Re-energizing Your Converting Equipment

Maximize Profits and Capabilities

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Abstract:

In light of the continued positive growth trends in the converting industry, many manufacturers continue to work to find ways to drive costs down and production up with existing or rebuilt equipment. ***The goal – to maximize profits and capabilities****. A trend that continues to grow are upgrades to electrical drives and automation of production equipment. Many producers have an established plan for these types of activities but some do not, ultimately missing out on the opportunity to maximize existing capital assets.*

Manufacturers are faced with the need to respond to changing market requirements for new products and processes, which at times, cannot be addressed by current production equipment. The manufacturer is then faced with the decision to either buy a new capital asset or purchase a used asset, which could be reconfigured for the production need. In either circumstance, used equipment or an existing asset rebuild may be the most economical path to follow.

Looking at a typical converting operation and processing assets, there are many options but also many questions that need answers.

Decision criteria – The Why's?

When deciding to retrofit or purchase and rebuild a used machine, there are many questions the manufacturer must take under careful consideration. These include but may not be limited to:

1. Is there a new market we are trying to address?
2. Is my production efficiency where it should be or meeting our goals?
3. Can the equipment produce to current quality standards and requirements?
4. Do I buy a new capital asset as opposed to a rebuild?
5. Who do I choose when retrofitting or rebuilding equipment?
6. What technology options are available for the equipment?
7. What technology options are necessary or required for production?
8. How do I get started, where do I look?

Naturally, there are more questions, but many of those are answered when addressing the above eight. Let's address each of the 8 points.

1. Is there a new market we are trying to address?

Oftentimes, a new market opportunity presents itself. This opportunity can come in the form of:

- A desire to capture market share in an existing market you may not be fully a part of
- A developing trend in the industry that you are unable to address
- A new product development, unique to you, but not yet commercialized

In all three cases, the manufacturer has multiple ways to accomplish them. The most frequent occurrence is a desire to capture market share in a market in which you have some penetration. Production limitations placed on you by the equipment or process, do not fully allow you to capitalize on this desired growth. Some of these equipment limitations may be very simple and inexpensive to fix. For example, you may be limited to a certain size core but your market desires coreless and varying sized cores as options. Your decision may be as simple as adding only those sizes you need through an equipment retrofit, rebuild or purchasing a completely new asset. This will allow you total flexibility for the market. Similarly, for developing trends, you may currently be producing products that meet part of the market need, but an emerging trend may be occurring you cannot fully address. This now presents the company, marketing and operations people the challenge of justifying the capital expense required to meet the new market needs. Finally, probably the least frequent occurrence, but quite possibly the most complicated, is new product development. In some cases, the choice is clear; your current assets cannot produce what you need, no matter the level of rebuild or retrofit. The challenge presented here is the choice between used equipment that almost meets the need, with a rebuild or buy new equipment. In some instances, the case may not be so clear. The new product that has been developed may require a somewhat different formulation, substrate or possibly coating technology. In many of those cases, current equipment may be able to produce those products with modifications to the drying systems, web handling systems or the addition of a coating cart system into the existing equipment. Of course, in addition to cost, considerations must be made to the impact these changes have to current products, equipment capacity and the length of downtime required to make modifications.

At first glance, used or retrofitted equipment seems like the most practical choice to address production needs, but as can be seen by just some of the issues that need to be addressed, it is not quite that simple.

2. Is my production efficiency where it should be or meeting our goals?

Production efficiency ultimately affects the bottom line of the operation and brings into question the overall effectiveness of your equipment. There are many metrics that exist to measure equipment effectiveness, one of the more common being OEE (Overall Equipment Effectiveness). When moving forward with defining what is required to improve your process, yield, output and efficiencies, a comprehensive analysis should be performed. This will identify the specific areas that affect your production efficiencies. This analysis will clearly pinpoint the areas for improvement and ultimately maximize the root cause solutions and capital expenses required to execute your upgrade or retrofit. Lets take a short look at what OEE is comprised of.

