4강 소성가공 시뮬레이션

4강 목차

4.1 소성가공 시뮬레이션의 개요

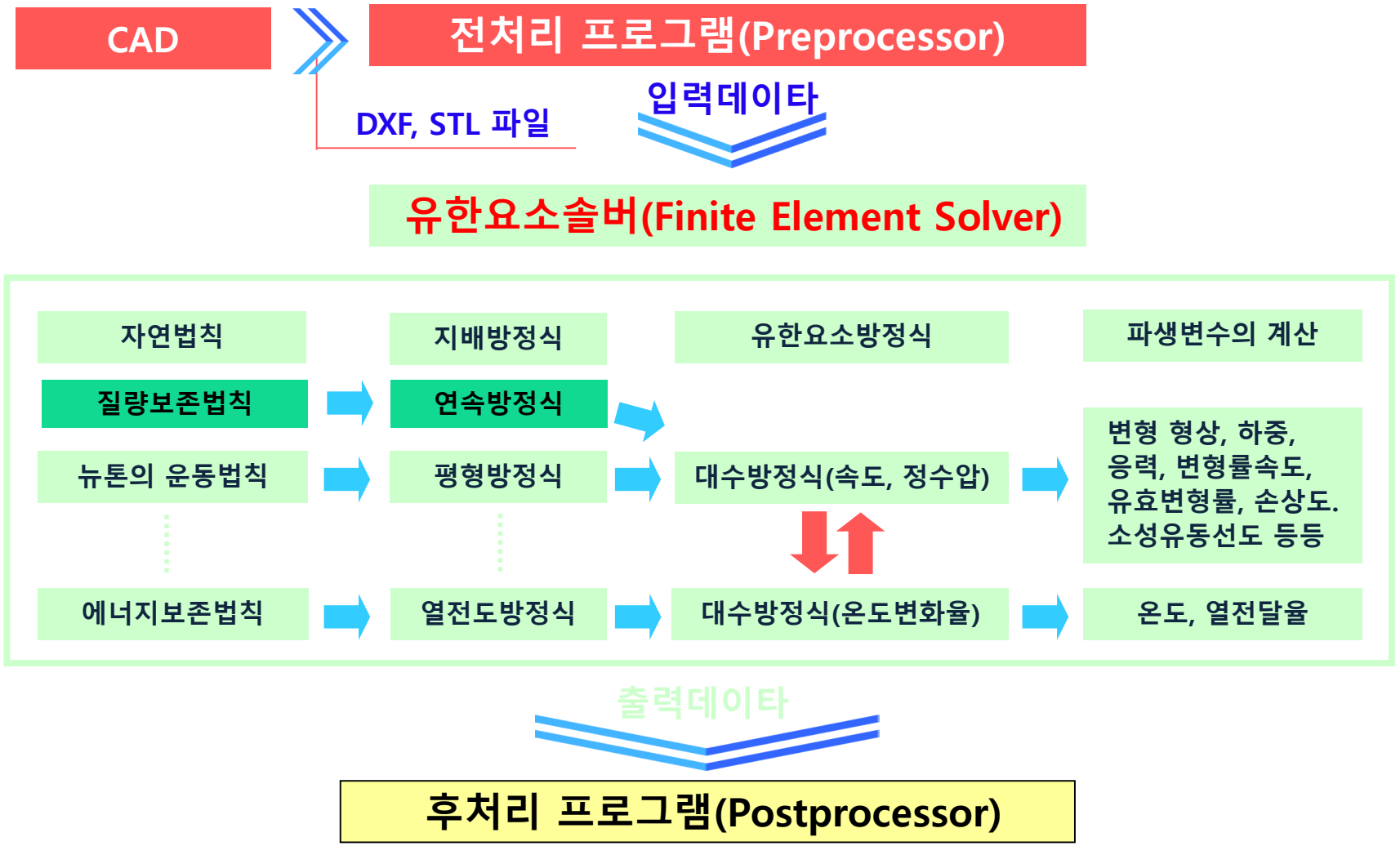
4.2 결과의 검증

4.3 개발 및 활용 효과

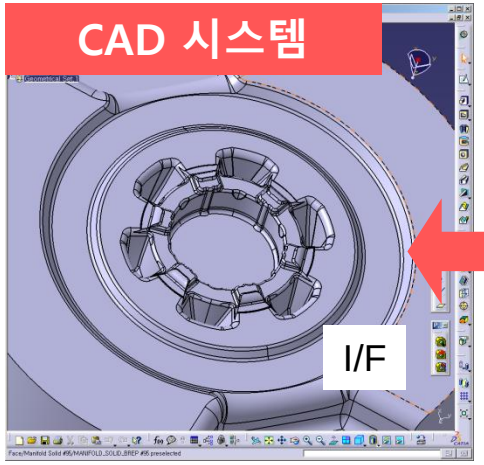
1.

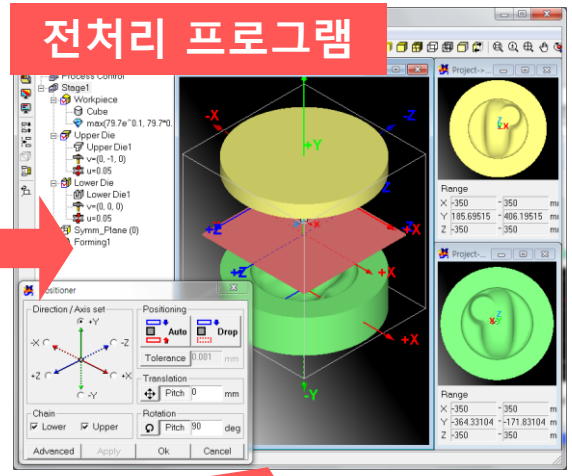
소성가공 시뮬레이션 개요

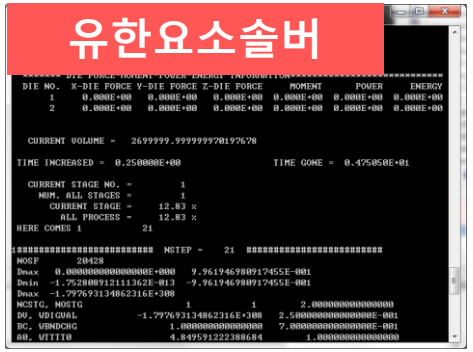
시뮬레이션의 흐름도

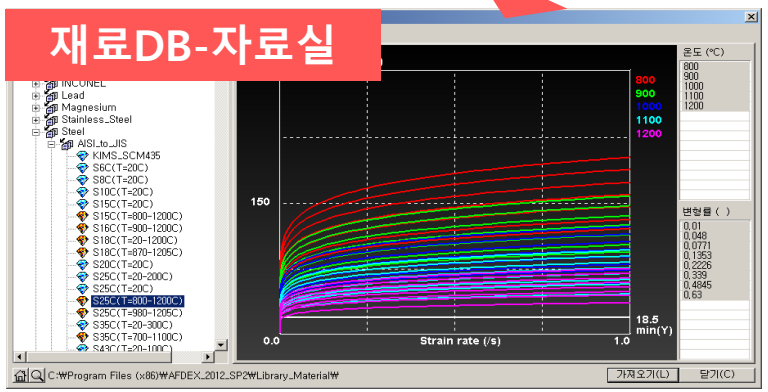

CAD
전처리 프로그램(Preprocessor)
DXF, STL 파일
입력데이타
유한요소솔버(Finite Element Solver)
자연법칙
지배방정식
유한요소방정식
파생변수의 계산
질량보존법칙
연속방정식
뉴톤의 운동법칙
평형방정식
대수방정식(속도, 정수압)
변형 형상, 하중,
응력, 변형률속도,
유효변형률, 손상도.
소성유동선도 등등
에너지보존법칙
열전도방정식
대수방정식(온도변화율)
온도, 열전달율
출력데이타
후처리 프로그램(Postprocessor)

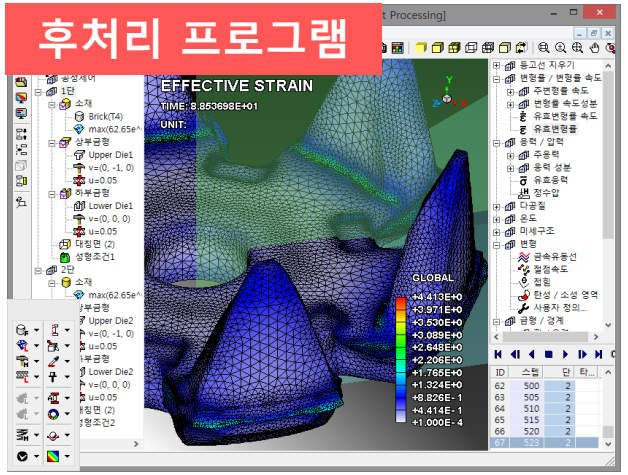
범용 단조 시뮬레이터의 구성



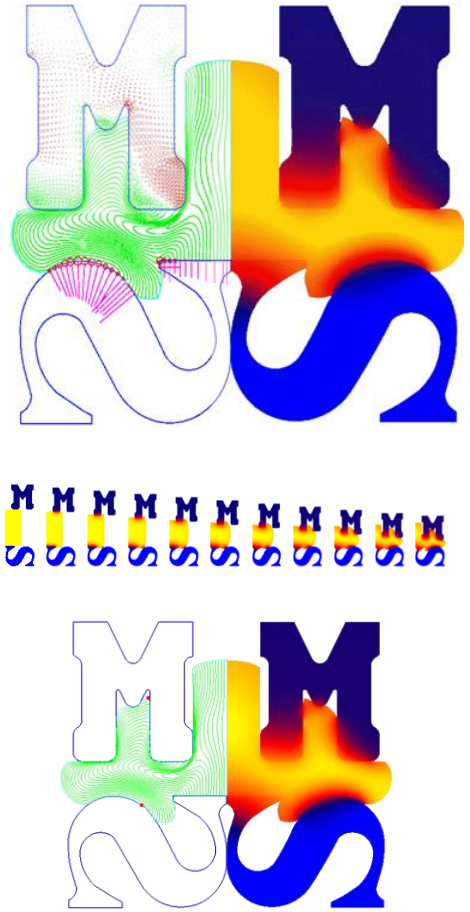


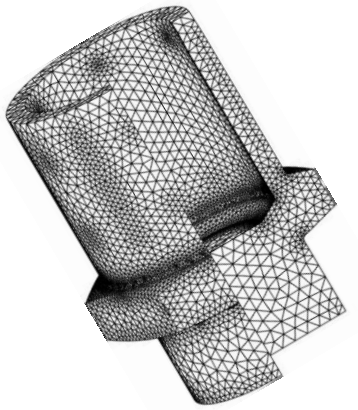


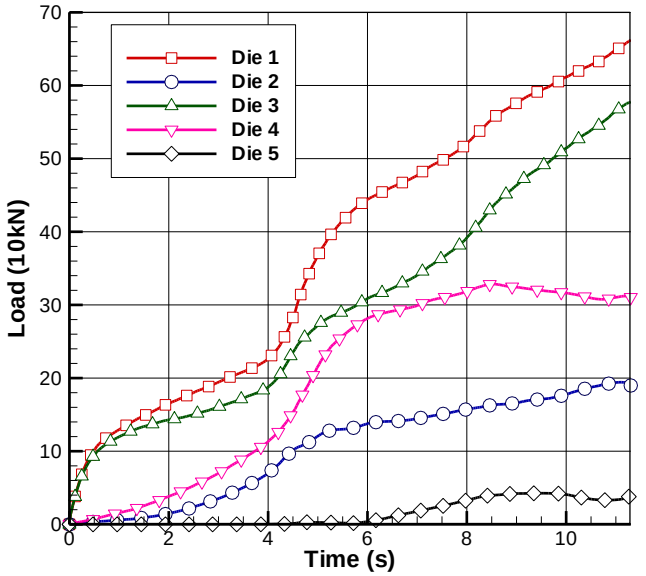




주요 결과





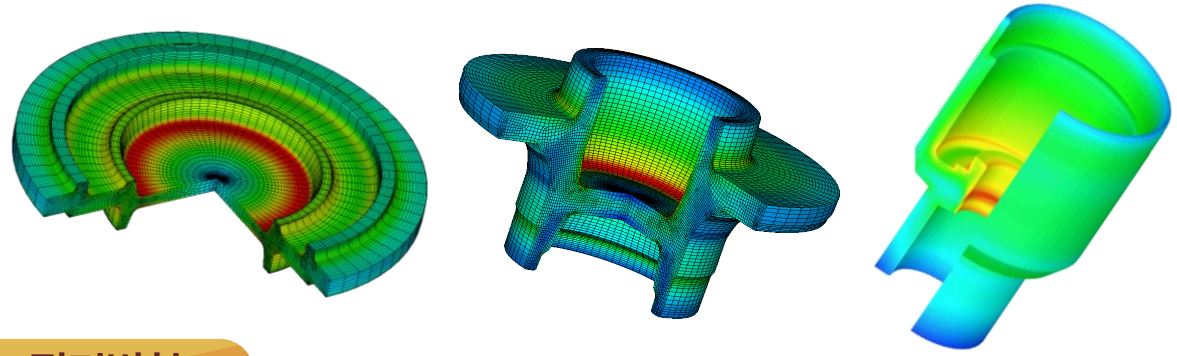


주요
해석 결과

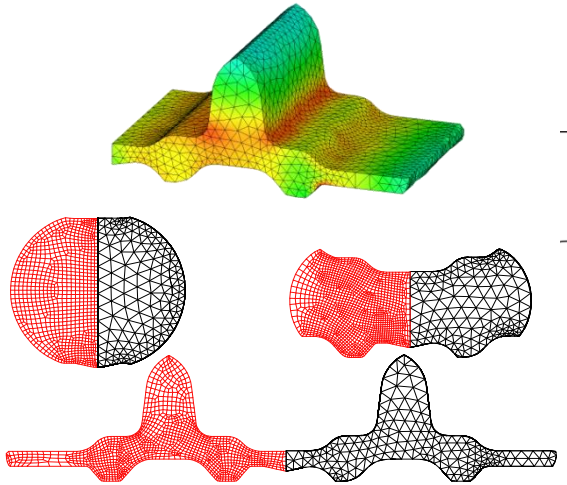
- 단류선
- 하중
- 온도
- 면압
- 소재/금형응력
- 변형률, 변형률속도
- 금속학적 특성
- 손상도/FLD

