AFDEX Leads the Way in Forging Innovation

Introduction

Forging has a long history of almost 4000 years and it still remains in the realm of creative, future-oriented way of manufacturing together with its consistent advance. Manufacturing capability of a nation is frequently measured by its forging competitiveness and resulting production volume.

It is well known that a sound forging process drastically lowers the production cost and simultaneously guarantees the quality enhancement. It is also essential in making the product far lighter and fruitfully meeting those environmental issues required in the current era. One of the main streams in the mechanical parts industry involves the soaring rate of application of metal forming methods. Note that metal forming process development is inescapably accompanied by the big amount of expenditure and long span of time as well.

AFDEX, a forging simulator targeted to the forging companies, has strenuously worked on those practical aspects described above and has steadily created so many remarkable applicative success cases. It is our privileged pleasure to introduce here a few of them carefully selected to the most benefit of those interested forging communities.

Innovations Observed in the Bearing Industry

Hanwha Machinery Co. (Schaeffler Korea now) firstly employed AFDEX in 1995 to resolve such a tricky set of metal flow line problems in developing a forging process for the 1st generation of hub bearing outer races. Contrary to the apparent outer appearance, its process design engineers are destined to encounter those typical technical barriers contained in automatic multi-stage closed-die forging with no flash allowed, which enforce them afterwards to be confronted with the problem of very complicated process designs, while even only one time of process design failure is about to incur severe temporal and economical damages.

Fig. 1 shows one brilliant AFDEX result presented in MFCAE (Metal Forming CAE users conference) in 1996. The first picture from the left shows a typical faulty product of the race with unbalanced metal flow lines with respect to the horizontal symmetric line, which was frequently observed in the 1st generation of outer races in a hub bearing assembly at that time. In spite of rather a nice outer appearance, a world-class bearing company sentenced the product to be insufficient on the technical basis of bad metal flow lines. It is quite regrettable that the faulty prototype was obtained after 3 times failures by a painstaking 6-month-long

empirical trial and error approach. Forged products gotten from automatic multi-stage processes usually require such a long span of development time and it is mainly because those mass production machines are under various uncontrollable working conditions, while circumventing solutions turned out to be nearly impossible. A noteworthy part of due attention is the analytic metal flow line obtained by AFDEX, whose application was originally carried out for the introductory purpose of AFDEX to the company of Hanwha.

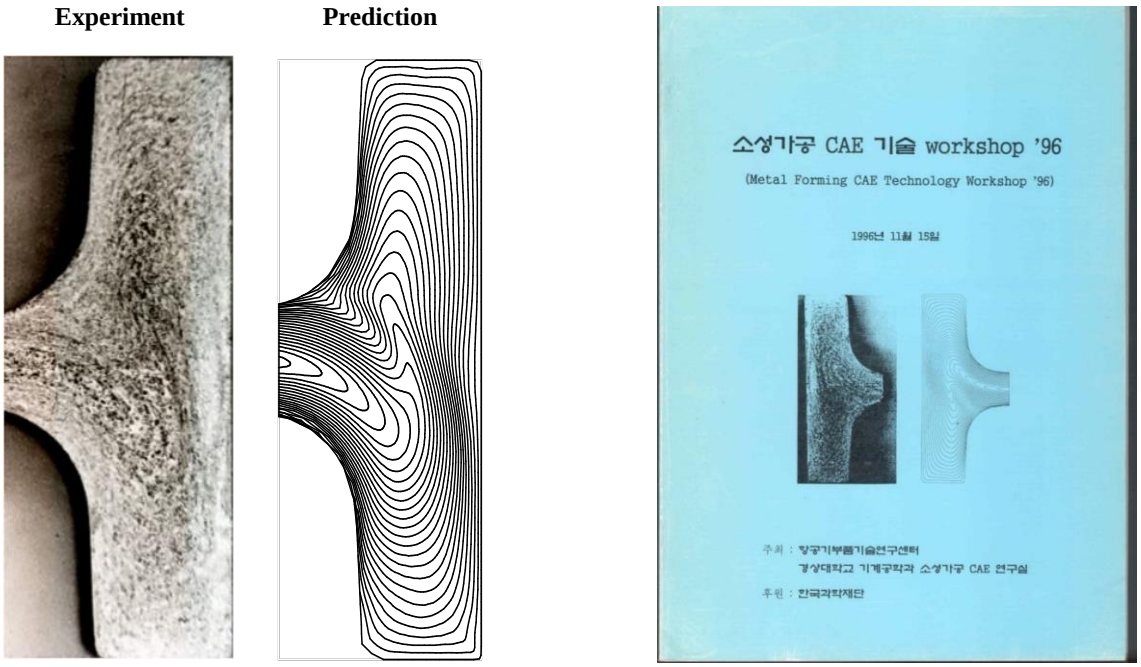

Fig. 1 The 1st generation of forged hub bearing outer race in 1995 (a piece of real prototype, left and its AFDEX prediction, right)

