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TEXTILE FINISHING ENVIRONMENTS

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Textile Finishing Environments

Introduction

The 19th Century laundry industry evolved in dramatic fashion from its humble and sometimes oppressive beginnings. From a place in time when owners and workers, predominantly immigrants, were commonly identified as uneducated due to lack of language skills. Many of these forward-thinking operators were driven to find innovative methods to improve laundry processes and their personal quality of life. Motivated with a "can do" anything spirit, these early operators concepts established the foundation for the industrial laundry processes of today.

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Industrial laundry processing grew to keep pace with the ongoing demands of the industrial revolution of the 20th Century. Laundry processing quickly became segmented into the industrial, healthcare & hospitality marketplaces, each having its own unique processing requirements and equipment based on the served customer's needs. Over time, industrial laundry markets would explore growth & expand into other served markets. However, they typically stayed within their specific laundry core processing competency. Each end customer had specific requirements with respect to textile finishing needs for cleanliness, ironing, folding, garment pressing, materials laundered, packing and delivery. Industrial laundries of today have evolved into automated, efficient, real-time metric driven processing centers. These sites are capable of production outputs measured by tons of laundry produced daily. Grounded to many of the core concepts developed years ago, it's common for new industrial sites to leverage the most advanced automated processing equipment available. This helps to ensure consistency with operational processes, relying less on key people with specific skills or training.

Smaller owner-operated laundries, or on-premise company-owned sites continue to do well and should never be overlooked. With specific processing capabilities, they are efficient and capable of exceeding end customer expectations. Providing specific services to fulfill customer needs is not uncommon with smaller laundries. These sites are often found to be well managed, providing a high quality finished output. It's not uncommon for smaller sites to employ a diverse workforce, resulting in fewer pounds per operator produced than a larger industrial laundry. Smaller operations will typically leverage more direct labor with specifically trained skill sets with a reduced focus on automated equipment. This often results in processing at a slower pace, in exchange for delivering a high-quality final product.

Key inputs for sustaining laundry operations are common for both large industrial and small on-premise laundries. Aside from water, soap, and chemistry; a quality source of heat energy, compressed air, and three phase electrical service are all required to support proper site operations. A steam boiler will often be used to support the largest percentage of heat processing needs; from washing, drying, ironing, garment finishing and tunnel needs, with a standby thermal fluid heater for specific point solutions as required. The proper sizing and volume of compressed air is sometimes overlooked as plants are designed or expanded. The requirement for quality compressed air is very important. The finishing environment requires a stable, clean compressed air source for consistent folding, stacking, and ironer roll pressure. Electrical service must be balanced, properly phased and grounded to properly support processing operations. Any faults/shortcomings within these noted services can present unseen dangers to staff and often negatively impact equipment performance, including possible damage of laundered material.

Preventative Maintenance

Core to any laundry, regardless of its size, is preventative maintenance. The chief engineer defines the strategic business plan for sustained operations, including a budget and resource schedule to support known equipment service requirements. Plant engineers are responsible for the execution of a tactical plan, working closely with production managers to minimize equipment down time while supporting the defined PM schedule. Production managers communicate with the engineering team when equipment is not operating up to a plan standard or is offline in need of repair. Unfortunately, even the best maintained equipment at some time will present an issue. Some issues can be resolved internally with staff and parts on site, and others may require calling outside resources to aid with problem resolution. Part of the chief engineer's role is to have a contingency plan with contacts in place for sustaining site operations for when these events occur.

An effective preventative maintenance program should address noted items:

- Employee skill sets/training
- Site housekeeping
- Engineering training
- Documentation review
- Task-based risk assessment
- Sources for external support
- Local contractors
- Equipment manufacturers contact information
- Comprehensive PM equipment schedule
- Operational cost metrics
- Event tracking of trends and costs
- Site operations contingency planning

The evolution of a good PM program takes time to develop the proper inputs and planning tools. A computer-based software solution that captures all information and automates as much of the work order management PM process should be used. This is a living and evolving process as the needs of each site may not be the same. Owners must embrace the merits of maintenance and the return on investment that a good program affords…you can pay now, or you can pay more later!

Equipment manufacturers provide an "Operations & Maintenance (O&M)" manual that provides a breakdown of maintenance points, and the frequency when they should be addressed with every machine. This information should be used when developing a site-specific PM program. If unsure about the manufacturers equipment PM plan, contact the equipment manufacturer for clarification and guidelines for servicing equipment. Typically, maintenance tasks are broken down as daily, weekly, monthly; and some manufacturers might include hours of operation service intervals. It is recommended that site engineers keep an on-hand inventory of key replacement components to support quick response and minimize risks for potential downtime. If unsure about

what items to have on site, most manufacturers offer a recommended list of spare parts that should be kept on-hand. Additionally, many will offer wellness and service support contracts that can help augment your captive maintenance force in the completion of critical PM and maintenance tasks.

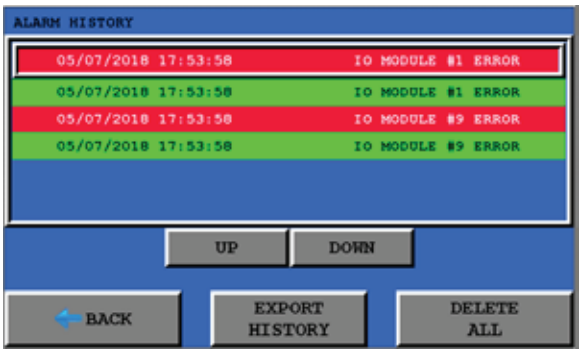
Listed below are examples of a few generic folder, feeder and ironer maintenance recommendations broken out into daily, weekly and monthly service intervals. This is for reference; you must consult your OEM for specific product maintenance procedures for your equipment.

Daily – Inspect guards/covers, confirming they are in place and functional. Qualify that E-Stop switches are operational and that machine motion stops as required. Replace any missing safety labels. Clean and de-lint all equipment including motors and drives. Clean and wax stainless skis and fold blades. Vacuum out inverter housings and electrical cabinets, inspect compressed air supply for water service as required.

Weekly - Inspect and service drive systems, replacing damaged components as required.

Inspect/clean chemical buildup on the iron at first chest. Inspect and replace damaged belt drive materials as required. Inspect and replace missing roller tracking material. Lubricate ironer bearings.

Monthly - Inspect and replace damaged conveyor belting. Clean, adjust and lubricate roller drive chains, replace as required. Inspect and replace rubber bumpers as required. Check all roller bearings, replace in pairs as required. Lubricate all cylinder shafts and rod ends.



Example of PLC Equipment Alarms

The most significant improvements to machinery to help with equipment PM and general operation over the last few years are control systems and machine displays. All OEMs have migrated to some variation of a touch-screen controller for their equipment. The screens for controls and displays vary across manufacturers. Controls platforms can be PC/Windows or PLC based, making it an easy and familiar platform for operators to use. All systems commonly offer a detail level of equipment diagnostics presented in a format that's easy to read and not coded with acronyms.

Garment Processing

Modern laundries with garment processing often use a steam tunnel with a specific configuration of a hot board press. Steam tunnels are a production piece of equipment that can be sourced in several sizes and configurations from various manufacturers. Items processed in a steam tunnel will be wrinkle-free with the appearance of having been pressed. Hot board press designs are wide ranging, and typically designed for specific applications. Because each product supports a specific application not all laundries will use all combinations of equipment.

An effective layout will minimize the number of operators required to handle and move items. Material handling of garments, and the storage and transportation between operations is a key factor with plant processing efficiency and productivity. Keeping garments in transport baskets for extended periods of time will allow wrinkles to set in and adversely impact operational objectives. When possible, it's best to minimize the amount of time garments spend in baskets or in sling bags. An effective garment system design will take all of this into consideration when designing a proper plant layout.

Tunnel Finishing Basics

Items can be processed through a tunnel finisher as wet-to-dry, damp-to-dry, or dry-to-dry. The type of process that is used is dependent on the moisture content of the goods to be processed.

Dry-to-dry will generally make the shortest time to process, but will not provide the best end-state quality appearance. Also, to get to the "dry" state it means that energy is used elsewhere in the facility where it may not be the most efficient.

Damp-to-dry will generally produce the best quality finish and overall is the most productive.

Wet-to-dry offers the least productive process due to the large amount of moisture that needs to be evaporated. The quality yielded tends to be better than dry-to-dry although not as well as damp-to-dry.

Process:	Starting Moisture Content:
Dry-to Dry	0 to 5%
Damp-to-Dry	35%
Wet-to-Dry	100%

Steam Tunnels Examples

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Tunnel finishing can be conducted on any of the three following types of machines: straight-through, U-turn, or triple-pass. On a straight-through machine, the goods are inserted on one end and retrieved on the opposite. U-turn machines send the goods through a "U" shaped path and are returned at the same end as the entrance. Goods follow an "S" shaped path on the triple-pass machines. Goods are either sent through the conveyor shoulder-to-shoulder or front to back. If the tunnel finishing machine is maintained properly, goods should exit the tunnel finishing equipment wrinkle-free.

Interior surfaces of a steam tunnel require regular cleaning to avoid buildup of a tar-like substance that will form inside the tunnel. The frequency of cleanings will be dependent on the garments processed and wash/rinse chemistry. Failure to properly clean and maintain the interior of a steam tunnel might result in eye and lung irritation to those operating around the machine. This tar-like substance is often a result of oils or wash chemistry remaining on the washed garments that then evaporates from the garments while passing through the tunnel. It is recommended that a visual inspection of items exiting a

steam tunnel is conducted to look for what might appear as smoke or off gassing. Both events are indications that wash/rinse processes are not effectively cleaning and/or rinsing excessive chemistry from the garments.

Garment Pressing Basics

Not all pieces of linen will go through a garment pressing system; generally, only higher-end items. There are various types of machines which assist with this process depending on the type of linen. With few exceptions, laundries predominately use steam as a heating source for all types of finishing presses. Like flatwork ironers, these presses also use vacuum systems to remove evaporated moisture from the pads. Vacuum may also be used on some finishing presses to hold garments onto the press (similar function to a vacuum feed table on a feeder or flatwork ironer). Most of these machines use one of two primary pad materials, with spring padding being most commonly used. In certain scenarios, with garment materials that can withstand high temperatures, a silicone rubber padding can be used.

Examples of Garmet Press Equipment

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The pants press can either be a legger/utility press or a pants topper press. The legger/utility presses utilize a padded buck, padded head, and leg shape board to press out the leg areas of the pants. A foot pedal is used to control the upper head. The padded buck and head are equipped with a steam inlet and a vacuum to remove the moisture introduced from the steam. The pants topper press uses a large steam coil and dual inlet blower to provide instant heat while drying and removing wrinkles from the upper section of pants.

When it comes to shirt pressing machine types, there are a few different options depending on the laundry operation. The buck press is offered in a single, double, or multiple buck variations. In this variation, the operator will load the shirt onto the buck, which is the body of the shirt. Generally, once the shirt is loaded onto the buck it will then be clamped at the sleeves and the neckline. A double, or multiple buck machine, will allow the operator to load another shirt while the other is being pressed.

Another option for the torso area is a tensioning unit. These units perform by holding the garment under pressure while introducing steam from the inside of the shirt. Tensioning units are versatile in that they can function with most garment lengths and sizes while providing for a high-quality finish.

The next step in the process for high quality finishing is pressing the collars and cuffs. This is generally done using a collar and cuff press. With this machine, the operator will place the collar and cuffs over pads before lowering down the head of the press overtop of them allowing the cuffs and collar to be pressed in one motion.

Sleever presses allow the operator to press only the sleeves of shirts. The operator will slide the sleeves over inflatable bags that can be adjusted to the correct size of the garment. Once the sleeves are in place the inflatable arms will slide into the steam chamber cabinet.

Maintenance guidelines for many of these machines are similar to other finishing equipment that utilize steam and vacuum systems. It is important to frequently check the functional operation of steam traps on these machines. Also, it is essential that a common routine is followed for cleaning the filters within the vacuum system. Over time, it will be necessary to replace the pads covering the press. The most effective maintenance guideline for these machines is cleanliness; keeping them clean and free of excess lint will be very beneficial to the lifecycle of the machine.

Garment Sorting, Pairing and Distribution

Soiled linen will generally be delivered mixed together with different levels of soil and types of materials. Smaller linen services will count and sort by hand what is delivered. In this scenario, operators will separate similar items and load them onto a conveyor that travels to a distribution station, where they are then loaded into the correct carts, bins, or slings/rails. Once a laundry reaches a large enough volume and it becomes financially unviable to use human counters/sorters, an automated soil system is used. With this type of system, the laundry can expect to see more than 2,000 pieces/hour counted and sorted compared to less than 100 pieces/ hour sorted manually. There are various types of sorting systems from a wide array of technologies using vacuum tubes, conveyors, and RFID scanners.

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Comparable to your home laundry, it is necessary to group similar items together to achieve the best wash possible. Proper sorting techniques will maximize your quality, extend product life, and increase general laundry efficiency. Laundry operators must be sure to split loads in the following compatibilities: material type (weight, color, and fiber), type and degree of soil, finishing method, and wash chemistry. Once the textiles are divided into the four categories above, they are then sorted into separate loads based on weight. These weights are determined by washer pocket capacity, bulk loading factor, and textile type.

Accounting for the load factor is essential. Both overloading and underloading will have negative impacts on the quality of the wash. Overloading will decrease the ability to remove stains, whiteness, and the life cycle of the textile. When a machine is underloaded, its mechanical action is decreased which will result in a lower quality wash. However, it is important to underload when washing bulky fabrics. It is also important to use smaller loads when processing polyester blends compared to cotton. Overfilling a polyester load will lead to increased wrinkles and add time to finishing processes.

It is recommended to review the following when determining the load size of soiled items:

- Know the washer capacity, this should be provided by the manufacturer.
- Determine which garments/materials will be loaded together.
- Decide what the finishing process will be based on the fabric type.
- Compare the soiled weight to clean weight of the garments being loaded.

Science of Feeding
Linen Feeding Technology

There are several different types of spreader/feeders on the market today, all of which have reduced the handling of goods by operators and increased the throughput and production of the flatwork line. Different machine types include small piece linen feeders, semi-manual feeders, clip feeders, clip-less feeders, and rail/staging feeders.