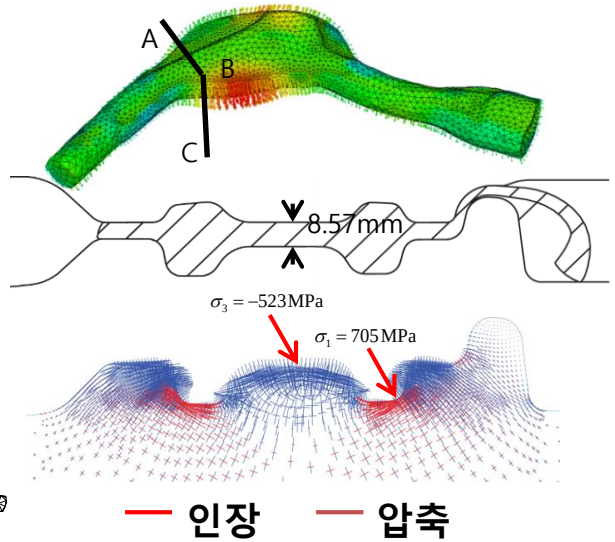
2차원 해석

축대칭

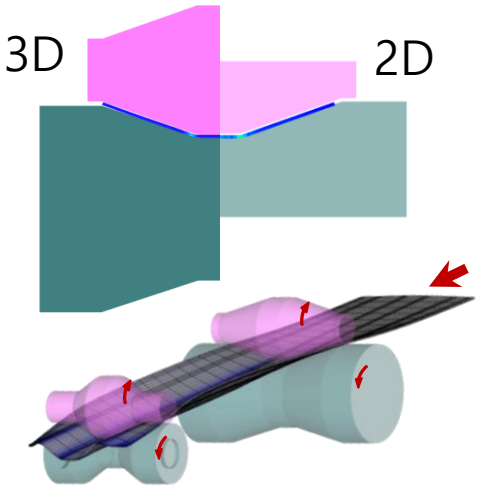


평면변형

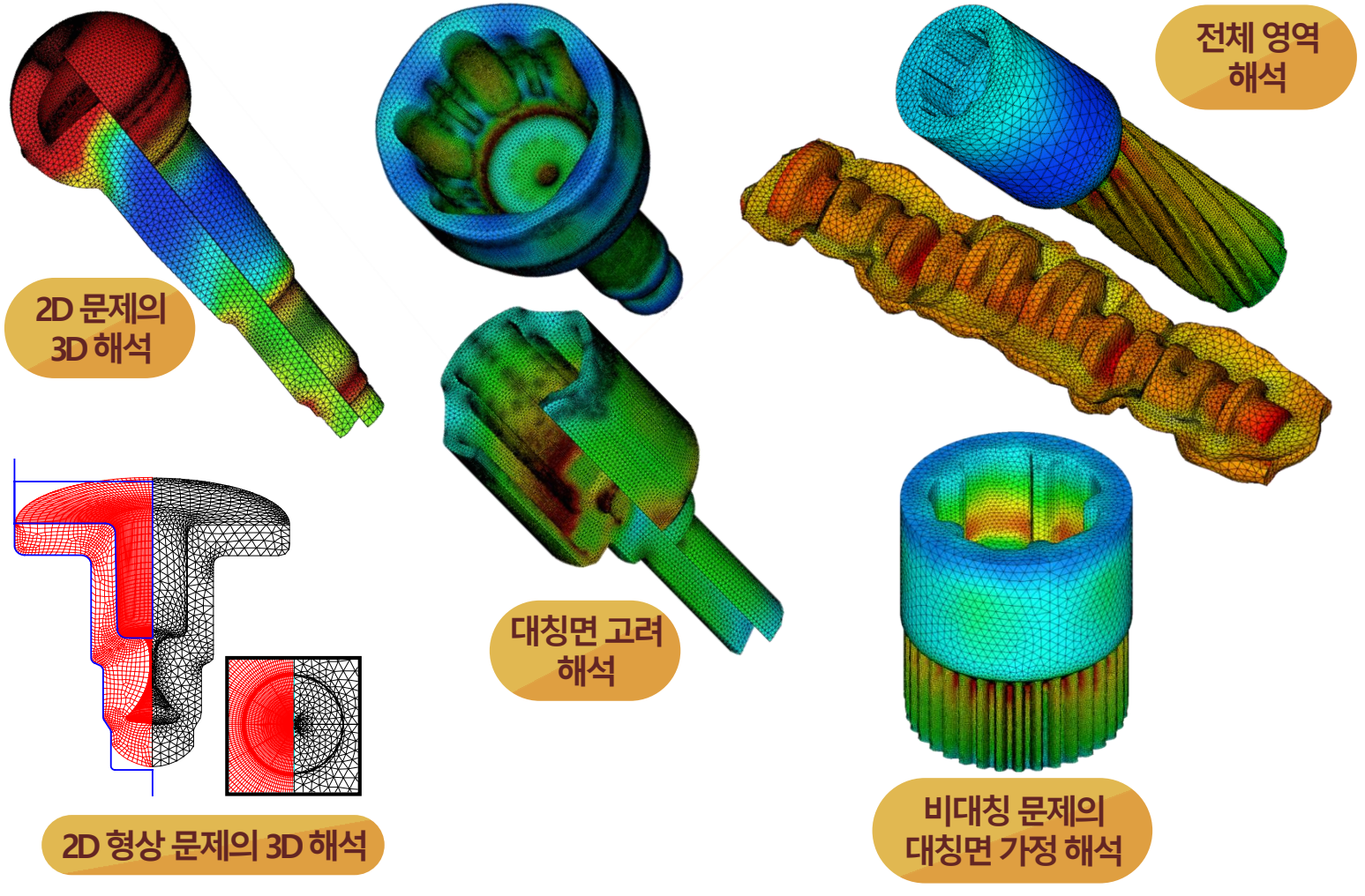




롤스탠드 #1

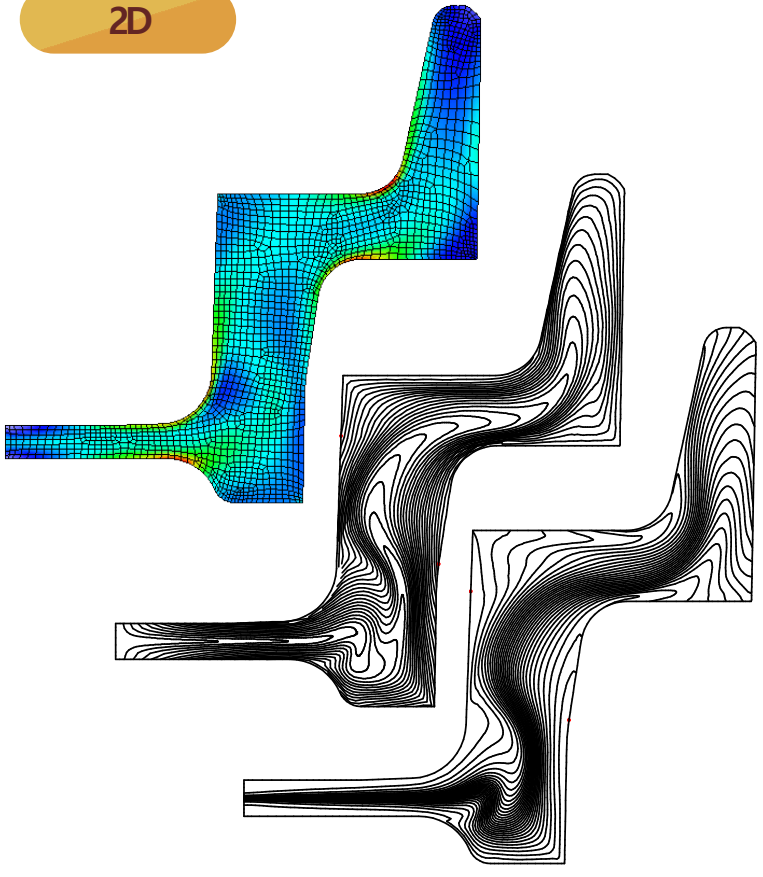


3차원 해석

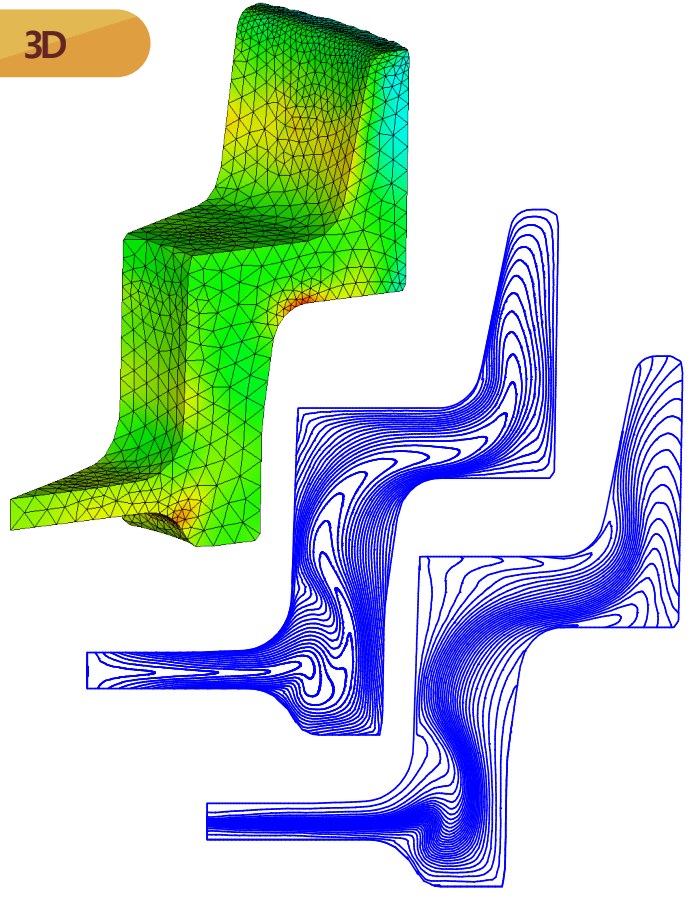


2D/3D의 결과 비교

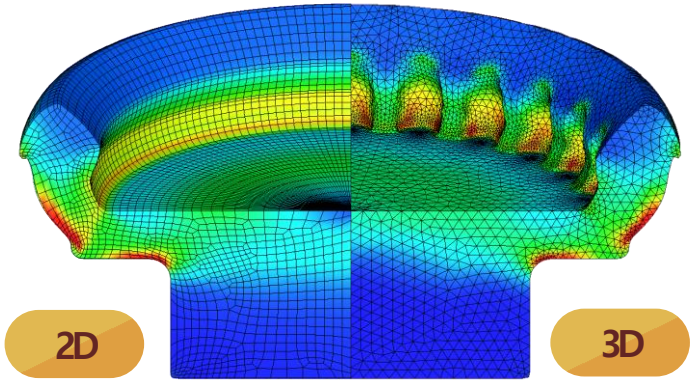
2D

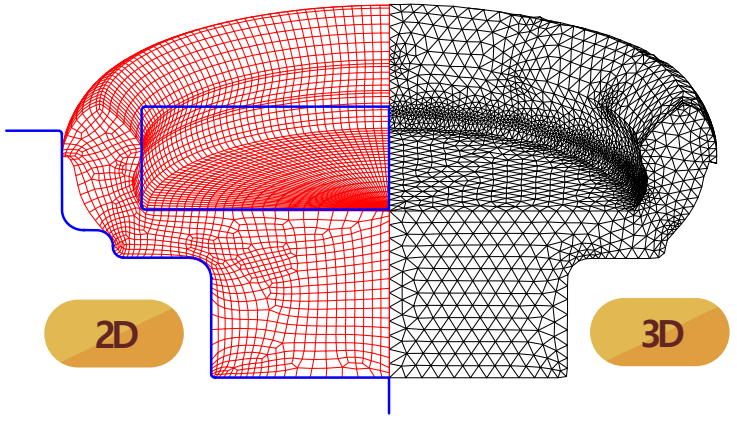


3D



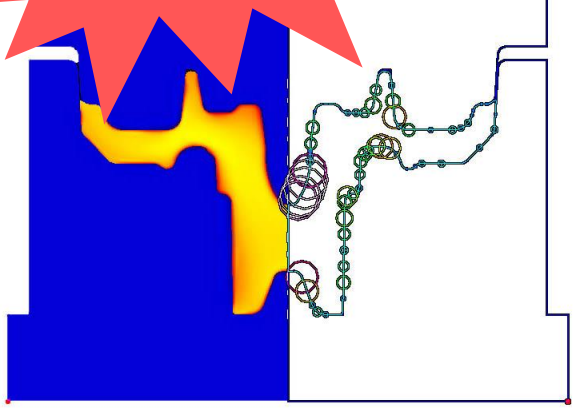
3차원 문제의 2차원 해석



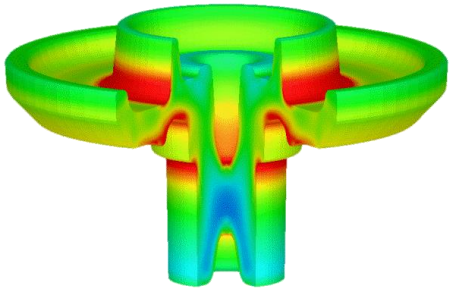


3차원 문제의 2차원 해석

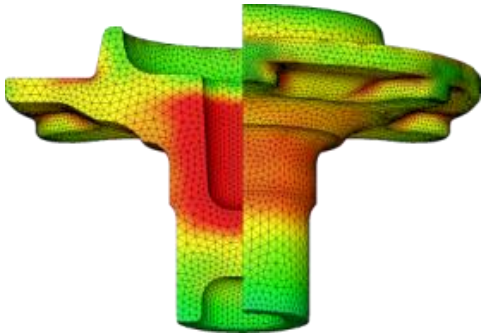
한번의
시험생산으로 성공!



2D



3D



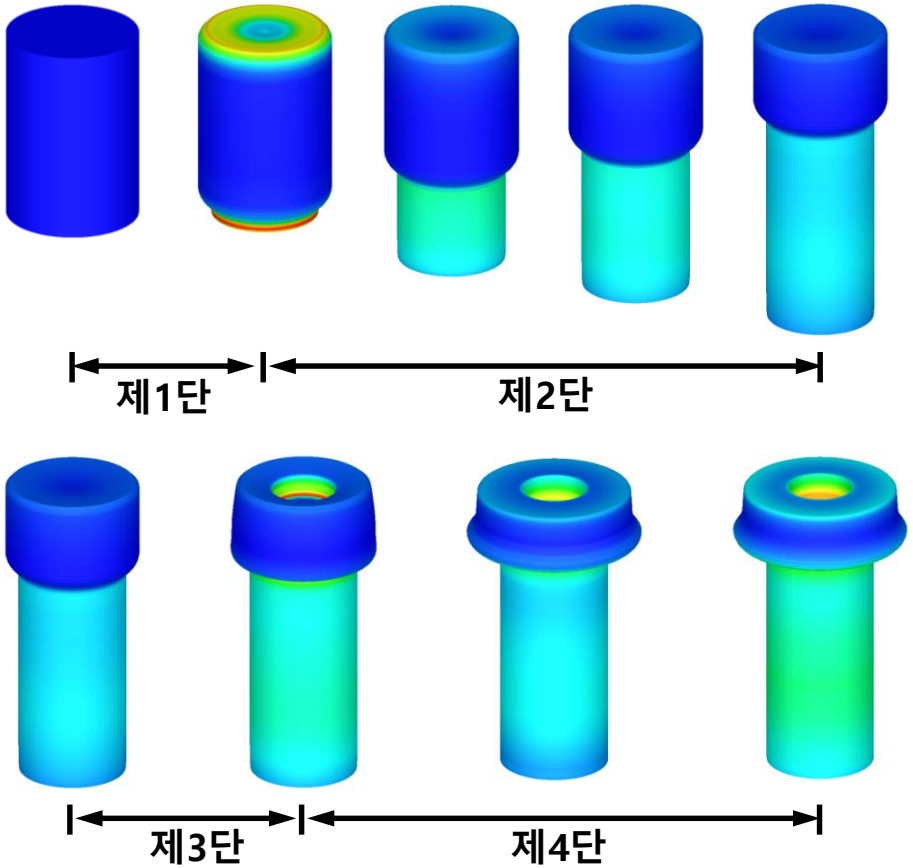
기존공정

일반형단조

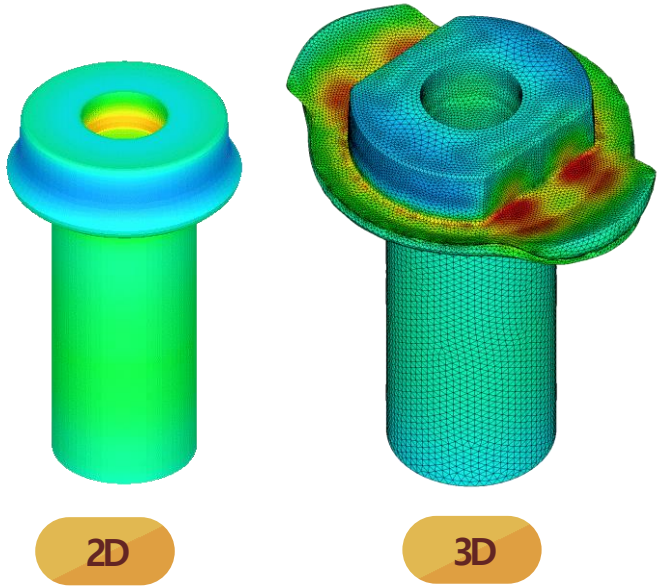
신공정

밀폐단조

2D/3D 연결해석 (2D/3D combined simulation)



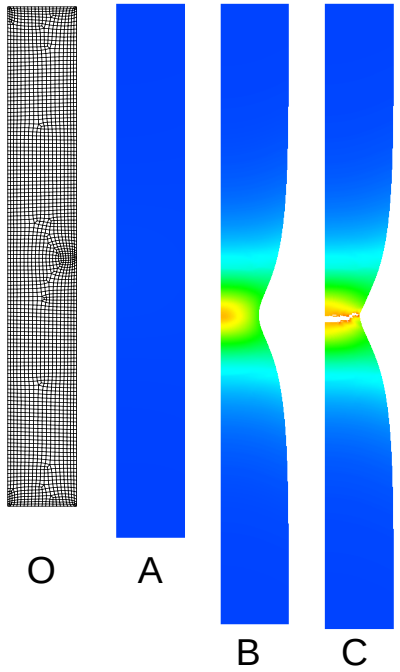
- 1-4단: 축대칭
- 5단: 3D

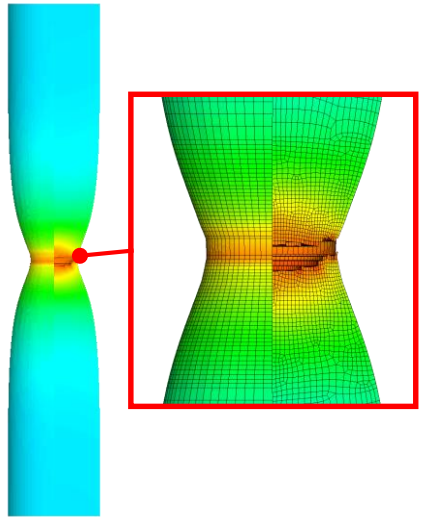


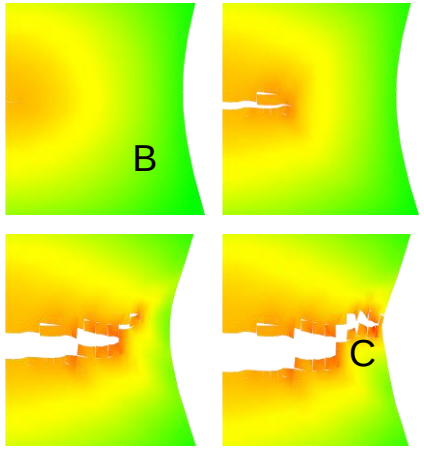
출처: Int. J. Adv. Manuf. Tech., 2008, 성진포머

