

PFFC

Serving Printers & Converters Since 1927

Ahead: A Bright Future pCL2

The Asian Marketplace pCL12

**Self-Adhesive Laminates in the
Graphic Arts Industry pCL14**

The Case for Contract Coating pCL20

Smart Converting: Web SPC pCL22

Services Directory pCL26

Custom Marketplace pCL30



Cover photo courtesy
Black Clawson Converting Machinery

SPECIAL REPORT

Coating & Laminating

With Exclusive Content Provided By



Robert Marsh says you won't find your company's future in a crystal ball, tarot cards, or tea leaves, but you might find it in Peter Drucker's advice: "The best way to deal with the future is to **create it.**"

Applied Films Corp. deals with its future with a metallizer that produces ultra-thin capacitors for hybrid cars and a new machine that features three sputtering chambers.

AET Films has introduced an upgraded polypropylene film that offers improved bonding characteristics and is moving into the hologram market.

Vacumet Corp. has moved into its new, 80,000-sq-ft plant in Austel, GA, to meet present, as well as future, demand for its metallized films.

In what is believed to be a technological first, Proma Technologies introduces a monochromatic hologram.

The future looks good for the metallizing industry, as the above sampling indicates, in spite of the fighting in Iraq and Afghanistan, threats of terrorist attacks, the ups and down of crude oil pricing, and a weak dollar.

Liz Josephson, manager of system sales at Applied Films, anticipates future growth in such markets as capacitors for hybrid cars and a new vacuum web coater with one to six deposition chambers.

As she says, "Toyota's Prius II hybrid cars use capacitors that can be produced on our MultiMet machine. They need thin-film capacitors, and our machines metallize three-micron-thick polypropylene for capacitors with patterning capabilities for this application." Some market observers see nearly 1 million hybrid cars on the market by 2007.

In addition to machines that make capacitors for hybrid cars, Applied has introduced a vacuum web coater that features multiprocess capabilities for the production

of flexible printed circuit boards and other products.

"Our standard SmartWeb machine," Josephson says, "has three deposition chambers. Each chamber can handle a variety of deposition tools, such as a planar magnetron, a rotatable magnetron, or an evaporator for metals. Each winding chamber has its own pump-down capability and so does each deposition chamber. This allows you to have different pressures from chamber to chamber.

"Very different layers can be deposited in each of the three chambers," she says. "The separation between those chambers is so good, you can have an oxygen process next to a process that would be poisoned by oxygen. Not only that, the Smart Web's footprint is small enough that it can fit into standard clean rooms."

SmartWeb machines are available in widths of 400 and 800 millimeters.

Aluminum Replacement and R&D

Bob Korowicki, president of Vacumet Corp., sees the metallized polyester film business continuing to grow domestically "at about 2%–3% a year; not as much as it used to. Keep in mind, metallizing is now a pretty big business. Total poundage has increased, especially over the last two to three years, and growth of 2%–3% translates into a lot of pounds of metallized plastic film. We have not seen many new applications developed over the past few years, just growth of existing products."

While aluminum replacement continues to offer opportunities for growth, "R&D work

is not as robust as it used to be," says Korowicki. He cites the lack of attention to product development at both the end-user and supplier levels due to cost reductions, as related to personnel. "Everyone is wearing multiple hats," he says, "and there isn't a lot of attention dedicated to product development."

Vacumet's plastics division is creating its metallizing future with the addition of two new plants. It has moved out of the Atlanta facility into a new 80,000-sq-ft plant in Austel, GA, in addition to the plant it opened last September in East Hartford, CT.

"We plan to be fully operational [at Austel] by the middle of March," says Korowicki. "Several pieces of equipment were relocated from our Atlanta facility, adding to our new Galileo 130-inch metallizer and 130-inch slitter. We provided space beside the new Galileo equipment for the installation of sister machines in the not-so-distant future."

In September 2004, Vacumet opened its East Hartford, CT, facility, "which is in addition to our existing plant in South Windsor, Connecticut," Korowicki says. "The addition of those two plants—Austel and East Hartford—will increase our current metallizing capacity by over 12 million pounds a year."

The metallized paper division of Vacumet also continues to grow "at a nice percentage," says Korowicki. "This is where the R&D really counts—by identifying new applications and creating products to meet those new opportunities.

"We recognized ten years ago that metallizing plastic films had become a service business. Anybody can buy the substrate. Metal-



Applied Films' new SmartWeb machine has three deposition chambers. Each has its own pump-down capability.

Laminated Envelope for **NASA** in Development

Lamart Corp. was selected by NASA to develop a laminated envelope for the proposed Aerobot to be flown around Titan, a moon of the planet Saturn (see June 2004 p22). According to Lee Smith, project manager, "Our ultimate objective will be to develop an extremely thin, exceptionally strong, and highly flexible material for the unmanned blimp." So far, Lamart has tested materials made up of as many as 11 layers of high-performance films with a combined thickness of a little more than 1 mil. Adds Peter Mahr, technical consultant, "...the real challenge comes from the ultra-low temperature of the atmosphere of Titan. The material must be flexible at temperatures as low as minus 196 degrees Cel-

sus. Therefore, a primary focus will be to identify films and adhesives that can function at these low temperatures."

The Aerobot will be delivered by rocket to Titan and piloted by computer on Earth. It will remain active for several months to conduct a relatively low-altitude survey of Titan's surface. The planet's atmosphere is more dense than Earth's, which permits the envelope to be filled with a light gas such as hydrogen. The vehicle will be about 10 m long.

CONVERTER INFORMATION

Lamart Corp., 16 Richmond St., Clifton, NJ 07015; 973/772-6262; lamartcorp.com

lizing of plastic film is a service of application. We went into paper metallizing because we found an opportunity to create products that were unique, not only by the paper that we bought, but by the chemistry we put either under or over the metal. With this new technology in hand, we created a third division, the Specialty Coating Division, to offer our customers the capability of developing coatings for paper as well as plastic films. Now, we create unique products, not just supply service."

A New Hologram

Frank Sereno, president of Proma Technologies, is bullish about his company's future. "We plan to double the size of our holographic business," he says. "In today's super-busy world, consumer products companies are looking to the supply chain for increased value. And we are geared up to manage their holographic requirements from graphic design to the delivery of the finished product."

For the Democratic National Convention in Boston last July, Proma teamed up with

Globe Ticket to provide holographic passes to the convention. Proma's HoloSECURE holographic paper provided the sophisticated security features the passes required.

And when the New Hampshire Intl. Speedway needed secure admission and parking passes, HoloSECURE again helped produce them. Each ticket had a different design, such as one for vendors, one for viewers, one for the press, and so forth. They were coded with sequential numbering. These foolproof passes also could be affixed to the windshields. If someone attempted to remove one, it would be destroyed.

As to new markets, Sereno says, "we anticipate the development of new business with the introduction of our monochromatic hologram, which we believe is a technological first."

It is a single-color hologram that traps light and reflects it without introducing the yellows, blues, and greens of conventional holograms that can alter the original color of the printing ink. According to Sereno, "If you think of an artist's palette of colors, we are now giving the creative people a new one that has the depth of HoloPRISM without the light-splitting effect. It gives you the depth without the distraction."



The Victoria's Secret gift box, which was in stores in time for the holiday shopping season, was the first commercial application of PROMA's new monochromatic hologram.



ESK's EllipsoMet evaporation boat (left) was designed to meet the need for faster operating speed, uniform metal deposit, and higher yield.



