

The Time is Right for Harmonization of Foam Standards

Roy Pask

*BASF Corporation
1609 Biddle Ave.
Wyandotte, MI 48192*

G. R. Blair

*Woodbridge Foam (retired)
8214 Kipling Ave N
Woodbridge, ONT, Canada L4L 2A4*

Mark Weierstall

*Woodbridge Foam
1515 Equity Drive
Troy, MI 48084*

ABSTRACT

The polyurethane industry is becoming more and more competitive and cost driven. Because of differences in test methods and specifications, global companies have been forced to develop different foam systems for each region in which they do business. This costs them time and money. This paper will investigate the impact of developing global specifications for foam applications on costs and on the material approval process. Much of the focus will be on the efforts of the Molded Foam Industry Panel to develop global specifications for automotive seating foams which employ the “best practices” in the industry, while at the same time eliminate non value-added and redundant requirements. The paper will also demonstrate how, through employing global specifications, companies can significantly streamline their product portfolios and in the process improve overall quality.

THE ISSUES

Using the automotive seating foam industry as an example, investigations show, for example, that there are at least 32 methods for measuring foam firmness, 10 compression set methods and 12 different fatigue tests for seating foam cushions. They are comprised of a variety of national, international, industry and in-house standards. Their differences arise from a variety of sources, including the use of different indenters for firmness, different calculations, different stresses, strains, and test speeds for mechanical tests and, of course, different fixtures and equipment - not to mention regional and individual company differences in requirements, even when the same methods are being employed. Even with a simple test like tensile strength, Figure 1 shows a variety of different tensile die cut specimens being used in the flexible foam industry. Figure 2 shows a few of the different size indenters being employed in industry to measure foam firmness. These are just a few examples that have created an extremely complex system for development, qualification, and quality assurance of foams. This all adds up to time and money. The end result is that raw material suppliers and foam manufacturers are required to maintain a large portfolio of products in order to meet the requirements of so many test methods and specifications.

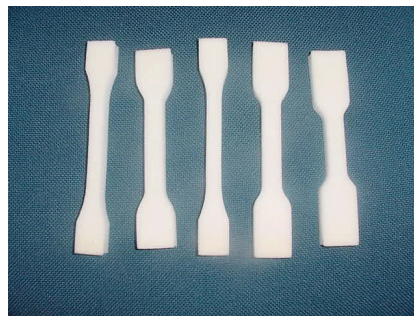


Figure 1
Different Tensile Specimens



Figure 2
Different Firmness Indenters

Maintaining this large portfolio of products creates both technical and logistical problems for large global companies. It can contribute to the loss of competitiveness for these companies, as they try to produce and maintain inventories and transport such a large number of products. The production part approval process (PPAP) is exacerbated by this complicated system of specifications. Clearly, consolidation and harmonization of test methods and specifications can minimize these problems. The system is suffering from neglect and from the growth of international companies. Many test methods and specifications have not been reviewed and updated in decades. The time to change is now.

THE MISSION

In 2004, a group of experts in the automotive trim industry formed the Molded Foam Industry Panel to address the problems associated with the complex system of test methods and specifications that was the norm in the automotive seating industry. The Panel recruited members from the “Big Three” U.S. automobile manufacturers, as well as from the major Tier 1, raw material suppliers and foamers. The plan was to have customers and competitors alike sitting around the table discussing industry problems and sharing resources and knowledge, without discussing pricing or other proprietary company information. What a novel idea ! But would it work? The group decided to start small and to remain focused on a relatively narrow market segment, namely automotive seating foam specifications. At the time, Ford, GM and Chrysler (Daimler Chrysler) had seating foam specifications that had not been updated in many years. Their U.S. and European subsidiaries had different specifications. Their specifications were a mish-mash of in-house, industry, national and international standards. They contained a number of requirements that were not particularly relevant to seating foams. For these companies to develop a global specification for seating foams that would be agreed upon and would also reflect regional differences and preferences, in itself, would be a tremendous challenge. Their mission was based on a set of guiding principles.