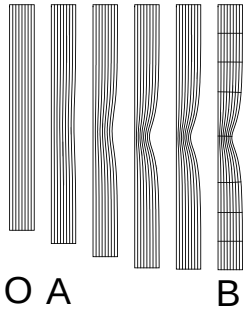
2.
결과의 검증

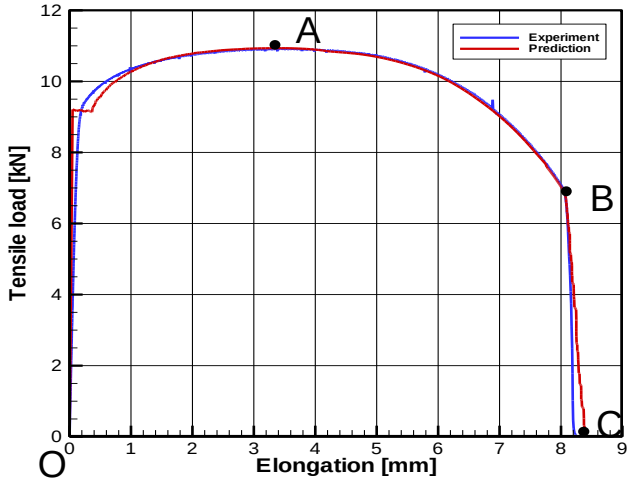
인장시험의 시뮬레이션 및 응용



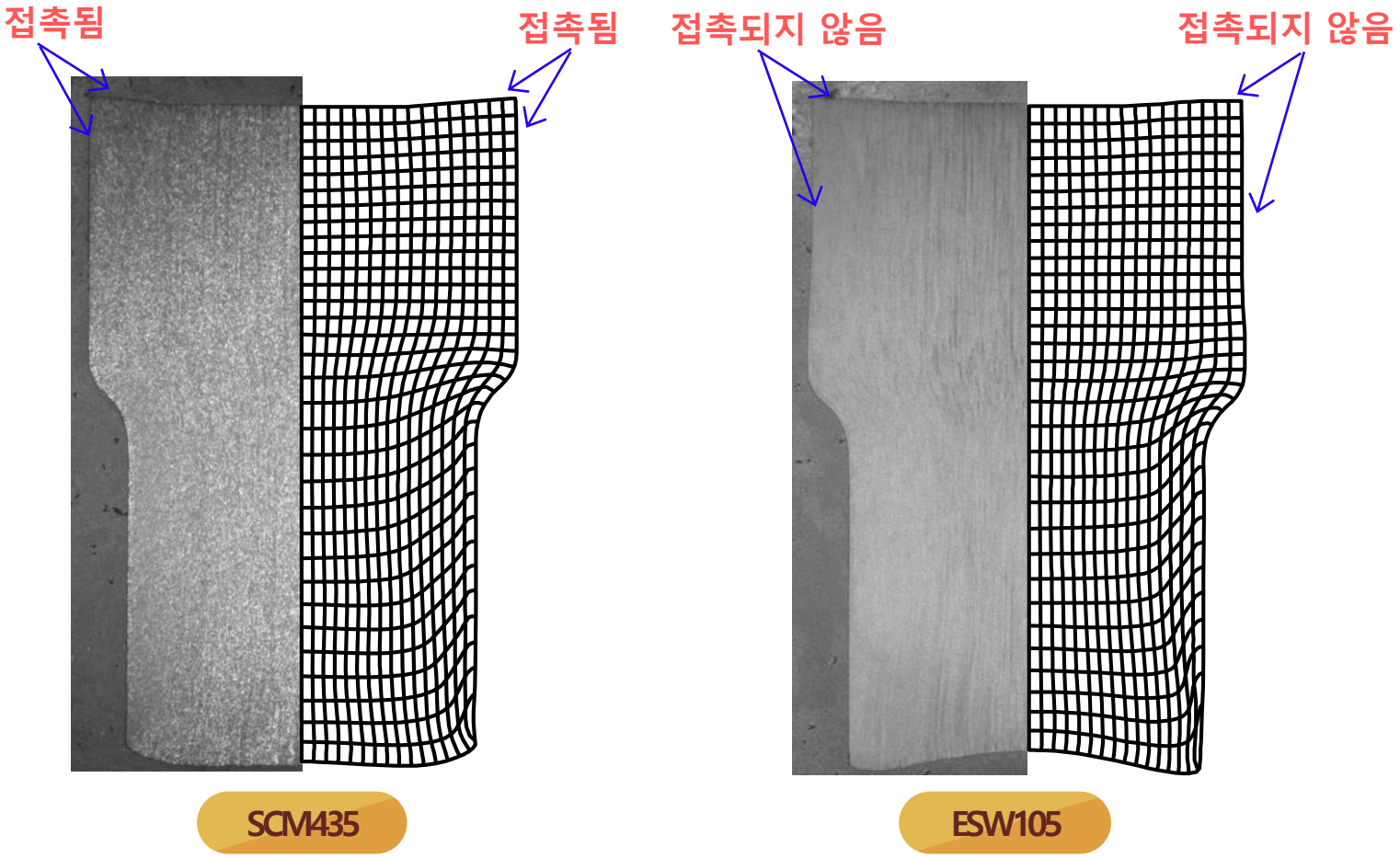






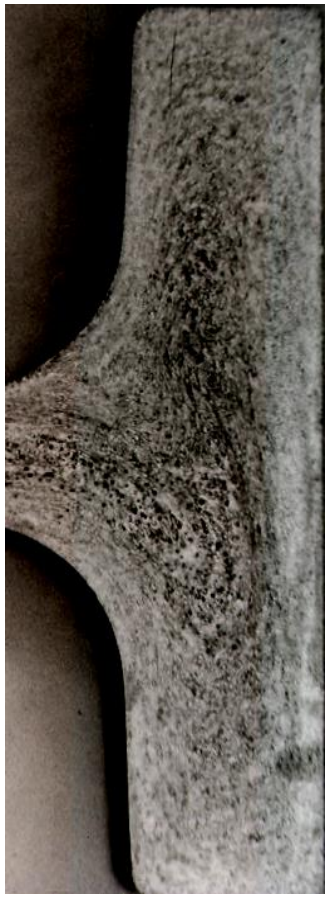


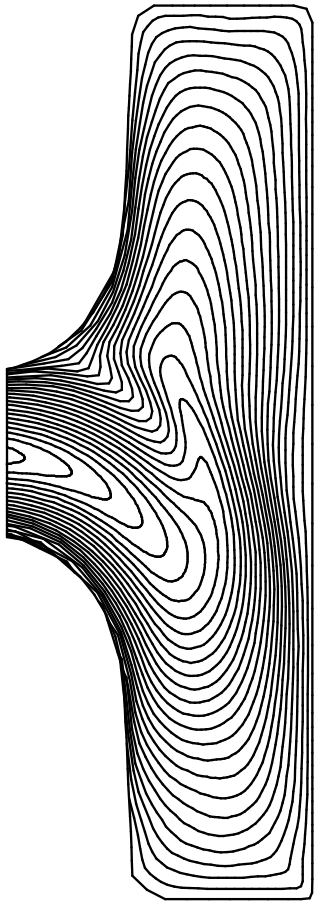
전방압출 시뮬레이션

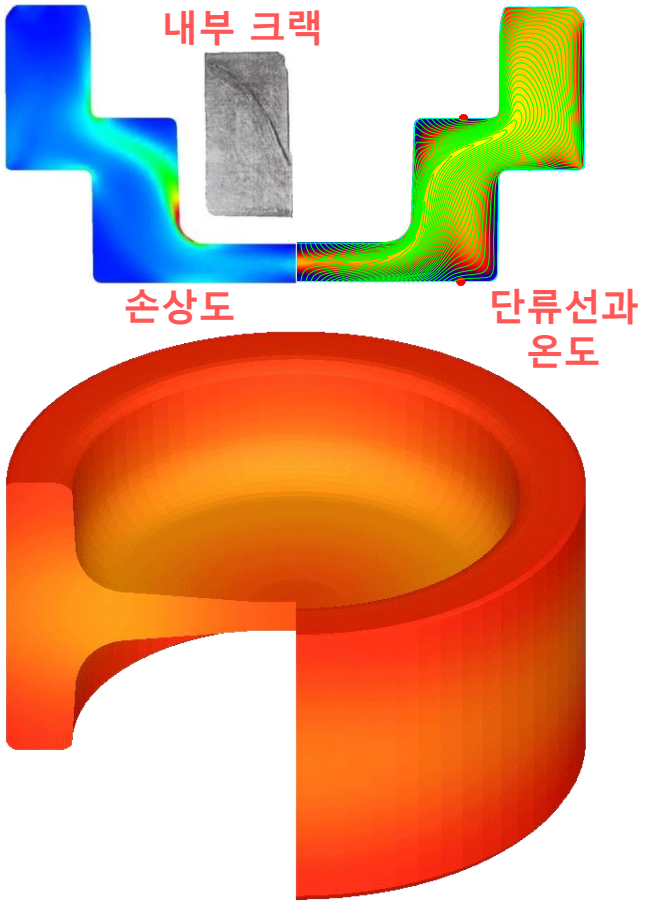


출처: 삼화스틸

자동다단열간단조 시뮬레이션

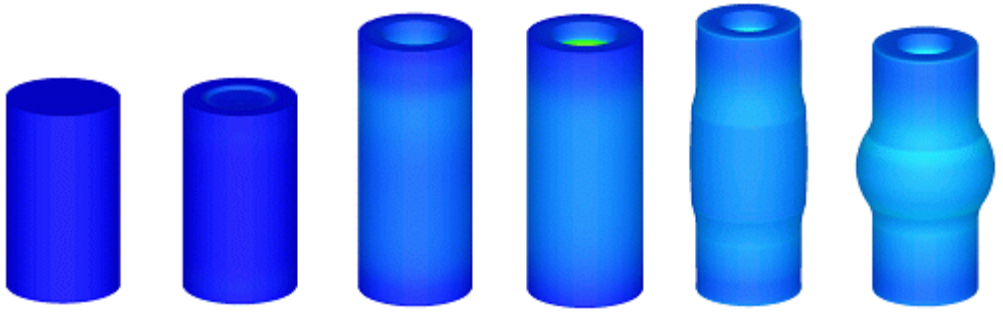


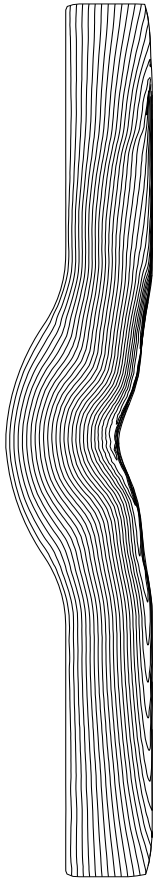




출처: Trans. ASME J. Eng. Mat. Tech. 1998 / Int. J. Mach Tools Manuf. 2000 / Trans. ASME J. Eng. Mat. Tech. 2007. 셰플러코리아