When considering a strategy for achieving maximum efficiency from a production facility, one of the most important elements to consider is the production equipment. By increasing equipment effectiveness, a facility can increase the throughput and quality of product with less downtime and scrap. Although simply stated, it involves a greater depth of detail. To begin with, it is essential to understand the equipment and to successfully evaluate the equipment problems.

When investigating equipment effectiveness, most manufacturers begin by evaluating the Overall Equipment Effectiveness (OEE), a quantitative measure of the yield of a machine. The OEE value of the equipment quantifies productivity into three major categories: **availability**, **performance**, and **quality**, taking into consideration the losses encountered within each of those categories.

OEE = Availability * Performance * Quality

To begin an OEE evaluation, an overall assessment of availability, performance and quality, must take place. Then, a more detailed investigation is needed to uncover specific problems and losses encountered in each of theses areas. Next, options must be reviewed to determine a proper course of action to correct the inefficiencies. Finally, a return on investment (ROI) must be calculated to justify the decision.

In general there are three options available to manufacturers looking to increase their OEE. They are:

- Fix the existing machine by implementing basic maintenance corrective actions
- Upgrade the existing equipment with new components
- Purchase new equipment.

Evaluation is essential for making the proper decisions regarding machine effectiveness. It will not only dictate the result of equipment productivity, but also the economic implications for several years to come.

Evaluating OEE

OEE quantifies productivity into three major categories, availability, performance, and quality. Machine availability is the most obvious requirement. Without a machine, there is no performance or quality. Questioning why and when the machine is unavailable will help guide the evaluation into a more detailed investigation.

$$\text{Availability} = \frac{(\text{Planned Production Time} - \text{Unplanned Downtime})}{(\text{Planned Production Time})}$$

Machine performance is measured by how fast product is being made. Simply stated, it is the speed at which the machine runs.

$$\text{Performance} = \frac{(\text{Cycle Time} * \text{Number of Products Processed})}{(\text{Production Time})}$$

Producing a quality product is the objective of every manufacturer. Increasing speed and availability of the machine is useless if the final product is scrap.

$$\text{Quality} = \frac{(\text{Number of Products Made} - \text{Number of Products Rejected})}{(\text{Number of Products Made})}$$

The evaluation of all three components - availability, performance and quality - and their interrelation will determine the best solution for increasing the OEE of the machine. By understanding the losses, and their impact on the machine, one can gain a clearer picture of the overall machine performance.

Availability Losses

In a perfect world, a machine would be available 24/7/365. However, this is only an ideal perspective, from which one can measure true machine availability. There are several real factors that affect availability, planned and unplanned downtime. Planned downtime includes vacation, holidays, and scheduled maintenance. Unplanned downtime includes equipment failures, set-up and adjustments. It is possible to factor the planned downtime; however it is the losses due to unplanned downtime that can negatively impact machine availability.

Equipment Failure or Breakdown. Equipment failure is a major cause of production downtime. In order to decrease this loss, it is necessary to have an active preventative maintenance program, which will help to diminish any unforeseen failures. This will insure that the machine is evaluated at regular intervals and serviced according to the findings. Additionally, old equipment may become so maintenance intensive or difficult to troubleshoot that an upgrade or retrofit might be required.

Set-ups and Adjustments. Set-ups and adjustments, along with calibration, are needed to prepare the machine for an impending production run. If there is a significant amount of product change, the time required to perform these tasks can be quite large.

Performance Losses

Machine performance refers to the net production time during which products are produced. The more the machine produces, the greater the OEE. However, speed losses and small stops will inhibit the overall performance. If not recognized and addressed, these losses can cause the machine performance to be less than optimal.

Speed losses. Speed losses are categorized by any situation where the machine is not running at its optimal speed.

