BMT
BETA MANAGEMENT TEAM

Production Speed Digital Fabric Printing

BMT's Breakthrough Technology

The single most costly element of today's soft goods business is the holding of product and parts in anticipation of a sale. This process depends on the maxim that the best way to create profit is to mass produce and discount the surplus. To make this gamble work the apparel delivery system has developed a cumbersome structure designed to stockpile the inventory in staged production surpluses, then to sell finished product in tiered discount and therefore reduces the risk for each participant. While this process has in fact lowered cost it has also lowered profit and customer choice. In many ways this solution has made a badly weakened segment of the U.S. economy even weaker. The solutions to profit erosion and lack of consumer choice are the same ... individualized mass production and delivery. Mass-Customization has been the theoretical answer for years... BMT has now completed the first totally digital fabric printing production facility designed to make the answer a reality. **Here are the details:**

Demonstration Plant Location:	**Ontario, California**
Minimum facility size:	**5000 sq.ft.**
Sustained production speed:	**250 sq. meters per hour**
Fabric marking technology:	**Sublimation**
Fabric requirement:	**Polyester fiber of any construction**
Minimum personnel required:	**5 per shift**

BMT Links Production Directly to Demand

Digital Virtual Inventory

Imagine thousands of apparel products inventoried in a file cabinet on CD's. That's the advantage of creating a virtual inventory ... no space requirements ... no product storage ... no factoring ... no clearance discounting ... continuous turns all the time. Here's how a virtual inventory works using BMT's technology.

1. Designers and product managers start with the white style shape. A digital marker for the white style is produced. The white style sample is cut, sewn and fit and markers for each size are entered into the computer database. Designers working in 3-dimensional CAD software then decorate the white style with printed images or solids and review the printed style on a 3-D size model that can be viewed from all angles on the computer monitor. The 3-D version is then saved for later use and the printed style is broken into sewing elements for production.

2. The digital style arrayed as the decorated cut pieces is now passed electronically to the graphics department which color corrects and builds the graded art and size layouts for the digital printing press.

3. A short run (5-10) of each size is printed onto the cut pieces and sent to sample sewing to check art placement, fit, costing and to produce the sew-by samples.

4. If the style is to be offered as a product then a sample run is completed.

5. The print ready digital SKU's are then stored on CD's and the style is ready for production on demand.

Mass-Customization

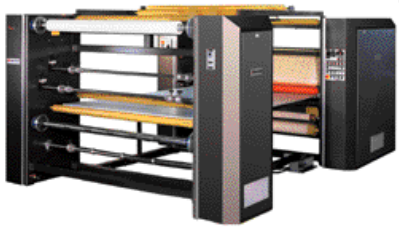
Mass production on an individual basis is defined as maintaining production speed and cost while producing individual output. This ability to mass customize is commercially viable only if production speeds and costs are not sacrificed. To meet competitive price standards in the printed fabric and apparel business requires a minimum speed of at least 200 yards per hour output with change-on-the-fly capability. In short, the assembly line marches ahead at the optimum speed but each unit of production can be different with no

loss of speed or excess cost. Since a digital press prints the image directly from a stream of data provided from the computer, the output speed never slows as the image changes from one design to the next. This constant stream of product must be digitally imaged directly from the production computers and controlled to respond to the inventory management system.

Digital Production Methods

There are three basic digital production methodologies. They can be used individually or mixed based on the requirements of the job.

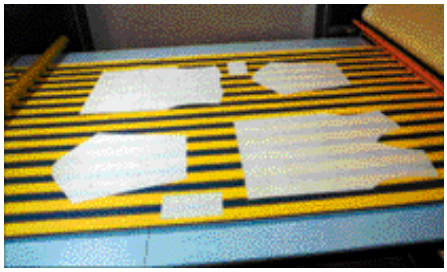
Roll to Roll (R2R)



This method is used when the fabric does not change during the course of the job but the print does. R2R is usually the choice when the job is a run of 3000 yards or less of a continuing repeat design(s). Because the print is digital the number of different print designs or colors in the run has no bearing on the cost or speed. However, since changing the fabric requires new setups for each different fabric used, the fabric must remain the same or the speed of production will be significantly reduced.

Roll to Piece (R2P)

When the job calls for changes in the fabric the best production method is to precut the fabric and use the R2P capability of the BMT printing system to maintain production speeds. In this method the precut white fabric pieces are dropped onto a contiguous stream of repeating print paper which then passes through the transfer roller dropping the now printed and finished cut pieces into the sorting trays. This method is best suited for garments that do not require exact design match across seams.



