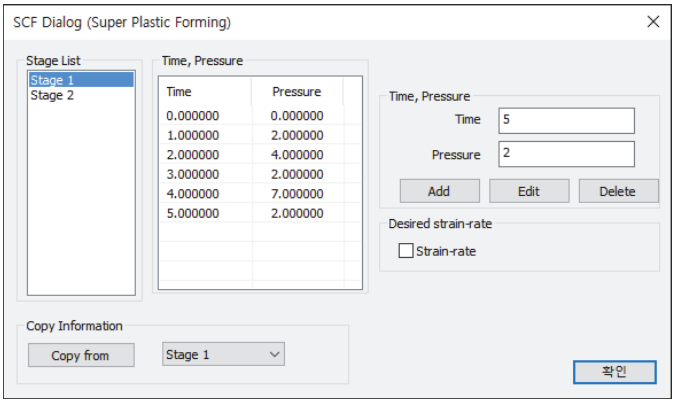


Fig. 1.21　SCF Dialog for Superplastic forming analysis

1.4 List of Academic Papers

Table 1.2 shows the list of academic papers published by AFDEX developers in the year of 2015. More details can be found at http://msjoun.gnu.ac.kr/.

Table 1.2　List of MFRC's academic papers in the year of 2015

13th Asian Symposium on Precision Forging	
1	Bauschinger Effect in High-Strength Low-Strain-Hardening Materials
2	Consideration on metal flow lines in forging and their prediction in ring rolling after forging
3	Elastoplastic finite element analyses of sheet metal forming by using sol id elements
4	Development of elastoplastic module in AFDEX
5	Effect of flow stress, friction, temperature and velocity on finite element predictions of metal flow lines in forging
6	Die fracture in hot forging of a fixed scroll
7	Residual effective stress of an axisymmetric forging after material remo val
8	Finite element analysis of internal pore closing phenomenon in bloom r olling
9	Criterion on enclosed die forging with a double-action link-type hydrauli c die set
2015 Spring conference of Korean Society of Manufacturing Process Engineers	
10	Investigation into effect of meshing size on prediction of residual stress in ultrasonic surface rolling process
11	Analysis of change of residual stress and shape of an axisymmetric forging due to turning
2015 Spring conference of Korean Society for Technology of Plasticity	
12	Modelling of guide roll and its application to simulating ring rolling
13	Finite element analysis of internal pore closing in rolling bloom
14	Elastoplastic finite element analysis of rectangle deep drawing process of clad-sheet
15	Elastoplastic finite element analysis of a square-cup deep drawing process using solid elements
16	Causes of fracture occurring in plate forging of clad plate
17	Investigation into effect of initial geometry and position of workpiece on die stress in hot aluminum forging of a fixed scroll
18	Approximate estimation of surface defect length of hot coil due to closing of surface pinhole defect in bloom rolling
19	Finite element analysis of shape rolling process considering mill constant
20	Finite element prediction of die wear in hot forging of a crankshaft
21	Optimized design of aluminum cold forging process for a part with reverse draft for both high yield and high productivity
2015 Autumn conference of Korean Society of Manufacturing Process Engineers	
21	Finite element analysis of a square cup drawing process with a large se ction reduction
22	Affection on high aspect decrease forward extrusion process by temperat ure non-uniformity of the workpiece and measure

	2015 Autumn conference of Korean Society for Technology of Plasticity
23	Experimental and numerical studies on cold forging of an aluminum aut o part
24	Die fracture in hot forging of a fixed scroll and effects of geometries o f material and die on the fracture
25	Finite element simulation of pure shear extrusion process with back pres sure
26	An engineering design of a fleshless hot closed die forging process for an aluminum fixed scroll
27	Comparison of rigid-plastic and elastoplastic finite element analyses of a n upsetting process considering elastic deformation of dies
28	Development of steady state approach for the analysis of extrusion proc ess

2. User supporting activities

2.1 Homepage innovation

From Nov., 2015 MFRC has started providing new AFDEX information service through its innovated and most updated homepage to AFDEX users and potential customers in global metal forming community, not limited to the domestic one. Joining recently Altair APA program has accelerated its globalization so much that English is set to be major lingual means. Chinese, Indian, Japanese and Korean users and Altair users can enter easily the related partners' homepages through the AFDEX homepage.

