History of the North American Deep Drawing Research Group (NADDRG)

As Told By Dr. Stuart Keeler and Dr. Bernard Levy

The research on sheet metal forming that lead to the formation of the IDDRG and the NADDRG began in 1937 when Prof. Swift of England began investigating tests for evaluating cup drawing. In 1954, a meeting of the Iron and Steel Institute (British) and Jernkontoret (Swedish) concluded that separate tests were needed for deep drawing and for stretch forming. In 1957, representatives from Belgium, Chile, France, Germany, and Holland met with representatives from England and Sweden in Amsterdam. The purpose of the meeting was to propose a standard procedure for the Swift Cup, which was to be the standard test for deep drawing. This meeting could be considered the birth of the International Deep Drawing Research Group.

The first official meeting of the IDDRG was in Paris in May 1960. It consisted of a three-day open colloquium for presentation of technical papers followed by a two-day closed meeting of the IDDRG, which consisted of delegations appointed from the following national deep drawing research groups: Belgium, Britain, France, Germany, Italy, Japan, Netherlands, and Sweden. It was decided at the meeting that the scope of the IDDRG should be, ”Common international research on and promotion of international coordination of research on sheet metal forming in general…”

The group established a meeting schedule for an open Biennial Congress on even-numbered years and Working Group meetings every year. The working groups were W.G. I – Processes, W.G. II – Materials, and, W.G. III – Tests. Each national group appointed or elected a delegate and two advisors for each working group. The group also decided that the IDDRG would be composed of national groups sponsored by a recognized technical society that represents the entire sheet metal forming industry of that country. Thus, there are no individual members of the IDDRG.

The genesis of American Deep Drawing Research Group (ADDRG) was when several American representatives attended the colloquium in Paris. On their return, they organized the USA Committee of the IDDRG under the sponsorship of ASTM Committee A-1 on Steel.

Nine men met on December 12, 1961 at ASTM Headquarters in Philadelphia to organize the USA Committee of the IDDRG. Membership in ASTM was not required. All agreed to invite additional representatives with wider interests to the next meeting. Publication of technical papers presented at the meetings was to remain the responsibility of the individual authors. The attendees at the first meeting were:

- Don Blickwede (Chairman) – Bethlehem
- Jerry Caum (Secretary) – ASTM
- Bob Heyer – Armco Steel
- J. Keith – American Metal Stamping Assoc. (later to be PMA)
- Bill Lankford – U.S. Steel
- Ed Reed – Chevrolet Div. of GM
- C. Schrader (for T. Washburn) – Inland Steel
- Roger Whitely – Bethlehem Steel
- I Williams – ASTM Committee B-7 – Bell Labs

The following meetings were for informal individual reports on work in progress in sheet metal formability from attendees. The American group never split into working groups because talks generally had overlap between materials, processes, and testing. The next meetings were:

1962 – April 7 – ASTM

- Contributed papers to Second IDDRG Congress – Dusseldorf

Sept. 27 – Detroit

1963 – March 26 – U.S. Steel - Pittsburgh

- Sent delegates to W.G. meetings in Stockholm

Nov. 11 – Bethlehem

1964 – May 5 – Armco

- Gave papers at Third IDDRG Congress & W.G meetings in London.

Oct. 19 – ASTM

Many changes took place in 1965. The name changed to American Deep Drawing Research Group (ADDRG) at the June 9 meeting at ASTM Headquarters, which had forty-eight attendees. The following two days (June 10-11), the ADDRG was host to the IDDRG Working Group meetings, which were held at ASTM Headquarters. For the October 18 fall meeting, the group abandoned the normal daytime meeting for an evening meeting at Cobo Hall in Detroit during the ASM National Metal Show.

The changes continued during 1966. An April 13 meeting took place at the General Motors Institute in Flint, MI. Then on October 31, another evening meeting held at the McCormick Place in Chicago during the ASM National Metals Show. The following major changes in meeting format were made:

- Created a Program Chairman
- Established the current two-day format
- Scheduled the first morning with a "focus topic" and a keynote speaker. For many years, the use of a focused topic with a keynote speaker had become increasingly rare. However, several recent meetings have started with one.

The ADDRG continued to evolve as an important group in the sheet metal forming. In addition to moving to twice-yearly meetings hosted by member companies, these changes included:

- 1967 – ASTM made ADDRG a full committee named E-26 – Deep Draw
- 1970 – ASTM changed the rules:
  - - ADDRG E-26 members had to be personal members of ASTM
  - - ADDRG E-26 had to write standards for ASTM
- 1971 – ADDRG withdrew from ASTM and joined ASM as an Associate Society
- 1974 – The name was changed from ADDRG to NADDRG because it was felt that Canadian participation should be recognized and that the IDDRG was planning to create a South American Deep Drawing Research Group (SADDRG).

While the ADDRG was evolving organizationally, the technical emphasis of the group was on determining the relation of r-value (the Lankford coefficient, or the plastic strain ratio) and n-value (the strain hardening exponent) to stretching and drawing, and development of the forming limit curve (FLC). Concurrent with those efforts, it was also imperative to have a repeatable and reproducible method to determine these parameters in industrial and research settings.

When the work on n-value determination started, tensile test machine output was a strip chart and running the n-value regression took a mainframe computer. Furthermore, methodology was needed to develop test practices that were usable on a production basis by steel and auto companies. This led to a number of sample configurations and calculation methods to minimize experimental effort in determining n-value.

Computer technology advanced rapidly, and running the n-value regression became much easier. However, taking data points from strip charts remained time consuming. With the advent digital data acquisition during tensile testing, n-value became another parameter that can be automatically calculated by the acquisition software.