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Small piece linen feeders are typically the simplest of the spreader/feeder class machines. These machines do not have a spread mechanism and are used by operators when hand feeding multiple lanes of smaller goods like napkins/pillow cases. Rather than feeding directly onto the small ironer infeed table, this machine provides a larger and more ergonomic space to feed those smaller parts. Most designs include vacuum for the trailing edge, vacuum table top, and hold down wheels. Newer designs include a lighted working surface and lane indicators. When in operation, vacuum draws tails of longer rectangular items like pillow cases into a vacuum chute. While this applies slight resistance to the trailing edge, the operator places the leading edge onto the table top. With the trailing edge contained in the vacuum chute the operator can restart the process without delay. The objective is to edge the parts with minimal separation between fed items. Most units have space to place a feed trough or carts directly in front of the operator underneath the machine infeed table. All units can manage larger items like sheets by hand, however, owners are limited to accumulator/folder capabilities at the end of the line.

10.

Semi-manual feeders are typically slow, requiring three to four operators positioned centered in front of ironer far enough away for clear access to ironer infeed. Operators feed large goods in a single lane by hand onto the infeed conveyor belts running at opposing angles to each other loosely spreading the sheet leading edge, passing it on to a small conveyor or delivery box if equipped. Two operators located in front of the ironer on each side will take the sheets trailing edge from the delivery box and feed it into the ironer. As a hand fed sheet is going into the ironer chest, operators are required to help the process by fully spreading the sheet flat to prevent bunching or wrinkles. Production numbers for this semi-manual process will be lower than more advanced equipment. This process relies on employee training and handling skills to maintain proper feeding quality and will vary with operator's skills. This equipment design is old and due to the minimal guarding and safety features it presents a risk to end users. Also, it consumes a great deal of operational space that can be put to better use. In recent years, some laundries have locked out or removed these machines because of the safety hazard associated with them.

9.

Clip spreader feeders are named such because of the operator interface used to load and then transport goods into the machine for ironing. Clip feeders tend to have a lower drop rate than clipless machines, and are available in several different designs. Most often the highest quality feed lay-down comes from clip machines equipped with a vacuum paddle transfer. However, these types of clip feeders also require a regularly detailed PM for the delinting of blowers to maintain proper operation. With regards to employee training and operational skill sets, clip feeders are easiest to use.

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Operators will clip the corners from the same side of a sheet into feed clamps, which then travel into the machine where a transfer to spread clamps takes place. Depending on the machine design this transfer can occur equally spaced across the front of the feeder where items are spread and then moved to center. Other clip machines leverage a single point transfer design that ensures that the spread and feed of each piece of linen is centered prior to transferring to the ironer or folder. Once the spread clamps have grasped and spread the item, there are several different ways that laydown can occur based on manufacturer and model. Single deck clip feeders typically require two to four operators and have a wide range of line speeds from 60-130 fpm. Dual deck clip feeders operate like single deck clip feeding machines providing increased throughput capacity and the ability to overlap items without over cycling the spread mechanism. The versatility of a clip spreader/feeder machine is part of what makes them so popular in the industry. Clip feeders can accommodate a wide range of goods, from small table linens to large king-size sheets and duvets.

Many models also have the capability of converting to a small-piece mode to handle smaller goods in multiple lane arrangements. This dynamic capability affords end users extreme flexibility as they optimize the use of their equipment and labor.

Clip-less machines work much like their name implies,

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there is no need for the operator to find and clip corners of the goods into feed clamps. Once the operator positions the approximate midpoint of a sheet onto a narrow stationary conveyor belt, the sheet is transported into the machine. The number of stations can vary from one to three and have claimed line speeds grater then 150 fpm. Much like a semi-manual process the leading edge of the sheet will pass over the end of the feed station conveyor. As the trailing edge becomes apparent, the transfer clamps will locate the trailing edge corners that will later become the spread and fed leading edge. The transfer and speed of the spread mechanisms typically produce a lower quality and often uncentered leading edge fed into an ironer, as well as a much higher drop rate than clip machines. Operators should evaluate feeders based on the total number of items that were fed and folded as opposed to only piece rate for number of fed parts. Clip-less designs are limited to processing goods that are single layer flat and include square corners. These feeders typically lack the ability to hand feed smaller parts in multiple lanes. Clip-less designs do not support processing Duvets, Contour Sheets and small parts in multiple lanes.

Another type of spreader/feeder that is used strictly for larger goods would be rail or staging feeders. Rail feeders work much like clip feeders do, but the big difference is the loading takes place away from the front of the

machine. This allows for operators to stage goods on a rail system, preloading the machine. This can be useful to keep operators working while a machine downstream may have stopped, or the rail can be preloaded so that the machine continues to run when employees go on break. Rail and staging feeders are larger machines with a much larger footprint. They also have an increased cost up front, as well as increased maintenance and potentially a higher cost of replacement parts, as there are more clips, supports, etc. These machines are also operated by three to four individuals and have claimed throughputs of over 1,000 pieces per hour.

Spreader/Feeder Performance Metrics

In today's market, the emphasis is on speed, throughput and quality. Those three factors are key drivers when sizing new equipment. Clip-less machines lay claim to having the most throughput, achieving over 1,000 pieces per hour with healthcare sheets. Today, it's not uncommon to hear claims of 1,200-1,800 pieces per hour with healthcare sheets. Single deck clip feeders are slower, with claims in the 900-1,000 pieces per hour mark, regardless of product type *(Note: Dual deck clip machines offer performance in the 1,200-1,500 range as well).* Clip feeder performance applies to both hospitality and healthcare sheets or linens; providing a consistent, higher quality of feeding and a lower drop percentage than clipless machines. Clip feeders are observed to have a 2-5% drop rate at the feeder, while some clipless machines have been observed to drop up to 15% of the goods at the feeder, reducing throughput. Typically, any drop rate over 5% is viewed as unacceptable by laundry standards. It should be noted that dropped linens typically are sent back for rewashing which diminishes sales revenue per piece life-cycle, while increasing the cost per piece produced.

Speed claims for individual feeders is one thing, but the real world limiting factors in the laundry comes down to ironers and operators. The speed and throughput of the ironing line is determined by the running speed of the ironer. The fastest claimed clipless feeder won't out-produce a clip feeder if it is paired with the incorrect ironer type and size. Operators are also a limiting factor in laundries based on their training, effort and fatigue. Lack of proper training can lead to higher drop rates and lower quality. Fatigued operators will yield lower production numbers as they get further into a shift. It's been found that the typical operator can only feed 300-350 pieces per hour for the duration of a shift. Some select individuals for short periods of time may yield higher production numbers, but in most cases higher rates will not be sustainable.

When optimizing a feeder and ironing line performance, it's also important to look at the default formulas offered by manufacturers. Most machines will require different formulas to be set up by the user for each specific style, size, or material of goods to be processed. This is often required because not all materials respond the same when

Healthcare Example:	Clip Feeder	Clipless Feeder
Feed Rate	900 parts per hour	1000 parts per hour
** Drop/ Misfeed Rate	3% (27 Parts)	15% (150 Parts)
** Throughput	873 parts per hour	850 parts per hour
Quality Feeding	Consistently Good	Inconsistent
Operator Fatigue occurs at 300-350 pieces/hour/person	3 operators @ 300 parts/hour (sustainable for duration of shift)	2 operators @ 500 parts/hour (operator rotation and sheet preparation is required to sustain pace.

being spread, and the fact that operators may feed parts differently than their coworkers. Some newer equipment does not necessarily require a formula change based on goods being processed. This is because the spread device measures the width of each fed piece, and spreads to a certain distance based on that measurement. However, formulas are still important to have for specific items and on a feeder if it's linked to a folder at the end of the line. Customers will want goods sorted or separated on the back end, requiring formula data to be passed down the line to the folder. Just like there is no single feeder for all tasks, there is no single formula for all goods.

Markets Served and Relationship to Feeder

There are a few different laundry processing centers that use finishing spreader feeders and they each have different needs and requirements that must be fulfilled. The major industries include healthcare and hospitality, inclusive of food and beverage.

The healthcare market for industrial laundry equipment includes hospitals or large-scale laundry processing plants that are contracted to fill the need for healthcare facilities and out-patient clinics that don't have their own processing capabilities. The healthcare market is driven by throughput, with a reduced emphasis on final quality. This market tends to leverage clipless machines to achieve their desired throughput performance metrics. More recently, insurance carriers are holding healthcare facilities to account for the quality of the patient experience. This has resulted in a recent emphasis on finish quality becoming more important consideration for the hospital and laundry provider.

The hospitality industry needs are different than those of healthcare, and include hotels, resorts, cruise ships, etc. There is stricter attention paid to detail regarding quality and the presentation to the end user of the finished linen. Sheets/linens processed in the hospitality market are often a higher quality than standard healthcare products, making clip feeders of various configurations the more prevalent machine of choice. Food and beverage items typically are smaller, and many of them will be hand fed in multiple lanes into an ironer using a small-piece linen feeder configured with vacuum. Table linens can also be fed by hand on small-piece linen feeder, provided the folder at the end of the line will support those items. Some of the large table linens can also be processed on a clip feeder in single or two lanes depending on the ironing line configuration. As you design your processing environment it is important that you plan for the future and install dynamic equipment solutions to help reduce brick and mortar costs, as well as operational labor and energy costs.

Spreader/Feeder Configuration and Features

Every manufacturer has a different take on spreader/feeders. No two machines are the same because different manufacturers believe in different ways of doing things. However, even with all the differences, there are a few configurations and key features that almost every manufacturer has on their piece of equipment. These features include single deck and application of vacuum, controls, drive systems, and spread systems.

The overwhelming majority of spreader/feeders on the market are single-deck configurations. The term "single deck" is referring to the table that the spread parts are laid down on. Clip-style single-deck machines are often capable of running small goods as well. However, different manufacturers take different approaches to doing this. Some manufacturers use an automated table where the table height lowers down as the feed stations move or rotate up and out of the way. These machines are often expensive, complicated, and require more maintenance. Other manufacturers have a main laydown deck that does not move, and instead provide a lower small piece feed deck where the table moves into position when needed.

One feature that is very commonly provided by manufacturers is vacuum. Each OEM uses vacuum in a myriad of different ways. One application is the use of a vacuum table with perforated belts. This helps provide better quality of the goods by keeping them tight and flat to the belts as they are conveyed through the machine. Some manufacturers provide vacuum feed tables on both hand

Vacuum Box

**Applies resistance onto the trailing edge of a fed sheet finishing line.*

Vacuum Paddle

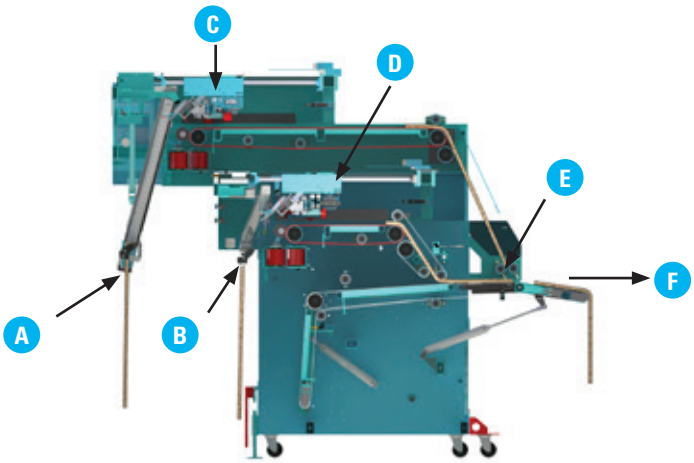
Transfers the leading edge onto infeed or vacuum table..

Vacuum Table

Keeps the leading edge and sheet body in contact with vacuum table surface.

fed and large piece tables as part of the functional design of the machine. A second application of vacuum would be with vacuum boxes drawing the trailing edge of the good in as it is being spread. This helps aid in the spread movement as well as holding the trailing edge tight. Vacuum boxes often may have a brush or belt assembly to aid in the spreading of the lower portion of the goods. Vacuum paddles are another very popular feature on machines. These paddles are used in the transfer of goods from the spread clamps to the laydown table. This often provides a crisp, consistent leading edge on the part and good quality throughout the line. However, even though vacuum is a very common feature on machines, it is not without its disadvantages. One major disadvantage is vacuum in any configuration is very maintenance intensive. If vacuum is not consistently maintained and kept free of lint and debris buildup, laydown quality diminishes substantially. Other disadvantages include the noise of a vacuum system and energy required to operate it.

A unique design on the market is the dual-deck feed-clip spreader/feeder. For practical explanation, it contains two machine spreading systems within one panel chassis. This design increases throughput without overworking the feeder spread clamps. Each spread deck cycles in half the time of a single deck with the same production output. The advantages of the dual deck machine are reduced cycles, extended durability, redundant spread deck in the event of failure, ability to overlap parts at 130 fpm, reduced drops, consistency with fed items, and higher net productivity than a single deck clip feeder machine.



Common Locations & Descriptions of Dual-deck Feeder

- **A** Location of two upper deck feed clip carriages
- **B** Location of two lower deck feed clip carriages
- **C** Location of upper deck spread carriages, independent operation.
- **D** Location of lower deck spread carriages, independent operation.
- **E** Location of incline conveyor controls sheet overlap
- **F** Discharge to flatwork ironer

There is no shortage of moving parts on spreader/feeders. The drivetrains of the machines can be complicated, and companies can use a variety of systems to drive machine decks, spread systems, spread belts, etc. Machine decks are typically driven by electric motors with a combination of gearhead and reduction ratios. Attached to these motors may be any variety of chain or belt configurations. Manufacturers are moving away from roller chain and sprocket setups. In its place, poly-chain, also referred to as timing belt, is becoming the most common material because of its ease of maintenance and reduction in noise. It is also very common to see combinations of round belts, v-belts, and flat belts. Drive systems are becoming more electronic in the respect that mechanical and pneumatic components commonly found in older equipment are being replaced by electrical components or electrically driven actuators.

Internal to a spreader/feeder is the spread system. This configuration will vary amongst manufacturers in terms of the number of hand-offs and locations. Some use multiple hand-off locations, one for each station, as the station transports the goods vertically up and away from the operator. Requiring multiple drives on rails with multiple transfer points with two or more alternating spread clamps. Another approach is center single point transfer in which all the individual stations move up and toward the center of the machine for the hand-off. This approach reduces the drive complexity of the spread rail as only one driver is needed to move both spread clamps as they are tied together with a simple belt mechanism. Center-point transfer ensures parts are centered on the machine when laid down every time without exception. The current evolution of high-speed spread systems leverages variable frequency drives, and a servo- or stepper-driven spread rail system to insure consistent and durable equipment operations. All equipment designs are different and require various types of spread systems.

No single configuration is better than another. It's important to understand the skills and knowledge base needed to service spreader feeders. Most equipment manufacturers will offer specific equipment service training to help develop team members requiring detailed knowledge of equipment.