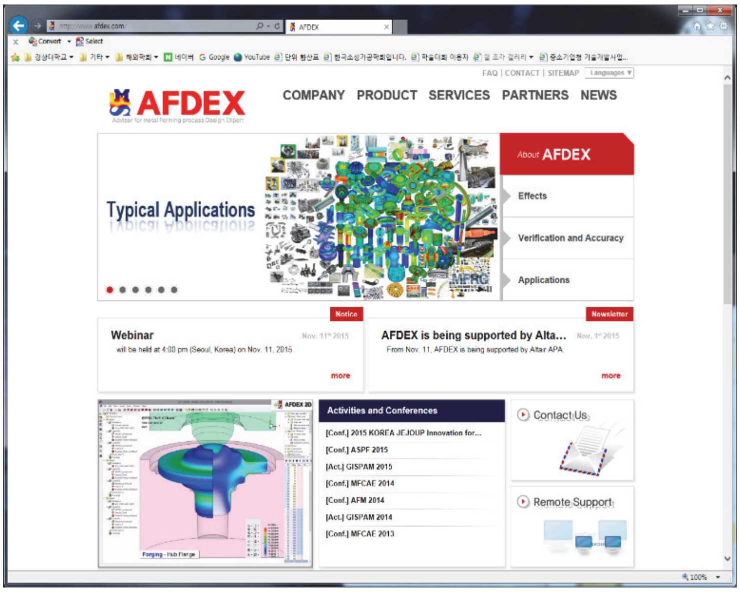


Fig. 2.1 AFDEX homepage (http://afdex.com/)

3. Developers Meeting

The most recent Developers Meeting was held at Gyeongsang National University on July 2nd. Many topics were enthusiastically discussed to figure out their current status and final destinations which were not limited to the subjects of elastoplastic module, elastic die deformation, PRE/ POST, microstructure prediction, heat treatments, and the parallel processing (Fig. 6). Currently basic functions for heat treatment are secured, while the publication of beta version is expected within the year.

Fig. 3.1 AFDEX developers meeting

This meeting started with first presenting the overall development situation and the relevant SWOT analysis by CEO Dr. Man-Soo Joun, respectively followed by the recent advances in each development area.

Especially the meeting turns out to be quite meaningful, as it has fully provided a development road map for AFDEX (Fig. 3.2) and a fundamental framework for the industry-university-institute cooperation (Fig. 3.3). Developer's meeting is supposed to be regularly held twice a year, more specifically at the earlier part of each period.

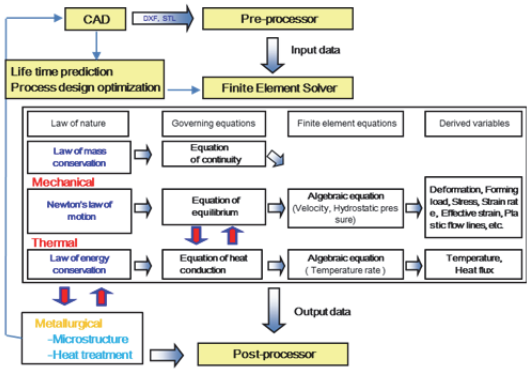


Fig. 3.2 Development road map for AFDEX

Fig. 3.3 An organogram of industry-academic-institute cooperation

4. External cooperative activities

4.1 International cooperation

4.1.1 Overseas research co-work

MFRC and Purdue University in the United States agreed on the MFRC's sponsorship program for an applicative research on microstructure evolution and its prediction of resulting mechanical properties to be performed by Purdue University for three years starting from 2016. Purdue has already accumulated basic research outputs, as it fully secures relevant research information and papers on metallurgical characteristics based on the past history the material experiences during the manufacturing process. MFRC is going to fully support the fund. By the way the research outputs are supposed to be in the market by MFRC's commercialization work.

By strengthening the cooperative development researches with world-class universities, MFRC looks forward to accelerating its development pace of AFDEX's cutting-edge module and also utilizing the chances as those of expanding human network with top-class research community and researchers.

It is notable that Purdue already uses AFDEX at the department of Mechanical engineering from the year of 2011 for the educational purpose (homepage: https://engineering.purdue.edu/ME363/). Meanwhile prof. M.S. Joun was previously invited to the university in 2012 and gave a seminar on the subject of intelligent metal forming simulation technology.