ESK's LaserMet evaporation boats (right) feature a patented surface treatment that facilitates initial wetting and break-in.

The Victoria's Secret gift box, which was in stores in time for the holiday shopping season, was the first commercial application of the new monochromatic hologram. "They chose it," Sereno says, "because it reflects the true color of their box with depth and subtlety."

At AET Films, Bill Minnich, market manager, sees a solid future for packaging substrates "that can replace metallized polyester and aluminum foil," he says, "in the high-barrier food packaging applications. Barrier, as a property in packaging, is essential in today's world of single-serve and other packaged goods that require longer shelf life while maintaining freshness." AET Films recently introduced a product

to meet this need: MPF-2, a metallized, non-sealable biaxially oriented PP film that, according to Minnich, offers excellent moisture and oxygen barrier. MPF-2 is designed for primerless adhesion in extruded polyethylene or Surlyn (DuPont) laminations. "We've launched it," Minnich says, "in 55 gauge and may introduce other thicknesses down the road depending on market demand." Minnich is aiming his new film at the snack foods, bakery, pet food, and similar markets.

AET also sees steady growth for its MIRAGE embossed, metallized holographic films, which, says marketing and training manager Bill Swain, "are being used for aerosol labels,

flexible packaging, gift wrap, point of purchase displays, and boxboard laminations. We are able to provide these films for wide web applications up to 63 inches wide.

"The driving force behind holography," Swain says, "is that brand managers need greater shelf appeal for their products. MIRAGE holographic films add an additional eye-appealing appearance to the package that brand managers want to differentiate their products." AET offers some patterns without shim lines with their wide web, high-speed equipment "that helps overcome some of the price barrier historically associated with using this highly effective promotional tool," says Swain.

Boats and Growth

Steve Sedlak at ESK Ceramics has a positive outlook for his evaporation boat business. He's the sales manager for metallizing in North America and sees growth in his territory matching that of America's GDP.

“Worldwide, we expect more than double-digit growth,” he says.

ESK was formerly Wacker Ceramics, a division of Wacker-Chemie GmbH. It became a Ceradyne company last summer, according to Sedlak. ESK Ceramics’ headquarters remains in Kempten, Germany, with the US office in Saline, MI. Ceradyne Inc. is a specialty ceramics company based in Costa Mesa, CA.

“A lot of the demand for our boats,” Sedlak says, “revolves around flexible barrier packaging. There is a huge demand. But there are always pressures to become more efficient and more competitive. Metallizers are wider and faster than ever and evaporation rates need to keep pace. So, we work continuously to improve the performance of our boats.

“In recent years,” Sedlak says, “ESK developments have included commercialization of our EllipsoMet and LaserMet evaporation boats. These include a patented surface treatment that facilitates the initial wetting and break-in. The surface treatment allows for higher evaporation rates and easier operator control. Tangible results have included reaching operating speed faster, achieving more uniform metal deposit, and higher yield of first-quality metallized material. ESK works directly with customers to maximize their metallizing efficiencies.”

Sedlak looks to Asia for an increase in total sales of evaporative boats because “most of the new machines are going there, and we are involved in them. So the long-term outlook we see is very positive.”

A Wider Outlook

A broader view of the metallizing industry comes from Craig Sheppard, executive director of the Assn. of Industrial Metallizers, Coaters & Laminators (AIMCAL). In Sheppard’s view, “Metallized films and papers have proven themselves as the material of choice where barrier and esthetics are key factors. Metallized substrates will continue to gain share in these areas due to their high performance and economics.

“The greatest challenge facing metallizing companies is strengthening their position in the supply chain. Large raw material suppliers are increasing the cost of materials used in producing metallized films and papers and large end-users are exerting price pressures on the finished products. The ability of the metallizers to address these issues will be the key to their long-term growth and prosperity.”

A global view of metallizing comes from Paolo Rauegi, executive VP of Galileo Systems. Paolo says, “As for the outlook of the US metallized packaging market, local producers are going to face more and more pressure from overseas. There is still a high level of new capital equipment investment in the Asian emerging countries, and all that new production cannot be absorbed by their internal markets only. Therefore, they must find export opportunities, and the US is a prime target, even with the weak dollar. Because some of these countries maintain an artificial peg to the dollar, the currency issue is not really a question for them. Therefore, US producers are facing state-of-the-art equipment, low-price raw materials, and cheap labor.



Vacumet's new Austel, GA, plant is expected to be fully operational by the middle of March with this new Galileo 130-in. metallizer.

“As for Europe,” Raugei adds, “we have seen a movement to geographic diversification by establishing new plants in low-cost countries that are also emerging markets. It is surprising, though, that it is not only the Europeans who take advantage of these opportunities but also some of the same entrepreneurs who are active in Asia and elsewhere. It looks like they have a dif-

ferent outlook on international investing and global opportunities.

“In summary, I expect US producers to continue investing in new equipment technology to keep up with imports. Global investing will continue, and I expect that ‘new-wave’ entrepreneurs will establish new plants in strategic areas that will offer low cost and provide access to the US market.”

CONVERTER INFO

PROMA Technologies

24 Forge Pk., Franklin, MA 02038;
508/541-7700; holoprism.com

Vacumet Corp.

22 Riverview Dr., Ste. 101, Wayne, NJ
07470; 973/628-0400; vacuumet.com

SUPPLIER INFO

Assn. of Industrial Metallizers, Coaters & Laminators—PFFC-ASAP 380.

aimcal.org

AET Films—PFFC-ASAP 381. aetinc.com

Applied Films Corp.—PFFC-ASAP 382.

appliedfilms.com

ESK Ceramics—PFFC-ASAP 383.

ceradyne.com

Galileo Vacuum Systems—PFFC-ASAP 384. galileovacuum.com

Contributing editor Robert Marsh is former executive director of AIMCAL and a retired marketing communications manager for ICI Americas, where he managed advertising, sales promotion, and product publicity for Melinex polyester films. Prior to joining ICI, he handled advertising assignments for DuPont Co.

Dr. William Llewellyn looks at the potentially **dynamic marketplace** in Asia.

Overall market growth in Asia is stronger than in North America and Europe, but demand varies country by country, reflecting the prevailing economic conditions locally and also reflecting the cultural and social differences among countries in the region. Highest growth rates currently are seen in China (18%–20% per annum) and in Southeast Asia, most notably Thailand (12%–15%), and in India (20%). The 3% annual growth rate in Australia and New Zealand is in line with European norms. Lowest regional growth is in Japan at 0%–1%.

Taken as a whole, the Asian market represents a significant 23% of the total worldwide demand for labels of all types. Of that total, self-adhesive labels take the major

share—46.5%. The average annual growth rate, forecast at 8%–10%, conceals wide country-by-country variations.

Glue-applied labels are the second most used labeling technology in Asia with 36.4% of the market and an estimated 4%–4.5% annual growth.

Sleeving technologies represent 15.5% of the market today and continue to grow at 5% per annum. Certainly this is affected positively by the growth in PET bottles for beers and mineral waters in the region, especially in China.

In-mold labeling is interesting: With less than 1% of the market currently, it is nonetheless growing at an estimated 15% year over year.

Material Choice

Paper is the label substrate of choice in Asia, with 90% of the market. Film stocks account for just 10% of all label face materials in Asia but are exhibiting a greater growth rate because of their higher overall performance, their predominant use in sleeving and in-mold technologies, and their above-market growth in the leading self-adhesive technology.