Small Stops. Small stops are losses due to short periods of time in which the machine is shut down for minor adjustments, such as cleaning.

Quality Losses

If the product coming off a line is not "saleable", then it is considered scrap. The entire process has been wasted on product that will never make it to the consumer. It is important not to lose sight of quality when evaluating the OEE. Availability and speed often take priority, and quality is left behind. The key point to remember is that without a good product, the rest of the operation is useless. In general, quality losses are generated during start-up, while the machine is ramping up, during adjustment, and during normal production, as rejected product is created due to process instabilities.

Losses During Start-up. Losses during start-up are typically attributed to the system ramp up when the process and machine parameters are coming into specification. Unless all of the process parameters are within their tolerance, scrap material is being produced. Such typical parameters are ovens coming up to temperature, line speed ramping, and tensions stabilizing during and after the ramp up period. The quicker these parameters can be brought into their tolerance band, the less scrap will be produced.

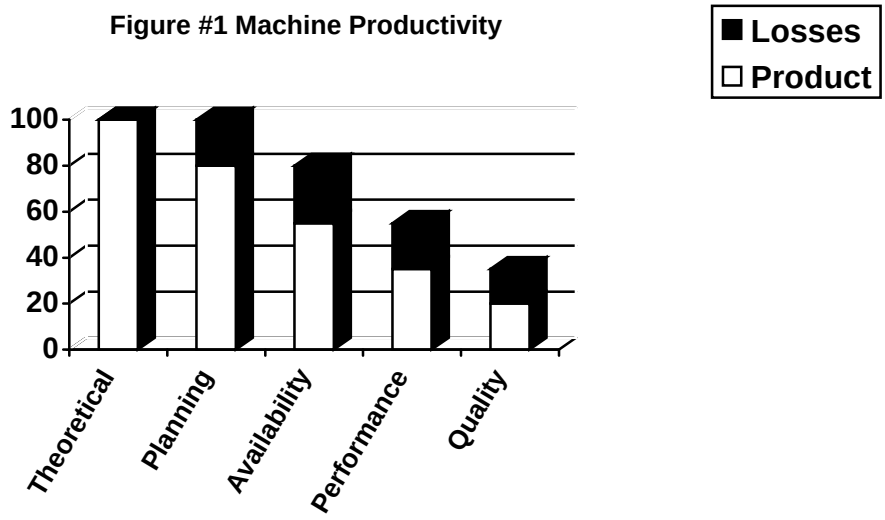
Losses During Production. During production, scrap is sometimes produced predictably, such as a splice going through a machine. Other times it is produced unpredictably, such as a process parameter going out of specification, or a web handling control issue, resulting in a web break.

Productivity Improvement Opportunities

A thorough assessment of the components and their losses will yield a comprehensive understanding of how the OEE can be increased, ultimately resulting in increased yield. The actual productivity of a machine, P_r, is a value that is derived from equipment OEE * the planned production time (planning factor).

One of the most obvious ways to allow more products to be shipped is through a speed increase. Typically, this is feasible through improvements that are made in the process, through the chemistry, rheology, or other technological improvements. Keeping in mind that many of these advances were not available when the machine was initially installed, there may be many opportunities to increase machine productivity. The machine productivity chart in Figure 1, shows that the value of the theoretical productivity is equal to 100%.

Figure #1 Machine Productivity



In many cases, productivity improvements can be greatly increased by upgrading existing equipment. Typically, the productivity of industrial machinery can be increased by as much as 33% by retrofitting existing rolls and drive trains. However, it is extremely important to note that the mechanical system must also be evaluated to ensure that it is capable of handling the stress incurred by the increased machine speed.

To reiterate, machine availability is affected by losses due to equipment failure or breakdown and set- up adjustments. Machine performance is affected by speed losses and small stops. Quality is affected by losses during start up and production. Based upon this understanding, it is now a question of how to increase gains, decrease losses, and improve the overall process of the machine.