Molded Foam Industry Panel Guiding Principles

- **Operate within anti-trust guidelines**
- **Use international standards, wherever possible**
- **Emphasize functionality in test method selection**
- **Identify “best in class” methodologies**
- **Remove non value-added requirements**
- **Improve repeatability and reproducibility (R&R)**

THE PROCESS

The first step in the process was to analyze each of the OEMs' specifications. After creating a list of the basic types of test requirements, each panel member was given a survey. The survey's data was used to rank each test on the list in terms of functionality, i.e., in terms of criticality and relevancy to the manufacture and use of automotive seats. From this survey, a list of core tests for seating foams was identified.

Molded Foam Industry Panel Core Tests

- **Hardness (Firmness)**
- **Hysteresis Loss**
- **Tear Resistance**
- **Wet Compression Set**
- **Foam Durability**
- **Aged Hardness Loss**

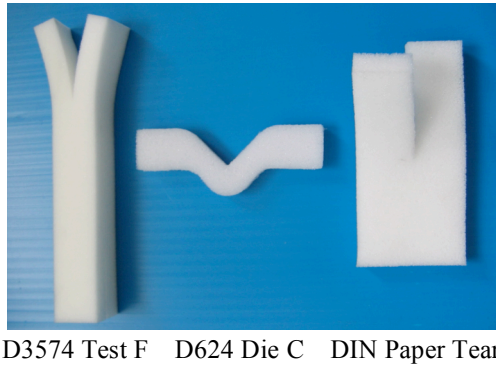
This core list of tests was augmented by additional environmental and regulatory requirements, like odor, staining, fogging and flammability. These tests are required and in some cases could not be changed or be replaced. Separate task groups were set up to see what could be done with these tests. Although these task groups are still meeting monthly, they have made some progress in improving these requirements based on "best practices" and improved R&R.

Molded Foam Industry Panel Recommendations

- ***Fogging* – Standardized Time and Temperature, Still Investigating Photometric vs. Gravimetric Measurements**
- ***Odor* – Replace Human Panels with E-Nose Instruments**
- ***Staining* – Replace Contact Method with Vapor Method, Standardized Time and Temperature**
- ***Flame (FMVSS 302)* – Reference ASTM D5132 as the Most Definitive Procedure Remove In-House Versions of FMVSS 302**

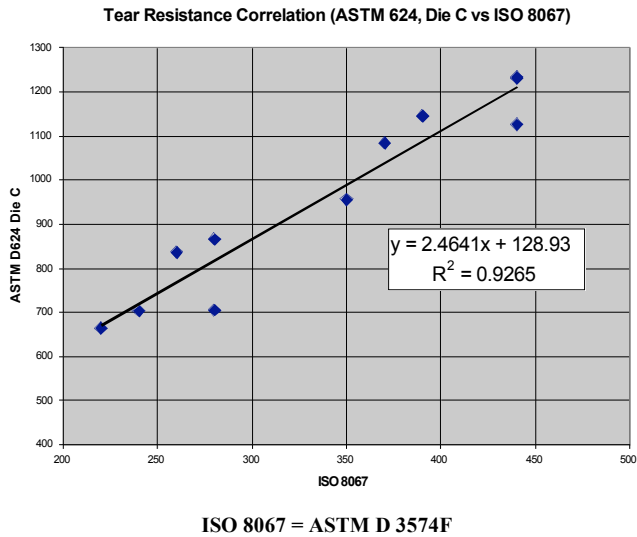
In the process of revamping these specifications, the Panel recommended that some requirements be eliminated. For instance, the survey of Panel members indicated that tensile and elongation were not really relevant to the manufacture and use of car seats. Most of the stresses endured by a seat cushion are in compression, not in tension. Consequently, tensile and elongation were removed from the specifications. Other non-specific or non-relevant requirements like flexibility, steam resistance, and solvent resistance were also eliminated or replaced. In other cases, test requirements that have historically been used were replaced by a more functional or repeatable test. One such example was tear resistance. Tear resistance was identified as one of the core tests that were deemed to be the most critical to quality and performance. The traditional method for the measuring tear resistance of seating foams was the ASTM D3574F Block Tear test. This test basically measures the tear propagation strength of the foam, i.e., how much force does it take to continue to propagate a tear that has already been made. But, the Panel members felt that the more relevant measurement would be to measure the tear initiation strength of the foam, i.e., how much force does it take to start a tear. The team investigated several other tear tests being used in the flexible foam industry. Figure 3 shows three tear tests that were compared. The object was to find the tear test that best relates to foam processing, seat assembly, seat function and repeatability. The group looked at and compared the three tear tests, namely, the D3574F Block Tear, the D624 Die C Tear and the so-called DIN Paper Tear.