Piece to Piece (P2P)

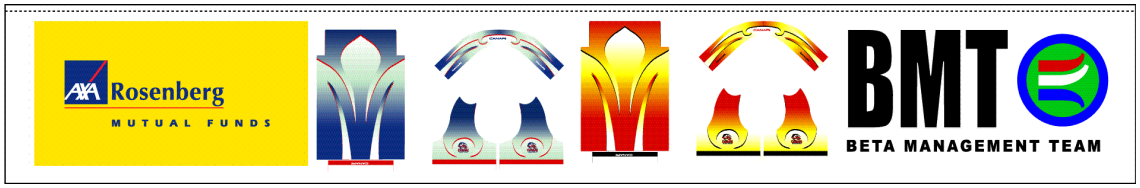
When the job is engineered to tight tolerances and non-repeating design the P2P method of production is the best choice. This method requires the prints of the cut pieces to be imposed on the paper and streamed through the transfer unit. The cut pieces are then dropped on the paper and the finished printed fabric is collected and sorted for sewing. The unique feature of the P2P method is that its speed and quality are independent of changes in either the print design or the fabric choice. This means that the P2P method can theoretically be used to produce product inventory that matches the exact mix required to replace consumer sales. This demand throughput production has the potential to reduce inventory to the absolute minimum.

Fabric inventory is kept in white either pre-cut or uncut with digital cutting markers stored in the virtual inventory and cut pieces are printed and sewn on demand. Orders are printed on “change on the fly” digital presses that have a capacity of about 300 square yards of nested cut pieces per hour. Since the pieces are already cut with the appropriate fabric direction the printing layout need not be concerned with grain and is therefore about 15% more efficient than a normal marker. The digital press is “change on the fly” and therefore capable of printing one or many of a style with no loss of time or additional cost. Once the SKU’s and count have been fed into the print control computer the press changes styles and sizes on the fly, converting the virtual inventory to a physical inventory containing only the styles and sizes already ordered at that time. By finishing only sold items the space for storage and cost of inventory liquidation are avoided. Since the inventory is digital the entire line can be transported in a single express envelope or

Internet packet to a remote printing site next to low cost sewing facilities anywhere in the world. Print ready SKU's can then be triggered for production from any properly authorized site in the world over the Internet. Since the total volume of sales is driven by consumer choice not inventory pressure the critical information and commitment occurs at the retail / consumer interface not at the buyer level. This shift from "inventory push" to "consumer pull" may take decades at the traditional retail level, but consumer demand drives the Internet, and apparel e-commerce will build until choice returns to the retail store. The trick is not so much managing the inventory as it is directing the throughput. Different SKU's can be printed side by side and since the press changes on the fly the cost is the same no matter what the volume.

"Change-on-the-Fly" Printing

The technology that enables this breakthrough in merchandising and product cost is "change-on-the-fly" printing using process colors on a continuous streaming donor. First, sales orders the SKU's and production volume from the digital inventory, the files are networked to the production managers print control computer. Once the printing operator has electronically organized the production run, the digital press produces a roll of printed donor paper. The donor roll is then placed on the fabric printer where either cut pieces or roll goods are permanently printed. The printed pieces are then bundled and delivered to sewing for final assembly.



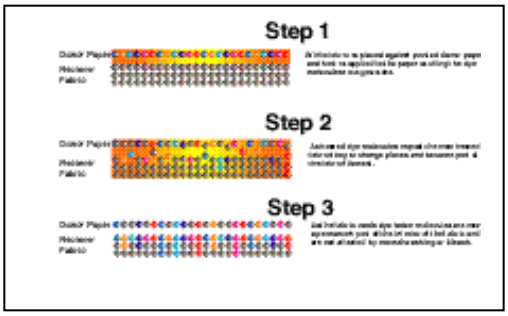
The concept of a continuous roll of donor paper or a continuous roll of fabric is not new. What is new is the ability to produce different prints, styles and sizes without ever slowing down the production process to change inks or substrates. This "change-on-the-fly" environment can only be accomplished with breakthrough technology in the use of process colors.

Printing with Process Colors

Imagine using one brush to paint the Sistine Chapel? Half of your time would be spent just cleaning the brush! However, what if you could produce the whole beautiful scene by just visually processing four colors? Throughout the printing world that's what happens every day, in magazines, on billboards, on your desktop printer, in your television and on advertising materials everywhere. The color photographs in Time Magazine could hardly be produced efficiently if each color had to be printed separately and the press had to be disassembled and cleaned after each pass. The only way you could print Time would be to reduce each picture to "paint by the numbers" spaces then put only those six or eight colors on the press. Even that solution would require so much preparation and post printing clean up that you would have to print tens of thousands of copies to get costs under the newsstand price. In fact, fabric printing is only one major type of printing left that doesn't use process color. Fabric printers have tried, but the physical dynamics of placing process color dots in exact position on a moving piece of stretching cloth at a speed that makes profits possible ... has been impossible. One way to solve the placement problem is to print all four of the process colors at the same time in one pass. This will assure the printer that all the process dots are in the proper position. The best method for printing the complete image at the same time is to print on a donor and the transfer it into the fabric in one permanent step. When this process uses dye dispersion transfer it is called sublimation.