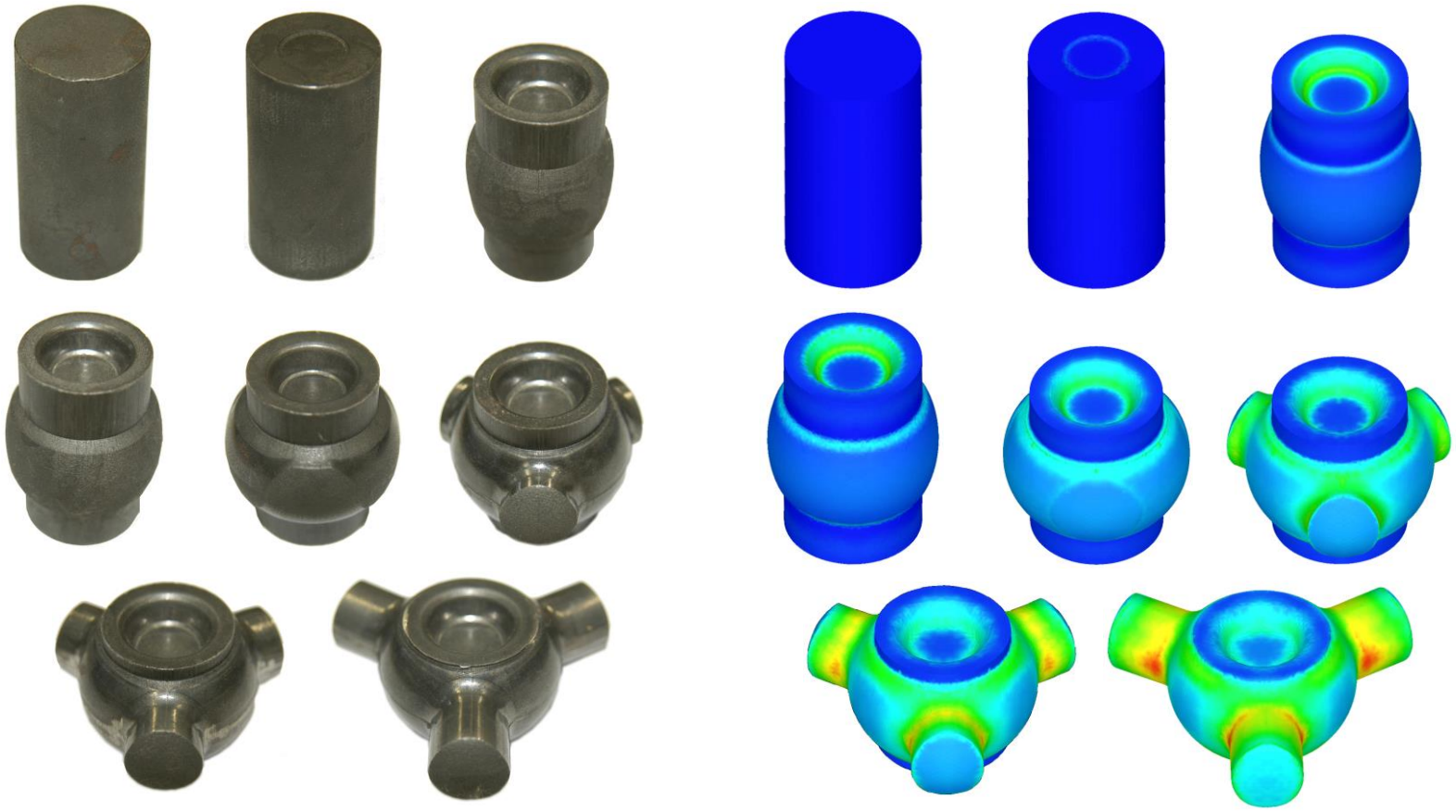
자동다단냉간단조 시뮬레이션





출처: KSME Spring 2006, 성진포머

냉간폐쇄단조 시뮬레이션



출처: 경상대 TIC

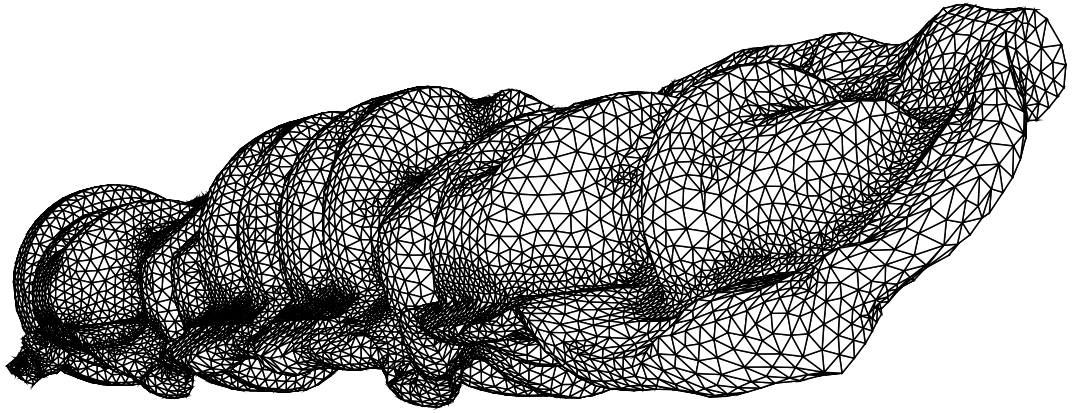
냉간폐쇄단조 후 사이징 공정 시뮬레이션

폐쇄단조

사이징

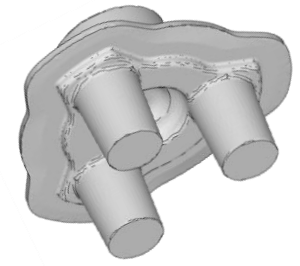
출처: KSPE Fall 2007, 진ENG, 경상대 TIC

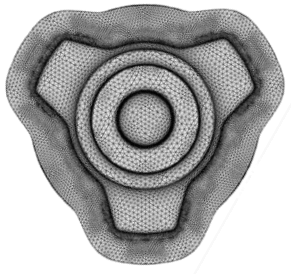
해머 단조 시뮬레이션

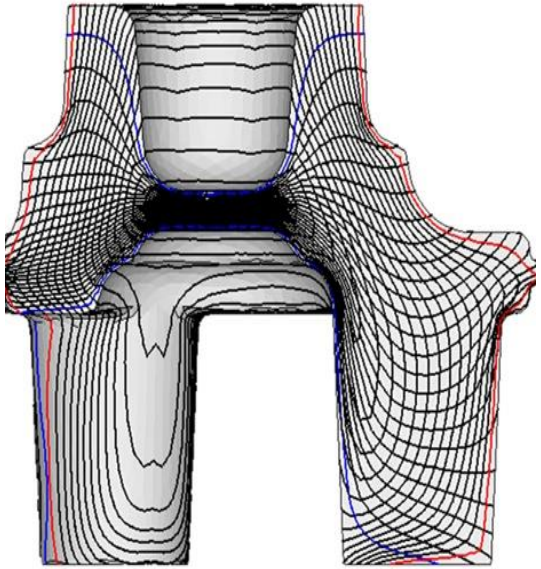


출처: DFC

열간형단조 시뮬레이션

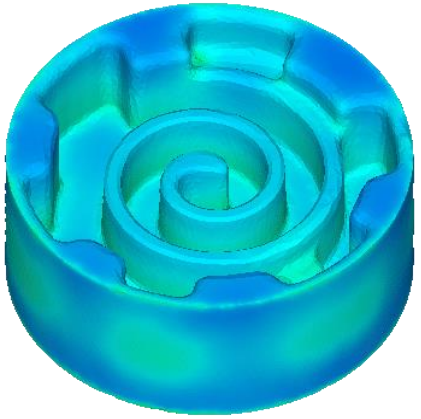


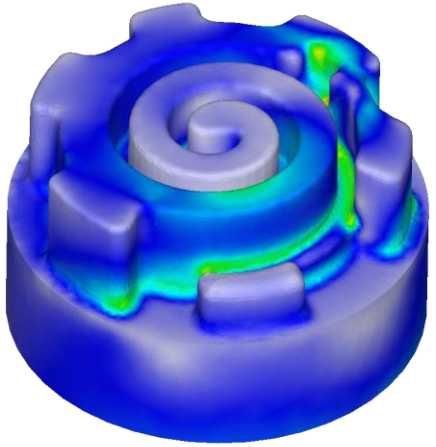


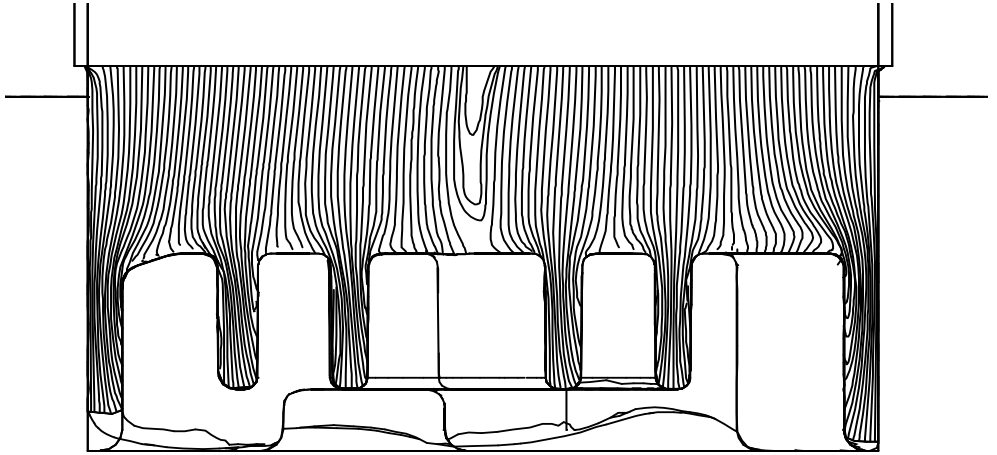


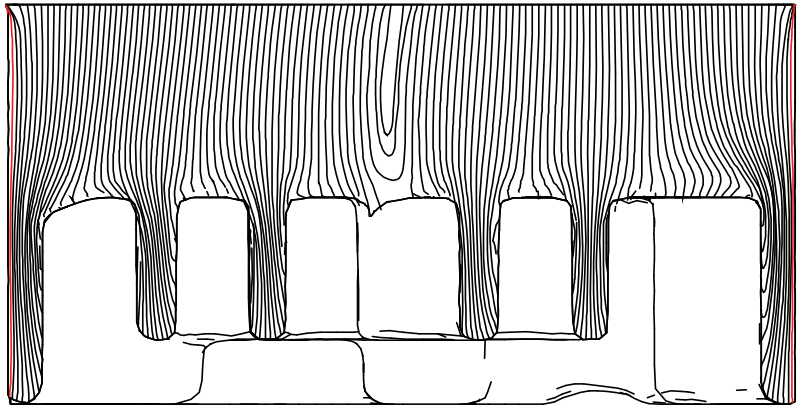
출처: MFCAE 2015(KITECH)