In both papers and films, there is a drive toward lower weights and thinner face stocks.

Paper sources in Asia are a mix of “local” production with more than 100 mills supplying a wide range of coated and uncoated papers—primarily for self-adhesive labels—and “imports” of medium to high wet-strength coated papers for glue-applied labels for beverages. However, we expect to see further development of locally produced non-wet-strength paper grades, followed by wet-strength qualities for wet glue labeling. Asia is self-sufficient in sources of high quality films for all label applications.

The Converter Base

The position of label printers in the value chain is becoming increasingly vulnerable due to the high number of companies involved and the lack of consolidation—a reflection of the position in both North America and Europe.

While there is clear movement toward narrow web print and

flexography in particular in the key Chinese market, the main installed base of presses in Asia remains in sheet-fed lithography and letterpress. This is a direct expression of the relative lack of technical education and support available in many parts of the region. Press manufacturers, self-adhesive laminators, and ink manufacturers are addressing this issue, so we can expect to see accelerating change in the choice of label production technologies.

Market Trends

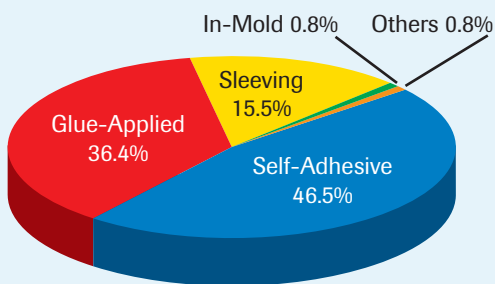
While Asia is at a much earlier stage in its development than many of the world’s major label markets, it nevertheless represents relatively developed consumer economies, and its product manufacturers and retailers are focused on brand differentiation, particularly through packaging and, of course, labels. As elsewhere, this is encouraging brand owners to use a broad palette of decorating technologies, rather than declaring allegiance to just one.

While the so-called “labeling” technologies continue to dominate, there is increasing competition from direct-printed packaging such as cans and flexible pouches in the beverage sector.

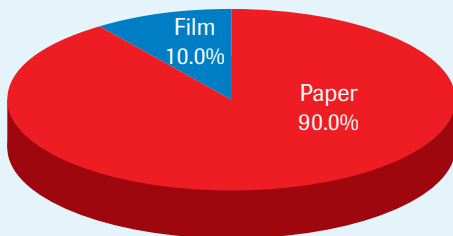
Asia is as focused on innovation as the rest of the world, and functional labeling is attracting considerable interest—particularly “intelligent” labeling features—as demography and lifestyles change in the region. Increasingly, the influence of major global brand owners and retailers is being felt in the region, with the label industry’s value chain supporting their efforts with improved material availability, technical support, and infrastructure investments.

The opportunities for American and European label industry players to develop strategic new business in this dynamic market area certainly are not to be ignored; and as growth slows in the developed world economies, Asia has to be the next real business development opportunity.

Dr. William Llewellyn is a senior consultant for AWA Alexander Watson Assoc. and an independent international business and technical consultant. He has a doctorate in chemical engineering and more than ten years in senior management positions with Van Leer Metallized Products, UK. Full details of “Labeling Markets: Asian Sourcebook 2004,” newly published by AWA Alexander Watson Assoc., are available via the Web at awa-bv.com.



Asia: 2003 Market Shares by Labeling Technology



Asia: 2003 Label Materials

Source: © AWA Alexander Watson Assoc.

Under Pressure: Self-Adhesive Laminates

Elizabeth Park provides an overview of the **current** status of self-adhesive laminates in the graphic arts industry.

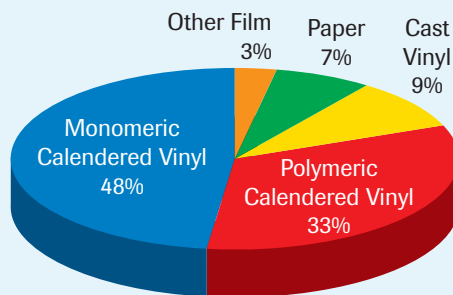
Although the development of wide-format digital printing technology brought welcome growth and new application areas, the market for self-adhesive graphic arts materials is entering the mature phase of its life-cycle. This is putting pressure on coaters and laminators to work closely with other value chain players to become not just product-oriented but solutions-oriented providers in the face of an increasingly complex competitive base of non-adhesive technologies, from plasma screens to banners and direct flatbed ink jet print.

In Europe, self-adhesive vinyl—still the dominant material choice—represented around 35% of the printable media used in graphic arts applications. Major markets are point-of-purchase and advertising applications and exhibition graphics; vehicle, corporate, and architectural graphics; and traffic and safety signage. Annual growth rates are estimated at an overall 2%–3% for the medium term, with vehicle graphics advancing at 9% per annum and corporate and architectural graphics at 7%. In 2004 these two markets accounted for 17% and 14% of the total European self-adhesive graphic arts market, respectively.

Films and Their Use

Short-life monomeric calendered vinyl films still represent the bulk volume of self-adhesive graphic arts products, with 48% of the total, but these low-technology products today are a commodity. The industry's profitability lies in the higher-priced, higher-technology cast and polymeric calendered films.

Cast vinyls offer the highest durability, the thinnest face films, the best dimensional stability, and the best conformability, but with just 10% of the overall self-adhesive vinyls market, they are niche products, primarily used for top-of-the-



2004 European Self-Adhesive Graphic Arts Market: Percentages by Material Type

Source: © AWA Alexander Watson Assoc.

range corporate identity applications and vehicle graphics—especially over compound curved, riveted, and corrugated surfaces.

Manufacturing costs are high, involving clean room conditions and expensive casting paper. Nevertheless, since production runs are comparatively low, these are the products that can be produced most effectively as custom color-matched films for company logos, for example.

Polymeric calendered vinyls—relatively new kids on the block—today are challenging cast vinyls in performance and are the fastest-growing materials in self-adhesive graphics, with a share of 33% of the total market today. They are arguably the most versatile products in the self-adhesive portfolio, with good durability, dimensional stability, and handling characteristics—and at a lower price than cast films.

High-performance films are required in the road traffic signage market—particularly reflective grades. Growth in this sector depends on national and pan-European legislation, since most sign face materials are specified, and on opening up new

economies such as those in the old Eastern Bloc countries.

Adhesive and Converting Technologies

With many applications for self-adhesive vinyls involving irregular, rough, and otherwise inhospitable substrates, often out of doors, solvent-based adhesives are the prevalent technology. Major coaters and laminators offer a range of special-purpose adhesives—for example ultra-removable, low-temperature performance, and permanent—plus characteristics that make for better, smoother application of the decals, including repositionability.

Converting technologies now span the original screen printing process, computer sign-cutting, and the broad raft of digital print processes, where wide- and super-wide-format ink jet finally have emerged the victors. Continuing growth in ink jet technology at 20% per annum is forecast: It is a real opportunity area for the self-adhesive graphics industry, and it is estimated it will represent close to 30% of the total self-adhesive graphics market in Europe within five years.

Market Status

Under the continuing pressure on margins caused by the long and complex value chain and the high cost of raw materials—particularly petrochemicals and resins—a degree of rationalization has taken place. This involves primarily the laminators, most of whom are global players, but pan-European distribution groups and print groups are emerging now, offering production at multi-

ple locations in response to the demands of brand owners for high quality and consistency in their promotional graphics.