3. Can the equipment produce to current quality standards and requirements?

As equipment ages, oftentimes the tolerances of the equipment begin to drift. These can be mechanical or electrical in nature and both ultimately impact product quality. Varying levels of maintenance can also have either a negative or positive impact on product quality. Even if a machine is properly maintained and the mechanical systems are sound, the electrical (drives and

controls) systems, especially analog systems, become harder to maintain and less reliable due to equipment drift.

Additionally, the market may dictate newer and tighter tolerances on things such as coating weights, wrinkles, roll quality and the like. These new standards and tolerances may force a detailed evaluation of the current production asset to ascertain the best course of action required to meet the market demands.

4. Do I buy a new capital asset as opposed to a rebuild?

Once it has been determined that you need to *'do something'* to address one of the following:

- A desire to capture market share in an existing market you may not be fully a part of.
- A developing trend in the industry that you are unable to address
- A new product development, unique to you, but not yet commercialized

The biggest question is what to do next?

They include:

1. Upgrade or retrofit your current asset
2. Buy a new asset
3. Buy a used asset and reconfigure/rebuild it for the application and process

Although seemingly simple, each one of the above choices presents its own set of challenges. Let's look at each one separately.

Upgrade or retrofit your current asset

Once you have determined through an initial analysis that your current asset, with some work can address the need, you will need to address a number of questions individually to determine if the upgrade/retrofit makes sense.

- What upgrades are required?
- What is the desired end result?
- What safety implications need to be addressed?
- What is my current cost of maintaining the asset?
- Can I produce more volume on the equipment if an upgrade is performed?
- How much downtime will the operation incur and can it be absorbed?
- How soon into the future will capacity constraints be hit based on the marketing projections?
- What is the ROI of the project?
- Who do I work with?

With this in mind, let's look back at the areas of availability, performance and quality and how these can be addressed positively through a retrofit / rebuild.

Availability Gains Through Retrofit

One variable that can greatly alter availability is unplanned downtime. It is considered to be the "Black Hole" which is often overlooked. This can also be categorized as losses in two major

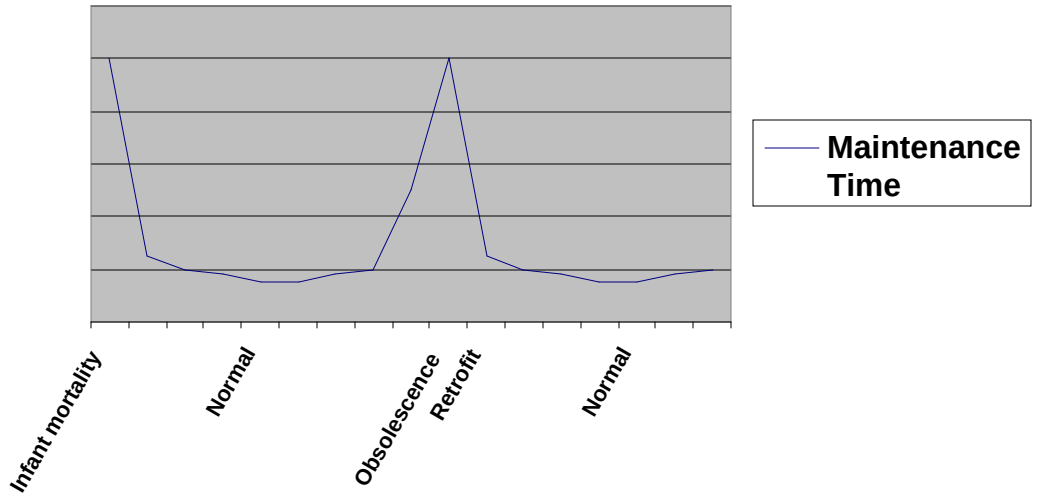
categories, equipment failures and set-up adjustments. Many times, modifications can be made to existing equipment that can help reduce the amount of losses that affect the availability of a machine, and at the same time be extremely cost effective.