알루미늄 열간밀폐단조 시뮬레이션



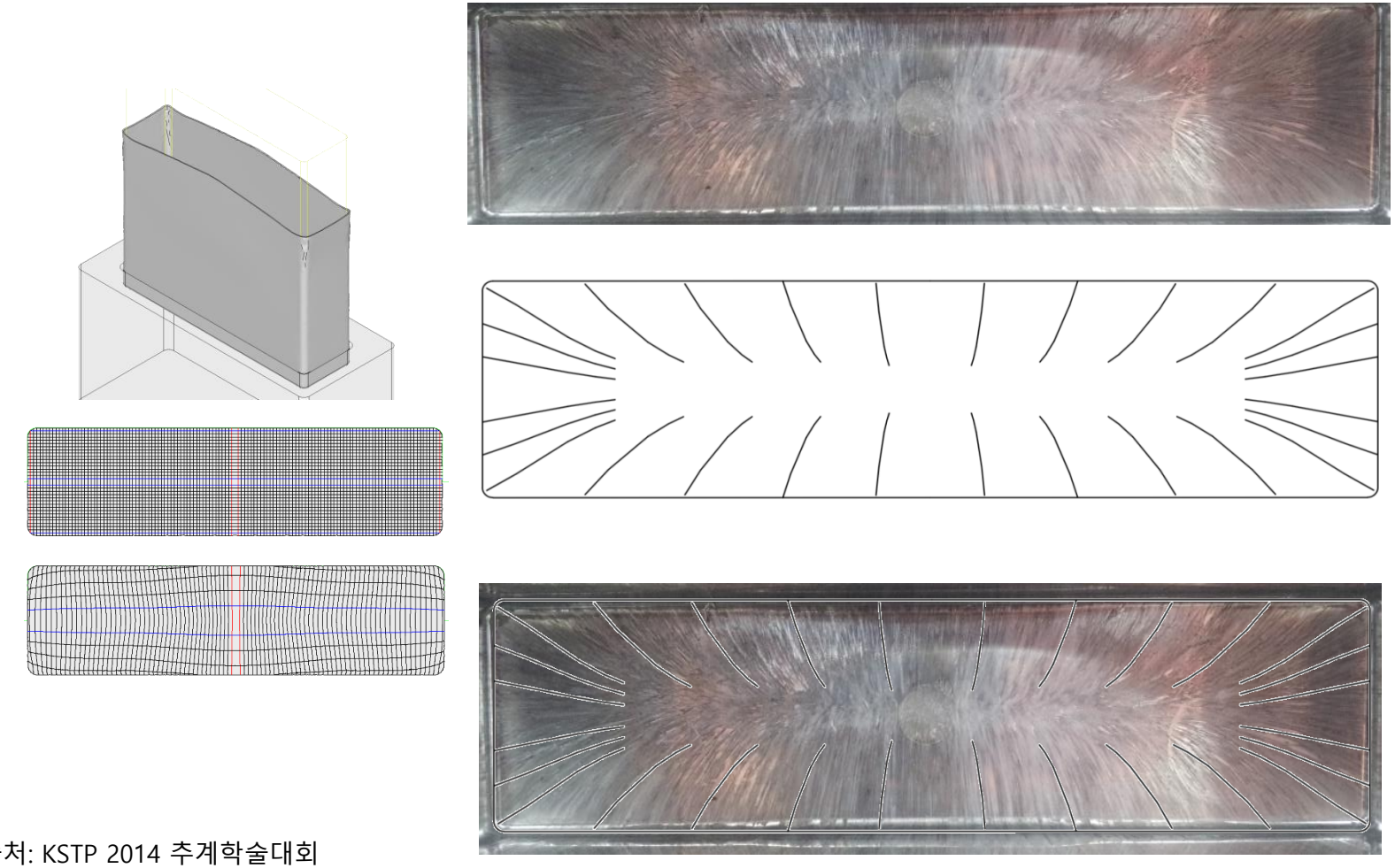






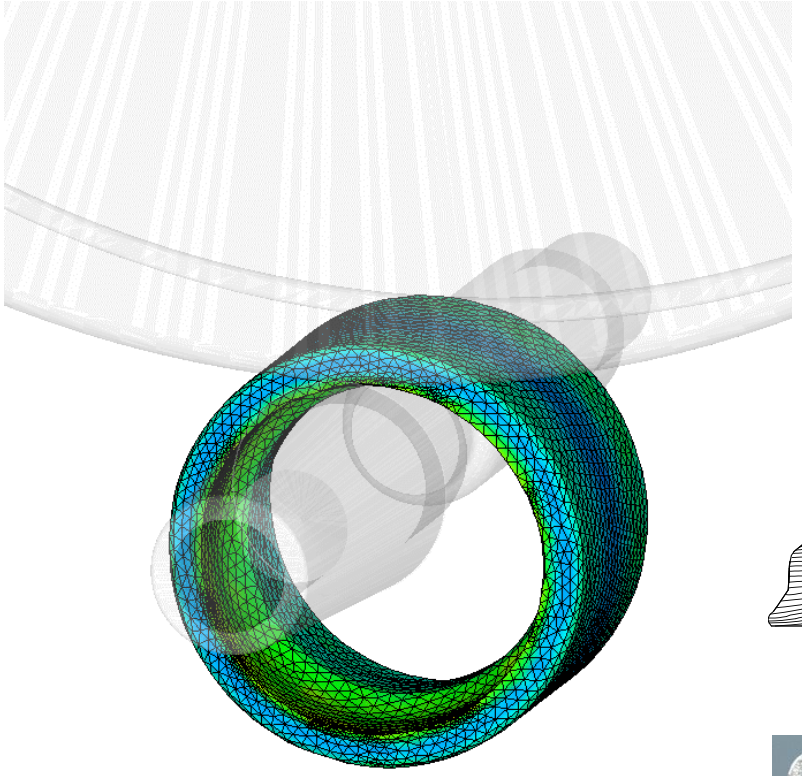
출처: KSTP 2014 추계학술대회, 세방금속기술

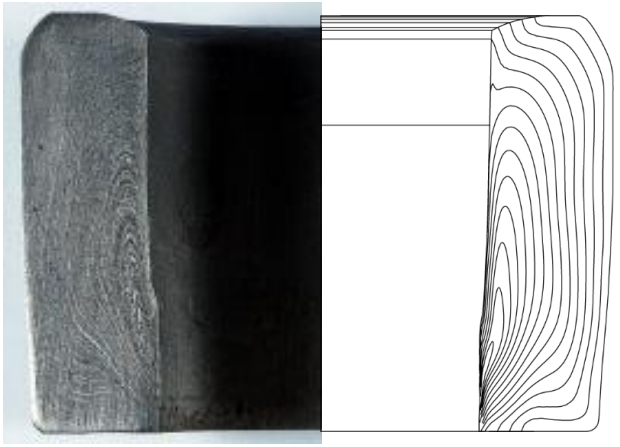
냉간충격압출 시뮬레이션

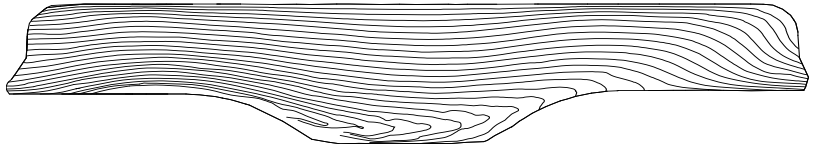


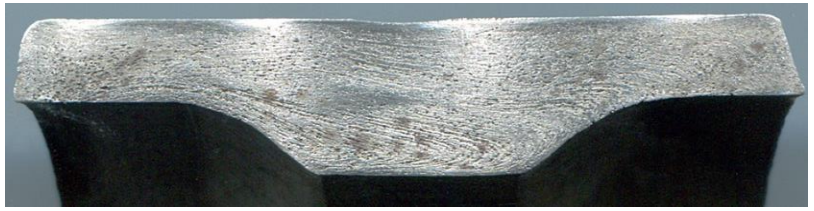
출처: KSTP 2014 추계학술대회

열간밀폐단조 후 온간링롤링 시뮬레이션



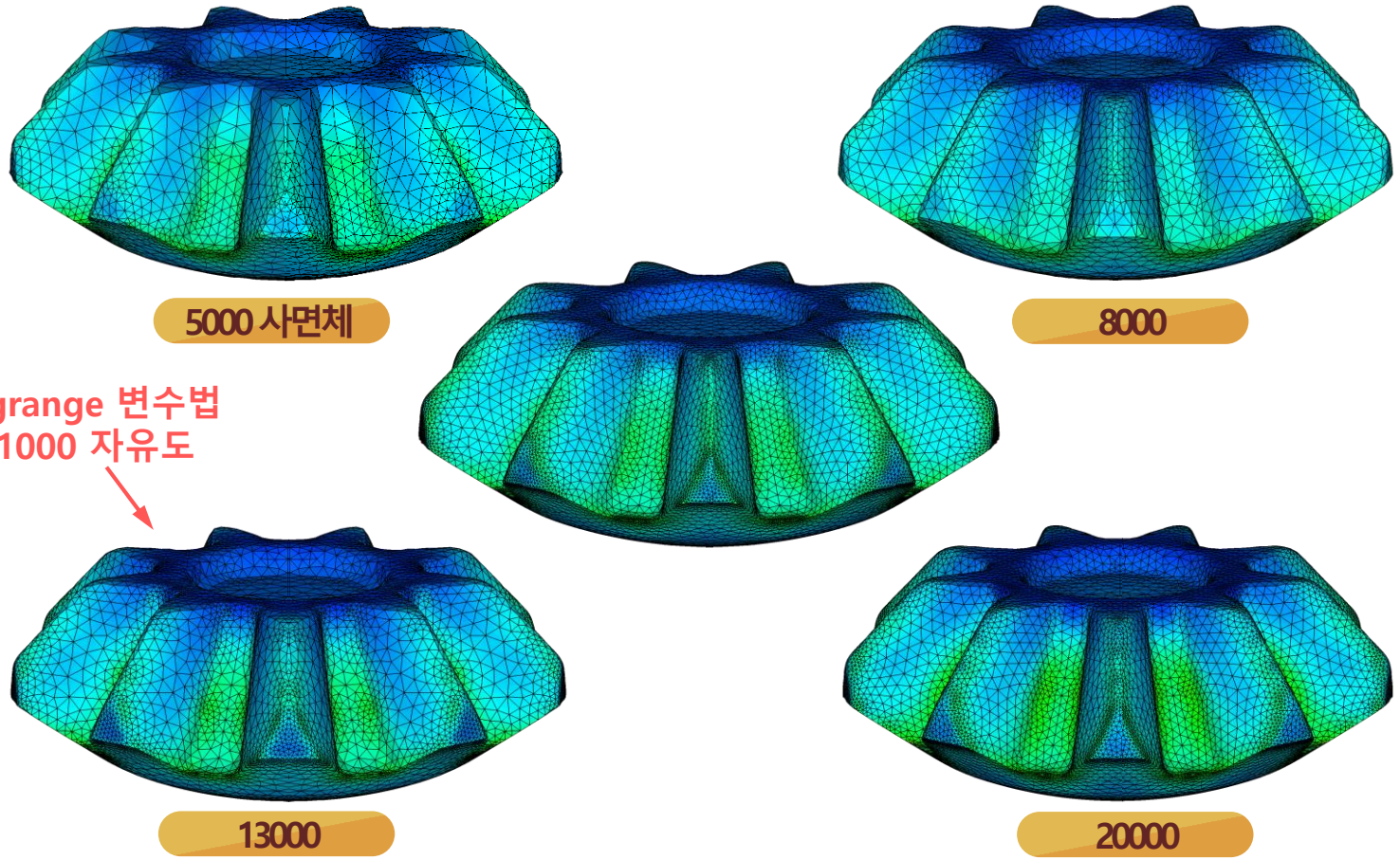






출처: 대명공업, KSME 2014 추계학술대회

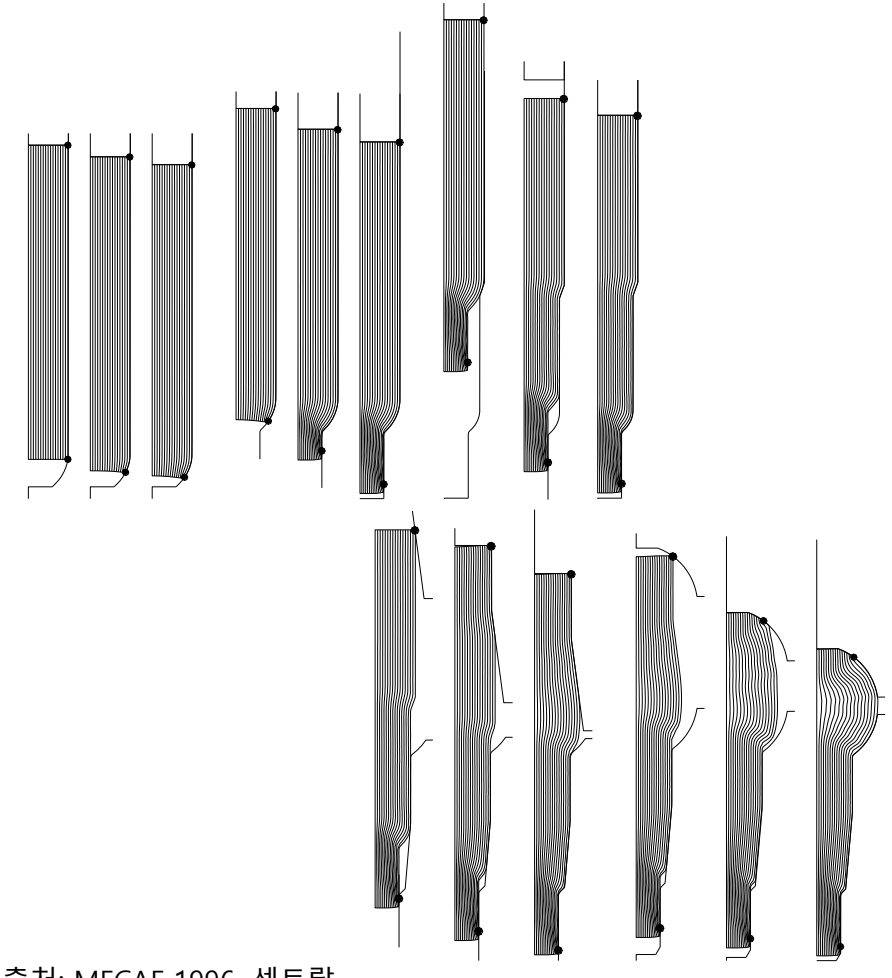
요소 수에 좌우되지 않는 안정적인 해석 결과