Helping to fuel this highly competitive business environment is the increasing base of manufacturers of lower-cost digital printing presses, media, and inks in Asia—particularly China and Korea—which are exporting actively to the rest of the world.

Elizabeth Park has more than 20 years' experience in the coating and laminating industry and joined AWA Alexander Watson Assoc. as a senior consultant in 2004. A graduate in chemistry, she began her career with Smith & McLaurin (later James River Graphics and Rexam), initially as a senior chemist focusing on the development of imaging coatings, later moving into a succession of increasingly senior positions in general management. In 1997 she joined Avery Dennison Roll Materials Europe as senior product manager and subsequently was appointed to a number of key strategic posts, most recently as the division's director of business development and growth initiatives.

ADVERTISERS INDEX

For FREE advertiser & product information visit pffc-online.com!

Company	Page #
3M Converter Markets	CL16
Arlon	CL16
Basic Adhesives, Inc	CL20
Black Clawson Converting Machinery, Inc	CL13
Catbridge Machinery	CL21
CMM-Paperloop	CL10
ConQuip, Inc	CL8
CP Films	CLBC
Double E Company Inc	CL6
Douglas-Hanson	CL5
Dri-Tec	CL4
Enercon Industries Corp	CL16
Faustel	CL7
Inta-Roto, Inc	CL17
Interflex Laser Engravers	CL18
Johnson Laminating	CL9
Kroenert Group	CL19
Maxcess International	CL1
National Processing Services	CL14
New Era Converting Machinery	CLIBC
Nordmeccanica N.A., Ltd.	CL11
Pearl Technologies, Inc.	CL25
Polytype	CL15
Rad-Cure Corp	CL14
Texmac, Inc	CL20

The Case for Contract Coating

To make or to buy? This decision is faced by many managers in the converting industry today. Mark Chappell outlines the benefits of utilizing contract manufacturers.

Many companies in the graphics, medical, and electronics industries make use of external resources to meet their manufacturing needs. Even those that consider in-house manufacturing a core competence are under increasing pressure to balance the need to react quickly to market dynamics against the risks/long lead times associated with capital investments.

In the converting industry, the investment in capital and people is particularly high. Even though the initial cost of a fully equipped coating line may be reasonable, the unidentified cost is in the training and expertise of the people responsible for its design, running, and operations.

A contract coating company can offer versatile coating capability both in terms of technology and run size, from large-scale operations to small-scale trial facilities.

It is unusual for a single coating technology to be optimal for every product. During product development, it can be beneficial to access a range of coating options—a strong case for outsourcing. This approach can reduce overall production time and optimize time spent on expensive equipment.

However, for the manufacture of certain constructions, the application of one coating directly onto another during one pass may be the only suitable approach. Other characteristics may be achieved only through the drying/curing method: The ability to dry off solvent-based systems before cross-linking with UV, for example, can offer unique properties.

With ever-increasing regulatory issues concerning the safe and environmentally friendly disposal of hazardous waste, the cost of monitoring and updating compliance with manufacturing practices can be costly (and has to be paid for upfront). This situation can be improved through the outsourcing of coating processes, as the “supplier” is responsible for these issues and their implementation. Contract coating companies are obliged to be expert in solvent handling.

The investment in environmental control equipment is likely to be significant and often can be justified fully only when the utilization is high. Given a downturn in the market or a change in technology or solvent type, such equipment still needs to be maintained and kept running. A contract manufacturer active in a range of industries is in a better position to absorb these fluctuations in market demand.

Time Savings and Cost Benefits

A critical savings made through outsourcing is in time. Contract coaters have experience handling a range of coatings—especially during the development process. Investing in external contract coating can reduce OEMs’ time, while giving them access to commissioned equipment and trained teams that can meet a range of challenging requirements using a variety of coating methods and curing systems.

Outsourcing eliminates the investment in time required for building and commissioning specialist manufacturing facilities and enables companies to respond rapidly to developments in their markets. For any business that suffers from fluctuations in demand due to economic or market factors, outsourcing can introduce stability and help absorb fluctuations in the market. A significant element of risk is attached to in-house manufacturing, with the obligatory capital investment, recruiting and training staff, and regulatory compliance costs.

Other associated costs include the development of new manufacturing infrastructures, quality production equipment, and monitoring. Clean room manufacturing also is becoming increasingly important for meeting stringent cosmetic and visual standard specifications.

Joint Development Programs

Benefits accrue from joint programs involving in-house and outsourced resources.

Teams of chemists, materials scientists, and process engineers are needed to ensure products under development meet performance, quality, and cost targets. Their experience allows them to adjust formulations accordingly to match process conditions to product performance. Close cooperation is essential between both parties to ensure the learning process that accompanies product development is quick, effective, and free from risk. Formulations developed in R&D labs may not be appropriate for the demands of large-scale manufacturing, and material webs may require special treatments to achieve the desired adhesion performance.

It is essential contract manufacturers recognize the need to safeguard confidentiality when taking product designs through to the end-product in the market. Their commitment to total confidentiality is a core competency as a business partner to OEMs.

Factors Influencing the Decision

Many factors are involved in this decision: Customer satisfaction can vary widely for reasons that go beyond technology, capacity, and cost. Customers first have to identify their strengths and weaknesses and decide which processes to outsource. The next step is to locate contract manufacturers with the appropriate expertise and agree on requirements for price, services, and performance, taking into account the labor cost required to perform the task internally and the best method of minimizing financial risk.

The reason for performing trials and cost/risk analyses is to reveal the benefits of outsourcing particular processes. Contract coaters are experienced in facilitating evidence-based decisions, and they perform pilot and large-scale manufacturing regularly for companies still deciding whether to

outsource or to finance in-house coating options but lack sufficient scale-up capability.

Contract coating can enable companies to meet manufacturing requirements cost effectively, at relatively short notice, and provide OEMs with the flexibility to respond to their market to maintain a competitive advantage.

Mark T. Chappell is sales and marketing director, Europe, for Intelicoat Technologies, intelicoat.com.

Web processing is not a piece-part manufacturing process, so don't try to analyze it that way.

Although many roll goods manufacturers and converters have attempted to implement statistical process control (SPC) in their production areas, few have been successful. The reasons behind this problem lie with the basic statistical assumptions in the calculation of process capability and the use of Shewhart Control Charts.

Process capability calculations assume:

- ⊙ The process is in statistical control.
- ⊙ A single, normally distributed population is produced over time.
- ⊙ Each part produced has a unique value.
- ⊙ Individual parts are independently and identically distributed (IID).
- ⊙ Subgroup samples are rational.

Now let's consider each of these assumptions.

The process is in control. The majority of roll goods manufacturers that have attempted process capability analyses have used one of the following techniques:

Many assumed process capability could be defined by taking a minimum of 25 consecutive end-of-roll physical samples, with each of these samples containing subgroup sizes of four (or more) from cross-directional (side-to-side) test locations while the process was at "steady state."

Still other manufacturers believed their process capability could be defined through the use of historical data.

A few manufacturers calculated process capability by selecting a single roll of product that had been run at "steady state" and testing virtually 100% of the roll.

Each of these techniques has major flaws that preclude the ability to truly define the actual process capability of a roll goods manufacturing process.

To begin with, "steady state" calculations may or may not include all the process sources of natural variability. In many manufacturing operations, control loops for solids and/or viscosity, for example, may take hours to occur. Should samples be taken in less than that time, standard deviation calculations will be low resulting in artificially low control limits.