Figure 3



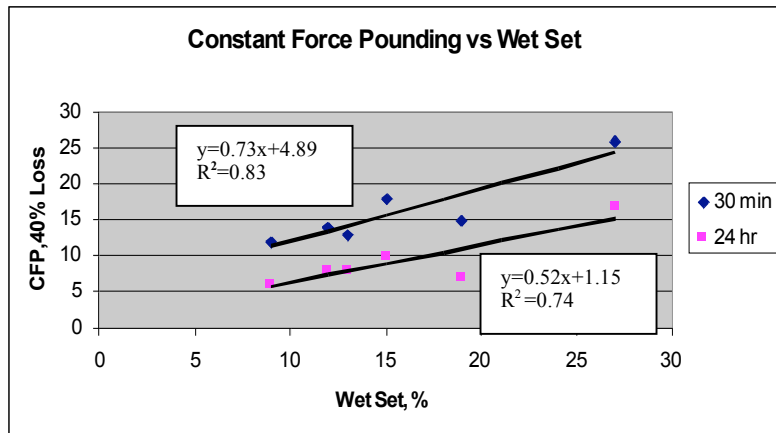
After careful study, it was determined that the ASTM D624 Die C tear had the greatest relevancy to automobile seat processing and assembly. An added benefit is that the Die C test is much more repeatable than the ASTM D3574F Block Tear. The Panel then established a correlation between the two tests. Figure 4 shows that correlation.

Figure 4



Another test that has made the list of core tests for the Molded Foam Industry Panel's recommendations is the Wet Compression Set test. This test, which appears in most Asian flexible foam specifications, conducts compression set at elevated temperature and high humidity (50° C / 95%RH), rather than the traditional dry heat compression set test in ASTM D3574 at 70° C. The Wet Set test has shown a very good correlation to Pounding Fatigue (ASTM D3574I₃/ISO 3385), i.e., it is predictive of durability. Figure 5 shows the correlation of Wet Set to Pounding Fatigue.

Figure 5



Because of this predictive nature of the Wet Set test, the Panel also recommends that both the original and humid aged compression set requirements be replaced by Wet Set in typical seating foam specifications. The ASTM D3574 J2 (autoclave) conditions (5 hours @121° C) has traditionally been used as a measure of accelerated aging of flexible foams. It is now known that it actually is a thermal degradation test that does not really relate to actual aging of flexible foams under the temperature and humidity conditions normally encountered in a vehicle. The photo in Figure 6 shows what these severe humid aging conditions do to a fully trimmed out leather automobile seat.