Science of Flatwork Ironing

Ironing Technology

The science of ironing has remained relatively unchanged over the years. It's the application of technology, equipment designs, heat sources used, and configurations of deep chest ironers that have evolved to support demands of the market/industry. In today's modern laundries, the capability of the ironer is typically what dictates the production capacity of the processing line.

(There are limited exceptions to this which will be covered below). Keeping ironers optimized from a utilization, and maintenance perspective is the best way to realize an ROI from a textile finishing line. As we review the science behind the ironing process, a simple model (Figure 1: Ironing Pie®) was used to depict the four major variables that dictate capability. This chapter of SSTT Finishing Technology will explain the science behind these components. Although brief, this description of the "Ironing Pie®" is an important concept to understand. It is critical that laundry operators understand the relationship between each piece so that they can properly establish formulas for processing linens in an efficient and cost-effective manner. In review, the four "Ironing Pie®" components; Temperature, Moisture Content, Pressure, and Time are shown as equals only for a point of reference. Equal and balanced distribution of the four elements is not the case in a true ironing application.

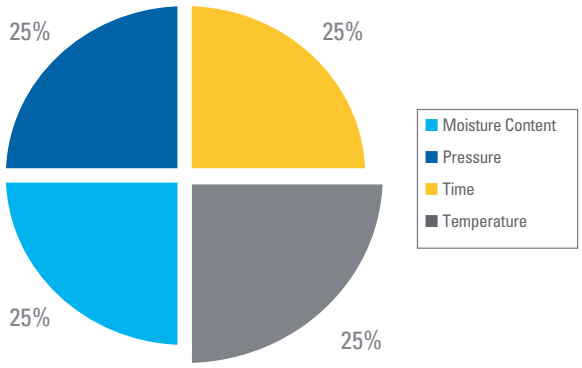


Figure 1 Ironing Pie® "Temperature".

Ironing Temperature

Heat unarguably has the single most direct effect on an ironer's ability to iron. Heat as a variable must be valued as the chest surface working temperature. The most common temperature range is from 325°F – 365°F (ideal operating range based on the heat source, and the melt point of various blended materials). The most commonly found form of ironer heat energy is steam, given that most laundry facilities already have boilers and the capacity to support the steam demands of the ironer (it should be noted that steam boilers run more efficient when they have the proper load placed on them). Steam ironers tend to operate in the 325°F – 340°F range, while thermal fluid heated units can operate at higher temperatures. Variations in chest temperatures during production can result in poor ironed quality with damp/wet items exiting the ironer while prolonged exposure to extreme high temperatures can damage items. This magnifies the importance of having a consistent moisture content in the linens as they are presented to the finishing lines. By doing so, established formulas will provide consistent quality, and production output.

When establishing formula operating temperatures, it's recommended to consult your linen provider for guidance on how to properly care for your items. Knowing the items maximum recommended exposure for temperature is always something to consider. The most common configuration is to operate the ironer as hot as possible and adjust line speed to control an items exposure to heat.

Once an ironers maximum operating temperature is established, any reduction in chest surface temperatures will increase the time required for the items to be under pressure, resulting in slower line speeds. To offset operating at a slower line speed, other pieces of the "Ironing Pie®"must be addressed. You can reduce the items moisture content by increasing your extraction times, or extraction time under pressure *(depending on how the linens are washed in conventional washer/extractors, or if they are processed in batch tunnels).* Additionally, you can positively influence lines speeds to address higher moisture content by simply adding additional rolls/surface area to your ironer.

Ironer Heat Sources

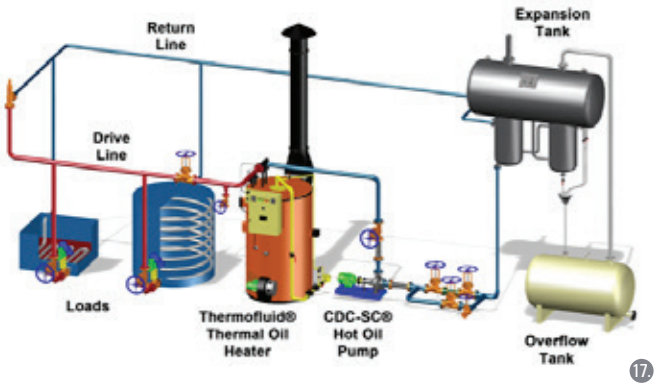
Steam

Steam heated ironers are piped so the heat source is away from the main process, circulating steam through the ironing chests. Utilizing steam traps on the underside of each chest section allows the steam to transfer all its energy to the heating surface before condensing and returning to the heat source. Steam pressure can be controlled to allow even heating across the entire surface of the machine. However, with steam it's often difficult to control precise process temperatures. For example, high temperature steam systems require chemically treated feedwater to prevent scaling and corrosion. Flash losses may reduce energy efficiency up to 13% and malfunctioning condensate traps can further increase energy losses. Additionally, process temperature control may be limited to ±10°F due to the difficulty of maintaining pressure control valves.

16.

Thermal Fluid

Thermal heated ironers use thermal fluid to continuously transfer heat from the fluid to the ironing surface. Thermal fluid is more stable than steam and operates at much lower system pressures. There are no blowdowns or flash losses to reduce thermal efficiency, nor any ongoing fluid makeup requirements. When selecting a thermal fluid, the following characteristics should be considered:



17.

Benefits and Considerations to Using Thermal Fluid

Thermal Stability: There should be no significant change in the chemical composition following repeated heating and cooling cycles

Intrinsically Safe: It should not present an extreme fire or explosion hazard under normal operating conditions. Properties such as flashpoint and fire point should be evaluated prior to selection. A thermal fluid system should never be operated above its atmospheric boiling point due to the potential for mist explosions around leaks.

Chemically Safe: Incidental exposure should not be hazardous to operating personnel.

Low Viscosity at Ambient Temperature: High viscosity fluids may require heat tracing on all lines to facilitate cold system startup.

Low Vapor Pressure at Operating Temperature: Low vapor pressure eliminates the need to pressurize the entire system to prevent pump cavitation.

Good Physical Properties: The heat transfer coefficient is directly proportional to the specific heat, density, and thermal conductivity, and inversely proportional to the viscosity.

Processing oils come in 3 main types: Aqueous oils such as brines and glycols, and Mineral oils and Synthetics such as silicones and aromatic blends. Mineral oils are

the best choice for ironing as they have been refined for a proper balance of flash point and viscosity. The maximum temperature of the oil should never exceed 610°F. Allowing the oil to operate above this temperature will cause thermal cracking and begin to break down the oil. Over time, this will reduce the oil's effectiveness in dispersing heat throughout the system. As the thermal conductivity of the oil decreases, the gas consumption of the heat source will increase to compensate.

Thermal ironers are configured in either remote heater or self-contained heater varieties. Remote thermal ironers are also piped so the heat source is remote to the main processing area. An external thermal heating system requires a trained mechanic to operate and maintain it. Depending on the number of appliances utilizing the heating system, the operating temperature of the ironer is limited due to the site's shared needs of the remote heater system output. A self-contained ironer incorporates the heater, burner, pump, and expansion tank onto the ironer itself. It's for this reason that this type of stand-alone ironer is referred to as self-contained ironer. This type of ironer allows for greater temperature control of the oil, as its sole requirement is to support the needs of the ironer. The heaters proximity to the ironer chest negates any heat loss from remote processing pipes as well as direct control over the output of the ironer system burner. This configuration of ironer is a good point solution for accounts that have no additional boiler capacity but need to add ironing capacity.

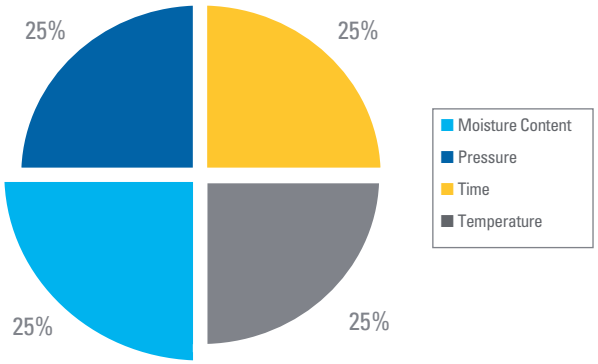


Figure 2 Ironing Pie® "Moisture Content"

Materials Moisture Content

Moisture Content is a key component within the "Ironing Pie®" that starts as a weighted comparison of a linen's ability to retain moisture after having been processed through a press or washer extractor cycle. This is achieved by weighing dry linens before being washed and again after the linens have been processed as delivered to the finishing line ready to be ironed. Moisture content can then be calculated by following the formula below:

$$\text{Moisture Content} = \left(\frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Wet Weight}} \right) \times 100$$

	Steam Ironer	Remote Thermal Ironer	Self-Contained Ironer
PROS	• Temp 325°F – 340°F • Boiler is not on production floor • Supported by most common laundry heat source • Supports use of polyester pads and ribbons	• Temp 325°F – 365°F • Thermal heater is not on production floor • Operates at lower heat source pressure	• Temp 325°F – 365°F variable. • Independent heat source • Operates at lower heat source pressure
CONS	• Temp is dependent on central heat source shared output psi and BHP • Difficult to control precise process temperatures • Operates at a higher heat source pressure • Process pipes subject to corrosion	• Temp is dependent on central heat source shared output temp and GPM flow rate • Requires high temp Nomex pads and ribbons • Thermal fluid requires annual testing/replacement as required	• Thermal heater is on production floor • Requires high temp Nomex pads and ribbons • Thermal fluid requires annual testing/ replacement as required • Increases complex maintenance requirement for an Ironer

Its recommended that items contain 30%-40% moisture content before ironing. Adhering to this guideline will help assure a quality ironed finish, while minimizing linen damage. It's true that a reduction in an item's moisture content is directly related to increased processing line speed under temperature as noted above, but fully dried items should not be processed through an ironer. Attempting to achieve lower extraction percentages might not be practical as a scale of diminishing returns will occur with no value added. Every site is different and each needs to qualify its own capabilities for this measure. When a site is having issues controlling moisture content, pre-conditioning loads in a dryer is another process that can be considered. What's important is to develop a process producing repeatable moisture content for items processed on the front end of the finishing line. Items exiting the ironer should maintain 2-3% moisture content, as this will allow smooth folds and preserves the life of the fibers, while reducing the creation of lint and static electricity. Items ironed fully dry without moisture retention present are prone to fiber damage, excessive accumulation of lint and creation of high levels of static electricity.

Increased front end item moisture content will increase the amount of time required for an item to be under pressure, resulting in slower line speeds which decreases throughput. To offset the impact of slower line speeds, increasing chest temperature and contact area under pressure, both will aid in restoring line speed. When chest temperature is operating at the highest potential for output, pre-conditioning select items has the potential to reduce moisture content, inversely restoring an ironing lines capability for throughput. It should be noted that discharging items with elevated moisture content will typically result in poor fold quality, folding equipment jams, and unplanned operational down time. Also, it can present a hygienic liability as mold can manifest on damp linens that are stored or packaged for shipment to end user.

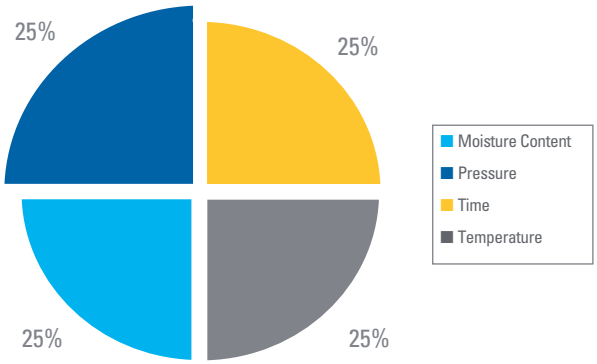


Figure 3 Ironing Pie® "Pressure"

Ironing Contact Pressure

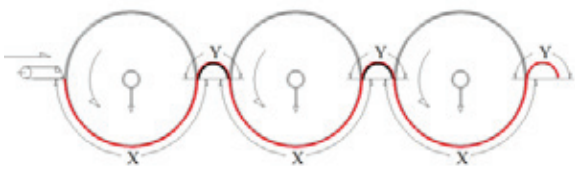
The "Ironing Pie®" defines pressure as the location where the padded roll applies pressure onto a sheet against a deep chest simultaneously. There are two components to pressure; the first is the surface area under pressure which is dictated by the size of the roll utilized, and the number or rolls with which the ironer is configured. The other pressure variable is the applied surface physical force between an ironer roll and its respective chest surface.

The first pressure variable is established at the time of equipment purchase, often within the customer bid specification which defines specific site configuration factors and performance throughput. Ironer OEM's are best suited to provide guidance sizing an ironer, since each manufacturer will understand the impact and limitation regarding contact area under pressure and how their ironer will perform. It's debatable if the use of this term might have been over-marketed, a simple statement is the size of the ironing surface should be looked at as a linear value and not the accumulative total area of square inches. It's necessary to understand the impact of contact area under pressure is fixed to the number and size of rolls utilized. It is not recommended to leverage this value as the single qualifier for ironer performance or to justify the purchase of similar sized 2 or 3 roll ironers. Many additional factors require consideration *(i.e. chest type, construction, design, number of rolls and size of rolls all need to be part of the selection process).* Make sure to use all factored

inputs to correctly define ironing needs, a good up-front purchasing decision establishes a flatwork line return on investment for years to come.

Understanding the Term "Area Under Pressure"

Area under pressure is best measured as a linear value without regards to ironer working width. Doing so provides a better representation of the working capabilities for the ironing surface as distance under pressure. It is important that rollers and chest maintain equal even pressure across the working width to insure quality ironer performance and maximize line speeds.



Linear ironing pressure = Sum of (X + Y)

Location X = Is the only true area that's under roll/chest pressure.

Location Y = Is the heated gap and transfer plates under guide ribbon pressure tension.

Location W = Is the width of the heated chest.

The term "contact area under pressure" is commonly represented as shown, being the complete heated surface area available. Unfortunately, utilizing 100% of this calculated space is not practical. True that the results of this value are correct for area calculation. However, it can be misleading if not fully understood; know that oversizing ironer width increases the value for area under pressure but will not increase line speed or improve system performance.