In many instances, 25 consecutive end-of-roll samples represent less than a day's production. A single day's production can never include the normal longer-range sources of machine, raw material, and environmental effects impacting product variability. These may take several days to a number of months to occur.

Also, because the process is at "steady state" does not mean that assignable causes are not present. Unless a conscious effort is made to find and eliminate assignable causes before capability studies are performed, the resultant standard deviation statistics will be inflated, resulting in incorrect (wide) control limits, regardless of the control chart system utilized. Examples of steady state assignable causes might include out-of-round rolls, nonuniform drying, incorrect roller speeds, and out-of-control (but not necessarily out-of-specification) critical raw materials.

In the second case, historical data always is comprised of multiple populations. Some of these may be assignable and some inherent. Cross-directional profiles, machine harmonics, seasonal changes, machine wear, and operator adjustments are all sources of different populations.

Process capability definitions never can be valid until assignable causes are eliminated and inherent sources of multiple populations, such as certain types of cross-directional profiles and machine harmonics, are defined.

In the third case, the 100% analysis of a single roll of product never will have all the normal time sources of variability impacting the process and cannot be used for process capability studies.

A single, normally distributed population is being produced over time. Although it is possible for a single population of product to be produced over a specific time

Example #1

In this case, test values were obtained from both edges and the center. Therefore, subgroup sample size is 3. A total of 32 rolls were produced in this run.

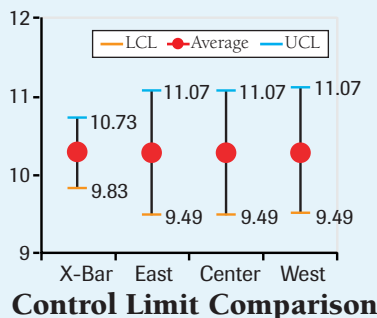
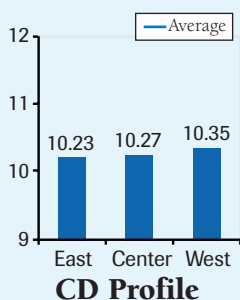
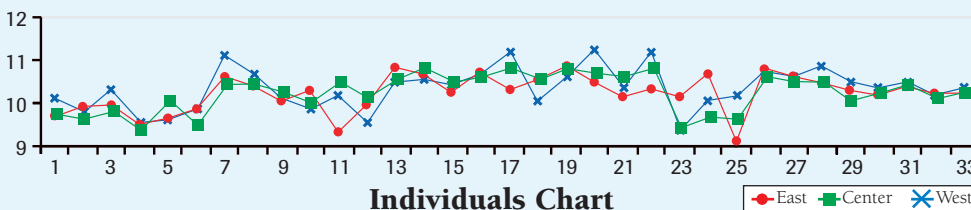
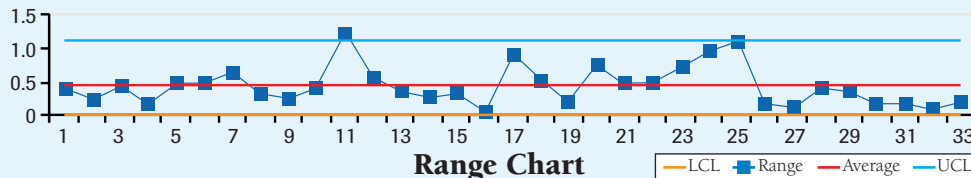
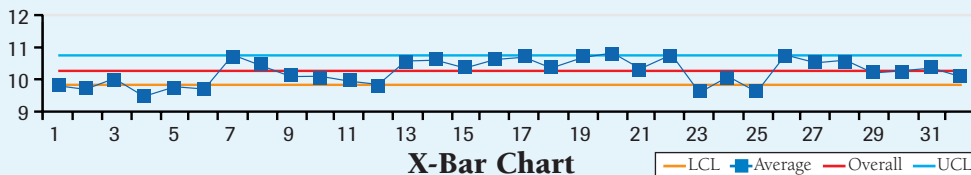
X-Bar Chart clearly shows the very large number of apparent out-of-control points and patterns on this chart. This chart would suggest the process is entirely out of control!

Range Chart suggests only one point is out of control. It is important to stress that this chart "looks" at cross-directional range. Because the samples are cross correlated, the use of Shewhart's R-Bar and D2 and D3 is incorrect. As you will see later, the upper control limit, in particular, is artificially low, further suggesting that none of the test values are out of control.

Individuals Chart clearly shows a cross-correlation effect with all three test values tending to track together throughout the run. In other words, as the overall system shifts up or down, the individual test values tend to track up and down. In addition, one should note the relative randomness of the test values at the end of each roll. No one value is always high or always low. This suggests a flat side-to-side profile.

CD Profile clearly shows the flat cross-directional profile. Note that a statistical test, the Analysis of Means, should be used to confirm this conclusion.

Control Limit Comparison compares the Shewhart X-Bar control limits using cross-directional subgroups of three with the actual natural variability of the system with limits adjusted to $n=3$ for comparison compatibility. In this case, the Shewhart control limit values understate the real values by more than 75%. Bottom line: The entire production run was in control. In this case, the use of cross-directional samples in the calculation of Shewhart X-Bar charts would have resulted in total havoc in the production area. An incredible amount of manpower and production time would have been spent in attempting to find and correct bogus out-of-control sources. Those involved, from upper management to the production operators, would quickly reach the conclusion that SPC was ineffective in their operation. Is it any wonder plant after plant has tried and discarded the use of conventional SPC?



period, a typical production run normally will consist of multiple populations. These may be due to inherent cross-directional profiles, machine harmonics, raw material batch changes, operator equipment changes, short-term environmental changes, etc. In other words, typical within-run and run-to-run product variation is a composite of inherent populations and, usually, assignable causes.

This composite may or may not approximate a normal distribution over time. Roll variability studies must be performed to understand and quantify expected patterns and levels of variability; otherwise, product disposition and/or SPC judgments will be flawed.

Each individual part has a unique value. Roll products do not consist of “parts,” rather product variability is “integrated” in all directions. This means that a roll product can have an infinite number of test values depending on the test location within the roll. For roll goods, there is no such thing as “a single unique value.” This assumption, how-

ever, is a critical component of conventional statistical process control.

Individual parts are independently and identically distributed. Roll product test measurements are almost never IID. With few exceptions, these measurements are correlated. Correlation effects can and do take place in both the cross (side-to-side) direction (cross correlation) and the machine direction (autocorrelation). Standard deviation calculations, therefore, cannot be performed in the normal manner. In essence, the impact of correlated data on any roll goods SPC systems will preclude the use of normal Shewhart control limit calculations.