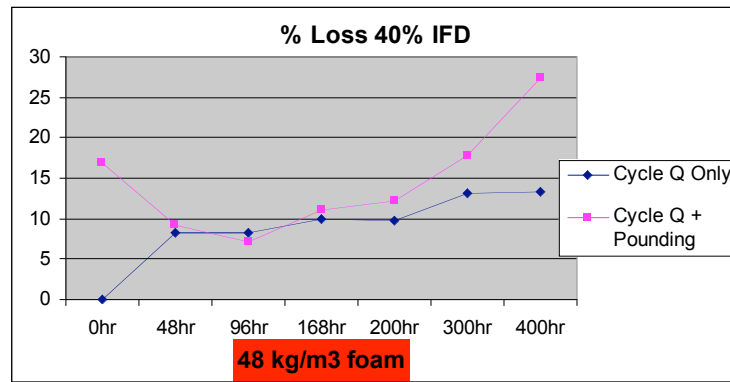
Figure 6



Leather Seat Exposed to Autoclave for 5 hr @121° C

Because of the severity of the autoclave test, the Molded Foam Industry Panel has initially recommended the use of the Wet Set conditions for an aging test to determine the loss of thickness and hardness (IFD/CFD) after environmental aging. However, this has not been acceptable to all of the OEMs. Some feel it is not severe enough to be used as an accelerated aging test. Additional aging studies have been done using the GMW 14124 Cycle Q conditions, which are 400 hours @ 80° C / 75%RH. The study investigated the effect of these conditions on foam firmness and foam durability. In Figure 7, the data shows that for a typical seating foam, the Cycle Q aging has very little extra impact on durability for the first 200 hours of aging, but then something changes with the foam that makes it much more susceptible to the flexing action of the Pounding Fatigue test. What actually has changed with the foam has not yet been identified. Dynamic mechanical analyses failed to detect changes in modulus or T_g and solvent swell testing failed to show changes in foam crosslinking. The search for the best accelerated aging test continues.

Figure 7



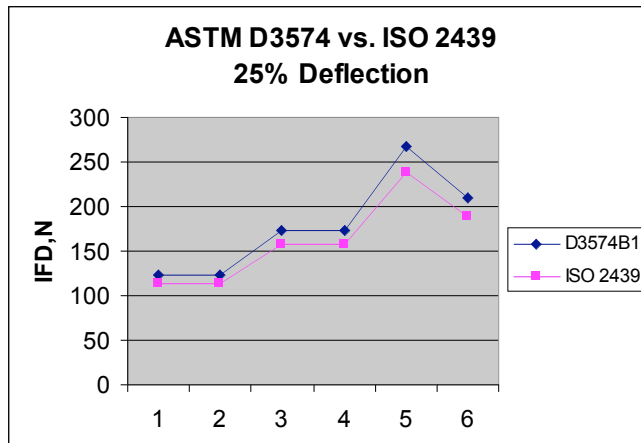
In summary, the process by which the Molded Foam Industry Panel has systematically reviewed OEM's specifications for automotive seating foams has only been highlighted. The group continues to meet monthly to review progress, make recommendations and initiate new studies. But this is not all of the story...

TWO PRONGED ATTACK

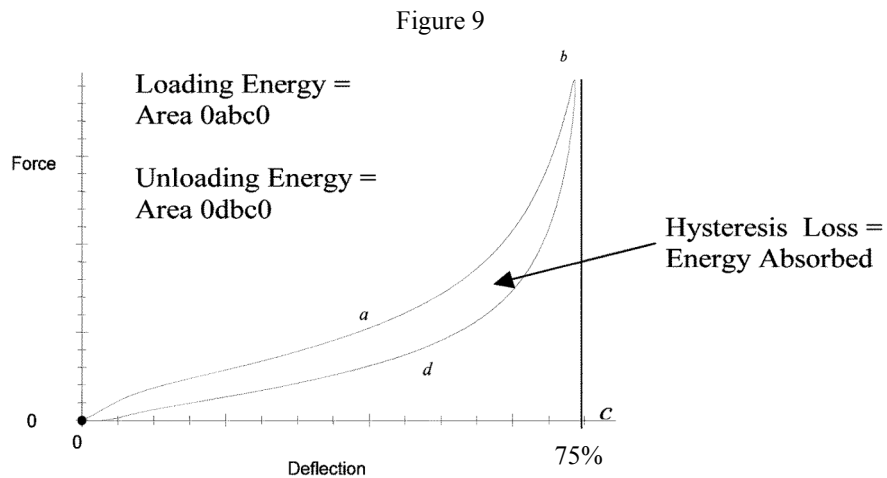
The Molded Foam Industry Panel activities are being supplemented and complimented by ASTM International (American Society for Testing and Materials International) actions. Earlier in this decade, ASTM became an international company and it has invested heavily in expanding the use of its standards globally. In the top ten of the most requested of all of the 30,000+ ASTM standards is ASTM D3574 *Standard Test Methods for Flexible Cellular Materials- Slab, Bonded, and Molded Urethane Foams*.

