

CENTER FOR PRECISION FORMING (CPF)
Membership Benefits (August 2017)
(<https://cpf.osu.edu> and <https://ercnsm.osu.edu>)

The Ohio State University (OSU) has established the Industry/University Cooperative Research Center (I/UCRC) on Precision Forming (CPF, <https://cpf.osu.edu>) focusing on the needs of metal forming industry. Initially, from 2007 to 2012, the National Science Foundation (NSF) partially funded this activity together with the participating companies. CPF is using extensively the knowledge base, developed at the Engineering Research Center for Net Shape Manufacturing (ERC/NSM) at The Ohio State University that is now merged with CPF. (<https://ercnsm.osu.edu>)

Current industrial members of CPF include:

AFTON CHEMICAL, AIDA, ALTAIR, AUTOFORM, BATESVILLE
TOOL & DIE, CHRYSLER (FCA), DIE CAD GROUP, ESI NORTH
AMERICA, HONDA OF AMERICA, HOUGHTON
INTERNATIONAL, HYSON METAL FORMING SOLUTIONS,
IMRA, IRMCO, MIDWAY PRODUCTS, nanoPRECISION,
NATIONAL MANUFACTURING, NUCOR, POSCO,
QUAKER CHEMICAL, SFTC, SHILOH INDUSTRIES,
TE CONNECTIVITY, Ltd.

At CPF, the project and topics of R&D are suggested by member companies who set the priorities for research by voting in the semi-annual Industrial Advisory Board (IAB) meeting or by discussing their interests with CPF Director. CPF uses, in addition to commonly used engineering software packages, the commercially available DEFORM

2D and 3D for applications in forging and 3D-PAM-STAMP as well as LS-DYNA for sheet metal forming.

New members are welcome to join CPF. Membership fees are:

- \$30k/year for Full Membership, for 30 votes (more than 500 employees)
- \$15k/year for Associate Membership, for 15 votes (less than 500 employees)
- \$10k/year for Affiliate Membership (no voting rights / less than 500 employees)

The CPF reports are available only to Member Companies. For questions, please contact Dr. Taylan Altan, Director of CPF (e-mail: altan.1@osu.edu, phone: 614-292-5063)

CURRENT PROJECTS:

CPF-1.1 - WARM FORMING OF AL ALLOYS

This project started in October 2013. The scope of work of this project includes: (a) review of the state of the art review, (b) properties of Al alloys at elevated temperatures, (c) lubrication at elevated temperatures, (d) experiments/trials with an interested CPF member. The emphasis is on 7xxx series alloys

The topics (a) and (b) are completed while (c) and (d) are in progress.

CPF-1.4- FORMING OF AHSS USING A MECHANICAL SERVO DRIVE PRESS

These projects started in August 2013 and include (a) state of the art review, (b) determination of mechanical properties for AHSS selected by CPF members, (c) evaluation of lubricants, (d) FE simulations and deep drawing tests in a 300-ton servo press from Aida America (a CPF member), (e) tests/try outs, (f) guidelines for forming AHSS in a servo press. The die set is designed and is manufactured by a CPF member, Shiloh Industries.

The overall objective is to explore how the capabilities of the servo press (slowdown of ram speed, dwell, double hit at BDC) could improve the formability of AHSS.

Initially deep draw tests, using a die set manufactured by Shiloh, have been successfully completed. Parts from various AHSS (DP590, CP800, DP980, TWIP 900, TWIP 980, TRIP 1180 / thicknesses 1.0 to 1.4 mm) were drawn to 50 mm depth without wrinkling and fracture.

Work is in progress to (a) obtain larger draw depths and (b) modify the die inserts to form more difficult parts.

We are also conducting studies with Hyson on using a servo press and a servo hydraulic cushion to improve stamping of various materials (stainless steel, Al 6xxx).

CPF-2.1 - DETERMINATION OF MATERIAL PROPERTIES (TENSILE, BULGE AND FRICTIONLESS DOME TESTS)

Bulge test (using viscous material as pressure medium) was developed at CPF several years ago. It is routinely used to obtain biaxial stress-strain data for simulation for various materials. Several reports and non-proprietary papers are published

A project is completed to develop the frictionless dome test (extension of CDH) to obtain biaxial stress strain data. Biaxial flow stress (true stress-true strain data) have been obtained for various materials, including AL 5182-0 and several AHSS (DP590, CP800, DP980, TWIP 900, TWIP 980, TRIP 1180). Several reports were issued in 2014.

A method has been developed to use combined tensile and bulge test data for more accurate FE simulations.

We also developed practical methods for obtaining true-stress/true-strain (flow stress) curve from tensile data.

CPF-2.2 - FORMING OF AL ALLOYS AT ROOM TEMPERATURE IN A MECHANICAL SERVO-DRIVE PRESS

This project started in May 2013. The die set has been designed (in cooperation with Honda) and manufactured by Honda. Initial forming trials on a 300 ton Aida servopress were conducted in May 2015.

In addition, simulations and deep drawing tests were also conducted using the Shiloh die and the 300 ton Aida servopress. The results were successful, although the max draw depth was less than 70 mm. The objective is to increase the draw depth and also use smaller die corner radii to form more difficult shapes. Several reports were issued in 2014 and 2015.

This study will continue in cooperation with Shiloh Industries and Hyson.

CPF-2.3 – FRICTION, LUBRICATION AND TEMPERATURES IN FORMING AL AND AHSS

A study to evaluate lubricants for forming 270 MPa steel was completed in 2010. Several reports and non-proprietary papers were published.