When the process design was based on the AFDEX usage it remarkably took only two weeks to accomplish all those reliable parts development for the 1st generation of hub bearing assembly, which might well be dubbed as an innovation once and for all. The incident directly related to AFDEX is quite well reported in two pages of Technology Part of 60 pages long in the book titled “50 years of Korean bearing industry”, published in 2003 by FAG Hanwha Bearing Co., with a volume of 350 pages long. By the way academic publications on this topic stated above can also be found in two ASME research papers, one of which corresponds to M. S. Joun, M. K. Moon and R. Shivpuri, 1998, “Automatic simulation of a hot-former forming process by a rigid-thermoviscoplastic finite element”, ASME Trans., J. Eng. Mater. Technol., while another can be seen in J. S. Lee, S. J. Yoo, H. K. Moon and M. S. Joun, 2007, “Hot deformation behavior of bearing steels”, ASME Trans., J. Eng. Mater. Technol.

Fig. 2 additionally depicts the first application of AFDEX to cold forging by Hanwha Machinery to analyze and optimize the tapered roller bearing product. Beyond any doubt such an application of AFDEX at that time in developing an optimized product had provided the company a solid platform to maintain the competitive technology level in the field of tapered roller bearings. Engineers working in the company with a product portfolio of simple but diversely many kinds tend to stick to the empirical data and existing process designs. When supported by the simulation tool like AFDEX in those cases, we are humbly sure that more tangible improvements and even some marvelous innovations are expected.

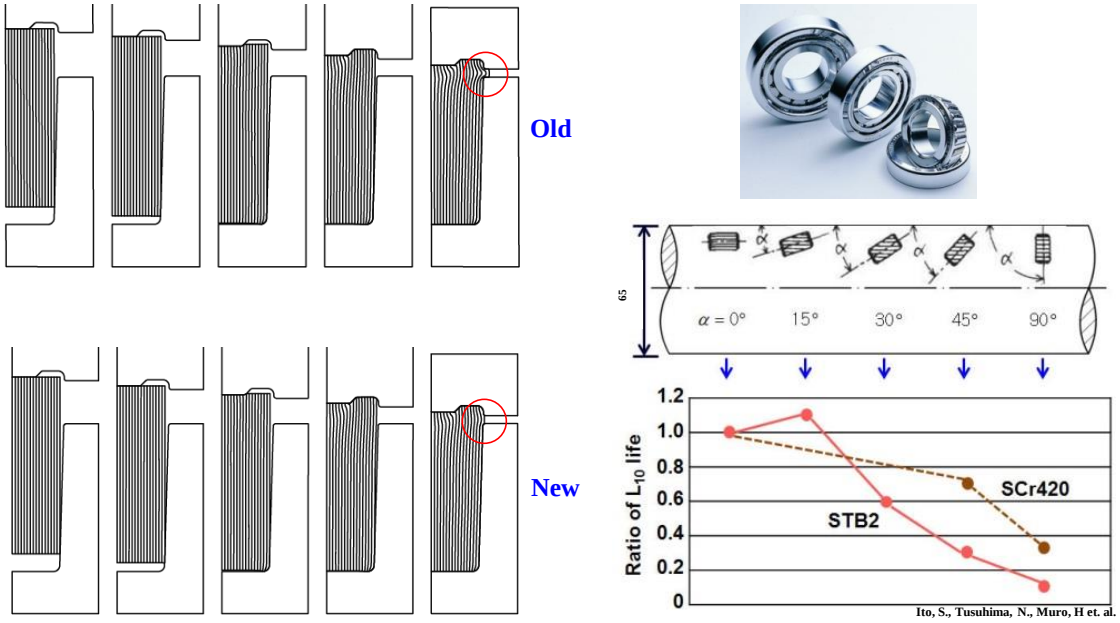

Fig. 2 The forging process for a tapered roller bearing since 1995 (The lower left figure is the work of Saito et al.)

Fig. 3 depicts an optimized process design applied to the product of a flanged hub bearing outer race. Prior to the AFDEX guidance were produced those faulty products shown on the far left in the figure which had been loaded to the commercialized automobiles in the past, while the application of AFDEX has yielded innovative quality-supported products seen on the right. Recall the fact that enhanced parts strength is also secured in a robust manner even with 30% less material used. The metal flow lines near the grooves on the right figure where bearing balls are in contact with the product in service are quite sound and well balanced, and the resulting amount of scrap is undoubtedly preferred by the company and relevant end users.