In Subcommittee D20.22 (Cellular Materials – Plastics and Elastomers) members have systematically reviewed and compared the sixteen methods in D3574 to their counterparts in ISO (International Organization for Standardization). The goal has been to harmonize the ASTM and ISO versions of these tests. The process is slow, but there has been some modest progress in achieving technical equivalency. Because of historical regional differences some methods may never be harmonized. One such method is the Indentation Force Deflection (IFD) test used to measure flexible foam hardness. ASTM D3574B1 and ISO 2439 are similar tests, but because of differences in sample size, preflexing and dwell times, the numbers do not easily compare. However, Molded Foam Industry Panel members, in their dual roles as D20.22 members, have established correlations between the two methods. Figure 8 shows that the ISO 2439 IFD test gives consistently about 8% lower hardness numbers.

Figure 8



A number of other activities in Subcommittee D20.22 resulted from the Molded Foam Industry Panel initiatives. One of them was the inclusion of the Wet Set test conditions (50° C / 95%RH) as D3574K, Wet Heat Aging. Another was the addition of a hysteresis loss method into D3574. There are many in-house methods for measuring hysteresis being used in industry. Now there is a standardized method that can be referenced in global specifications. Hysteresis loss is listed as one of the Core Tests in the Panel's seating foam specification recommendations. Figure 9 is the D3574 hysteresis loss method.



Another Panel initiative has led to the addition of a line call-out system for foams into ASTM D3574. This system reduces a specification to a series of letters and numbers, which can easily be included on a production part engineering drawing or on a purchase order. Below is an example of such a line call-out for a flexible foam.

ASTM D3574 Line Call Out

D3574 Type [Slab]
Coring [Uncored]
Urethane Chemistry [Polyether]
A Density [15.5 kg/m^3] min
B₁ IFD [13mm thick specimen 80-140N] range
C CFD [3.0-4.0 kPa at 50%deflection] range
D Compression Set [10% at 50% deflection, C_t] max
E Tensile [80 kPa] min
F Tear [0.25 kN/m] min
K Dry Heat Age [15% CFD change] max
L Wet Heat Age [10% CFD change] max
X₁ Flammability – MVSS302 [102mm/min] max
X₂ Odor – SAEJ1351 [3] max
X₃ Staining – ASTM D925A [no staining]
X₅ No auxiliary blowing agents may be used to manufacture product

A number of other ASTM D20.22 activities will further assist in the development of global standards. These projects are currently being worked on in the Subcommittee.

ASTM D20.22 Projects Currently in Progress

- **Addition of a hardness (IFD) test for seat bolsters into ASTM D3574**
- **Translations of D3574 into other languages, German already completed**
- **Addition of the constant deflection fatigue test into D3574**
- **Addition of the ISO 2439 IFD test into D3574**
- **Addition of the ASTM D624 Die C tear test into D3574**
- **Performance of additional round robins to establish test method precision**
- **Incorporation of vapor staining test into ASTM D925**
- **Incorporation of constant penetration force test into ASTM D5672**