Decreasing Losses Due To Equipment Failures. As equipment gets older, maintenance requirements increase. With most mechanical components, utilizing mature technology that does not rapidly change, provides spare parts that are readily available. However, this is not the case with all machine electronics.

While many sensors (limit switches, thermocouples, etc) are the same mature technology, other more advanced sensors, (ultrasonic sensors, beta gauges, etc) are not, and are evolving rapidly. The latter is true of Programmable Logic Controllers (PLC's), computers and drives. AC drive technology for example, has seen major manufacturers release new models every 18 months as more advanced technology becomes available. Although this provides capabilities and features that were not possible before, it also creates a challenge with regards to maintaining the equipment.

In the life cycle of equipment, there comes a point where the maintenance of electronic equipment becomes disproportionate, primarily due to obsolescence and the lack of availability of spare parts. According to a Fortune 50 converter, it is expected that in a 45-year average equipment life cycle, there will be 3 major controls retrofits to address obsolescence. (Figure 1)

Figure 1. Control System Lifecycle



Decreasing Losses Due To Set-up Adjustments. Set-ups and adjustments, along with calibration, are all part of preparing the machine for an upcoming production run. This can

be a time consuming task if there are several product changes. Additionally, older electronics can exacerbate this situation by increasing the required change over time. For example, in an older analog drive and control system, there can be a great amount of drift that requires constant calibration. In addition, limitations due to the lack of availability of multiple or down 'loadable' parameter sets will limit the tuning flexibility of the drive.

The set-up and adjustment time can be significantly reduced through the use of automation that can be retrofitted to many older lines. Controllers such as digital drives, tension controllers, and temperature controllers require less calibration due to drifting issues, and are able to handle a higher range of products. Furthermore, Supervisory Control Data and Acquisition (SCADA) systems, have a recipe-based structure. These allow the machine parameters to be downloaded prior to the next production run. The recipe eliminates the time required for a point-by-point set-up and can simply be acknowledged from a single point of entry at the appropriate time. Due to the accuracy of a computer controlled recipe set-up, the line will be less likely to generate waste as a result of improper set points. Additionally, SCADA systems can be integrated with OEE analysis, providing a window on the process not previously available to production management.

Through automation, changeover time can also be drastically reduced. For example, changing the machine configuration for multiple web paths can easily be automated, further reducing losses and increasing the availability of the machine.

Performance Gains Through Retrofit

Machine performance is directly dependent upon speed losses. This categorizes any situation where the machine is not running at its optimal speed. Although some circumstances may be understood at the time of equipment purchase, and are a conscious decision, others are due to incorrect machine operation. Both conditions merit examination for improvement.

Decreasing Speed Losses. Sometimes process or product requirements may be the factor limiting machine speed. In the web converting industry, an example is having a heavy coatweight without enough dryer capacity to run at full speed. This situation may be a direct result of budgetary constraints during the initial purchase. However, it is now worth reassessing. Consider the following:

- Are the assumptions still valid?
- Has the cost of the equipment decreased?
- Is there any new technology that can be used to accomplish the same thing?

It may be discovered that assumptions made during the original decision making process are no longer valid, making it economically worthwhile to retrofit additional equipment to achieve maximum speed.

Decreasing Short Stops. In another circumstance the equipment may not be allowed to run at full speed due to the requirement to slow down or stop to make a splice. More than likely, this feature may have operated properly after the machine was handed over, but over time machine performance had deteriorated, raising a myriad of questions, such as:

- Are there parts broken or misadjusted?
- Are the procedures being followed?
- Was the original system not robust enough?
- Did the original design allow for enough latitude?

In any of these cases, the situation is causing lost potential revenue, and needs to be rectified. Considering these dilemmas, there are many solutions that have proven successful in the web conveyance industry through the implementation of retrofits and upgrades.

