HOW TO INTERPRET TECHNICAL ARTICLES

We have now completed our first pass through thermoforming. There is obviously much more to cover. Design of parts, for one. But perhaps it's time to pause to contemplate what all this verbiage is all about. So, in this tutorial, we pause to examine perhaps the thorniest issues confronting even the smartest thermoformer. First, why on earth do we need these abstruse technical articles, anyway? And second, is there really something important among all the graphs and equations?

Why Do We Need Technical Articles?

And perhaps more importantly, why are they featured so prominently in the Quarterly? And who on earth decides which technical articles to feature? The answer to the last question first. The SPE Annual Technical Conference or ANTEC is the primary supply of technical efforts in our industry. Each year in early May, half-a-dozen learned works are presented at ANTEC. These papers are usually generated from academic or advanced industrial research programs. As we all know, there are only a handful of universities worldwide financed sufficiently to do research in thermoforming. Who decides which articles to feature? Since I have been reviewing the ANTEC papers for dozens of years, I think I have a good idea what work should be of interest to thermoformers in general. Why put them in TFQ? In reality, there is no other forum that brings together technical and practical aspects of thermoforming. We all need to realize that visionaries are working on solutions to the myriad technical problems that we face daily. And that their results can find an appropriate repository. Researchers love to be appreciated. It's second only to having their work financially supported. If I had my druthers, I would publish all the ANTEC technical articles. As it is, I try to pick out those that seem to focus on meaningful problems in our industry.

You Mean There Really Are Important Results Buried in All Those Equations and Graphs?

Yep. The biggest challenge for each of us is to find out those results. In this tutorial, I'll try to give you a synopsis of a typical technical paper[1], and one way of understanding it. The paper usually begins with the *Abstract* or summary of the work. For you business types, this is akin to the *Executive Summary* of a report. By reading this, you'll quickly determine if the paper fits in your general area. If it doesn't, go on to something else. If it does, you'll need to read further. With any proper paper, an *Introduction* section follows. In this section, the authors usually identify the problems they are solving. They also identify other technical works that are relevant to the problems. These references are important to people who are doing similar research. Once the problems have been posed, the authors present the methods and materials used in attempting to solve the problem. Polymers and additives are usually described in detail. Procedures are also detailed, with specific pieces of equipment or computer programs carefully documented. Again, this is important to others working in this field, since others need to know if, in order to repeat the experiments, the materials must be compounded or the equipment needs to be constructed or the computer programs are not commercially available. The next section usually features the step-by-step procedures needed to solve the problems. Good researchers know that this section must be methodical so that knowledgeable readers will believe their results. In short, you cannot say, "We put the sheet in the oven for a while" or "We mixed some ABS with some HIPS and just extruded it." Credibility is the key to acceptance.

On occasion, the researchers need to mathematically generate or analyze their results. Here's where nearly everyone's eyes glaze over. Math really isn't the thermoformers' forte now, is it? But again, think, "Credibility is the key to acceptance." A good researcher knows that his audience may insist on mathematically reproducing the final result. Unfortunately, there never is enough room to fully detail the math. So we only get the highlights.

And now we get to the *Results*. The results are normally presented as tables or graphs. Then in a section usually called *Discussion*, they are interpreted by the author. The reader should always keep an open mind at this point, since the most important parts of the results are, in fact, the tables and graphs. It is not uncommon for another researcher to use these results to form entirely different opinions. And in fact, you, as an astute reader, should also be able to form your own opinions.

And ...?

So there you have it. The skeleton and meat of a technical article. If you have decided that this paper is of interest in your work, you will have tried to follow the author's work with some diligence. At this point, you must sit back and ponder the work. Did the author, in fact, solve the posed problem? Are the materials and methods appropriate for the solution? Is the work complete or just an outline? Do the results make sense? And finally, do you agree with the author's conclusions?

Perhaps the most difficult thing for all of us lies in deciding how significant the work is to our work. If the materials are not easily available, if the methods employ exotic or expensive equipment, if the math is beyond our capabilities, we may decide not to try to extrapolate the work to our problems. Or we may decide to contract the work to the author's laboratory.

Probably a more difficult aspect of this is determining whether, in fact, the work can be extrapolated. If the work is done for XXX polymer, for instance, can we apply the results to YYY polymer? If the work was done on ABC machine, is it applicable to work done on XYZ machine? For computer modeling, for example, can we find all the necessary physical properties for our polymer? And so on.

And Finally ...

After reading and trying to digest many technical treatises, you will become sensitive to probably the most important feature of all. Is there something in the author's work that triggers new questions or offers insights to old problems? Things that the author never saw or pointed out. In other words, is there a new invention hidden in the work? Or another way of solving an entirely different problem? Or a hidden clue showing why a specific problem has never been solved?

For those of you who thrive on this aspect of our industry, I offer the following challenge. Carefully reread either A.C. Mack, *Quality Management in An In-Line Thermoforming Operation*, TFQ 19:1, pp. 5-10, or M.J. Stephenson, *A Snapshot of the Quality and Variability of Continuous Cut Sheet Thermoforming Operations*, TFQ 17:4, pp. 9-17, together with C.-H. Wang and H.F. Neid, *Solution of Inverse Thermoforming Problems Using Finite Element Simulation*, TFQ 21:1, pp. 5-10.

Do you now understand a little of the process control problems we all face? You still don't? Really?

Keywords: ANTEC, technical articles, technical interpretation

[1]For this discussion, I'll focus on the typical ANTEC paper format. Most other technical papers follow a similar format.

[This is one in a series of articles introducing general concepts in thermoforming.]