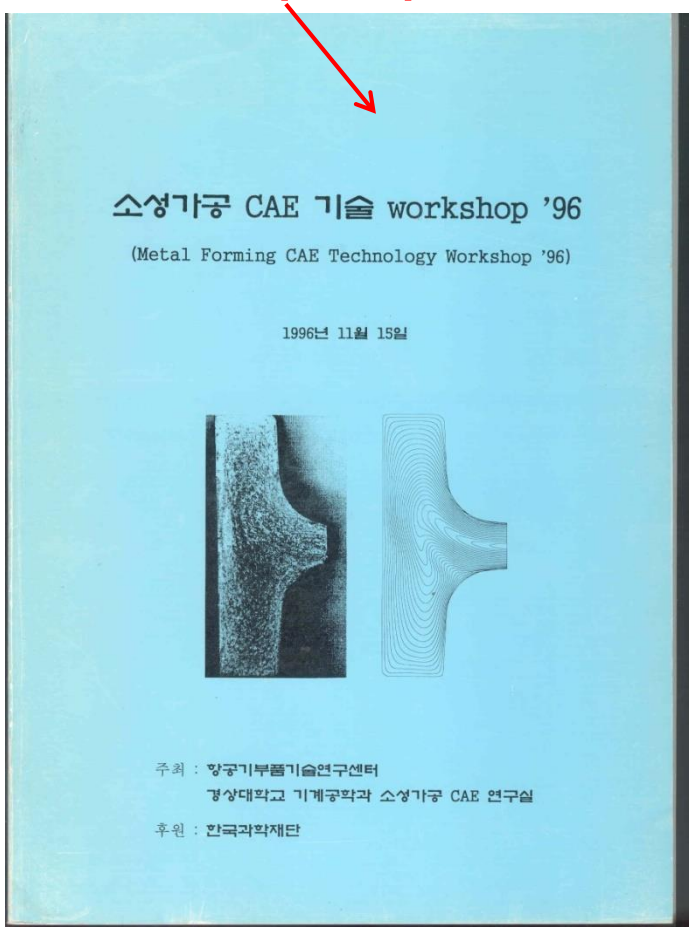
출처: BRIMET

3.
개발 및 활용 효과

1996년도의 해석 결과 - 냉간포머단조 국산화에 기여



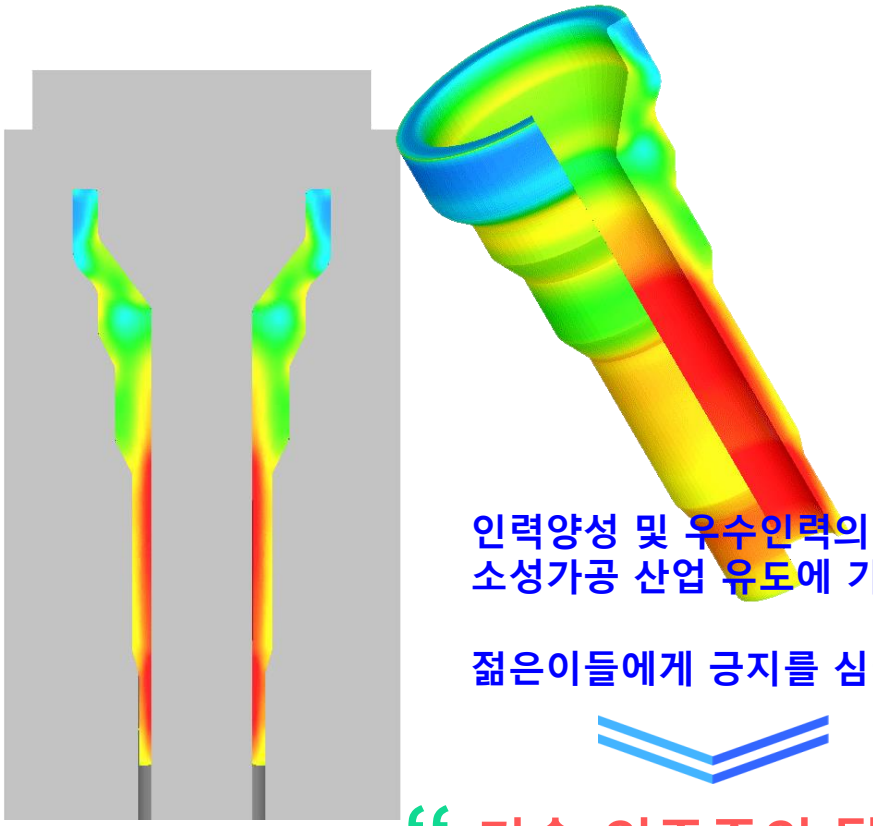
MFCAE의 효시



출처: MFCAE 1996, 센트랄

청년에게 우리도 할 수 있다는 자신감을 무의식 중에 심어줌

대형선박용 엔진은 모두 라이선스 생산!
고급 공작기계 가격의 40% 차지 컨트롤러가 외산!



AFDEX 해석결과

AutoCAD
CATIA
Pro/ENGINEER
UNIGRAPHICS

ABAQUS
ANSYS
HyperMESH
LS-DYNA
AUTOFORM

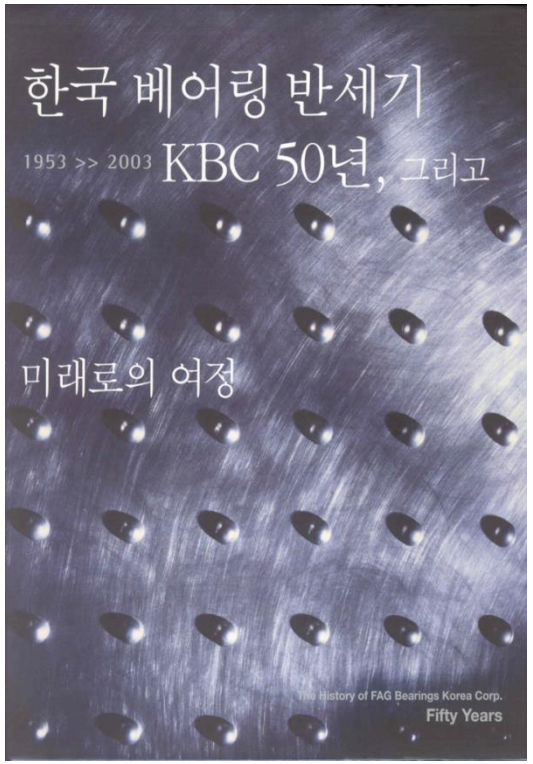
AFDEX (한국)
DEFORM (미국)
FORGE (프랑스)
Q-FORM (러시아)
SIMUFACT (독일)