Evaluating and optimizing common trouble spots can achieve proven successes of performance gains through retrofit. For example:

Unwind Splicing Reliability. By converting the splice control from a traditional lap splicer to a predictive unit, the tail length can be minimized. This provides a better splice that can be conveyed through the machine more reliably.

Unwind/Rewind Diameter Control. One of the most troublesome components in a legacy drive system is reliable diameter calculation. This is due to processor speeds or limitations in the systems firmware. This leads to instabilities ultimately increasing the occurrence of web breaks or missed splices. A new system, using a digital drive, performs this calculation at the drive level eliminating the problems associated with poor diameter calculation.

Automated Features. Once the entire line is under the control of a single system, higher automation features become possible. For example, automatic nip jumping to allow splices to pass through the line, or sequential line thread with tension loop enabled to allow the line to produce with increased yield.

Human Machine Interface (HMI). Through the effective use of strategically designed or centrally placed HMI's, machine functionality can be improved significantly. Centralized control improves the overall efficiency of machine operation. An additional benefit is the centralization of all process data relevant to production. This data can then be passed to the plant wide information systems. Even if the Manufacturing Enterprise System (MES) system is not computerized, a well structured process control system can accept and process this type of information if it is input manually. Remember, information is king.

Quality Gains Through Retrofit

Quality losses occur when product coming off the machine is not deemed to be saleable product.

Losses during start-up. Losses during start-up are typically attributed to the system ramp up where the machine parameters come into specification. The quicker these parameters can be brought into their tolerance band, the less scrap will be produced. Here, retrofitting a

machine with an updated control system can have very positive results. Following are some examples:

- **Increased Drive Stability.** Advanced DC and AC drives have the capability to perform the necessary calculations for outer loop, such as tension control. In addition, they can digitally control the outer loop at the power converter level. This provides the line with a more responsive system that can accommodate a wider range of substrate and dynamic conditions.
- **Other Digital Controls.** The use of digital controllers for temperature and pressure loops will greatly enhance the reliability and predictability of a system. They also provide wider latitude to handle many substrates without changing parameters. This will allow the system to stabilize faster due to the many advanced control algorithms. The outcome is a faster process parameter stabilization.
- **Rejects during production.** It is understood that scrap is a result of both predictable and unpredictable events. Whatever the case, each of these situations can be handled effectively by retrofitting the equipment with the proper systems. To help reduce predictable scrap, it is important to minimize both the occurrence and the effect of the disturbance. Consider a typical unwind scenario. Mounting larger rolls and leaving less material on the core would have an overall positive effect by eliminating the number of splices required during a production run. This would generally involve at least a drive upgrade, and possibly a new unwind to handle the larger rolls.

  A well designed unwind will also control the tail length of the splice, minimizing the possibility that a long tail will get caught as it is transported through the process. This reduces the chance of web breaks, reducing the likelihood of unpredictable scrap.

  Many times unpredictable scrap is not as apparent as a web break. It may be a dryer temperature that is out of specification, causing a curing problem that is not found until the QC lab checks the roll, or worse yet, when a customer has an issue with the product. To reduce this type of scrap, an aggressive program must be put into place to constantly monitor the parameters of the equipment. This can be accomplished through retrofitting the equipment with proper sensors and control systems to monitor the process parameters.

In the web conveyance industry, as in many industries, quality deficiencies can be corrected by implementing the following improvements:

Fault Detection. Using the advanced fault finding capabilities that are part of most modern controllers, the up time of a line can be extended. Faults, such as web tension instabilities, are more readily identified. In addition, parts can be replaced before the fault becomes a critical ‘show stopper’ enabling the line to run longer.