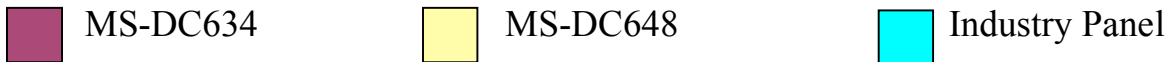
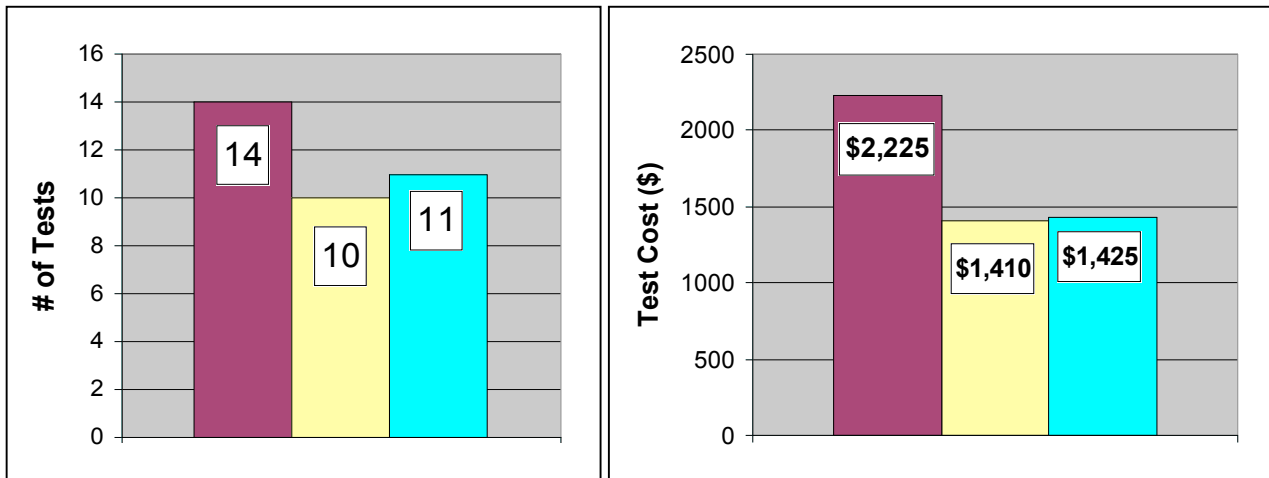
When these projects are completed, it will provide the specifiers of flexible foams with a greater international standard toolbox to use in developing global standards for the products they use.

WHY DO ALL THIS ??

All this work begs the question, “What is the benefit?” It certainly has taken a great deal of time and effort for the members of the Molded Foam Industry Panel and the ASTM D20.22 Subcommittee. Intuitively, it makes sense that having specifications that transcend international borders can make doing business simpler. But does it reduce cost? Again, using the Molded Foam Industry Panel as an example, their recommendations for seating foams has reduced the number of requirements by about 1/3. The Panel has developed their own specification for seating foams which can serve as a template for which the OEMs can use to develop their own global standards. This template specification reflects both a reduction in the number of requirements, but also the most functional and repeatable methods being used in industry today. If one were to review the new global seating foam standards for Ford, GM(proposed) and Chrysler they would see that they are substantially the same as the Molded Foam Industry Panel specification. Figure 10 shows the reduction of tests and costs between the old Chrysler Spec (MSDC634) and the current one (MSDC648) in comparison to the Industry Panel recommendations.