Contact area under pressure = Sum of (X + Y) x Width

The second pressure variable applies to surface force displaced by the rolls/chest points of contact onto the heating surface. This area is used to press and iron the moisture out of the linens. A general guideline for heavy, deep chest ironers is not to exceed 7 psi for down force. It's important to consult your ironer OEM to define upper limits regarding maximum pressure/force for your ironer. While the roll/chest are pressing items passing between them, concurrently each roll is drawing vacuum into its center. During this process the roll pads are being heated and transferring moisture from the linens to the pad (often in the form of steam). This action occurs in that zone noted as contact area under pressure. As each roll rotation continues, the heated wet section of roll becomes exposed to the cooler open area outside the chest starting the process of cooling and drying the pads. The ideal state would be for each roll pad to remain hot and become dry before contacting the next piece of linen. Therefore, it is important to have as hot and air tight an "ironing box" as possible making insulated covers and canopys very important. Removal of moisture during the ironing process is only as effective as the moisture content of the last ironing roll at the point where that roller exits the ironing chest. This means that during production only the last ironer roll will ever become dry during the cooling/drying phase. It will retain more heat than the other rolls providing a pressed quality finish. The more rolls in operation on a deep chest ironer spreads the working load of the ironer, improving contact pressure and improving the ability for each roll pad to become dryer in its final rotation. The measure is not linear, but a simple example

is a 2-roll ironer where each roll is required to support 50% loading compared to a 3-roll where each roll only has a 33.3% load. This reduces the roll working load by 17%; making its process quicker even when the roll contact under pressure is proportionally reduced. Adding rolls produces faster line speeds provided the heat source can support the additional loading. Beyond that, any direct increases with temperature would create additional gains to line speed.

During production, ironer pads will wear and restrict the ability to draw vacuum through them. The fewer number of rolls, the more critical both pressure and vacuum settings can be. It's recommended to be conservative with roll pressure settings as excessive roll pressure will cause rapid pad wear, reduce the life of the spring press, and require increased waxing and consumption of wax. Know that during production the ironer roll pads are either being heated or cooled, excessive vacuum drawn thru the roll pads in a cooling phase will lower the pad surface temperatures and inversely cool the chest as they remake contact with the hot chest surface. The impact of temperature loss from excessive vacuum draw can vary by machine design. The presence of insulated canopies, and the condition of the ironer and its heat source will all impact how much. Your equipment OEM is best qualified to identify the most effective solution for roll press and pads for their manufactured ironers performance. Changing the weight of roll padding and/or type of spring press can have an expensively negative impact to equipment performance and should be avoided.

Ironer Operational Requirements

Effective use of proper roll down pressure is directly related to the need for proper waxing. This is key to reducing friction under pressure between the rolls and chests, supporting increased ironer speeds, preventing goods from rolling, for producing fine finished work, and reducing static electricity. The right wax used in the proper amount will also aid in preventing soil deposits on chests and padding. Over-waxing, or improper application of wax, will increase friction to the rolls and chest, reduce output, create additional build-up, and soil goods. Due to different providers of ironer wax/lubricants it's not as simple to qualify a single source for powder and smear waxes. Schedules for waxing are best managed around employee's break and lunch times to minimize disruption to planned production run times. You are encouraged to meet with your local provider of laundry consumables for support on selecting the proper wax for your application as no one type fits all needs.

A few topics to keep in mind when selecting a wax:

1. Know your ironer operating temperature segmented into the following three ranges.

   Low Temp <300°F - 315°F = Paste Smear w/Clean & Wax Compound

   Hot / Design Spec Temp 315°F – 335°F = Powder Wax / Karagami Flake/Chip

   High Temp / 335°F to 365°F = High Temp Paste or Powder Wax

2. Know the blends and types of materials being processed on your ironer.
3. Understand the pH residue in sheets. Sheets with High-pH chemistry have the potential to foul chests. These situations might merit using a wax with a cleaning agent.
4. Laundry ventilation, waxing the ironer creates off gassing. Some smear waxes will fog and some flake waxes will have an odd smell.
5. Remember your consumable provider of laundry wax will in some cases also provide you roll pads. Share your waxing process and procedures with them to insure you get maximum life out of the pads.

Cleaning of chests needs to be done on a regular basis. A light cleaning should occur as part of the waxing process. It can be accomplished by utilizing a waxing cloth with cleaning scrim that's manufactured into the cloth. After running a wax cloth through, it's a good idea to send a couple of clean older items thru the ironer to be sure to remove any residue that might remain on the chest surfaces. Use proper safety procedures when waxing an ironer as the potential risk for fire is high, if unsure of your processes contact your OEM for guidance.

Monitor the first 10-12 inches of the first chest, this is the location where cool, wet sheets make first contact with the hot chest. It's also the location that will have the most rapid accumulation of chemistry scale and will establish the frequency requirement for chest cleaning at your site. Excessive scale at this location can also be an indication of potential issues with other areas of the laundry wash, rinse, and extract process that may be in need of attention.

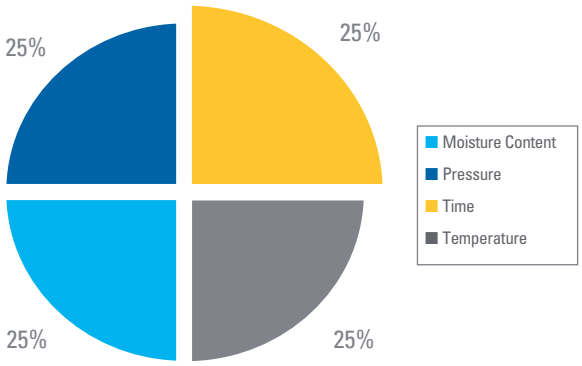


Figure 4 Ironing Pie® "Time"

Ironing Duration of Time

The "Ironing Pie®" defines time as three different variables. The duration of time for each variable is site-specific and all are impacted by the factors identified in the "Ironing Pie®".

- Start Up Time
- Production Time Under Pressure
- Cool Down Time

Key input factors specific to ironer time are desired operating temperature, items processed, moisture content, and contact pressures.

Start Up Time, is the duration of time required to raise the temperature of the ironer from its current static or ambient temperature up to "hot" wax ready operating temperature. This segment of time is directly dependent on the type of ironer, specifically its heat source with respect to starting chest temperatures. During this time most laundries will execute a wax procedure and will replace any missing guide ribbons so that when complete the ironer is production ready.

Production Time Under Pressure, is the segment of time when the ironer is hot at operational temperature and available to run flatwork production. This is when equipment utilization becomes a measurable, and where an ROI can be verified while looking for opportunities for improvement. A good approach is to tune the ironer line speed for sustainable site operations that's item-specific for predictable, repeatable results. During the utilization review, note all identified shortcomings; some can be resolved as tuning opportunities while others may be fixed constraints requiring a more complex series of solutions. A good objective should be to keep the ironer chest covered with items and processing with minimal gaps. Items should exit the ironer with 2-3% moisture retention to prevent static electricity, producing a quality ironed, wrinkle-free appearance. Avoid attempting to configure line speeds to operate beyond the slowest piece of equipment or at full boiler capacity, some cushion is required to absorb momentary changes within the plant operating environment.

Time under pressure is the amount of time the ironer roll is pressing items into a hot chest. This value has a direct relationship to the amount of fixed contact area under pressure. The longer this linear contact pressure distance is, the less time under pressure is required to iron. Other factors that can impact time under pressure are fabrics; for example 100% cotton will require more time under pressure than a cotton/poly blend or microfiber.

Cool Down Time, is the time required to lower the temperature of the ironer from operating speeds down to cooler "touch-safe" temperatures. It's obvious that cool down times will be affected by operating temperature and the type of medium used to heat the ironer as well as the size of the ironer itself. Even if your daily operations never fully shut down laundry boilers, it's important to qualify the time required to cool the system for servicing the unit and restarting. Certain PM and servicing activities should not be attempted on a hot ironer (i.e. replacing spring press, padding rolls, servicing traps/gaskets/flanges).

Configurations of Ironers

Ironers are commonly classified by their "as-built" configuration with the number of rolls, heat source, size of chest, and working widths. The laundry industry currently uses four basic types of ironer chests and designs:

Rigid deep chest

18.

Flexiblechest

20.

Direct fired heated roll

19.

Small roll/shallow chest

21.

The rigid and flexible chest ironers refer to the large deep chest pressure vessel and roll. Small roll/shallow chest ironer is typically a Super Sylon or America Hypro using a series of 10, 11 or 12-inch diameter rollers with canvas aprons. Heated roll ironers do not use a pressure vessel, instead they utilize a cylinder with heat *(gas flame or electric)* directly onto the inside surface of the ironing roll. Using several wide textile ribbons to insure linens remain in contact with the cylinder outer surface provides contact area under pressure. All ironers, regardless of chest type, are heat exchangers and by design some will have greater energy efficiency and operating processing capabilities.

Large Roll Deep Chest

Deep chest ironers work as a heat sink to passively displace heat energy through a solid ironing surface into the damp sheet contacting it. Depending on the materials used in construction of the deep chest pressure vessel, some ironers thermal conductivity has been considered more advantageous than others. This has resulted in two distinctly different engineering concepts to manage deep chests heat sink energy. The first being the Rigid Heavy Deep Chest, and the second being the Flexible Deep Chest.

Heat Exchanger: The ironer's pressure vessels, the chest, transfer plates and gap pieces.

Heat Sink: A device used to transfer higher thermal energy so it can be absorbed into its cooler surroundings without significantly changing its heat source operating temperature.

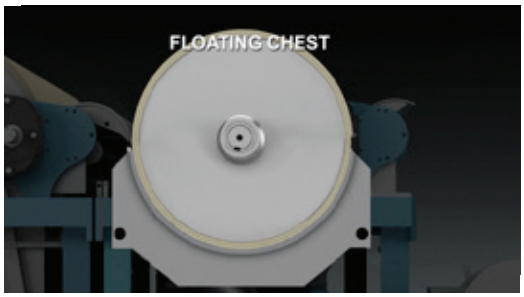
Thermal Conductivity: The property of metal conducting heat. With respect to the ironer, this value needs to factor the size of heat sink, its mass and density of materials used within its construction, and load place onto the system when ironing.

Heavy Chest Concept: Uses a thick-walled heat exchanger and will take longer to bring to temperature. The large heat sink provides exceptional heat retention during production. This is accomplished without significantly changing its heat source requirement for consistent operating temperature during production. Do not assume this is a direct measure of energy efficiency, to truly qualify that several other inputs must be considered.

Thin Wall Flexible Chest Concept: Uses a thin-walled heat exchanger, providing quick time to temperature. The small heat sink provides a reduced ability to absorb temperature changes during production. Significant heat source changes are required for consistent operating temperature during production. Do not assume this is a direct measure of energy inefficiency, to truly qualify that several other inputs must be considered.

Rigid Heavy Deep Chests are constructed of thick, rolled boiler plate, held in shape with several stiffener channels welded across the back side the chest. The carbon steel is finely polished providing a smooth working ironing surface. The chest is heated through stiffener channels that are welded to the outside of the rolled chest plate. These channels are notched and allow for steam or oil to flow back and forth across the entire length of the ironing surface. This method allows for a continuous,

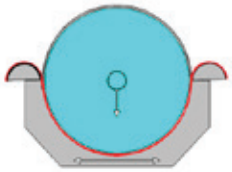
even heating of the ironing surface. Some manufacturers designs allow for the chests to self-center or float inside the ironing frame around the press roll during operations. An advantage of this design is allowing the padded ironing rolls to overfill the chest, constantly adjusting the chest position based on the condition of the pads and springs.



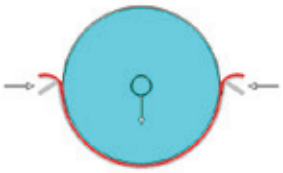
All ironers require some type of roll suspension and their designs vary; some might use independent pneumatic cylinders. If the applied contact force from the independent cylinders becomes unequal, needing adjustment, a non-uniform drying surface has been created resulting with a poor finish and fold quality. Another popular design uses positive torsion bar to ensure even and constant contact force across the width to the chest. Use of a torsion bar optimizing ironer contact area under pressure ensures roll to chest operation remains balanced without having to make minor changes during production. Deep chests are known for their longevity and repairability in the field. Deep chest gouges resulting from items like medical EKG Tab Electrodes becoming embedded in roll pads can be repaired by welding, grinding and buffing the damaged areas as needed.

Most flexible chests are constructed using twin wall sheets of stainless steel. Some will include a secondary liner and some designs use a hinged-type chest configuration. The chests can be heated with steam or thermal fluid oil. The thin pressure vessel material profile allows the chest to contour or flex around the diameter of the roll while under pressure, thereby increasing the available ironing contact surface under pressure and applied force.

However, due to the repeated motion of flexing a pressure vessel with applied force makes them susceptible to metal fatigue and distortion through repeated heating and cooling cycles. As a result, life expectancy of a flex chest will typically be shorter than that of a heavy boiler plate deep chest. To help extend the working surface life of these chests and improve their durability, some manufacturers have added secondary liners to the ironing surfaces.



Floating Heavy Deep Chest



Conventional Flex Chest

Small Roll Shallow Chest

Small roll shallow chest configuration, aka Super Sylon or America Hypro, is an older designed ironer no longer manufactured. These ironers are only available used or in rebuilt condition. This machine design is proven to be a capable ironer provided they are intact and properly maintained. The concept for this design uses three passes with a sheet at various temperatures and pressures before discharging the sheet to a folder. There are a few things to be aware of regarding this design:

Small Roll Shallow Chest Ironer (Shown with canopy installed) 22.

Small Roll Shallow Chest Ironer (Shown without canopy installed) 23.

- Removing the ironer aprons will reduce its ironing contact area by more than 66%.
- Mechanical inner workings of gears, bushings, bearing are not engineered for operating speeds much over 100 FPM. Exceeding the designed operational limits for line speed and operating pressure risks damaging the machines inner workings should be avoided.
- Energy consumption is higher than a modern deep chest.
- Typically operated with no canopy which further increases energy demand
- Many points requiring regular maintenance.