Consistent Process Setpoints. For product to run correctly, the machine parameters must be set to the proper value for the production run. Although this seems like an obvious statement, it is actually difficult to achieve consistently since there may be dozens, if not hundreds of parameters on the machine that must be set. If manually set, there is a good probability of human error. There is also a level of subjectivity that is introduced when one operator or shift likes to run the machine one way versus another shift or operator. This leads to different quality products from shift to shift. An automated solution uses a computerized recipe set-up. By using a computerized recipe setup, the machine parameters are correctly and consistently downloaded to the machine, providing for uniform product quality settings.

Web Efficiency. A customer who uses flying splice equipment understands the value of minimizing material left on a core after a splice over. A process upgrade to implement auto splice as a function of diameter can drastically minimize the wasted web.

Coating Control. By adding a coating thickness gauge/monitor to the control system the process line can be operated in a closed loop fashion.

Labor Optimization. As a result of automation, operator involvement can be minimized in certain areas that have traditionally required a great amount of operator interface. Auto splice and alarms generated from the main SCADA computer reduce the need for operators to stand by the line and monitor its status.

Buy a new asset

Once you have determined through an initial analysis that a new asset is needed, you will need to address a number of questions individually to determine if a new asset is viable.

- What are the process requirements?
- Should we buy a new or used machine and does a used machine exist to do what we want?
- What is the size of the market and market requirements?
- Should we integrate current products on the new equipment (if possible) and decommission the old?
- Is the current facility large enough to house a new line?
- How much capacity and expansion capabilities should be built into the equipment?
- What features are required?
- What is the ROI of the project?

Initially, it may appear that a new asset may be the best way to go. There are many upsides to going this route:

- Being able to specify exactly what you want
- Latest designs available
- Lower maintenance requirements
- Working directly with an OEM on a turnkey project

However, there are also downsides:

- High installation cost
- Lead times can be long (depending on the type of equipment)

If the downside becomes an impediment to moving forward with the project, there is another option;

Buy a used asset and reconfigure/rebuild for the application and process

As with a retrofit of your existing machine, which may cost pennies on the dollar, compared to new equipment, so too can the purchase and rebuild of an existing line. It is becomingmore commonplace for a manufacturer to explore the marketplace for the availability of used converting and production equipment. As the industry consolidates and downsizes in many areas, significant amounts of equipment are becoming available through machine resellers and brokers. The likelihood of a machine that meets a majority of the requirements for your production needs is becoming more probable. It also may entail purchasing separate sections of different machines to configure your production equipment. In the end, including the facility, support and equipment costs, a used asset, fully rebuilt to your exacting requirements could cost as little as 30 to 50 cents on the dollar of a new machine with the same features and capabilities. Why is this?

The fundamental mechanical designs of much of the equipment in production today have not changed significantly in the past 40 years. With some relatively minor mechanical rework, the equipment can be brought to current standards. There are significant savings that can be realized in reusing the machine frame, structures, rolls and mechanical systems. As indicated earlier in this document, the area which is subject to the greatest advancements is the controls and electronics. Remember, according to a Fortune 50 converter, it is expected that in a 45-year average equipment life cycle, there will be 3 major controls retrofits to address obsolescence. Automation is an item that the manufacturer will have to address anyway. If the equipment is available to be used, why not explore that option. Some of the questions that need to be address include but may not be limited to:

- What upgrades are required?
- What is the desired end result?
- How soon into the future will capacity constraints be hit based on the marketing projections?
- What is the ROI of the project?
- Where do I find this equipment?
- Is the current facility large enough to house a new line?
- How much capacity and expansion capabilities should be built into the equipment?
- How do I manage the project?
- What is fair market value for the equipment?
- How do I move the equipment once purchased?
- Who do I work with?

As the market changes and manufacturers desire to expand their business base and expand their capabilities, while doing it within the constraints of an ever-shrinking capital budget – rebuilt used equipment is becoming the way to go. The question then arises…who do I use?