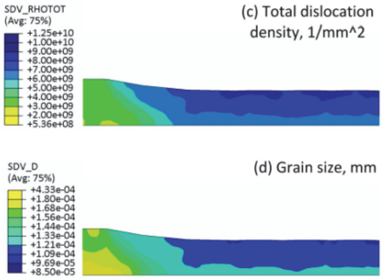


Fig. 4.1 Pre-study results by Purdue Univ.

4.1.2 MFRC Contracts with Altair for the Global Service

MFRC made a historical contract of APA with Altair, one of the top-three engineering software companies in the world, so that it may stably supply its software service of AFDEX to the global market, while APA stands for Altair Partner Alliance so-called. On the day of Sep. 16th previously, the signing ceremony hence observed more than 10 key players for the contract present at Pullman Hotel located in the city of Changwon, Korea, including Mr. Brett Chouinard (COO), Mr. Sungsoo Moon (Country Manager) from Altair, Dr. Man-Soo Joun (President), Dr. Jangho Lee (COO) and a few other researchers from MFRC.

Fig. 4.2 The APA joining ceremony on Sep. 16, 2015

AFDEX, the first commercialized CAE metal forming software in Korea, whose core technology was transferred from the university of GNU in 1998, has ever since enormously contributed to the successful growth and innovation in Korean metal forming industry.

Altair is globally known quite well as one of leading companies in the business sector of engineering SW cooperating closely with more than 5,000 customer companies in the world. And the program of APA is a SW liaison platform on which Altair's user companies may get an easy access to various software APA partner companies provide as well as Altair's in-house SW, whereas about 50 companies are currently in the APA family.

Dr. Joun, president of MFRC Inc., stressed out that becoming an APA member showed an objective worldwide recognition on the AFDEX's inherent strength of analysis accuracy and user-friendliness.

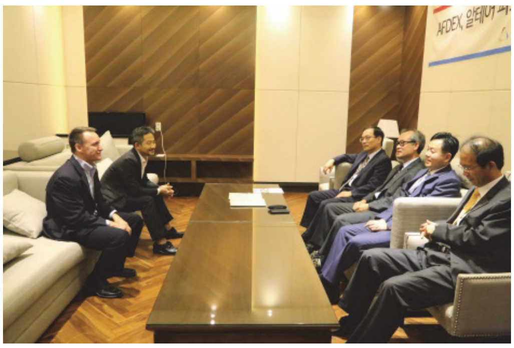


Fig. 4.3 Key players face to face at the ceremony

Dr. Joun also explained his plan in near future that the possible financial inflow from the co-work with Altair is expected to surely pave MFRC the road to an international engineering and consulting company with more than 30 qualified personnel and core researchers, cooperating with about 20 global universities and research institutes.

The cooperation of Altair and MFRC pertains to a significant importance when seen from the perspectives of eco-friendliness, light weight, high quality and production cost, as the issue of forging process design comes to pop up as crucial especially to users in forging industry and to those companies as well. It is quite pleasing to find that MFRC maintains a peculiar attitude toward users and market, as it dearly strives for their users staying happier than before through the very cooperation with Altair, especially in the course of fulfilling the every demand in the market with the token of qualified capabilities in the forging process analysis including predictive power in strength and life expectancy.

4.1.3 Global Webinar Sessions

MFRC has held two times of webinar session on Oct. 19 and Nov. 17, respectively, targeting the global Altair users including internal Altair employees, in order that it may introduce both AFDEX and MFRC to all the potential customers within current Altair's network. A webinar is a web-based seminar quite similar to the conventional off-line one, in which the faces of all participants can be displayed on the computer screen with presentation documents (PPT files, analysis results, etc.) simultaneously shared, even though there might be some time-lag between a presenter and the audience usually attributable to the regional internet speed.

The two webinars provided both the Altair community and MFRC with such nice chances of organically coordinating working forces in each company and deepening mutual understanding as well. Due to the big time difference between the regional attendees scattered worldwide and the presenter in Korea, one session had to be held at 3 - 4 pm KST (2 - 3 am, EST) for the people in Asian and East European countries, while the other session held at 11 - 12 pm KST (9-10 am EST) was aimed at those from USA and West European countries. Each chapter in the presentation covered in detail the subjects of "Introduction to MFRC and AFDEX, Its successful applications, and Demos for how-to-use and Q&A."