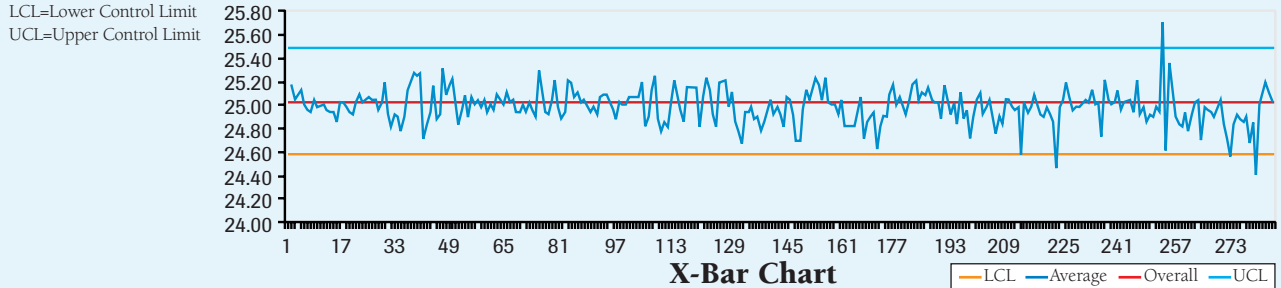
The subgroup samples are rational. Nearly all roll goods manufacturers that attempt to utilize conventional (Shewhart) SPC X-Bar and R charts do so via the use of end-of-roll physical samples. In these cases, two or more test values are obtained in the cross (side-to-side) direction. These test value groupings are assumed to be rational

subgroups. In fact, these samples are representative only of side-to-side variability and are nearly always cross correlated. In addition, if the production machine is producing material having a cross-directional profile, the individual samples will come from different statistical populations. Quite simply, this means that samples taken in the cross direction never can be rational. Rational subgroups must come from a single, normally distributed population produced over time and must be random and independent with regard to their selection from that population.

To demonstrate the danger of using Shewhart X-Bar and R charts using end-of-roll cross-directional test locations, let’s review two examples (one above and the other on pCL24). In each case, control limits were generated using the overall production run averages (X Double-Bar) and the average cross-directional test ranges (R-Bar). Shewhart A2, D3, and D4 values were used in these calculations.

The application of Shewhart SPC to a roll goods manufacturing system nearly always will result in misleading and/or erroneous conclusions that, in turn, will impact the understanding and minimization of variability within the manufacturing arena. Converters must be trained on and must use the statistical tools designed for continuous processes that will provide maximum benefits to SPC and Six Sigma practitioners.

EXAMPLE #2



Example #2

In this case, edge and center values were used also; however, the total number of rolls produced in this production run was 285.

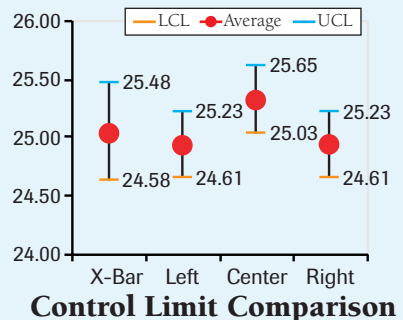
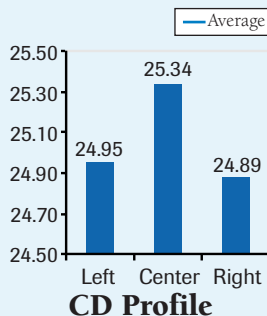
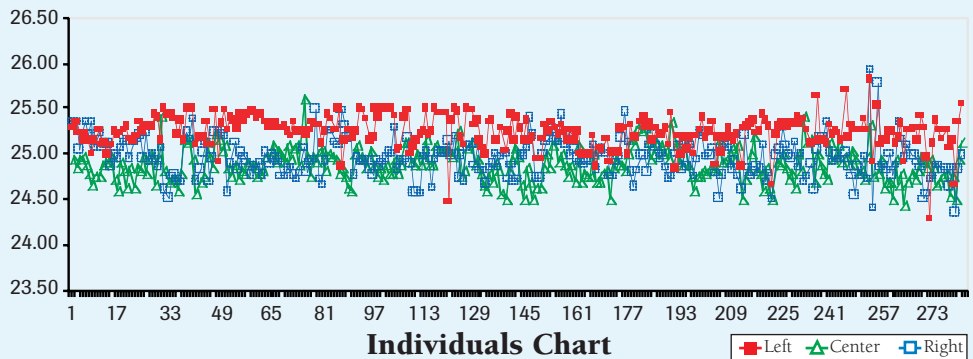
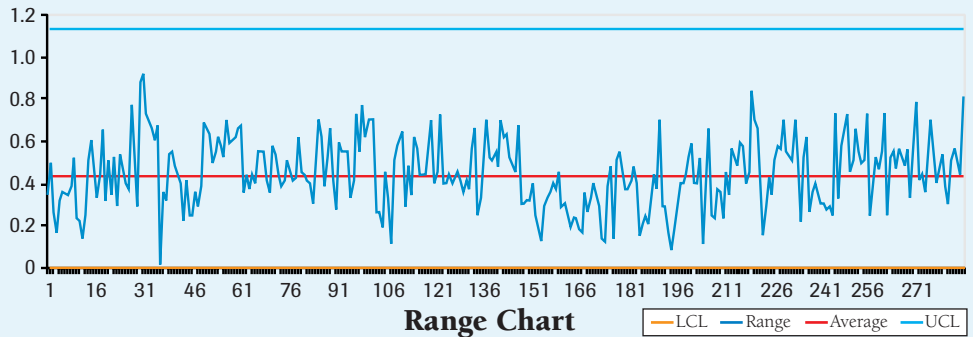
X-Bar Chart shows far fewer (three) out-of-control points. Chance would result in one out-of-control point in every 390 subgroups taken. Therefore, this would suggest this process is very nearly in control.

Range Chart also would suggest the process is in control; however, the "control" in this case is cross direction, not machine direction.

Individuals Chart clearly exhibits a pattern of nonrandom variability with individual samples taken from the center of the process nearly always having the highest test value. This pattern exists over time and indicates a "crown" cross-directional profile.

CD Profile clearly shows the "frown" profile suggested by the Individuals Chart. In this case, this profile was inherent; that is, always present during every production run. It is critical to mention that any CD Profile, whether inherent or assignable in nature, always will result in more outgoing product variability when compared with a "flat" profile.

Now we can see the impact of this cross-directional profile on the actual product variability in **Control Limit Comparison**. The X-Bar control limit range clearly is too wide due to the influence of the CD Profile in the calculation of these limits. In addition, it is very possible for this "one size fits all" chart to call out-of-control instances "in-control" and in-control instances "out."



References

1. Grant and Leavenworth. *Statistical Quality Control*. 5th Ed.
2. Montgomery, Douglas C. *Introduction to Statistical Quality Control*. 2nd Ed.
3. Schatzoff, Martin. *Advanced Statistical Methods for Web Product SPC*.
4. Frost, Paul and Edgar Gutoff. *Application of SPC to Roll Products*. 3rd Ed.

Paul J. Frost, president of PJ Assoc., Marina Bay, MA, specializes in roll goods processes, having taught these techniques in the US, Europe, Australia, and the Caribbean. Frost graduated from the Univ. of New Hampshire with a B.S. in chemical engineering and received an MBA from the Univ. of Hartford. Contact him at 617/471-3798 or pjfrost@pjassociates.com.