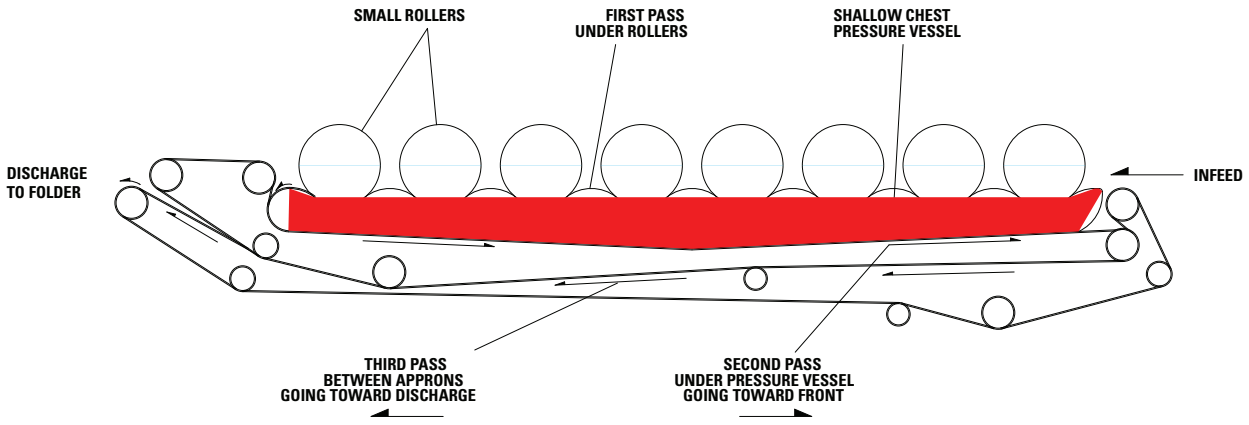
Small Roll Shallow Chest Ironer Super Sylon or Hypro

Super Sylon Three Pass: Number of times linen/sheet travels the length of the ironer during the ironing process before being discharging to a folder, typical of Super Sylon Ironer configuration.

First pass uses several small rollers up to 12-inch diameter, typically in pairs 4, 6 or 8 rolls.

Surface configurations on top of heated chest sections that have a slight wave profile. Because the rollers are small and chest roll profile is minor, this creates a small contact area under roll pressure. At the end of the last chest wave section the item is discharged into a device called an upper apron. The second pass is started at the back of the ironer when sheet is received into upper apron section and held against the underside of the chest heat exchanger while being transported back toward the front of the ironer where it's discharged into yet another apron section known as the lower apron. The third pass is started at the front of the ironer with sheets sandwiched between both upper and lower apron canvas sections moving toward the rear of the ironer to be discharged to a folder.

With this type of ironer, regular weekly care regarding lubrication of service points is a must. It's important to have someone on site knowledgeable with this ironer design and proper apron maintenance. Aprons will wear, tear and rip needing regular replacement. Failure of aprons is something that's going to happen; if not properly maintained and serviced, the frequency for replacement will be increased. The discharge of the ironer uses an assembly referenced as "Apron Harp". During production this assembly will rise and lower when production has stopped. Folders installed behind a small roll ironer with aprons need to be configured to allow the folder infeed to move freely with this "Apron Harp" assembly or risk possible damage to the ironer and folder.



24.

Heated Roll

The heated roll configuration is an older design concept that's currently being manufactured by various providers. Instead of a pressure vessel they utilize a cylinder with heat (gas flame or electric) directly onto the inside surface of the ironing roll. Over the years these units can be found with many different roll sizes in both diameters and working widths. By design, this configuration of ironer works best at slower operating speeds ranging from 5-45 FPM and is not a good choice for larger industrial commercial markets. Its served markets are smaller, on-premise laundries where space is limited, and high-volume throughput is not a daily requirement.

Some recent configurations of this design incorporate an ironer/folder/stacker as a single system, but most are working as smaller scale standalone single ironers. Common to all heated roll designs is the use of several wide textile ribbons wrapping the heated cylinder to insure linens remain in maximum contact with the cylinder outer surface. This design of ironer works well for its intended market and is subject to all the same elements noted in the "Ironing Pie®." The heat exchanger design used on the heated roll ironer is very ineffective. Owners of heated roll ironers should expect higher operational cost per pound produced when compared to larger steam or thermal fluid industrial ironers.

Benchmarking Ironer Performance

Its suggested to start with a simple process of documenting the existing state of your ironer's capabilities before making any adjustments. Accumulation of data should be in the form of standard load sizing common to your site for items as delivered to the flatwork line. This activity requires knowing the size of items to be processed, materials, ironer operating speed, starting moisture retention, steam pressure and chest temperatures. Once the potential ironer piece rate (ironer speed/item length) has been established in pieces/minute, it's suggested to review site specific operational variables (gaps, drops etc.) that will negatively impact potential throughput. Make sure to qualify steam pressure, chest temperature, and moisture retention. It might be required to run a few loads to establish a good baseline. Having this baseline information will allow the ironer and flatwork line to be further tuned by measuring the impact of change. For reference, a simple table is shown below for single and king sheet processing. This can be easily expanded to show ironer production utilization.

Item	Material	Sheet Lenght	Ironer FPM	Gaps Between Sheets in Inches	% Drops	Ironer 3 Roll 32 Max Piece Rate/Min-ute	Moisture Starting	Moisture Ending	Chest Temp	Steam Pressure
Sheet Single	Cotton	66	125	0	0.0%	22.7	40%	3%	325	125
Sheet King	Cotton	104	125	0	0.0%	14.4	40%	3%	325	125

Large Piece Folding Technology

Large piece folders manufactured today are capable of folding various widths, weights, and types of materials, in various lane and cross fold configurations. It's not uncommon to find folders with some type of accumulation device and delivery stacker attached. However capable these machines are, no single design configuration can do it all. Requirements for folding tumble dry 6.5 lb. spreads and blankets, table linen, and T180 cotton/poly sheets are all very different. We will focus most of this section on ironed flatwork processing of sheets, bedding materials and table linens with more common two primary with three cross fold configurations.

With so many different folders in the market today it can become challenging to determine which will best support your laundry needs. Making a smart purchasing decision requires good knowledge and understanding of your existing flatwork line configuration; including a detailed plan for growth. It is important to exercise due diligence and attention to detail when designing an operation to achieve maximum ROI. This might sound overly simple, but a few constraints that will directly impact all flatwork folders is the ironer capacity to iron, its size, and operating temperature. Or a spreader/feeder lacking the ability to feed parts flat and in the center of lanes consistently to include a stable source for clean quality compressed air. Large piece folders do not have the ability to make corrections for upstream events such as a poorly fed sheet, or fold wet parts due to an underperforming ironer, or lack of stability (capacity and/or volume) of a compressed air system. Inconsistent or problematic upstream situations need be addressed. A new folder will not correct or improve spreader/feeder, ironer, or infrastructure-related quality issues. Without correction, the folder will underperform, reducing any potential ROI, impacting final quality of folded items.

"The biggest cost of poor quality is when your customer buys it from someone else, because they didn't like yours"

W. Edwards Deming
(October 14, 1900 – December 20, 1993)

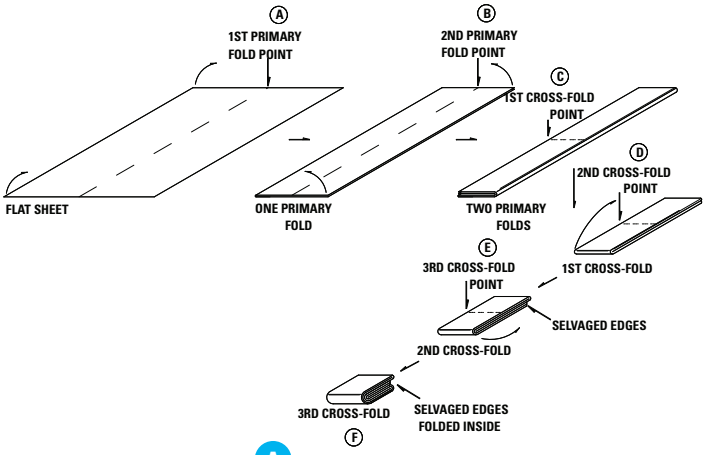
Table and bed linens are often processed using the same basic large piece flatwork folders. With the folder placed immediately behind an ironer, folder processing speed should be adjusted to run slightly faster than the ironer. This speed increase will insure the items transfer cleanly between the machines, without creating wrinkles. Too large a speed difference generates static on the underside of the items and results in a poor transfer of trailing edges. Folders will include some type of static dissipation equipment, static bar, and anti-static belting. But excessive static is not easily removed and can cause material to develop static cling with the conveyor belting. This results in mis-folds and jams within the folder. Ironer speeds should be adjusted so items exiting the ironer contain 2-3% moisture retention. This reduces static electricity and helps prevent overheating items in the ironer and damaging them. Any changes to the ironer speed will impact feeder transfer speed, and this too should be reviewed and adjusted as required. Items exiting the ironer are measured for length, and depending on its measured size items can be folded between one and two times. The first series of folds is commonly referred to as primary folding. Most often this is accomplished using a short release of compressed air to move the item into a set of rollers running in transverse direction to make the fold. It's a good practice to adjust the primary fold points so the leading edges of the sheet are slightly offset from trailing edges after folding. This allows leading and trailing

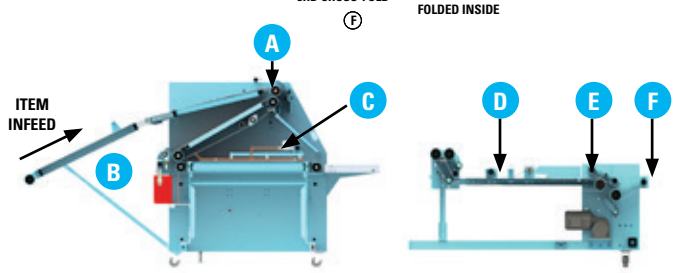
selvaged edges to be tucked neatly inside the primary folds and out of sight. Larger items like sheets or larger table linens can then be cross folded in single lane. Depending on the item size they may receive one to three cross folds. Some single lane folders are also designed to maximize smaller width table linen production, with two lanes of primary folding followed by two lanes of cross fold items resulting in one or two cross folds. Common fold devices used to accomplish the first cross fold use a short duration of compressed air for sheets, or mechanical folding blade for table linens to achieve a crisp fold crease. The fold configuration needs to be configured when the machine is ordered. Both devices work by directing the material to be cross-folded into a set of pinch rollers making the first cross fold. Depending on the large piece folder machine design and item size, the second cross fold is most often accomplished using some configuration of folding blade or reversing conveyors. The final fold, also known as third cross fold, is most always accomplished using a fold blade design thru pinch rollers.

Items having completed the cross-fold process are discharged to a large piece stacker. This stacking device is considered an integral part of the large piece folder. Capable of stacking folded items into a predetermined count to be advanced to a conveyor. This delivery conveyor can move stacks to several different types of equipment from a staging stack management conveyor, larger central clean goods conveyor, packing machinery, or work table to be used for loading carts. Depending on how a folder is optioned, a sheet stacker might support quality control reject functionally. This will exclude stacking stained or torn damaged items by bypassing them to a cart. Some flatwork folding systems will support multiple stackers for sorting items by size. These systems can be found in laundries when presorting the wash process is not practical.

Due to the complexity of large piece folders some problems can be difficult to diagnose. A problematic issue with primary folds may cause jams in the cross-fold section. The first response many people have when trying to resolve fold problems is to begin changing fold formula variables, this is often incorrect. Prior to changing formula values, it's important to ensure there are no mechanical problems present or any upstream events that need to be corrected. Consulting the user manual and manufacturer support services to help diagnose problems will prolong machine life, improve efficiency, fold quality, and reduce wear on the items being processed.

Common Configurations of Sheet Folds





PRIMARY FOLD SECTION
Braun Folder

CROSS FOLD SECTION
Braun Folder

Common Locations & Descriptions of Large Piece Folder

- **A** Location of 1st primary fold point, fold is made with item in motion
- **B** Location of 2nd primary fold point, fold is made with item in motion
- **C** Location of 1st cross fold point, item motion is stopped before making fold
- **D** Location of 2nd cross fold point, fold is made with item in motion
- **E** Location of 3nd cross fold point, fold is made with item in motion
- **F** Discharge to delivery table or stacker w/conveyor

Large Piece Folder — Markets Served

Hospitality providers supporting a larger mix of sheets and table linens often are looking to optimize flatwork line processing by using folders that provide multi-functional capabilities. These multi-functional folders increase the ability to keep ironer chests covered with parts for longer periods of time. This reduces idle time and equates to an increased ROI. For this application, a common type of folder configuration is a single, two lane, two primary folder, capable of supporting up to three cross folds in single lane and two cross folds in two lanes, with the 1st cross fold knife in two lanes.

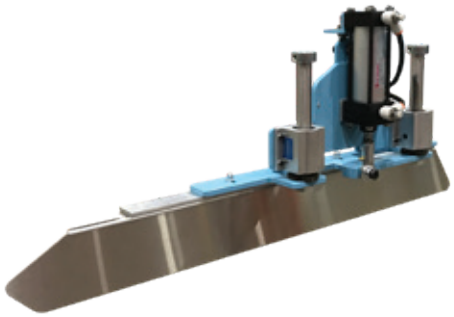
Healthcare providers for the most part, need to support sheets in single lane. To optimize their flatwork line processing, they look to use dedicated product lines with simple basic folders. For this application, a more common type of folder configuration is a single lane two primary fold, capable of supporting up to three cross folds in a single lane. This machine is commonly optioned with a 1st cross air jet and single stacker.

As previously described, laundry providers needs are specifically different, but the core base folder design is the same. Both folders are more than capable of supporting the needs for hospitality and healthcare providers, but not each other's requirements. Understanding your laundry's needs, its application and end customer requirements are key to smart purchasing.

Simply put, there are too many optional features to list when it comes to large piece folders. All manufacturers have a lengthy list of available options or standards supporting specific needs of individual laundry requirements. Basic large piece folders are available in standard finishing line widths of 120" and 130" to match most common ironer widths. Perhaps the most easily noticed configuration option is the discharge side, left or right, which must be specified at the time of order. The infeed conveyor of your large piece folder can also be configured length-specific to best suit your required footprint and ironer discharge height. Infeed conveyor options such as a doffer roll or spring-loaded conveyor (which allows the infeed table to move with the ironer's apron) provide further customization. Also, certain folds may be ordered with configurable options such as knife vs. air folds, and fold bypass. Large piece folders can discharge the finished package to a table or large piece stacker. Other options include, but are not limited to: goods classification systems, multiple sorting stackers, take away conveyors, turn conveyors, quality grading and sorting systems, machine interconnection, data management features and systems, production status indicators, lane and program piece counters, and auxiliary lighting.

What fold device option (fold blade or air jet blow pipe) is a good choice for my laundry? Listed are a few basic advantages and drawbacks of both devices regarding application at the first cross fold.

Fold Blades



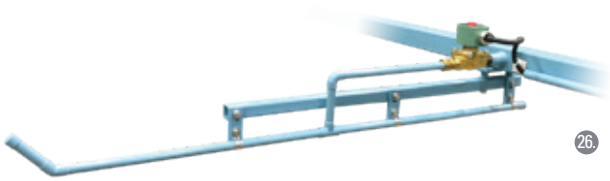
25.