A study on evaluation of 17 lubricants for forming Al 5182-0 was completed in Nov. 2013, including all the cup draw tests. A comprehensive CPF report is issued and a non-proprietary paper has been prepared.

A study on the evaluation of lubricants for deep drawing AHSS has been completed and a report was issued in 2014. Additional studies are being conducted as more lubricants are submitted to CPF for evaluation.

In 2015, we conducted a new project to evaluate and compare the Twist Compression Test (TCT), largely used by lubricant suppliers, with the Cup Draw Test (CDT) exclusively used by CPF to evaluate lubricants.

The CDT, developed at CPF, is now used by various lubricant suppliers and it is generally accepted to be an excellent test for evaluating various lubricants. Several of our non-proprietary publications are at <https://ercnsm.osu.edu>

CPF-5.1 - BENDING AND SPRINGBACK IN BENDING AHSS, AL ALLOYS AND COPPER ALLOYS

This project investigates how to (a) predict springback using FE simulations, and (b) reduce springback by various techniques (stretching, coining, double hit in a servo press).

The project includes: (a) state of the art review (completed), (b) simulations and comparisons with existing data (completed), (c) simulations of wipe bending, stretch and shrink flanging, U bending using the die designed/manufactured in project CPF-1.4. The project started in September 2013. Several reports were issued in 2014. Work is continuing in 2015 and 2016.

We developed a new and very practical method, so called “inverse analysis” to predict springback. Thus, we expect to reduce the number of “re-cuts” of the dies in stamping AHSS.

CPF-5.2 – BLANKING AND FLANGING OF AHSS

The objectives these projects are to determine (a) the “best” blanking/shearing conditions that cause minimum damage at the sheared edge (punch/die clearance, punch speed using the capabilities of the servo press and (b) the relations in flanging of a sheared edge and laser cut (or water jet cut) edge. Thus, we hope to reduce fracture during flanging. Several reports were issued in 2014 and 2015.

We have conducted a) hole expansion (using a large diameter punch) and b) half dome tests with sheared and laser cut blanks, in cooperation with Shiloh, KTH, EWI and Honda R&D. This study has been completed and illustrated which tool parameters affect the quality of blanked edge and how to improve them.

CPF-5.5- HOT STAMPING/FE SIMULATIONS AND APPLICATIONS

These projects started in September 2011. The work included: (a) an extensive review of the state of the art, (b) collection of input data for FE simulations of hot stamping, in cooperation with ESI (PAM-STAMP), (c) simulations of various case studies/parts, including parts with tailored properties using TWB, Tailored Rolled Blanks and Tailored Heated blanks. Several reports were issued. We reduced our efforts on this topic while increasing our effort in warm forming of Al alloys.

We believe this technology is mature and various press builders offer turn-key installations.

CPF-5.6 - PRACTICAL FE METHOD FOR PREDICTING FRACTURE

This project started in December 2013 and has two objectives: a) try to develop a method for predicting fracture for a given material and thickness by calculating the thinning rate during deformation (since in general, in practice, fracture is predicted based on empirically obtained max thinning during deformation), and (b) determine a simple method for obtaining fracture at plane strain conditions. Thus, the FLD curve can be determined approximately by using 3 points: (a) biaxial fracture in a bulge test, (2) tensile fracture and (3) plane strain fracture.

CPF-6.0 – FINITE ELEMENT (FE) SIMULATIONS

This project covers various topics related to FE simulations to determine how (a) input data affects the accuracy of the results, and (b) mesh type and size affect the results. Projects are under way on the effect of E-modulus and its variation upon springback prediction and on how anisotropy affects FE results.

Work is also in progress on non-isothermal (heated and cold dies / heated blank) simulation in stamping.

CPF-6.1 – DEEP DRAWING USING SPACERS AND SERVO HYDRAULIC CUSHION

Work has started in 2015 to evaluate and compare deep drawing with spacers (using constant Blank Holder Force (BHF), using various die geometries (Round Cup, Shiloh die and Honda die).

A new project is being conducted in cooperation with Aida and Hyson on the use of hydraulic servo cushion in stamping. The objective is to establish a procedure for optimum deep drawing conditions by determining the “best” possible BHF versus punch stroke curve, using a CNC cushion. Preliminary studies are conducted and show how best to use a servo hydraulic cushion.

COURSES ON STAMPING TECHNOLOGY.

Our experience in working with industry indicates that courses on the fundamentals as well as in practical use of (a) servo presses and (b) servo hydraulic cushions, are extremely useful for companies that invest in these new technologies. Therefore, we are developing (in cooperation with Hyson and Shiloh) courses on stamping, optimum use of servo presses and servo hydraulic cushions. These courses may be held at the Metal Forming Center of Hyson (300 ton servo press and 50 ton servo hydraulic cushion). They can also be held at the location of interested companies.

BENEFITS TO MEMBER COMPANIES

Each member company selects or suggests one or more research topics or projects, related to metal forming that should be conducted. This project may be (a) one that is already conducted at CPF (in that case the rate of effort on this project will be increased with the new member’s funds), or (b) an entirely new topic or project that is not yet addressed by CPF.

When working with member companies, CPF respects the confidentiality of certain detailed information that may be provided by the company. Results of research are not published unless publication is approved by the interested member company.

In addition, each member company has access to all CPF reports and other information available at CPF, obtained from various sources (literature, non-proprietary company information, international conferences, research reports mainly from Europe and Japan, etc.).

Additional information on CPF activities and ERC/NSM's experience in metal forming is given at:

- <https://cpf.osu.edu> (please note a large portion of this web page is Password protected. That portion("Members Only Section") is available to CPF members only).
- <https://ercnsm.osu.edu>

For questions, please contact:

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