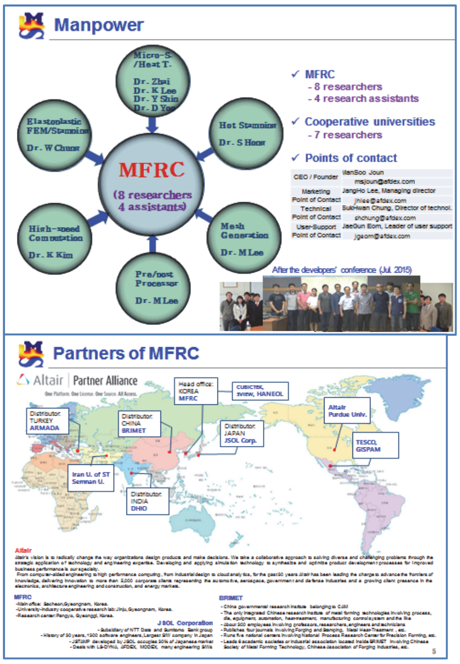


Fig. 4.4 A presentation in the Webinar

4.1.4 LS-DYNA & JSTAMP Forum 2015 Attended

Prof. Man-Soo Joun additionally attended the LS-DYNA & JSTAMP Forum for two days of Nov. 5th to 6th in Tokyo, Japan and delivered a guest lecture titled “An elasto-plastic analysis of clad plates”, which successfully dealt with both theoretical and experimental features including their results embedded, respectively.

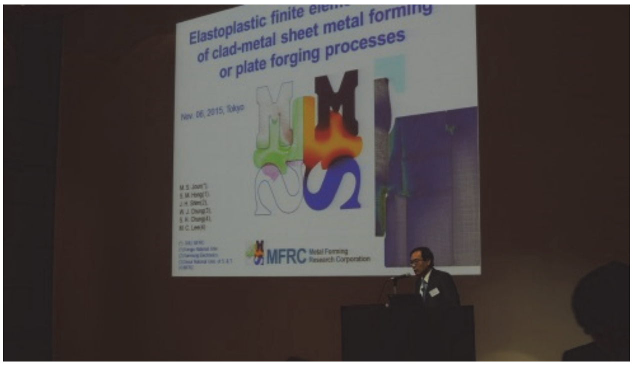


Fig. 4.5 LS-DYNA & JSTAMP forum 2015 in Tokyo, Japan

4.1.5 An Invited Lecture at HUST

Invited by Prof. Wang at HUST (Huazhong University of Science and Technology) in Wuhan, China, Prof. Man-Soo Joun, President of MFRC, visited the Precision Forming Center in the university and gave a lecture to 40 undergraduate and graduate students on the subject of “Present and future CAE in plastic forming technology.” HUST is known to be one of leading universities specially in the plastic forming field, currently using AFDEX for educational purpose in its two academic courses.

Fig. 4.6 Prof. Joun at HUST to deliver a guest lecture

4.1.6 ASPF 2015

MFRC participated in the 13th Asian Symposium on Precision Forging (hereafter Symposium), which was held in Gyeongju, Korea on Sep. 17th - 18th. The Symposium was co-organized by Gyeongsang National University (Prof. Man-Soo Joun), Pusan National University (Prof. Byoung-Min Kim) and Korean Society for Technology of Plasticity, with 60 participants from universities, and 10 from the research institutes and 30 from the companies.

Totally 57 papers on precision forging and in the related fields were presented in ASPF 2015. Several brilliant and trendy lectures were given by invited professors: “Flexible manufacturing innovation in net shape manufacturing” by prof. Dongyol Yang, KAIST, ‘Trend of precision forging in Japan” by prof. Isogawa, Daido University, “A new rotary forging process for sheet disk-like parts” by prof. Wang, HUST, “Evaluation of formability and forming analysis of thick Ti-Al clad sheet” by prof. Seokmoo Hong, Kongju University, and “Fabrication of precision parts using powder injection molding” by prof. Seongjin Park, POSTECH. Apart from the topic of academic researches, prof. Jangho Lee at GNU presented “GISPAM 2015 for international cooperation through forging.” After the Symposium, the technical tour to POSCO and Hanho Industry was made together with Korean historical experience tour to Bulguk Temple, Seokguram Grotto and other beautiful sites.