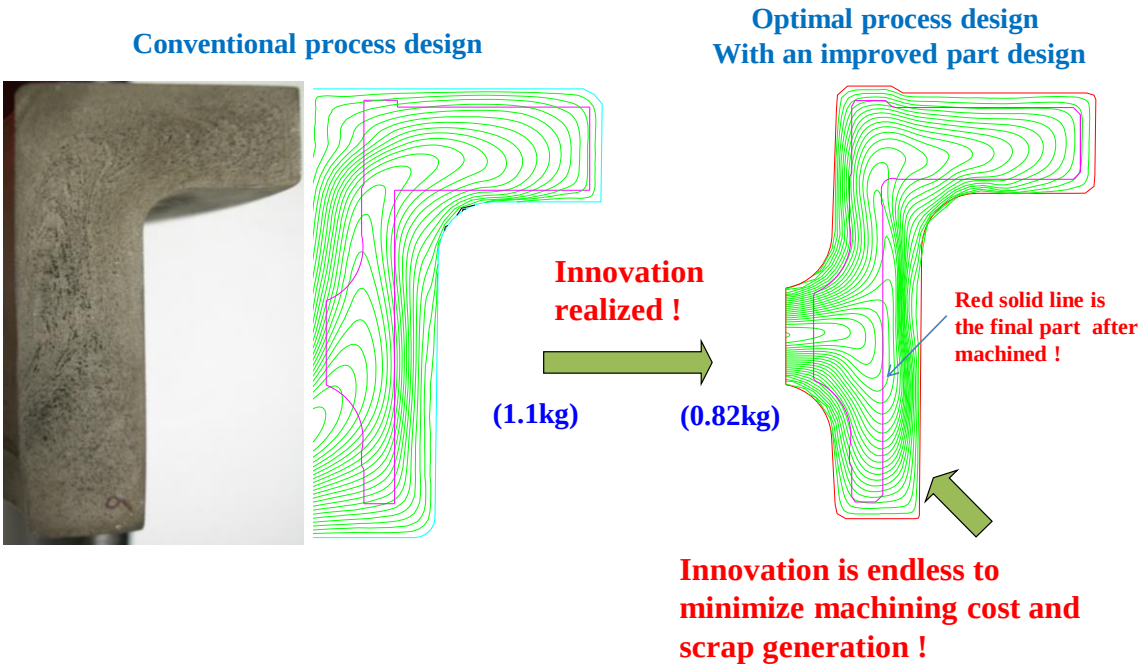

Fig. 3 A flanged hub bearing outer race from the forging process

Green Production

Green production is an irreversible trend of the era. In view of the fact that metal is in itself a lump of energy, reducing the scrap amount directly leads to the benefit of environmental protection, which is widely recognized to be one of the very tricky issues connected to various interested parties. Some end users and manufacturers like automobile companies are in favor of this, while not a small number of organizations and parties are definitely on the opposite side. AFDEX has been developed to meet such demands of the times especially for the forging companies of automobile parts with numerous applicative examples, one of which is shown in the figure below for a CV joint part in the hot forging process. AFDEX has contributed to this area in an enormous way, as Dong Eun Forging Co. Ltd., one of the most representative forging companies in Korea, is currently manufacturing those non-scrap products through the hot forging process.