There was also considerable discussion on determining r-value. Concerns included special specimen designs and the required number of measurements in the parallel region of the gauge length. Eventually usable practices were established for use in industrial and research applications.

Work on the relation of r and n to stretching and drawing, and development of the forming limit curve (FLC) was another key focus area. While the work of Keeler and Goodwin were individual efforts, the ADDRG meetings provided opportunities for stimulating discussions on this work, which has become known as the Keeler-Goodwin FLC.

The discussions on the role of r and n on stretching and drawing led to a successful cooperative program to evaluate the effect of r and n on formability in stretching and drawing. The program encompassed steels with different values of r and n and three production stampings. Specifically, the three parts represented stretch, draw, and a stretch draw part. This cooperative effort provided researchers with information on how to select n and r-values for different kind of parts. Another part of the work involved determining the safety margin for FLCs. At this point in time, it is hard to conceive the importance of this work for improving the application of steel grades in the automotive and appliance industries. This cooperative effort was presented at the 1972 IDDRG Congress in Amsterdam where it was very well received.

Another aspect of the work in this period was strain measurement methods and using strains and the FLC to determine if parts were safe. The effort to measure strain on parts using tapes led to an ongoing cooperative effort to establish best practices for strain measurement. Work included methods for applying electrolytic grids on steel sheet, finding sources for tapes that were used for strain measurement in this period, and recommending best practices. Considerable attention was also given to using the strain measurements and FLCs to determine if parts were safe. The work continued over many years as new ideas, needs, and equipment became identified. As the work proceeded, the information was used by many NADDRG members, which led to one of the first applications of engineering science to improve stamping plant practices.

The 1972 Congress and Working Group Meetings in Amsterdam marked a high point in North American attendance; five couples and several individuals represented ADDRG for our largest IDDRG Congress attendance.

In 1976, the NADDRG was host to an extremely successful Ninth Biennial Congress and Working

Group Meetings, which were held at the University of Michigan Conference Center in Ann Arbor, MI the week of October 12. Also by 1976, NADDRG membership exceeded 60 members.

By 1976, as the need for improved vehicle fuel economy and improved corrosion protection became increasingly apparent, emphasis shifted to formability issues associated with the use of high-strength low-alloy (HSLA) steels and galvanized steels, though other formability topics continued to be discussed.

In 1988, the NADDRG hosted the Fifteenth Biennial Congress and Working Group meetings. The Congress took place at the Hyatt Regency in Dearborn, MI with just over 300 persons attending. As the host country, there was unlimited North American participation at the Working Groups. The Working Group Meetings were held in Toronto. The North American participants and the national delegates traveled together by train, which provided an opportunity for further technical exchange and socializing.

In the latter 1980's and early 1990's, control of press shop operations became an important topic. Ford began to use the Limiting Dome Height, or LDH, test in their stamping plants as a means of determining whether part failure was the result of the steel or the process. This approach worked for Ford because management said it was a reliable test and on occasion forced press adjustment rather than always blaming the steel.

The use of the LDH test became an important topic at NADDRG meetings. It became clear that the LDH test was not suitable for research, but Ford continued to use it successfully as a production control methodology in their stamping plants. At the behest of Ford personnel, work was done to establish a uniform test methodology. The NADDRG ran a round robin test program to establish reproducibility between and within different companies and test locations. While results were generally repeatable on tests within a given lab, there was limited reproducibility on results from different labs.

The 1990's brought new technical interests. With the advent of interstitial free steels, there were reports from automotive stamping plants that parts stamped from these IF steels that were judged unsafe using existing FLC diagrams were in fact safe. An extensive cooperative effort was initiated, with the outcome being a modification of the Keeler-Brazier equation for predicting FLCs. The previous n-value limit of 0.21 for use of the equation was removed because IF steels with higher n-value steels followed the equation.

Concurrent with this effort, reliable ultrasonic test measurement equipment became available. As part of the NADDRG cooperative work that led to the modification of the Keeler-Brazier equation, the use of ultrasonic thickness gauges for strain measurement was incorporated in determining part safety using FLC curves. This work also served to facilitate the use of ultrasonic thickness testing in plant evaluations of stamping performance.

Other cooperative work involved trying to determine reproducibility in coefficient of friction using a draw bead test, and to establish standards to improve uniformity in measuring coefficient of friction between laboratories using the Nine Draw Bead Test. This work went on for many years, eventually recognizing that the Nine Draw Bead Test is not reproducible between laboratories.

NADDRG meetings provide an opportunity for informal exchange of ideas between attendees. It is also a format for discussing work in progress. The Auto/Steel Partnership project on Enhanced Forming Limit Curves originated from discussions at an NADDRG meeting in Cleveland in the mid-1990s.

As the years went on, it became increasingly apparent that the conventional IDDRG format of a congress in even years and working groups each year was not working. After many years of effort, Bernie Levy, as president of the IDDRG, was able to shift IDDRG meetings to an annual conference format that could better address current interests. The name change from congress to conference was based on a judgment that "congress was a misleading term and that "conference" had become a more normal term. As part of the name change, conference attendance became open to anyone that wanted to attend.

In 2000, the NADDRG successfully hosted one of the last IDDRG congresses [the 21st Biennial Congress] in Ann Arbor, Michigan. The last IDDRG Biennial Congress was held in 2002. Starting in 2003, the IDDRG holds a yearly conference in different host countries.

The North American Deep Drawing Research Group remains an organization of, by, and for its members. It is a completely volunteer effort, with the only membership requirement being participation. As technical interests of the membership have changed, so have the discussion topics at the meetings. Recent meetings have included interactions on springback, sheared edge stretching, computer forming simulation, needed material properties for formability analysis, and practical press shop problem solving techniques.