Advantage: Positive fold capable of providing crisp fold lines, is a proven and reliable technology.

Drawbacks: Because fold blades are a mechanical device, they have moving parts which can become out of alignment and wear out with time. Regular adjustment and maintenance are required to achieve reliable performance from knife blades. Another drawback is the physical contact between the blade and the linen. If the linen is too damp, or the blade too dirty, the goods can stick to the blade, resulting in poor folds or jams. Linen stuck around a blade can even draw the blade into the pinch rolls causing severe damage to the blade and other machine components. Blades can also be problematic when processing goods of varying thicknesses. A blade that is adjusted properly for thin goods may not work when

processing thicker goods. This problem can be mitigated by using spring loaded pinch rolls, which move apart to accept thicker linen.

Blow Pipe Compressed Air Folds



26

Advantage: Proven and reliable technology, and the simplicity and limited number of moving parts translates directly to reduced maintenance requirements. There are also fewer equipment jams when compared to fold blades.

Drawbacks: Inconsistent pressure or flow along a fold can result in poor folds, bunching of the linen along the fold, a skewed leading edge, and jamming of the machine. It is also important that the air blast is focused between the pinch rolls. If not, the fold may be inconsistent or fail to catch in the pinch rolls. Folds by air blast consume greater amounts of compressed air than those made by knife blade or reversing conveyors. It is critical to fold quality that the pneumatic system of the laundry is sized properly to support all the equipment attached. Compressed air that contains debris or moisture can damage the valves or clog the nozzles/tubes. Regularly inspect and empty the air filter/drier, if equipped.

Quality Inspection and Grading Systems

With improved control technology *(digital microprocessors and computers)* modern large piece folder manufacturers offer systems which streamline the inspection, sorting, and counting of stained, torn, or otherwise damaged goods. These systems typically discharge goods identified as stained or torn to predetermined locations, isolating them from regular production. Understanding the types of quality grading systems available, and their strengths/weaknesses is critical to selecting an appropriate and efficient system that will achieve a favorable ROI.

The most basic method for identifying stains and tears is by manual sorting; operators feeding, or presorting. The operator feeding a part will provide a visual inspection as the part is processed into the feeder. This method requires the greatest amount of time and labor. It also presents problems when processing large items because a single operator may have trouble inspecting without fully spreading the items.

Another method for identifying and removing damaged items is using equipment outfitted with reject capability. On a flatwork finishing line with a reject system, operators feed the items into the system and press a button upon spotting a stain or tear. The button press flags the piece as it travels through the finishing line and it is rejected at a configurable location. This type of system requires less labor and is more efficient than manual sorting, as operators can continually feed the finishing line. Another advantage of a finishing line with reject capability is that operators can see the entire, fully-spread item when looking for defects. Even operators with little training can identify stained or torn items. This traditional reject system typically creates a greater ROI due to the significantly lower price point.

The most complex reject systems are fully-automated, using cameras to inspect the items on the finishing line. The data collected from the camera is processed by a computer to identify and flag stained or torn items. The result is similar to that of traditional reject systems, but requires no input from operators. Vision systems *(camera based systems)* can identify stains and tears, and may also include features that allow sorting by size, color, pattern, and more. While these types of systems offer greater levels of automation they are not without drawbacks. Machine vision-based systems are the costliest approach to quality grading method and are not foolproof, making a favorable ROI difficult.

Large Piece Sheet Folder Performance Metrics

Because the large piece sheet folder can only process items as fast as the ironer can operate, you will find no value in measuring folder line speed to machine potential capabilities, because most of the time the ironer is the constraint dictating line speed to both folder and feeder. Large piece folders performance metric is a simple measure of usable throughput divided by items lost or rejected due to misfolding or jams. This will tell you how efficient the machine is operating. The impact of downtime because of folder jams or stoppage will diminish the feeder's ability to operate. These stoppage events need to be tracked and considered when reviewing the impact of folder performance.

Example: Your line standard is to process 900 sheets/hour. The folder has 10 misfolded sheets and rejected 25 for quality issues. Your formula for folder efficiency at the planned production rate of 900 part/hour might look something like this:

(1 – (Qty Misfolded ÷ (sheets/hour – qty rejected for quality issues) *100 = folder efficiency for that hour

(1 – (10 ÷ (900 – 25))) *100 = 98.86% efficient

In this example, every minute this folder is stopped due to its own error that equals 15 sheets lost per minute. A 5-minute folder stoppage would increase the value for misfolded items to 85 for this example, and decrease the folder efficiency to 90.29%

(1 – (85 ÷ (900 – 25))) *100 = 90.29% efficient

Small Piece Flatwork Accumulator Technology

Small Piece Flatwork Accumulator Technology

The laundry industry leverages only a few basic concepts of accumulation devices; multi-bar accumulator, rotary accumulator, carousel style (stack-n-store) accumulator and fold-n-stack accumulator.

These machines can be sourced as stand-alone pieces of equipment, or some can be included as integrated attachments to a large piece folder. Laundries processing large volumes of napkins will typically have a dedicated ironer and stand-alone accumulator system, while those who process smaller, or intermittent volumes of napkins, benefit from the versatility of a combination folder/accumulator. Smaller items are fed by hand in multiple lanes to optimize the use of the ironer, with the most common configurations being four and five lane machines. On a more common conventional flatwork line, these accumulators typically have a 120" or 130" working width. Though larger width ironers and accumulators are available, which allow for a greater number of lanes, these are product-specific systems for only small parts. When configuring a finishing line to run multiple lanes of small flatwork items, maximum efficiency is achieved when using as much of the ironer width as possible. Items are detected as they approach the accumulator and are then accumulated over draping bars, through mechanical movement of the draping bar, or by combination of air and reversing conveyor fold-n-stack. Counting systems are used to accumulate stacks to a preselected number as well as tracking entire line throughput. These machines typically require an operator on the back to remove completed draped stacks.

Small Piece Flatwork Accumulator Configuration

Multiple bar accumulators *(Visa or Napkin Accumulator)* use two draping bars per lane, parallel to the direction of piece travel. The draping bar remains stationary while an air jet blows the napkin down onto its respective accumulation bar. When the stack is completed, the bar will be pivoted left or right to an "unload" position. This occurs without affecting the accumulating stack and concurrently presenting the alternate bar to continue accumulation of napkins. While the new active stack is being accumulated the operator has time to unload items from the full bar.

Parallel Multiple bar accumulators

27.

Pros

Draping bars are stationary in operation, only moving to be unloaded. Two draping bars per lane; one active accumulating while the other is shifted for unloading.

Fewer moving parts and service points.

Cons

Item drape length is limited to the length of the draping bar, longer items require folding. Requires operator attention to feeding items on lane centers. Performance is dependent on consistent quality of clean compressed air supply.

Rotary accumulator draping bars

28.

Pros

Item drape length is not limited to the length of the draping bar. Two draping bars; one actively accumulating while the other is shifted for unloading. Tolerant of off-center feeding errors.

Cons

Draping bars rotate to catch items mid-point during operation. This motion can cause accumulated items to move and slip off draping bars. Several moving parts requires regular maintenance and timing adjustments. Performance is dependent on consistent quality of clean compressed air supply.

Rotary accumulator draping bars are perpendicular to the direction of piece travel. Draping occurs though mechanical motion of the draping bar that moves forward to catch the piece with the bar as it's dropping off the end conveyor roller. Due to the forward and return motion of a rotary style accumulator, catching the items can subject items shifting on the draping bar. When the draped stack is

complete, the full bar will be presented to the operator for unloading, while concurrently moving the empty alternate bar into position to continue the accumulation process. Carousel accumulators have draping bars perpendicular to the direction of piece travel, and each lane has several

Carousel accumulators

29.

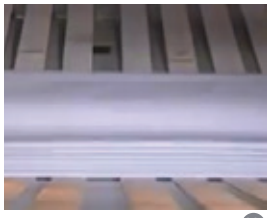
Pros

On some designs the draping bars are stationary during operation and move to advance completed stack. Four usable draping bars per lane. Item drape length is not limited to the length of the draping bar. Tolerant of off-center feeding errors.

Cons

On some designs, draping bars are moving during operation as part of the draping process and move to advance a completed stack. Motion can cause accumulated items to move and shift on draping bars. Several moving parts requires regular maintenance, timing adjustments and draping bar connecting chains.

Fold-n-Stack accumulators



30.

Pros

Some machine configurations allow lane pairing for wider processing capability.

No draping bar, item length is limited to conveyor bed length motion speed.

Tolerant of off-center feeding errors.

Cons

Several moving conveyor parts requires regular maintenance and lane timing adjustments for accurate reversing conveyor folding.

draping bars at a fixed distance apart riding on a chain drive. Designs vary as draping can occur though forward and back mechanical motion of the bars, or via a shield that moves the piece to the bar. Some include a combination with air blast. Upon reaching the desired stack count the draping bar advances and a new bar begins accumulation. Each lane can hold only a few bars of full stacks before needing to be unloaded, but only the end two bars of each lane can be unloaded at any given time without stopping production.

Fold-n-Stack accumulators are a more recent design, and that will fold and stack in direction that's perpendicular to the direction of piece travel. Each lane can independently fold forward or reverse while concurrently stacking the item, some designs will allow the linking of multiple lanes together to process larger items. Upon reaching the desired stack count the finished stack is advanced to the operator for unloading.

Common small products processed on a flatwork line are:

Napkins

Typically run in four or five lanes, and do not receive any folds prior to accumulation; they are draped and unfolded, over the accumulation bars.

Common dinner napkin is sized from 18 to 20 inch square.

Pillow Slips

Typically run in four or five lanes, although they can require primary folding prior to draping or stacking depending on needs of served market.

Common standard pillow case is 19 x 28 inch.
Common queen pillow case is 19 x 32 inch.
Common king pillow case is 19 x 42 inch.

Aprons

Typically run in four lanes; management of apron strings is a must. Aprons are fed bottom-first with neck band trailing. Operators are required to locate the strings and flip them on top of the apron body before it enters the ironer. Including starch with the wash cycle will help give body to the apron and set the strings when ironed. Specialized apron folders are designed to accommodate the unique shape and strings of aprons while producing a package with two primary and two cross-folds. However, these require a dedicated finishing line. Operator awareness, training, and good safety practices are critical to apron processing as the neck loop and strings present the risk of entanglement that may result in injury.

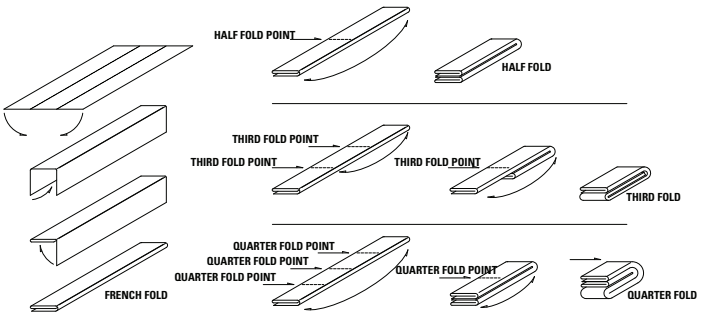
Note: There are several variations of aprons including type, material and size that will affect processing requirements.

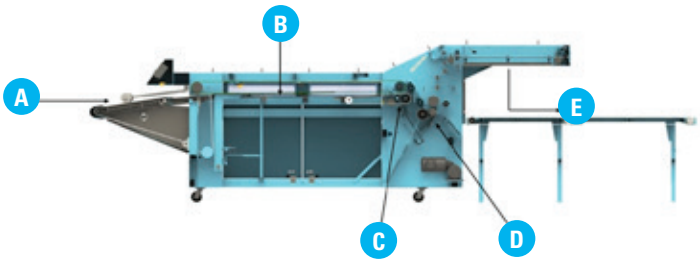
Small Piece Folding Technology

This chapter will focus on tumble dry machine folding process. The need for dry folding of small pieces occurs in almost every laundry around the world. There are three basic concepts to tumble dry small parts; manual hand folding, machine folding, or bagging. Each process is as simple as it sounds, but with many different solutions it can be confusing to determine what concept is correct. The end customer's requirements for quality folded parts, size, and presentation will always establish what process best supports their needs. Hand folding is just that, a slow, labor-intensive process typically used in clean rooms or by exception for a small amount of goods. Bagging is often used in industrial laundries processing large volumes of shop rags or towels where folding is not required. This is a very quick and efficient process.

Most small piece folders manufactured today are capable of folding various widths, weights, and types of goods with French fold and two cross folds. Other, more specific engineered equipment, is also available in the market for point solutions and is limited to the specific type of item for which they were designed.

Common Configurations of Towel Folding





Common Locations & Descriptions of Towel Folder

- **A** Dry items are fed into the machine
- **B** The location where french folds occur
- **C** First cross-fold location
- **D** Second cross-fold location
- **E** Drop stack section and delivery conveyor

Depending on the capabilities of the laundry and the volume/mix of products to be folded, some sites may elect to presort into categories (i.e. customer's goods, terry bath towels/mats, pool towels, other than terry products), optimizing the process at the folding machines.

It is important for items to be fully dry before folding them. This especially applies to the hems prior to processing in the folder, or there may be restrictions or jams in machines causing damage to the machine and the product processed. This dry condition also applies to parts like shop rags that are typically being bagged by weight and

Its recommended to consider the following when establishing your site process:

1. **Match load sizes for washers and dryers to optimally flow volume through the plant.**
2. **Sorting** *(pre-sorting prior to wash / post-sorting after drying)*.
   - Pre-sorting of items often most efficient provided equipment is in place and volume of categories support effect load sizes.
   - Post-sorting of items after wash/dry at the folding machines will slow operator feed rate, reducing throughput at the folding machine.
3. **Sorting towel folding machines can help reduce some of the post-sorting labor time.**
   - Be aware that post-sorting machines by design have reduced throughput, with operational limits regarding the sorting of two, three or four different size items depending on how the machine is optioned at the time of purchase.
4. **Transportation of clean, dry goods from the dryer can be done by:**
   - Rail system — efficient, labor and space saving, typically using slings to transport items to a table or bin next to the operator feeding the towel folding machine.
   - Manual process — with items unloaded from the dryer into carts moved to the dry folding area. This type of operation can require many carts, and floor space for those carts.

to avoid the development of bacterial growth or odors.