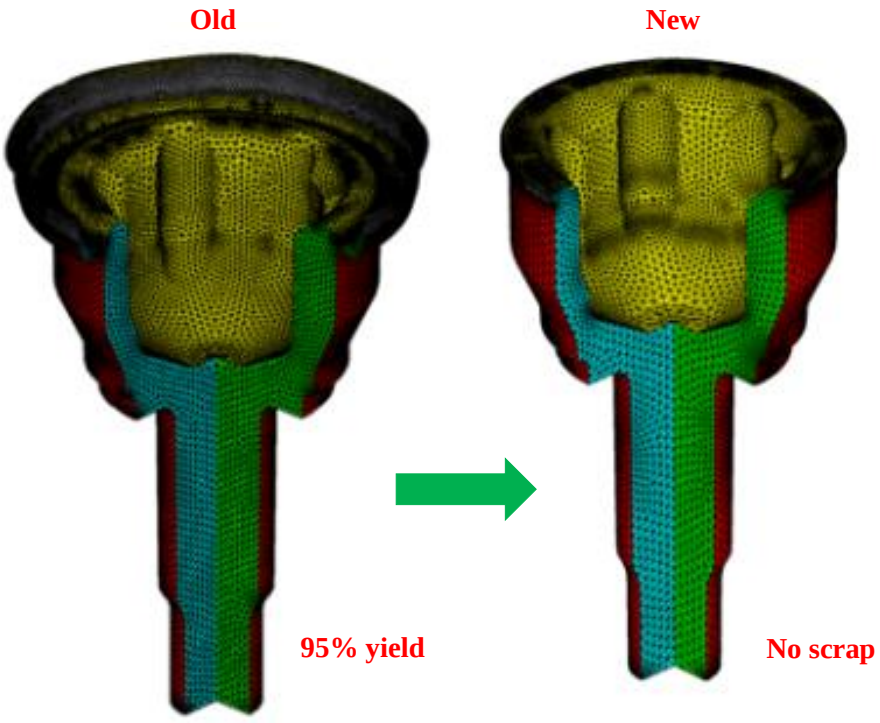

Fig. 4 A no-flash CV joint outer race through AFDEX's hot forging simulation

A Groundbreaking Short Development Time

People say these days that one of the main features in an automobile industry is the noticeably shortened time in developing new automobile products. It may be partly owing to the modularization advancement and expertise of the parts companies involved. As months of painstaking development time are indispensably required for new forging parts, it is nearly impossible to do without a reliable forging simulator.

Fig. 5 typically shows such an application in which Jinhap, a world-class GFA fastener company now, successfully developed such complicated parts with a proper assistance of AFDEX within only two months, while several foreign forging experts then proclaimed two years of development lead time at least was necessary for the Korean companies.

This kind of innovation, of course, has a profound impact on the due progress of automobile industry as well as forging companies inside. It is worthy of paying attention to the fact that AFDEX plays a pivotal role in exerting innovative and creative process design possible especially for small/medium enterprises of shallow application experiences so far. Moreover it is well adapted to the design of full automatic multi-stage forging processes, as those processes are analytically automatized with least interventions by the users. AFDEX has been said that it enabled forging companies in Korea to manufacture parts locally on their own engineering capability, which parts were previously imported from technologically advanced

foreign countries so that Korean forging companies now come to step on the more solid and positive business platform so as to successfully meet the needs from their partners of automobile companies.

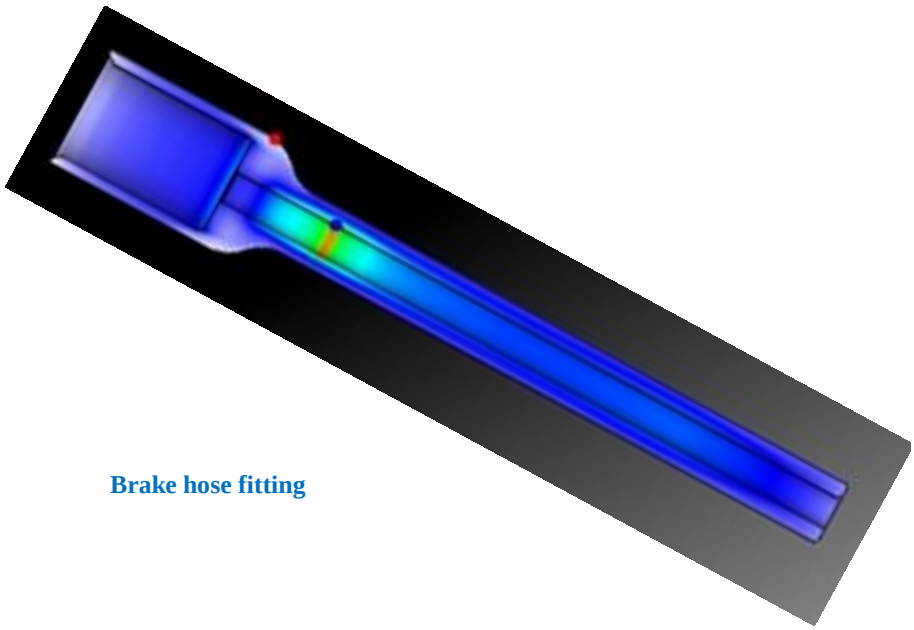

Fig. 5 Development time is innovatively shortened by AFDEX involvement

Conclusion

The statement that theory does not go with reality is not wise enough. Noting that the discrepancy between reality and theory is given as a matter of course, we see the gap might be successfully bridged by well-qualified engineers. Based on the experience gotten by AFDEX development team until now furtherly says the chasm between real and theoretical solutions is not big in most problems encountered in everyday engineering cases, and such gap is also within the easy resolution range of engineer's sound judgement. These days we observe that the concept of try-out in the past is getting diminished, and the forging simulator is steadily replacing those outdated players.

At this stage, however, we have to stress out the fact that the simulator is not able to deal with everything. It is not difficult to imagine the scene of "a big boss forging simulator", in which engineers become fainted and less influential, while engineers and a simulator get to be hostile to each other. Of course that will not happen. AFDEX will stay as a devoted friend to forging process engineers. AFDEX has no intention of substitute for the user's valuable experience, insight, and most precious creativeness.