Company Location; Contact - Phone Number	COATING TYPE & MAX. WIDTH		PILOT/LAB FACILITIES		COATING PROCESSES				COATING TECHNIQUES													
	ISO CERTIFIED	100% SOLIDS ADHESIVE	WATER-BASED SOLVENT	EB	UV	LAMINATING	METALLIZING	SLITTING	COEXTRUSION	EXTRUSION	OFFSET GRAVURE	ROLL COATING	ROTOGRAVURE	SATURATORS	SLOT DIE	AIR KNIFE	DOCTOR BLADE	BRUSH	TWO-SIDED ROD	SPRAY	VACUUM	
A.C.P. Cleveland, OH; B. Beeler - 440/235-8268	●		75"		60"		120"	●	●	●	●	●	●	●	●	●				●	●	●
ACPO Oak Harbor, OH; R. Ward - 419/898-8273	●						61"		●				●							●		
Acucote Graham, NC; L. Crutchfield - 800/228-2683			62"		●				●				●									
Adhesive Tapes Intl./Comengs Danbury, CT; 203/792-8279			65"	65"	65"	65"	65"	●	●			●		●			●		●	●		
Admiral Products Cleveland, OH; 216/671-0600							38"						●									
AET Films New Castle, DE; B. Minnich - 302/326-5500							110"		●				●									●
American Biltrite Moorestown, NJ; 856/778-0700	●	●	●	●	●	●		●	●				●								●	
Appleton Appleton, WI; C. Booher - 800/272-9516					●			●	●			●	●			●		●	●	●		●
Applied Extrusion Technologies Terre Haute, IN; 812/462-5246	●						40"		●	●	●		●							●		
Applied Products Machesney Park, IL; 815/633-3825	●	●	64"		74"	●		●	●		●		●	●	●						●	
Arrowhead Coating & Converting Cedar, MN; T. Gustafson - 763/434-5735			30"		30"	●		●	●				●			●				●	●	
Badger Paper Mills Peshtigo, WI; P. Tobin - 800/826-0494			63"		63"	63"		●	●			●	●	●						●	●	
Bekaert Specialty Films San Diego, CA; 858/576-0200	●		74"		74"	74"	74"	●	●	●	●		●		●					●	●	
Brady Coated Products Milwaukee, WI; E. Maercklein - 800/662-1191	●		64"		64"	64"		●	●	●		●		●		●					●	
C&H Packaging Merrill, WI; 715/536-5400			56"	56"	56"			●	●					●						●	●	
Catalina Graphic Films Calabasas Hills, CA; 818/880-8060			62"		62"	62"		●	●	●			●	●	●		●			●	●	
CFC Intl. Chicago Hts., IL; M. Mitrovich - 708/891-3456	●								●	●			●	●						●	●	●
Channeled Resources Group Chicago, IL; C. Frost - 312/733-4200	●		●					●	●												●	
Clear Focus Imaging Santa Rosa, CA; J. Bellah - 707/544-7990								●	●													
Cleveland Laminating Cleveland, OH; D. Berner - 216/883-8484	●		84"		84"			●	●				●	●						●		
Coated Product Sales Dayville, CT; K. Swartz - 860/779-2300			59"	59"	59"	59"	59"	●	●			●	●	●						●	●	●
Copy Cat Printing & Signs Minocqua, WI; R. Engell - 715/356-2410					●			●	●			●										
Coverluxe Woonsocket, RI; G. Abramek - 401/769-1400			●		●								●	●							●	
CPFilms Martinsville, VA; D. Goldstein - 276/627-3332	●		72"		72"	72"	72"	●	●	●	●		●		●					●	●	●
The Crowell Corp. Newport, DE; B. Adelman - 302/998-0557 x110			72"	60"	72"			●	●				●								●	
Crusader Paper North Andover, MA; 978/794-4900			65"		65"			●					●									●
Crystal Vision Packaging Torrance, CA; 800/331-3240			24"		24"	24"	24"	●	●	●		●		●	●					●	●	
D&K Group Elk Grove Village, IL; H. Hagene - 847/956-0160			62"		62"	62"	62"	●	●	●	●					●	●			●		●
Deccofelt Glendora, CA; 800/543-3226		●	●					●	●				●	●	●							

Company Location; Contact - Phone Number	COATING TYPE & MAX. WIDTH		PILOT/LAB FACILITIES		COATING PROCESSES				COATING TECHNIQUES											
	ISO CERTIFIED	100% SOLIDS ADHESIVE	WATER-BASED SOLVENT	WATER-BASED EB	UV	LAMINATING	METALIZING	SLITTING	COEXTRUSION	EXTRUSION	OFFSET GRAVURE	ROLL COATING	ROTOGRAVURE	SATURATORS	SLOT/DIE	AIR KNIFE	DOCTOR-BLADE	BRUSH	TWO-SIDED SPRAY	VACUUM ROD
Dorrie Intl. Norwalk, CT; L. Wade - 203/846-2087	●	●	●	●		●		●	●				●	●	●					●
Dunmore Bristol, PA; S. Young - 215/781-8895 x324	●		74"	74"	74"	74"		●	●	●	●			●	●	●				●
Ecological Fibers Lunenburg, MA; D. Lafanier - 978/537-0003							●	●	●				●							●
Faustel Germantown, WI; 262/253-3333			●	●	●	●	●	●	●				●	●	●	●				
Film Products Bolingbrook, IL; J. Petruccioli - 630/226-9800						61"		●						●						
Filmtech Bean Station, TN; N. Mullins - 865/767-3533								●												●
FilmX Technologies Dayville, CT; G. Kaiser - 860/779-3403	●		44"	44"	44"			●	●					●	●					●
4th State Belmont, CA; M. Larner - 650/596-1600																				●
Hammer Brothers Kansas City, MO; 816/842-7290			●						●											
Hampden Papers Holyoke, MA; B. Fitzgerald - 413/536-1000						61"		●	●				●	●		●	●			
Hanita Coatings New Town, PA; T. Carroll - 215/860-7479	●		82"	●	●	●	●	●	●				●	●	●					●
Hazen Paper Holyoke, MA; K. McCrodden - 413/538-8204			72"	72"	72"			●	●				●			●	●			
Holyoke Card Springfield, MA; T. Tkatch - 413/732-2107			59"		59"			●	●				●	●		●				
Hutchison Miller Sales New Britain, PA; P. Routier - 215/345-1824				61"	61"	40"		●	●				●							●
Impex Intl. Group Houston, TX; K. Schmidt - 281/877-0222				●	●			●	●				●	●						
International Converter Caldwell, OH; M. Nadeen - 740/732-5665	●		60"	60"	60"			●	●				●							●
Intertape Polymer Group Marysville, MI; C. Graw - 810/941-6344	●		60"	60"	60"	60"	60"	●	●	●		●	●	●	●	●	●			●
JCS Industries La Mirada, CA; J. Schulthess - 714/690-0380			●	66"				●	●				●							
Jen-Coat Westfield, MA; J. Tierney - 413/562-2315	●				75"			●	●	●	●									
JJ Converting Sanford, NC; 919/774-3516			77"	77"	77"			●	●				●							●
Johnson Laminating & Coating Carson, CA; 310/635-4929			65"	65"	65"	65"		●	●				●	●						●
Kapco Kent, OH; P. Zavracky - 800/843-5368	●		82"		82"	61"		●	●				●							●
Lamart Clifton, NJ; W. Yoder - 800-LAMART-9			●	●	●	●		●	●				●	●	●					●
Lamerdin Paper Co. Linden, CA; 209/786-0700	●		60"	●	●			●	●				●	●	●	●	●			●
Larsen Green Bay, WI; J. Blohowiak - 920/321-0808			●		●			●	●				●		●					●
Lenderink Technologies Belmont, MI; 616/887-8257	●		82"	●				●	●	●	●		●		●					
Liquid Control/Decker Industries North Canton, OH; J. Drake - 330/494-1313	●		●					●												
Ludlow Flexible Packaging Princeton, NJ; M. Harris - 609/720-5439	●		136"	136"	60"	136"	72"	●	●		●		●		●	●				●
Loparex Willowbrook, IL; W. McBain - 630/734-2700			●	●	●	●	●	●		●	●	●	●	●						●