With respect to the machine folding process, a laundry worker places an item to be folded onto the infeed of the folding machine. Depending on type of folder being used, activation of the infeed conveyor might require the operator to make a second motion activating an input to put the infeed conveyor in motion to start the fold process. Some machine designs support continuous infeed operation, those designs require no user interface other than placing the item onto the infeed conveyor already in motion. As the fed item enters the machine it will be measured, then folded to the desired pre-selected, pre-programed fold configuration, then stacked. Stacks are built in multiples of 5 with varying heights depending on the size of folded part. Commonly, once items are folded the stacks are placed in clean goods carts for delivery to the end users. These carts may or may not be lined with cart liners depending on the user's requirements. Some end users may require that goods be bundled, wrapped and bagged in stacks of a specific number. Several different delivery methods for transporting stack folded items from the folding machine to carts or pack-out exist. The configuration of purchased dry folding equipment *(return to feed, rear discharge or sorting machine)* will define this process, methods, or options available to transport folded stacks.

Markets Served and Relationship to Tumble Dry Small Piece Folding

Manual processing *(hand folding)* typically uses a large table with multiple personnel folding goods from piles of clean goods (on a table or in a cart) and stacking them in delivery carts. One person can typically fold and stack 120-200 pieces per hour. Most often found in clean room processing, this type of operation is end user specific. It usually involves hand folding and individually bagging and sealing goods for use in operating rooms or other similar environments. Laundries will have dedicated space for processing these goods and requirements for sterile hygiene and apparel to be worn when working in those environments. The advantage of a manual, dry folding process is that personnel can perform the final quality inspection, and in some cases delint each item as they are folding it. Also, fold quality can be higher as the fold is completed by a human that is constantly correcting and straightening each individual fold during the fold process. Aside from being a labor-intensive process, production rates of one person hand folding goods versus one person feeding a folding machine is not comparable; provided services should be costed accordingly.

Semi-Automated processing or bagging systems are typically found in industrial laundries producing a high volume of small parts *(e.g. shop rags or shop towels)*. The end user requirement for these items is simple; parts need to be clean/dry, and presentation is not a concern. With this process, goods are vacuumed and bagged by weight and delivered to the end user in a bag, reducing labor handling costs. It is important that all items must be completely dry to prevent bacterial growth or development of odor while stored in the bags. Also, operators must consider the cost of consumable bags when totally evaluating this cost and the associated ROI for using this method.

** Hospitality Standards		** Healthcare Standards	
Product Type	Pieces Per Hour	Product Type	Pieces Per Hour
Pool Towels	500-700	Hand Towels	1000-1200
Bath Towels	600-800	Bed Pads	800-900
Bath Mats	600-800	Patient Gowns	500-600
Pillow Caes	1000-1200	Scrub Bottoms	400-500
		Scrub Tops	500-600

*** Standards are based on full dry common sized items. Your piece rate will vary based on internal process, equipment used and product type. Recommened to review your actual tested metrics to this chart.*

Folding with a machine works best when items are pre-staged in either load slings or laundry bins. Machine operators remove individual goods from the bins and place them on the infeed table of the folder. Parts discharge onto a conveyor in a stack and an operator removes the stack by hand. The stack may be bagged or tied prior to being placed in a clean laundry bin for delivery to the end user. A small piece folding machine operator can feed between 500-1,000 pieces per hour depending on goods type and operator skill level. Another configuration of the same base folding machine is to have all folded/stacked goods discharged onto a take away conveyor. This discharge, when used with a takeaway conveyor, expands the options for tying and wrapping machines. This solution option results in a reduction of material and direct labor, while improving productivity.

ESTIMATED RETURN ON INVESTMENT
PROPOSED BRAUN PRECISION SERIES SMALL PIECE FOLDER VS. EXISTING HAND FOLDING

Assumptions:
34,000 Pieces per Week

	Estmated with Current Hand Folding	Estmated with Precision Series SPF	Estmated Annual Savings
LABOR SAVINGS:			
Total Folding Employees	7	2	
Days/week	5	5	
Shifts/Day	1	1	
Hours/Shift	8	8	
Wages/Hour	$10.00	$10.00	
Cost per Worker($/yr)	$20,800.00	$20,800.00	
Estimated Labor Cost per Year	$145,600.00	$41,600	**$104,000.00**
RETURN ON INVESTMENT FOR EQUIPMENT:			
Estimated Cost of Equipment:			**$37,608.00**
Simple Payback on Proposed Braun Precision Series Small Piece Folder over Exisiting Hand Folding (years):			**0.36**

Small Piece Folding Machine Configurations and Features

Three most common machine folder configurations are return-to-feed, rear discharge, and sorting by size machines. Equipment manufacturers will keep the base machine infeed, user interface and folding configurations the same with each of the noted configurations. Only changing the discharge or stacking sections to support the item's needs for movement in the proper direction after folding is completed. Sorting machines will often be longer in length to accommodate various-sized sorting takeaway conveyors. Differences with equipment designs may require machine infeed tables to start/stop with each part. Some will run continuously, while others will pause depending on width changes to the items being folded. Some vendor's machines have restrictive product ranges, which limit the flexibility of the machine. It is vital that the mix of goods processed best aligns with the machines range of capabilities. This reduces capital equipment cost, improves space utilization, and optimizes the use of available labor.

Return-to-feed machines can have a smaller machine footprint for laundries that have limited floor space. Operators that feed the machine are also removing the folded piece from the stack conveyor and placing the stacked goods in the delivery bin for the end user. This process may have a

detrimental effect on machine throughput, as the operator is performing multiple tasks. Items must be sorted by type prior to being fed into this machine. Sorting can occur before or after the wash/dry process.

Rear discharge machines have a potentially higher production throughput, as the operator feeding the machine is not required to multitask and is only concerned with feeding the machine. Folded and stacked goods are taken away from the machine and can automatically go onto a clean goods conveyor, if available. Some machines may have a larger footprint as the takeaway conveyor is external to the machine. Depending on the equipment design, this takeaway conveyor might be in-line with the machine for a narrow footprint, or extend out either side, increasing base machine width. Items must be sorted by type prior to being fed into this machine. Sorting can occur before or after the wash/dry process.

Sorting machines allow for all parts, regardless of size, to be processed concurrently. The process of measuring for size may have a detrimental effect on operator throughput because the machine may need extra time to measure each individual part, or delay infeed of the next item fed if it's a different size. This sorting function will vary depending on how the machine is designed to operate.

The most common types of folders on the market make folds using compressed air, mechanical fold blades, and reversing conveyors. Most folders use 2 or more of these functions to make the complete fold.

Compressed air folders use compressed air to complete the primary and cross folds. The compressed air is blasted at the dry fold items. The item is either stationary or traveling along a guide while the activated air folds the part along that guide. This type of folder requires a high consumption of compressed air. This type of fold is dependent on air quality. There may be a decrease in fold quality if the supply of compressed air falls short of the manufacturer's recommended pressure. If air filtering is poor and there is water or debris in the compressed air supply, it will limit the repeatability of the fold process.

Folders with mechanical blades are often used to complete the primary and cross folds. These mechanical components are clean, provide positive fold point of contact and need regular attention during equipment maintenance to reduce potential downtime. Folding blades often result in crisper folds of the final package when compared to compressed air folds.

Folders with multiple reverse conveyors use several variable frequency drives to reverse the conveyor drives at a specific time to complete the folds. The item traveling into a gap between two conveyors results in a cross fold when the lead-in conveyor is reversed. The complexity of these systems may present some challenges in troubleshooting the electrical system due to the increased number of drives and motors required.

Small Piece Folding Performance Metrics

All dry folding machines available on the market are directly affected by operator skill sets and the configuration of the work space. If items fed are skewed when placed by the operator on the infeed table, folds in the finished good will be skewed. Also, if the operator does not allow for proper spacing between the goods or places multiple goods on the infeed table of the machine, that can cause the folds to be incorrect and possibly do damage to the folding machine. Operator skill influences all aspects of quality.

Equipment capability or throughput capacity is a relatively simple formula. Using the folding machine measured speed at the infeed table, divide by the sum of the measured piece length, plus handling time converted into distance. The example shown below is the first step in establishing production targets for equipment operators.

Example: Folding machine infeed 150 FPM, 30" long towel and 2.5 seconds handling time.

FPM x Inch/Ft = In/min, (150 x 12) = 1,800 in/min
In/min ÷ sec/min = (1,800 ÷ 60) = 30 in/sec

Machine speed in Inch/min ÷ (handling time converted to in/sec) + part length = Pieces per minute

1,800 ÷ ((2.5 x 30) + 30) = 17.14 or 17 Pieces per minute

The example above is only a sample of single item base calculation, this should be measured against an actual operator using a sample lot of 100 parts fed.

Large Piece Blanket Folding Technology

This section will focus on the tumble dry machine folding process of larger items; blankets, knitted fitted sheets, spreads, and other heavy items that exist in almost every laundry around the world. There are three basic methods to manage folding these larger, heavy items. Common to all methods is the use of a folder engineered to accommodate larger, heavy, and often thicker items. These folders are referred to as blanket folders. Specific by design, blanket folders can be sourced in two basic size platforms. Larger units will support the use of an optional spreader feeder, providing higher production numbers. Smaller blanket folders are typically hand-fed and are approximately half the size of the larger units. Both designs support the use of a larger blanket stacker that has also been engineered to accumulate larger, heavy, thicker folded parts. Production rate and space requirement are commonly used to determine what method works best for a laundry's needs.

Blanket Folding Machine Configuration and Features

Noted folding systems, regardless of their size, operate much like a sheet folder, producing 1 or 2 primary folds and depending on the machine design, up to 3 cross folds. Larger systems, depending on machine design, can support up to 3 feeding operators. Blanket folders will not have the ability to make corrections for items fed off-center and/or poor-quality feeding. The smaller platform of a blanket folder is operated by a single operator. When processing larger items, this operator is required to pre-fold and feed that same item on-center. Production numbers for blanket systems will vary by size of items, operator's skillset, internal process and equipment. General production numbers for larger feeder/folder systems can yield 600-700 parts/hour, while smaller scale hand feed units range between 350-400 parts/hour.

With the larger blanket folder placed immediately behind a spreader/feeder and on-center, the blanket folder processing speed should be adjusted to run slightly faster than the feeder. This speed increase will insure the items transfer cleanly between the machines, without creating wrinkles. Too large a speed difference generates static on the underside of the items and results in a poor transfer of trailing edges. Folders will include some type of static dissipation equipment; static bar and/or anti-static belting. Excessive static is not easily removed and can cause material to develop static cling with the conveyor belting. This results in mis-folds and jams within the folder and unpleasant static shock to operators. Items exiting the feeder are measured for length at the folder, and depending on its measured size, items can be folded between one and two times. The first series of folds is commonly referred to as primary folding and is most often accomplished using a short release of compressed air to move the item into a set of rollers running in transverse direction to make the fold. It's a good practice to adjust the primary fold points so the item's leading edges are slightly offset from trailing edges after folding. This allows leading and trailing selvaged edges to be tucked neatly inside the primary folds out of sight. Then depending on item size, it may receive one to three cross folds. A common fold device used to accomplish the first cross fold is a mechanical folding blade. Depending on the blanket folder machine design and item size, the second cross fold is often accomplished using some configuration of folding blade or reversing conveyors. Final fold, or third cross fold, is most always accomplished using a fold blade design through pinch rollers.

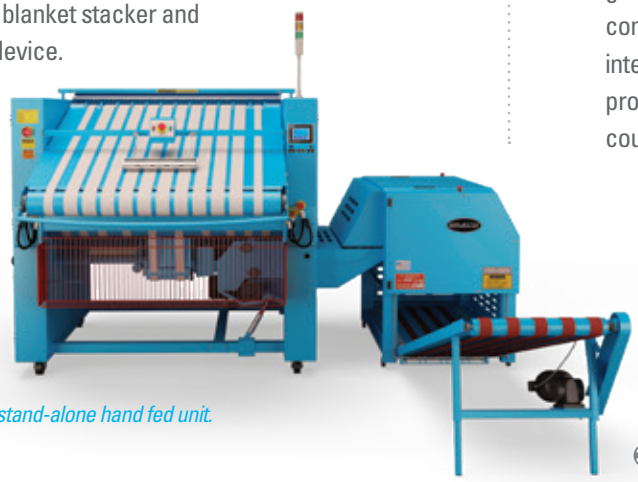
Items having completed the cross-fold process are discharged to a large piece blanket stacker. This stacking device is considered an integral part of the blanket folder, capable of stacking folded items into a predetermined count to be advanced to a conveyor. The delivery conveyor can move stacks to several different types of equipment from a staging stack management conveyor, larger central clean goods conveyor, packing machinery, or work table to be used for loading carts. Depending on how a folder is optioned, a blanket stacker might support quality control reject functionally, and exclude stacking stained or torn damaged items bypassing them to a cart.

Due to the complexity of large piece blanket folders, some problems can be difficult to diagnose. A problematic issue with primary folds may also cause jams in the cross-fold section. The first response many people have when trying to resolve fold problems is to begin changing fold formula variables; this is often incorrect. Prior to changing formula values, it's important to ensure there are no mechanical problems present or any upstream events that need to be corrected. Consulting the user manual and manufacturer support services to help diagnose problems will prolong machine life, improve efficiency, fold quality, and reduce wear on the items being processed.

Markets Served and Relationship to Large Piece Blanket Folding Technology

Healthcare providers with a larger product mix of heavy tumble dry items looking to optimize both processing time and labor are more likely to install a larger blanket feeder/folder/stacking system. A common configuration for this system design uses a two-station spreader/feeder positioned in front of a single lane, two primary fold machine capable of up to three cross folds with an optional blanket stacker and quality grading device.

Some healthcare providers have made a calculated decision to install two smaller stand-alone hand fed units, reducing both floor space and initial costs resulting in improved opportunity to balance equipment loading and PM planning. Hospitality providers and on-premise processing sites have similar items and needs, often with a smaller mix of items. Therefore, they are more inclined to leverage the smaller stand-alone blanket folder solution with an optional blanket stacker and quality grading device.

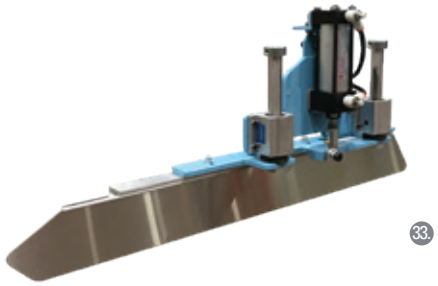


Smaller stand-alone hand fed unit. 31.

Larger blanket feeder/folder/stacking system. 32.