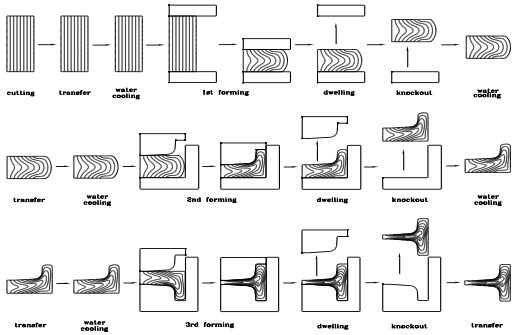
인력양성 및 우수인력의
소성가공 산업 유도에 기여

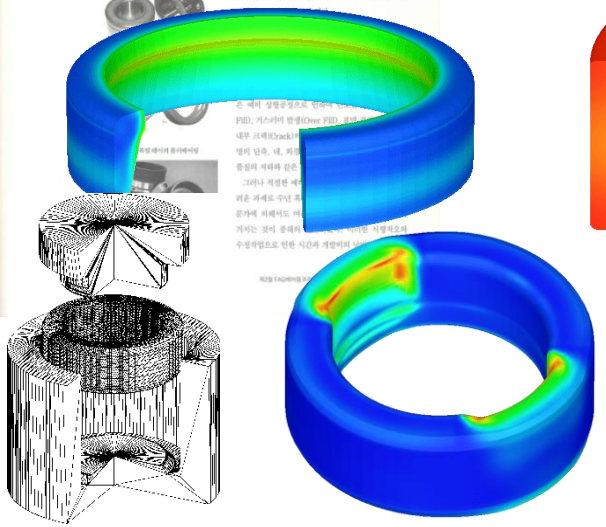
젊은이들에게 긍지를 심어 줌

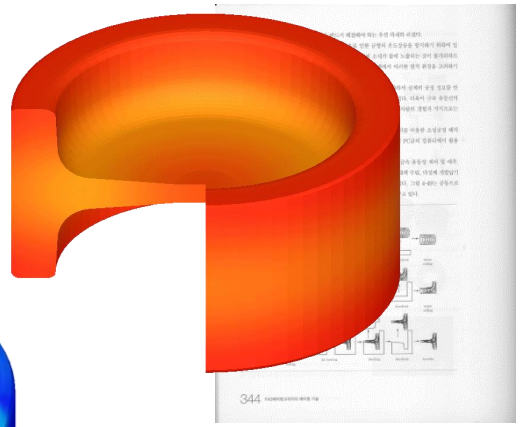
“ 기술 의존주의 탈피 ”

베어링 제조산업에 기여





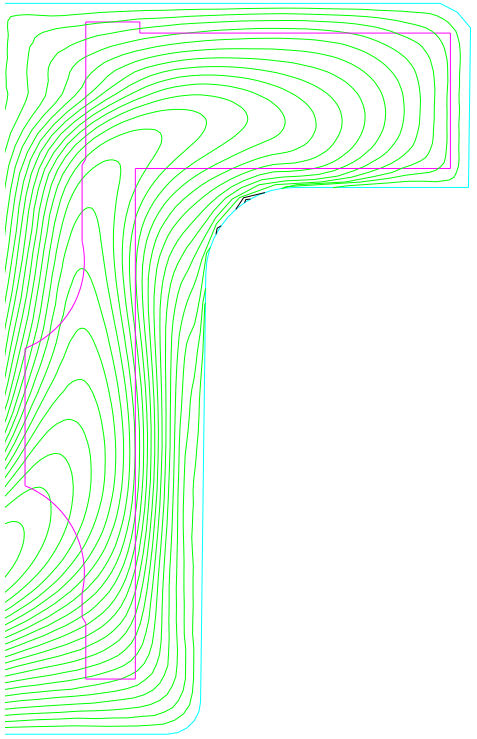




(4단원, 62 페이지 中
2페이지에 걸쳐 수록됨)

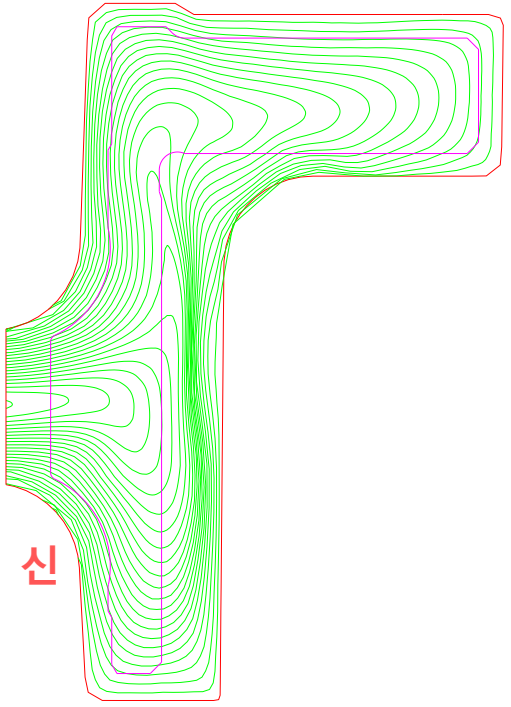
단류선 고려 최적 제품 및 단조공정 설계

기존 제품



1.1 kg

신제품

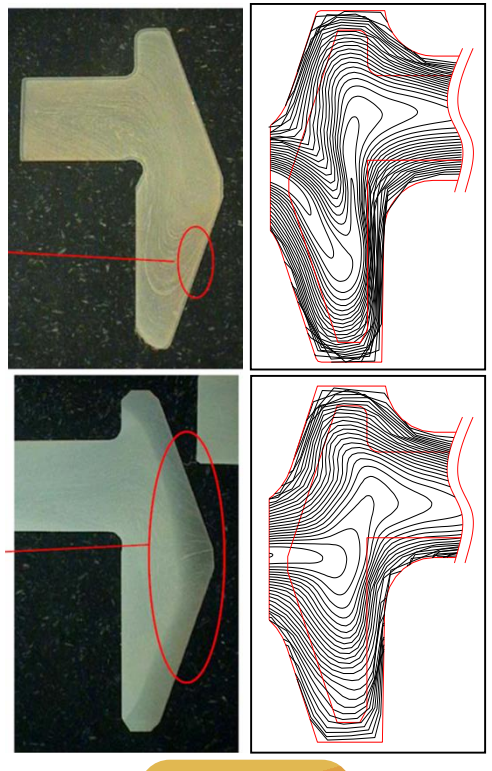


0.82 kg

베어링 부품 개발 적용 사례

“플랜지붙이 단조품 편석대 개선”