Company Location; Contact - Phone Number	ISO CERTIFIED	COATING TYPE & MAX. WIDTH			PILOT/LAB FACILITIES		COATING PROCESSES						COATING TECHNIQUES										
		ADHESIVE	100% SOLIDS	WATER-BASED SOLVENT	EB	UV	LAMINATING	METALLIZING	SLITTING	COEXTRUSION	EXTRUSION	OFFSET	ELECTROSTATIC	ROLL GRAVURE	ROTOGRAVURE	SATURATORS	SLOT DIE	AIR KNIFE	DOCTOR BLADE	BRUSH	TWO-SIDED ROD	SPRAY	VACUUM
MActac Stow, OH; J. Chapell - 330/688-1111	●	80"	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Majilite Dracut, MA; J. Kapeckas - 978/441-6800 x 7405		63"	63"	63"	63"		●								●	●		●				●	
McLaughlin Technologies Wilmington, DE; T. McLaughlin - 302/709-3334						●	●	●	●	●	●	●	●	●								●	
Medco Labs Bedford, OH; 216/292-7546		60"		60"			●		●	●				●	●							●	
Microseal Industries Paterson, NJ; M. Silverstein - 973/523-0704		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Midwest Foil Indianapolis, IN; A. Cope - 317/375-1821		47"		47"	47"		●			●		●			●							●	
Missouri Stencil Products Farmington, MO; R. Cheek - 573/756-1600				●											●		●					●	
Monadnock Paper Mills Bennington, NH; D. Lunati - 603/588-3311	●	82"			82"				●	●				●	●	●	●	●	●			●	●
Multifilm Packaging Elgin, IL; 842/695-7600	●	50"		45"	50"		●	●	●	●	●	●	●		●							●	●
National Converting & Fulfillment Ennis, TX; G. Riecke - 972/875-5096		88"	88"	62"	88"		●			●				●	●					●	●	●	●
NEPTCO Pawtucket, RI; G. Kassabian - 401/722-5500	●	60"		60"	60"	60"	●			●				●	●	●	●					●	●
Nichols Paper Products Nichols, WI; B. Dahlin - 800/558-8010					●		●		●	●				●								●	
Nothwestern Ohio Foam Products Wauseon, OH; V. Jacobs - 419/335-4850		72"					●			●												●	●
Nova Films & Foils Bedford, OH; B. Smethers - 440/201-1300					61"		●		●	●				●								●	
Olon Industries St. Charles, IL; J. Kozuch - 630/377-6566					62"		●									●						●	
Oren Intl. Pensacola, FL; M. Jones - 850/433-9080		72"			72"		●		●	●				●								●	
Penco Co. Cypress, TX; K. Coffey/P. Butler - 281/469-8225		36"		45"			●		●	●				●								●	
Penta-Tech Coated Products Bangor, ME; P. Gaudet - 207/862-3105				64"					●	●				●									
Polaroid New Bedford, MA; K. McCarthy - 781/386-7141	●			62"	62"	62"	●		●	●				●	●	●	●						
Polykote Warminster, PA; K. Lane - 215/443-9492		55"	26"		55"		●		●	●				●		●						●	
Polymer Packaging North Canton, OH; T. Lehar - 330/649-6000	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Precision Coatings Walled Lake, MI; T. Trayner - 800/521-8380	●	72"		72"	72"	72"	●		●	●				●		●						●	●
Protac Blaine, MN; K. Jonman - 763/780-4740							●																
Protect-all Print Media Darlen, WI; T. Starck - 262/724-3292		62"	62"		62"		●		●	●			●	●	●	●	●	●	●	●	●	●	●
Qualified Innovation Sugar Grove, IL; G. Fuller - 630/556-4136		40"			40"		●		●	●												●	
Rayven St. Paul, MN; R. Mercado - 651/642-1112		56"	72"	54"	56"	72"	●		●	●				●	●	●	●	●	●	●	●	●	●
The Robinette Co. Bristol, TN; 423/968-7800				50"			●		●	●				●								●	
Roysons Rockaway, NJ; L. Campanaro - 973/625-5570		78"		78"	78"		●									●						●	
Semper/Exeter Paper Crestview Hills, KY; 859/341-7100							●	●		●				●	●	●	●	●	●	●	●	●	●

Company Location; Contact - Phone Number	COATING TYPE & MAX. WIDTH				PILOT/LAB FACILITIES		COATING PROCESSES				COATING TECHNIQUES								
	ISO CERTIFIED	100% SOLIDS ADHESIVE	WATER-BASED SOLVENT	WATER-BASED	LAMINATING	METALIZING	SLITTING	COEXTRUSION	EXTRUSION	OFFSET GRAVURE	ROLL COATING	ROTOGRAVURE	SATURATORS	SLOT/DIE	AIR KNIFE	DOCTOR BLADE	BRUSH	TWO-SIDED SPRAY	VACUUM ROD
Service Litho-Print Oshkosh, WI; 800/544-1493																			
Sheer Veneer Waukesha, WI; M. Brooks - 262/442-4086																			
Sierra Coating Technologies De Pere, WI; R. Shade Jr. - 920/983-8000																			
Situation Materials Twinsburg, OH; D. Mills - 330/425-1387																			
Sonoco Products Co. Richmond, VA; H. Bacon - 804/232-5411																			
Southeast Nonwovens Clover, SC; S. Nielsen - 803/222-5711																			
Spinnaker Coating Troy, OH; B. Glett - 937/332-6500			60"	60"	60"														
Technical Coating Intl. Leland, NC; D. Stanbury - 910/371-0860			90"	90"	90"														
Thermal Innovations Manasquan, NJ; N. Fusilli - 732/223-5533			30"	30"	30"	30"	30"												
3 Sigma Troy, OH; M. McCrillis - 800/347-3091			60"																
Thilmany Packaging Kaukauna, WI; C. Landreman - 920/766-8222																			
H.B. Tollette & Assoc. Sacramento, CA; B. Tollette - 916/923-2076																			
Transilwrap Strongsville, OH; 440/638-2000																			
Tribex Rocklin, CA; R. Brigham - 916/630-7310				68"															
Troy Laminating & Coating Troy, OH; H. Grashoe - 937/335-5611			66"	66"	66"	66"													
Tufco Technologies Green Bay, WI; M. Corrigan - 920/336-0054																			
Unifoil East Fairfield, NJ; 973-244-9900																			
Universal Printing Co. St. Louis, MO; J. Thouvenot - 314/771-6900																			
U.S. Foils Cleveland, OH; M. Jach - 440/832-0403																			
Vacumet Wayne, NJ; T. Kura - 800/722-6822				86"	86"														
Wausau Coated Products Wausau, WI; K. Marfin - 715/848-2741			40"	40"	40"	40"													
Wausau Paper Rhineland, WI; S. Sullivan - 866/507-4689																			
WebCut Converting Eagan, MN; D. Weber - 651/994-7084																			
West Carrollton Parchment Co. Carrollton, OH; A. Berens - 937/859-3621																			
Western Michigan Univ.-Pilot Plant Kalamazoo, MI; J. Waller - 269/276-3530					40"														
Yasui Seiki Bloomington, IN; H. Seelig - 812/331-0700				27"	27"	27"													