Regardless of what manufacturer's blanket system is being put into service, both configurations work well and are capable equipment. When developing a ROI be sure to take time and review all production requirements and fold needs in detail. There are too many optional features to list when it comes to large piece folders. All manufacturers have a lengthy list of available options or standards supporting specific needs of individual laundry requirements. Perhaps the most easily noticed configuration option is the discharge side, left or right, which is best specified at the time of order. The infeed conveyor of your large piece folder can also be configured length-specific to best suit your required footprint. Large piece folders can discharge the finished package to a table if a large piece blanket stacker was not optioned. Be aware that discharging items onto a table requires a dedicated operator to be present at the folder discharge. Other options include, but are not limited to; goods classification systems, takeaway conveyors, turn conveyors, quality grading and sorting systems, machine interconnection, data management features and systems, production status indicators, lane and program piece counters, and auxiliary lighting.

Large Piece Blanket Folding Technology (continued)



33.

1st Cross-Fold Blade, provides a positive fold, capable of crisp fold lines and positive movement of heavy items into a fold point. Capable of supporting a wide range of items with various size and weights. This is a proven and reliable technology.

Large Piece Blanket Folding Performance Metrics

The large piece blanket folder's performance metric is a simple measure of usable throughput divided by items lost or rejected due to misfolding or jams. This will tell you how efficient the machine is operating to your defined plan standard. The impact of downtime because of folder jams or stoppage will diminish the feeder's ability to operate. These stoppages should be tracked and considered when reviewing the impact of folder performance.

Chart of goods types commonly processed in a modern healthcare laundry facility

Textile Finishing Laundry Equipment	Healthcare Product Description in All Sizes	Common Processing Methods
Tumble Dry Folding	Bib, Adult	Hand Folded
Tumble Dry Folding	Blanket, Thermal / Bath	Machine Feed & Machine Folded
Tumble Dry Folding	Blanket, Baby	Hand Feed Machine Folded
	Cover, Cart / Chair	
	Cubical Curtain	
Tumble Dry Folding	Diaper, Adult / Baby	Hand Feed Machine Folded
Tumble Dry Folding	Gowns, (all types)	Hand Feed Machine Folded
	Jacket, Warm-up	
Garment Tunnel	Lab Coat	Hand Feed Machine Processed
Tumble Dry Folding	Mat, Bath	Hand Feed Machine Folded
Tumble Dry Folding	Pad, Bed / Mattress / Crib	Hand Feed Machine Folded
	Pant, Pediatric / PJ	
Flatwork Ironing	Pillow Case	Hand Feed, Ironed, Folded
Tumble Dry Folding	Robe	Hand Feed, Ironed, Folded
Tumble Dry Folding	Scrub, Pant / Shirt	Hand Feed, Ironed, Folded
Flatwork Ironing	Sheets Flat / Draw	Machine Feed, Ironed, Folded
	Top, Pediatric	
Tumble Dry Folding	Towel, Bath / Hand	Hand Feed Machine Folded
Tumble Dry Folding	Wash Cloth	Hand Feed Machine Folded
	Shower Curtain	
	Sling Lift	

Chart of goods types commonly processed in a modern healthcare laundry facility

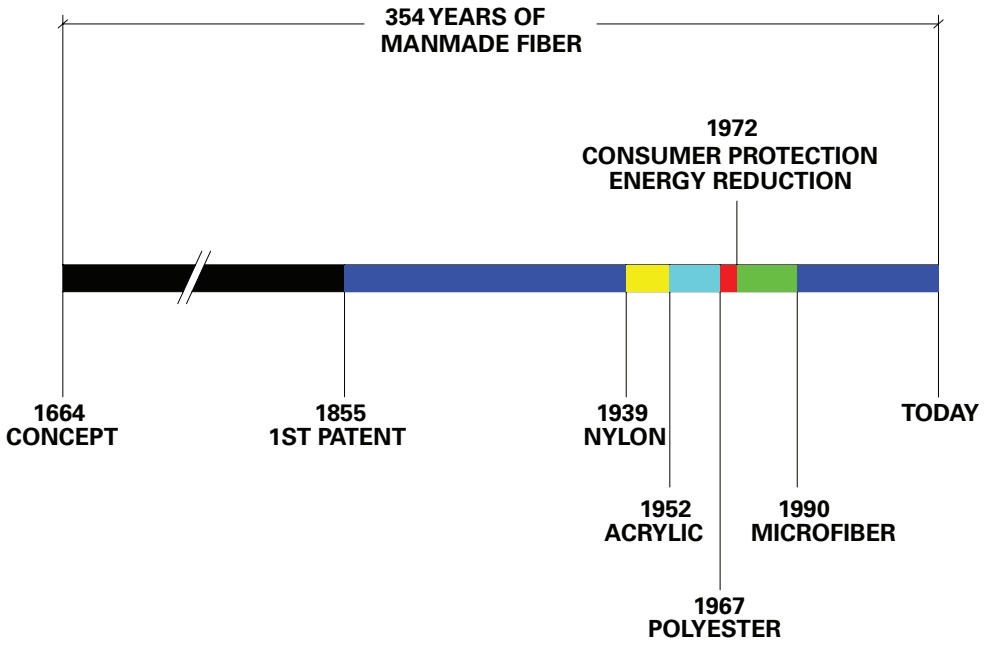
Textile Finishing Laundry Equipment	Healthcare Product Description in All Sizes	Common Processing Methods
Flatwork Ironing	Apron	Hand Feed, Ironed, Folded
Flatwork Ironing	Bar Mop	Hand Feed, Ironed, Folded
Tumble Dry Folding	Bath Mat / Robe / Rug	Hand Feed, Ironed, Folded
	Bed Skirt	
Tumble Dry Folding	Blanket	Hand Feed Machine Folded
Flatwork Ironing	Duvet	Machine Feed, Ironed, Folded
Tumble Dry Folding	Mattress Pad	Hand Feed Machine Folded
Flatwork Ironing	Napkin	Hand Feed Machine Folded
Flatwork Ironing	Pillow Case	Hand Feed Machine Folded
Flatwork Ironing	Sheets	Machine Feed, Ironed, Folded
	Shower Liner	
Flatwork Ironing	Tablecloths	Machine/Hand Feed, Ironed, Folded
	Table skirt	
Tumble Dry Folding	Towel, Hand / Bath / Pool / Kitchen	Hand Feed Machine Folded
Tumble Dry Folding	Wash Cloth	Hand Feed Machine Folded
Garment Tunnel	Coverall	Hand Feed Machine Processed
Garment Tunnel	Bar Mop	Hand Feed Machine Processed
Tumble Dry	Shop Rag	Hand Feed Machine Processed
Garment Tunnel or Press	Uniform, Pants / Shirts	Hand Feed Machine Processed

Material Science

World fiber markets in recent years have reached a couple of key milestones. One of the more significant was annual production usage surpassing 100 million tons. This measure included all fiber types, both man made and organic. Evaluation of global fiber markets indicate fiber usage density at 70% man-made fibers with remaining 30% sourced from cotton, cellulosic and wool. Synthetic fibers make up the bulk of the current market share with a minimum growth rate of +2% annually. It's clear that no perfect thread exists however, the trend and future is with man-made fibers.

Textile manufacturers will use different threads or blends of materials depending on the desired application, type of the seam, cost of material and product requirement for durability. Some of the common material types found in use today are Cotton, Cotton/Polyester Blends, Microfiber, Polyester, PolySpun Filament, and CoreSpun Filament. As material types differ, so does the requirement for laundering them. With the global supply-chain alternatives that exist today, the source for raw fibers used in the creation of yarns is not always equivalent. Some global sources provide better quality than others. What's important is to confirm limitations within your laundering process for the goods type provider you are working with.

The first known concept of man-made fibers was noted in 1664, and several years later in 1855 the patent for "artificial silk" was granted. It took an additional 84 years and the start of a second World War in 1939 before DuPont began commercial production of the first practical man-made fiber "Nylon." Its first use was as sewing thread, used in manufacturing parachutes and women's hosiery. Domestic markets of the day had only a small sampling of the new fabric as its availability became restricted to support the troops needs during World War II. By the summer of 1952, about 20% of textile mills fiber needs came in the form of man-made fibers. It was also during this time when DuPont began production of a wool-like product with the generic name "Acrylic." This material was coined as "wash-and-wear", and for a short time was considered a novelty product. It was aggressively refined and re-engineered, appearing in the form of



commercial polyesters well into the late 1960's. Industry moved forward with aggressive fiber development as new industrial requirements and technological markets required engineered specific fibers for greater comfort, flame resistance, release of soil, greater whiteness, dyeability, and improved blending. By the late 1960's, man-made fibers were used in about 40% of the textile mills' production. During this period many new material fibers later to be used in "Spandex", "Aramid" and "Para-Aramid" were also being developed. The 1970's brought a new level of federal consumer protection, mandating new standards for flammability of sleepwear, carpet and other similar consumer products. The impact from the petroleum energy crisis forced the fiber industry to improve its processes, reducing the amount of energy used to produce a pound of fiber by 26%. 1% of the nation's petroleum was used to supply 66% of the fibers used by American textile mills. Ongoing efforts with continued refinement and development of fibers was the standard for all fiber manufacturers. As we entered the 1990's and continuing today, the fiber industry started producing the finest microfibers used in fashion garments, consumer and industrial products. Environmental awareness had become a global theme for all industries. Every business, industry and manufacturer alike were all looking for ways to become "Green Providers." The fiber providers and textile mills were no exception to this ongoing effort. Future growth areas regarding fiber development are endless. Worth noting is the development of plant fibers with performance equal to man-made fibers that are biodegradable and renewable. As noted the future for fiber research, development and improvement is limitless.

Variations of goods types can range into the hundreds; factoring item sizes and material types this number extends well into the thousands. Not all suppliers of these items are equal regarding the quality of goods delivered *(regardless of how items are tagged and represented)*. Ask your material supplier for their processing procedure specific to items provided and evaluate them against your current process before putting them to any qualification testing. It is important to have good communication with end customers, housekeeping and buyers when it comes time to purchase new items or develop new room or textile goods packages. Helping decision makers identify potential product strengths, shortcomings, or limitations pertaining to how materials should be processed will ensure success for all involved.

It's recommended that you source enough new sample material to qualify said items through several complete laundry cycles. Then remove at least one each of any new item to be used later for baseline inspection comparison. After several complete laundering cycles inspect the item hems for shrinking, material for shrinking, material surface for wear, *(snagging, tufting, color fading)*, drying and ironing characteristics, folding issues or any impact outside normal processing that might present processing issues. Document and record all findings good/bad and share this information with all decision makers. Include samples of both new and laundered items for review before making an investment decision. What may look like a good financial buying decision could result in a very costly processing and account management outcome.

Textiles, regardless of fiber type, man-made or organic, all have life expectancy that will need to be considered. This loss can come in the form of abuse, incidental loss, or theft. Two good publications on this topic that should be reviewed are the Textile Rental Services Association white paper entitled "Textile Life, Loss and Replacement" and the other is the International Fabricare Institute Bulletin "Laundry Procedures No. 51." Both publications are an excellent source of information on the topic of product loss and areas impacting product life cycle.

Closing Remarks

As we started looking and inquiring about information with detail standards for finishing processes, it was amazing to discover just how little consolidated documentation existed on the topic of finishing technology. Therefore, a decision was made to task our resources with developing this continuation of Science Stands the Test of Time publications named "Textile Finishing Environments." Hopefully, as readers you have found the information intuitive, factual and where it applies science-based with various processes and products, while improving your awareness of the more common aspects related to industrial laundry finishing environments. Information contained is in part the repository of knowledge learned from years of collecting lint and working long nights. Additional information on this topic can be sourced from the TRSA in the form of educational seminars like "PMI" or publications such as "Laundry Operations and Management." Beyond informational services, TRSA offers a social network connection to quality-minded, experienced operators with real-world laundry experience.

Embrace the challenges of innovative change. Strive for excellence with people, process and product and you will find opportunities in the laundry industry fulfilling like no other.

Team G.A. Braun Inc.

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(Science of Garment Processing)
Ben Burris, Accumulation Devices Product Manager

(Science of Feeding)
Darren Sponable, Feeder Product Manager

(Science of Flatwork Ironing)
Bryan Knapick, Ironer Product Manager

(Science of Flatwork Folding)
Maxwell Krause, Large Piece Folder Product Manager

(Science of Tumble Dry Folding)

Rachelle Radi, Small Piece Folder Product Manager

Mark Kirby, Director of Finishing Technology

Photo References

Photo 1: Finishing System, G.A. Braun

Photo 2: Early Textile Finishing Environments, ShutterStock

Photo 3: Early Textile Finishing Environments, ShutterStock

Photo 4: Colmac Industries, website

Photo 5: Leonard Automatics, website

Photo 6: Colmac Industries, website

Photo 7: Leonard Automatics, website

Photo 8: Automation Dynamics, website

Photo 9: Small Piece Linen Feeder Vacuum Feeder, G.A. Braun

Photo 10: Sager-Model A Semi-Manual Feeder

Photo 11: Braun Precision Series Corner Clip Feeder, G.A. Braun

Photo 12: Chicago Dryer, website

Photo 13: Chicago Dryer SkyFeed, website

Photo 14: Vacuum Paddle, Girbau

Photo 15: Vacuum Table, G.A. Braun

Photo 16: Boiler Room Cleaver Brooks web site

Photo 17: Thermal Oil Heater Diagram from TECNICA CDCtecnicacdc.com.ar

Photo 18: Deep Chest Ironer, G.A. Braun

Photo 19: Unkown Source

Photo 20: Jensen Jenroll Express, Jensen Brochure

Photo 21: Super Sylon Chests, laundrylist.com

Photo 22: Photo 2005 © Tom Kirsch, OPACITY.us Liton State Hospital Ironer opacity.us/image2671_super_sylon.htm

Photo 23: Hypro 6 Roll Flatwork Ironer American Model, bidspotter catalog

Photo 24: Super Sylon Illustration, G.A. Braun

Photo 25: Fold Blades, G.A. Braun

Photo 26: Blow Pipe Folds, G.A. Braun

Photo 27: Visa or Napkin Accumulator, G.A. Braun

Photo 28: Rotary Accumulator, G.A. Braun

Photo 29: Carousel Accumulator, Chicago Dryer Company

Photo 30: Fold-N-Stack Accumulator, Chicago Dryer Company

Photo 31: Small Blanket Feeder/Folder/Stack System , G.A. Braun

Photo 32: Large Blanket Feeder/Folder/Stack System, Chicago Dryer Company

Photo 33: Fold Blade, G.A. Braun


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