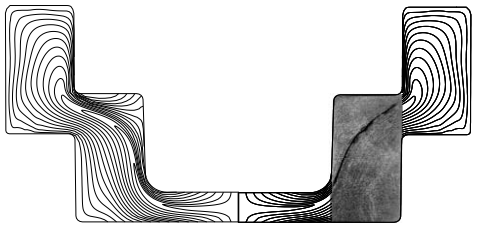
개선 전

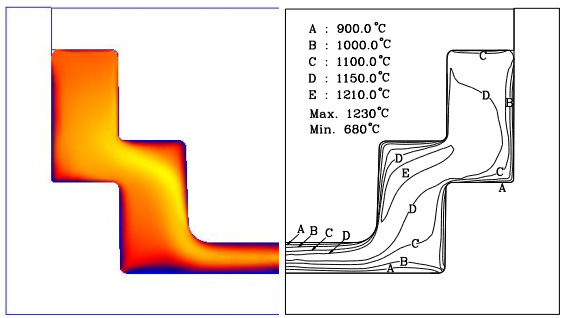


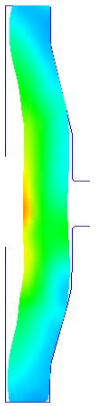
개선 후

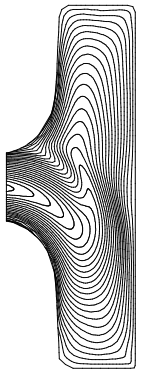
출처: MFCAE1998, Schaeffler Korea

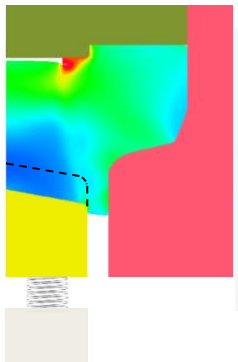
고질적 문제 · 분쟁의 해결 및 방지

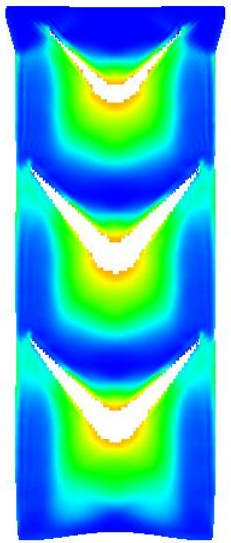






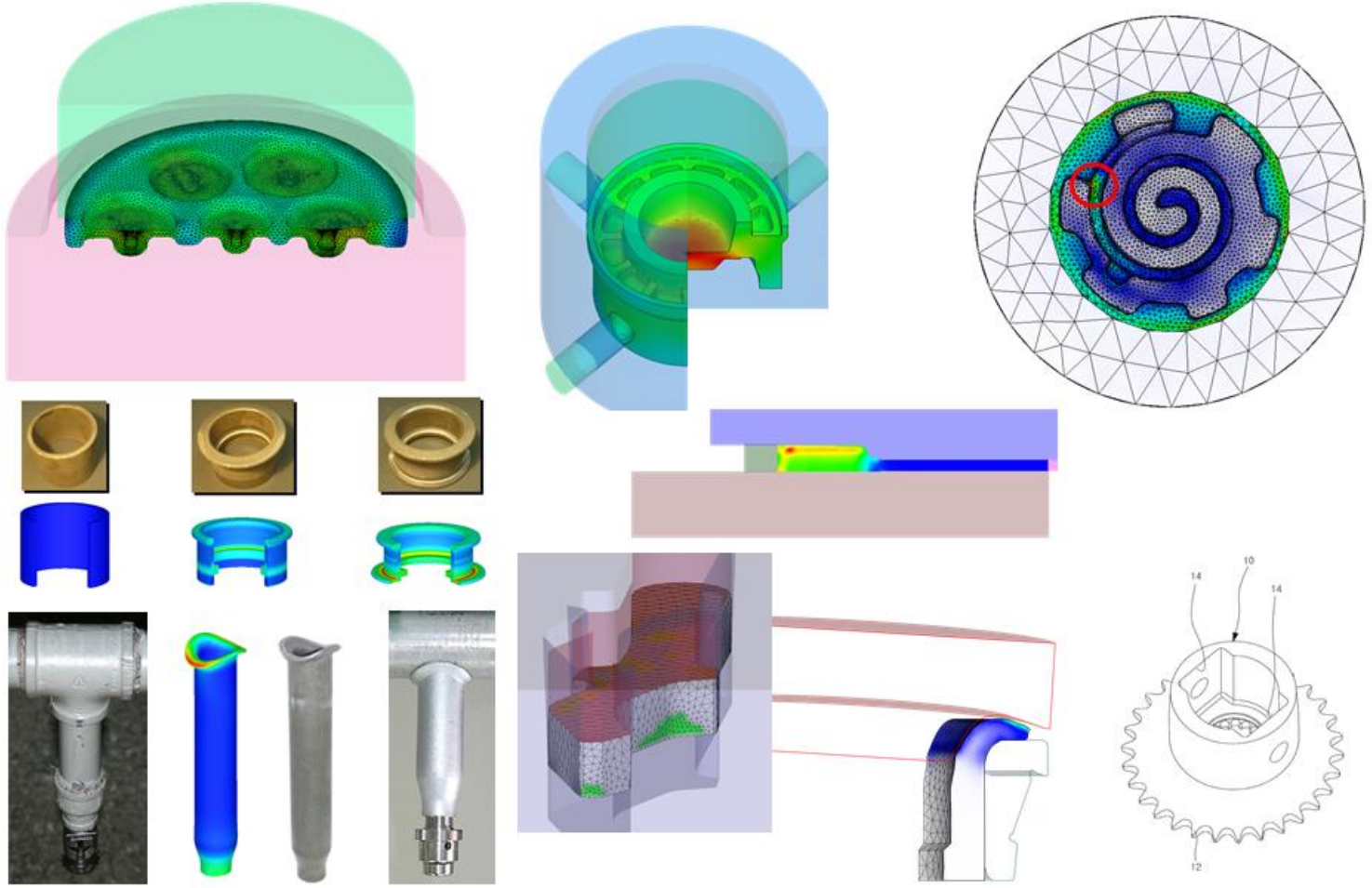






출처: 삼양금속, 조은공업, 진산금속, 서흥금속, 셰플러코리아

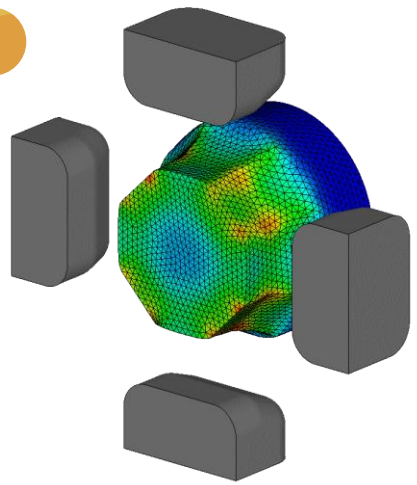
친특허성

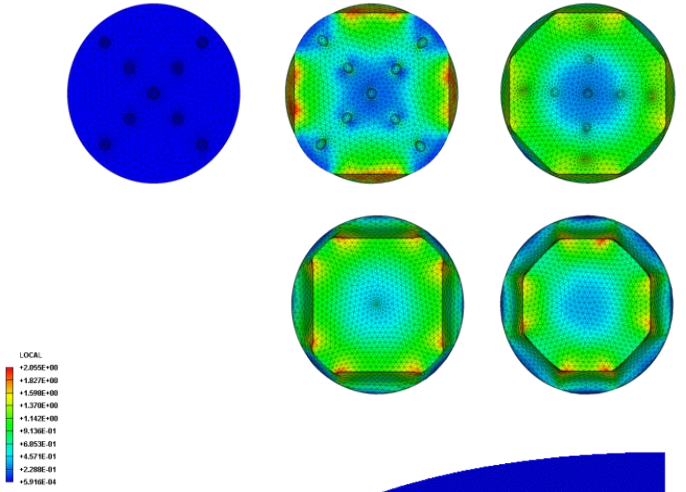


출처: 하이원, 온일, 세방금속기술, 삼광모터스, 경상대 TIC, 우성정공

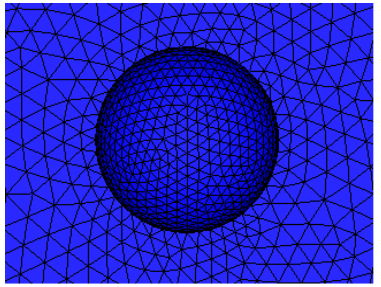
실공정 테스트의 어려움 해결

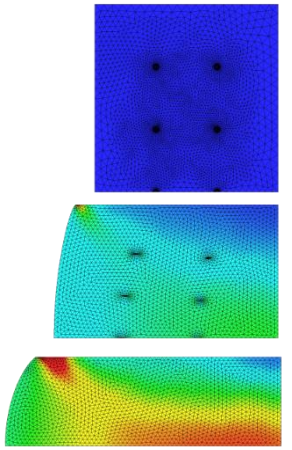
반경단조

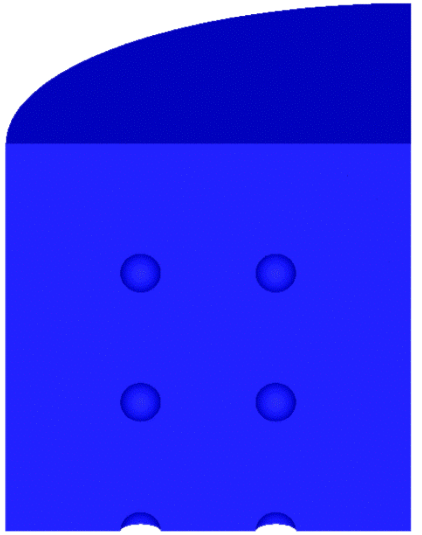




실린더 압축, 업세팅





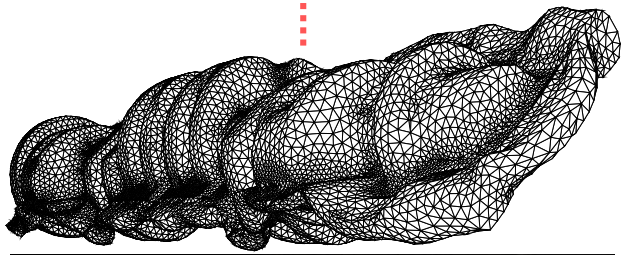


출처: AEPA 2008 / KSPT 2010

개발비용 절감

금형비 절감 연간
US $ 63,000

소재 중량 약 1톤
공정실패 시
시간/비용 매우 큼

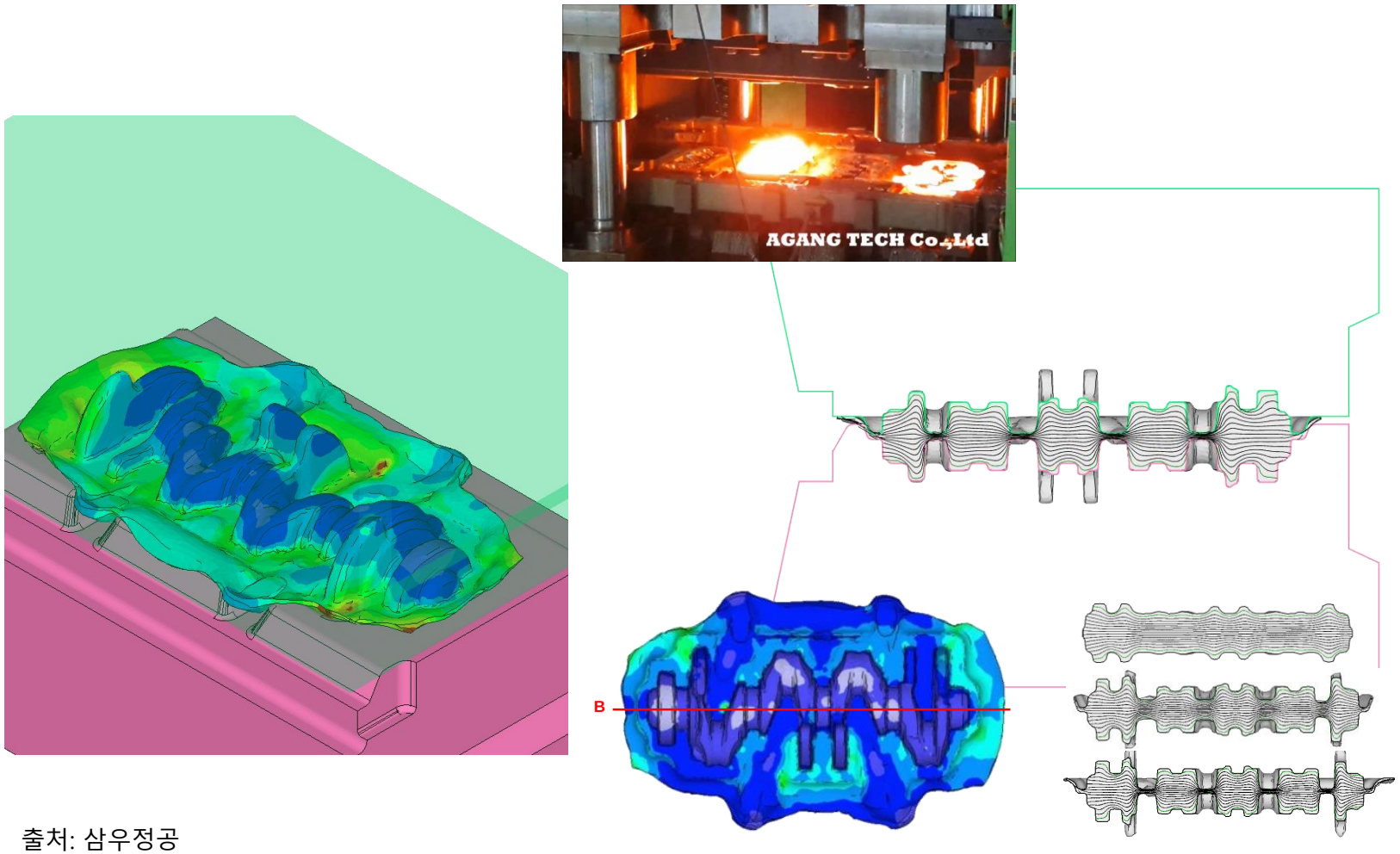


출처: MIFCAE 2000(현대자동차), DCF

수율 증대 - 친환경 생산

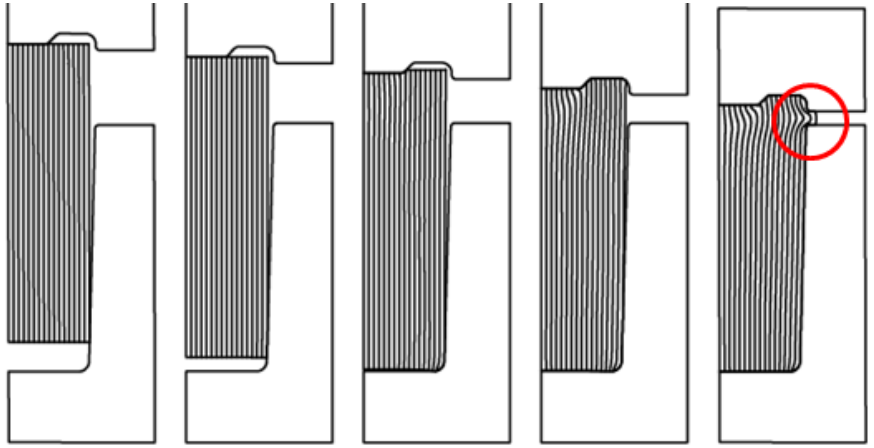
출처: 동은단조

기술력의 상징 - 고객과의 신뢰 증진

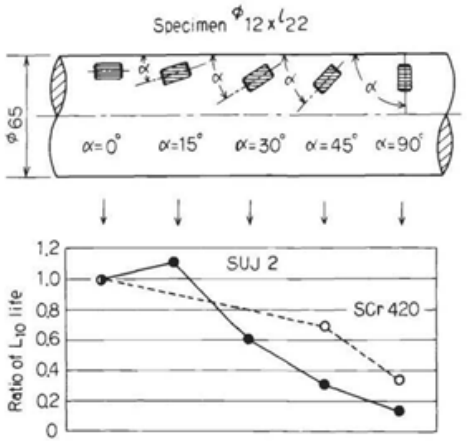


출처: 삼우정공

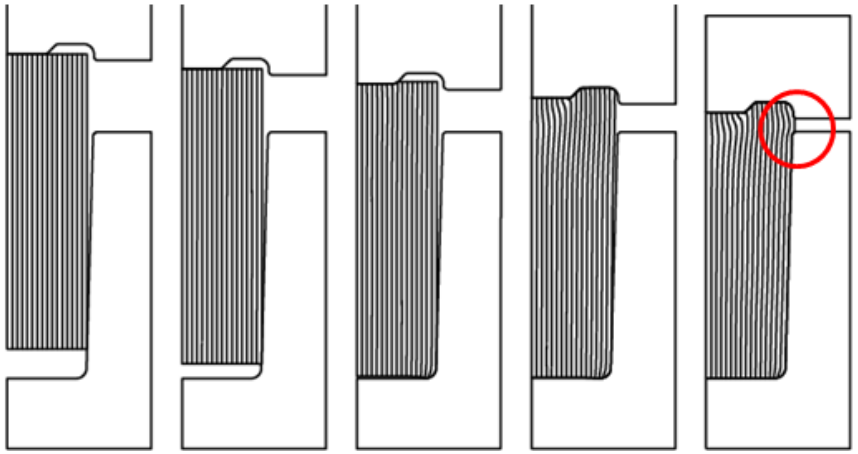
품질과 원가 경쟁력 향상



Old

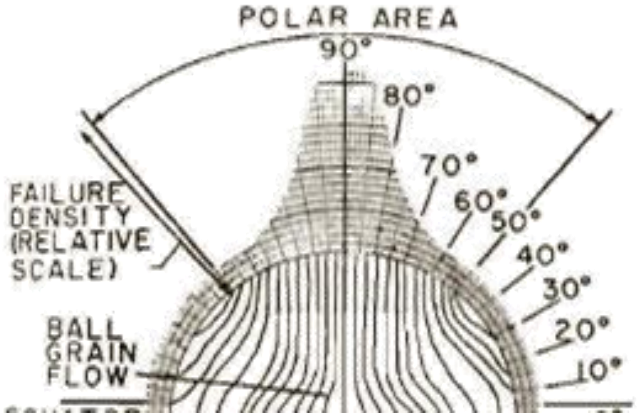


New



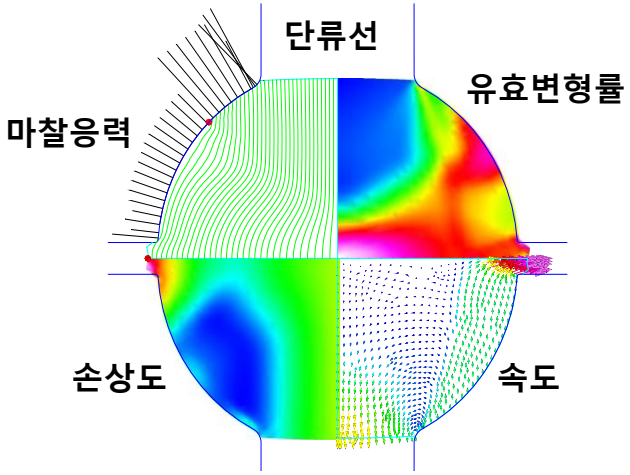
출처: 세플러코리아

품질과 원가 경쟁력 향상



기존

개선



출처: KBR