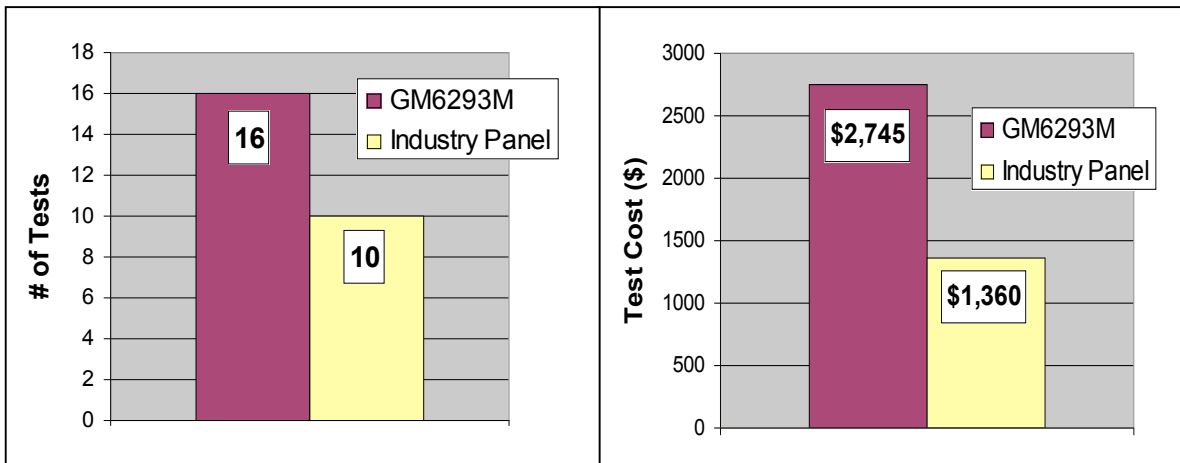
Figure 10

Chrysler Seating Foam Specification Before and After Revisions in Comparison to the Industry Panel



Similarly with the new proposed GM global specification for seating foams, which has not yet been finalized, there is an even greater reduction in tests and test costs, as shown in Figure 10.

Figure 10
Proposed GM Specification as Compared to the Industry Panel Recommendations



These testing costs savings are for one material for one set of tests. Cost reductions can be magnified substantially in a multi-lot PPAP program. However, the real cost savings of harmonizing standards globally will manifest itself in reduced portfolios. Having products that can be produced and sold on a global basis means that a manufacturer can use basically the same products wherever the market is. It should substantially reduce the number of products they need to carry in inventory and provide them with greater flexibility in supplying products during plant down times and product changeovers. The more functional performance standards should improve quality and reduce warranty claims. New product development time can be reduced by focusing on requirements that are critical to the product's performance. Logistics and transportation can be simplified by the reduced product portfolio. All in all, this can help companies remain competitive.

SUMMARY

In summary, the intent of this paper was to demonstrate the value of harmonizing standards on a global basis. The challenges in doing so are great, but they are not unachievable. By using the Molded Foam Industry Panel and ASTM initiatives as an example, there is no reason why this process cannot be applied to other market segments to develop harmonized global specifications. Our markets transcend international borders, so should our specifications. Granted, there will be always regional differences in technologies and preferences, but it will be a win-win situation to agree on as many things as possible. If there is a morale to this story, it should be a testimony to the power of a team. As a team much more can be achieved working together than everyone working on their own.

ACKNOWLEDGEMENTS

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BIOGRAPHIES

Roy F. Pask



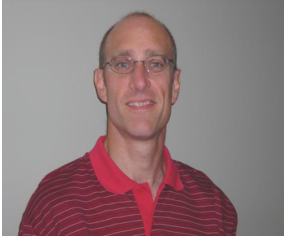
Roy Pask has been with BASF Corporation since 1968 where currently he is Supervisor of Polymer Physics in the Urethanes R&D Department. With over 30 years of foam testing experience, Mr. Pask also represents BASF on a number of industry associations including the Center for the Polyurethanes Industries, the Polyurethane Foam Association, the Carpet Cushion Council, the Society of Automotive Engineers, the Molded Foam Industry Panel and the American Society for Testing and Materials, where he serves as subcommittee chairman for cellular material and urethane raw material standards. Roy did his undergraduate and graduate studies at Wayne State University in Detroit, Michigan.

G. Ron Blair



Ron Blair received his degrees in Glasgow Scotland. He continued his studies at the University of British Columbia before joining Royal Dutch Shell Plastics Laboratory in Holland. During his six years with Shell, he worked in various functions including fundamental research, plastics testing and latterly, polyurethanes. In 1976 he joined Monsanto Canada, which became Woodbridge Foam Corporation in 1978. Ron has held various processing and chemistry positions and recently retired from managing the Woodbridge Corporate P3T Lab in Woodbridge, Ontario, Canada. Ron is currently a Polyurethane Industry consultant and can be contacted at ronblair@hotmail.com.

Mark Weierstall



Mark Weierstall has received an Associates Degree in General Studies from Macomb County Community College and is currently pursuing a Mechanical Engineering Degree. He has 23 years of experience in the automotive foam industry where his activities have mainly been focused on product development, physical testing, and specification development for seating and energy management foams. He currently manages Woodbridge's Corporate Comfort Laboratory in Troy, MI.