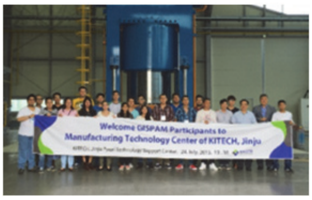
Fig. 4.7 The 13th ASPF

4.1.7 GISPAM 2015

This summer MFRC has operated the international education program of GISPAM 2015 for five weeks stretching from July 20^{th} to Aug. 23^{rd} in which 20 Mexican university students and 1 Korean as well has been involved in the subjects of mechanics, CAD, and the 4 Korean made engineering software of AFDEX, Z-CAST, MAPS-3D and Midas NFX, whereas GISPAM 2016 next year is supposed to comprise those engineers from small and medium sized local companies in root industries.

The program of GISPAM originally started last year to meet the requests by the State of Mexico in Mexico in order to educate the Mexican students solely for the software of AFDEX. At that time very qualified top 5% Mexican students and their accompanying professors as well as GNU Korean students participated in the course, while 13 Korean and 3 foreign instructors offered the course in English, and all Mexicans were financially fully covered by the State of Mexico. Totally satisfied and encouraged by GISPAM 2014, the State of Mexico wanted to expand the course to be five weeks long with more students and together with more expanded subjects so that it again dispatched their delegation of 20 people this year.

Fig. 4.8 Softwares taught in GISPAM 2015



KITECH


Hyundai WIA

Samsung Heavy Industry


POSCO


Creative Korea & Innovation Center

Midas-IT


Hanho Industry

Samsung Electronics


GTIC

Fig. 4.9 GISPAM Technical tours

4.1 Exhibiting at Altair's EATC

Last September 29th to Oct. 1st , three people from MFRC participated into EATC (European Altair Technical Conference) held in Paris, France. EATC is well known to the community as an annual technical conference for Altair customers, where various simulation applications are widely shared and new software products are also introduced so that it may constitute an optimistic place of product promotion to the Altair partner companies.

Fig. 4.10 Promotion of AFDEX at Altair's EATC in Paris

5. Developers' news

5.1 Ph.D. degree

Mr. Jae-Gun Eom, one of key players at MFRC, finally got the Ph.D. degree, whose research has been long focused on the critical research issue of the state-of-the-art forging technology.

Title	A study on the Flow Stress Acquisition at Room Temperature and its Effect on Plastic Deformation
Abstract	The paper presents a method for acquiring true stress–strain curves over large range of strains using engineering stress–strain curves in a tensile test coupled with finite element analysis. The flow stress is described by the Hollomon law-like form in which the strain hardening exponent is calculated from the true strain at the necking point to meet the Considére condition. The strength coefficient is assumed to be constant before necking and a piecewise linear function of strain after the necking. With the predicted flow stress, a tensile test is simulated by a rigid-plastic finite element method with higher accuracy of less than 0.3% error between experiments and predictions.
Selected papers	- Evaluation of damage models by finite element prediction of fracture in cylindrical tensile test, 2014, Journal of Nanoscience and Nanotechnology, Vol. 14, No. 10, pp. 8019-8023. - Effect of strain hardening capability on plastic deformation behaviors of material during metal forming, 2013, Materials and Design, Vol. 22, No. 6, pp. 1010-1018. - A new method for acquiring true stress-strain curves over a large range of strains using a tensile test and finite element method, 2008, Mechanics of Materials, Vol. 40, No. 7, pp. 588-593

6. Public notice

6.1 User's conference

Despite of all the demands for MFCAE 2015, the AFDEX User's Conference, was not held because of holding international events, ASPF and GISPAM. Please be advised that this year MFRC is determined to host such public events as fruitfully as possible and MFCAE 2016 will be held in Jeju Island, Korea at August 18-19, in which presentations in Korean (not limited to in English) are also heartily welcome. We anticipate AFDEX users' more active participations into the conference. Thank you in advance for your continuous and strong support on the event.

E-mail: mfrc@afdex.com

Table 6.1 Users' conference of MFCAE 2016 schedule

Place	Date	Area	Content
Ramada Plaza, Jeju	Aug. 18 (Wed) ~ Aug. 19 (Fri)	Jeju	Users' conference

Fig. 6.1 Ramada Plaza hotel in Jeju island