Sublimation

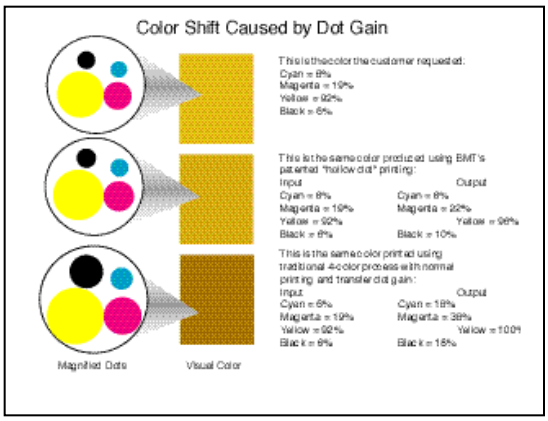
The illustration shows how heat is used to create dye laden gas that chemically changes the fabric to a new color. Since different fabrics and constructions react differently to liquid dyes and inks the problem of dot placement is only half of the battle. Each fabric has a



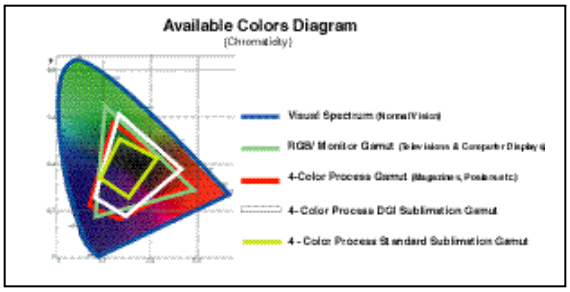
different pattern of expansion when a dot of liquid is placed on it. Just as ink from a felt pen expands more on a napkin than it does on bond paper the dyes in printing have uncontrolled expansion or gain on different fabrics. For years printers have tried to use 4-color process sublimation but an undesirable side effect of the flowing gas in the sublimation process has made it impossible to hold high resolution 4-color and to successfully match colors. This frustrating side effect is called dot gain.

Dot Gain

The increase in the measured tint value during prepress, platemaking, printing and transfer is known as dot gain. Dot gain is the effect that occurs when a larger-than-specified dot appears on the final printed piece. For example, you might specify a 10 percent dot, but when you measure the final printed piece the resulting dot is 15 or 20% larger. Standard printing technology has developed compensation curves and techniques for dealing with 20% dot gain, but the 200% dot gain common in sublimation (gas transfer printing) is too much for conventional technology to deal with.



Dot gain is a normal and expected phenomenon of the printing process. Variations in the amount of dot gain in sublimation printing occur because of differences in donor papers, inks and final substrates. Traditionally compensation for dot gain occurs in the process of color separating a scanned image. In sublimation printing however, the massive dot gain that occurred during the gas transfer of dye from the donor paper to the receiving fabric caused the dots to overlap at about 50% saturation and therefore negate the available colors produced by process color printing. Dot gain makes images look darker than they should, and when printing in process color, can cause unwanted color shifts (why isn't the sky blue?) and loss of subtlety in photographic prints. Dot gain in standard 4-color process sublimation reduces the colors available (see diagram) too less than a commercially viable palette.



Dot gain is a simple concept to understand. The paper absorbs the ink and the ink spreads from the image. Depending on the absorbency of the paper, the ink may spread very little or a great deal. That's dot gain. Each place where ink is put on paper, the ink spreads. When the ink spreads, the resulting dot size is larger than the specified dot size. A 15% dot may end up looking like a 17% dot. While this change may be insignificant by itself, when you combine the four pages of a color separation, dot gain can change the color of the image, usually degrading the image quality. When you factor in the additional step of turning the dots to dye laden gas and propelling them into a fabric receiver the dot gain becomes almost uncontrollable.

Since the color produced by a halftone screen depends on dot size, dot gain (or less frequently dot loss) can change the color intensity of the printed piece. Typically, the more dots you print (higher line screens at higher resolutions typically produce more halftone dots), the greater the dot gain.

BMT's Solution to Dot Gain

The technicians at BMT used radical thinking to solve the age old barrier caused by massive dot gain. The concept was to get each individual dot to implode rather than explode when transformed into dye laden gas. This new technology allowed BMT to develop inks, a digital press and a multi-use transfer unit that operate faster with higher resolution and color choice than current fabric printers, yet change print and fabric "on the fly" at no additional cost.