5. Who do I choose when retrofitting or rebuilding equipment?

Once a specification has been developed it is best to choose a partner who is experienced in the industry. This partner can be a systems integrator with mechanical expertise who specializes in the industry or the OEM. Other specifications include the equipment, complexity of the retrofit / rebuild and schedule. In either case, the project can and should be handled on a turnkey basis to prevent any oversight resulting in budget problems.

6. What technology options are available for the equipment?

In most cases, mechanical rework of some machinery will be required. It could be as simple as a new drive train to accommodate a new AC motor or something more complex such as adapting an unwind stand for automatic flyovers. Modifying and reconfiguring the existing equipment and therefore taking advantage of the cost savings realized from material, fabrication and engineering savings addresses most mechanical modifications. Additionally, as needed, new or used mechanical components, which were not part of the original machine, could be added. The electrical systems are another situation. As highlighted earlier, technology changes in electrical controls change frequently, often creating a dilemma for the manufacturer – What do I want versus what do I need to do the job? Depending on the final goal, this could vary significantly. Let's take a look at some of the options available and benefits of those options.

There are many possibilities to examine when upgrading or improving your process through automation and controls on existing equipment. Several strategic areas will typically return the most yield for the investment. These are drives, PLC's (Programmable Logic Controllers), operator panels and SCADA (Supervisory Control and Data Acquisition)..

Drives. Typically this is the first component users will improve for increased throughput and higher reliability. Modern digital drives are relatively easy to retrofit to existing machinery, assuming the mechanical equipment can handle it. Most older lines are fitted with DC drives of varying vintages – everything from "Gen-sets" to DC Digital drives exist. All of these systems were state-of-the art at the time of installation, but technological advancements have made many of these systems obsolete. Additionally, older analog systems are subject to drift and do not allow for the flexibility required. Many of today's production lines run multiple products or substrates and are challenged with the level of quality and control required by the market. Another challenge faced by maintenance staff is support. The original drives manufacturer no longer support many of the systems. Spare parts and service are hard to find, putting production in an extremely vulnerable position with respect to risk and potential downtime. Depending on the capital available and ROI calculations,

there is the choice to reuse the existing DC motors if practical (typically if existing motors are 500VDC armature/300V field) or replace with AC motors and drives. Today's latest generation of AC drives offer many benefits to the user, some of these include:

- Reduced cost of motor maintenance
- Improved power factor performance at the magnitude of 15%
- Better power utilization on coordinated drive systems via common bus designs
- Reduced foot print and increased space savings
- Faster response to speed or process disturbances
- Integrated processors with multiple control algorithms (vector, v/hz, motion)

There are many factors influencing the decision, but due to the flexibility of the technologies, a system can certainly be configured to meet the automation and budgetary requirement of any retrofit or rebuild project.

Programmable Logic Controllers. PLC's are great for retrofitting old high maintenance relay panels and early proprietary controllers. They can be used to replace and integrate many single controller functions, like temperature controllers, into one unit. Additionally, with PLC's or embedded controllers, high levels of communication and integration can be achieved allowing unlimited flexibility for the process. Benefits include but are not limited to:

- Compact space utilization
- Information exchanged from the lowest levels of the process to the MES level
- Flexibility as process changes
- Product specific parameterization
- Ease of maintenance
- Communications Options

Like any other automation platform, PLC's and embedded controllers are subject to product life cycles as well as original equipment manufacturer's support. Therefore, it is important to investigate the controller platform that may outfitted with your existing or new 'used' equipment.

Operator Panels. Operator Interface or Human Machine Interface, is a prime rebuild improvement that increases reliability and reduces operator error. An ergonomically designed operator panel based on a strong software or firmware platform will make the line more intuitive. Elimination of large control consoles laden with pushbuttons, meters and pots will improve your space efficiency, and give you intuitively designed interfaces.

SCADA. SCADA (Supervisory Control and Data Acquisition) systems, in most retrofits, are considered an add-on component. It improves process understanding, typically installed as a layer between the production equipment and an enterprise level system. As simple system architecture is depicted in Figure 2.

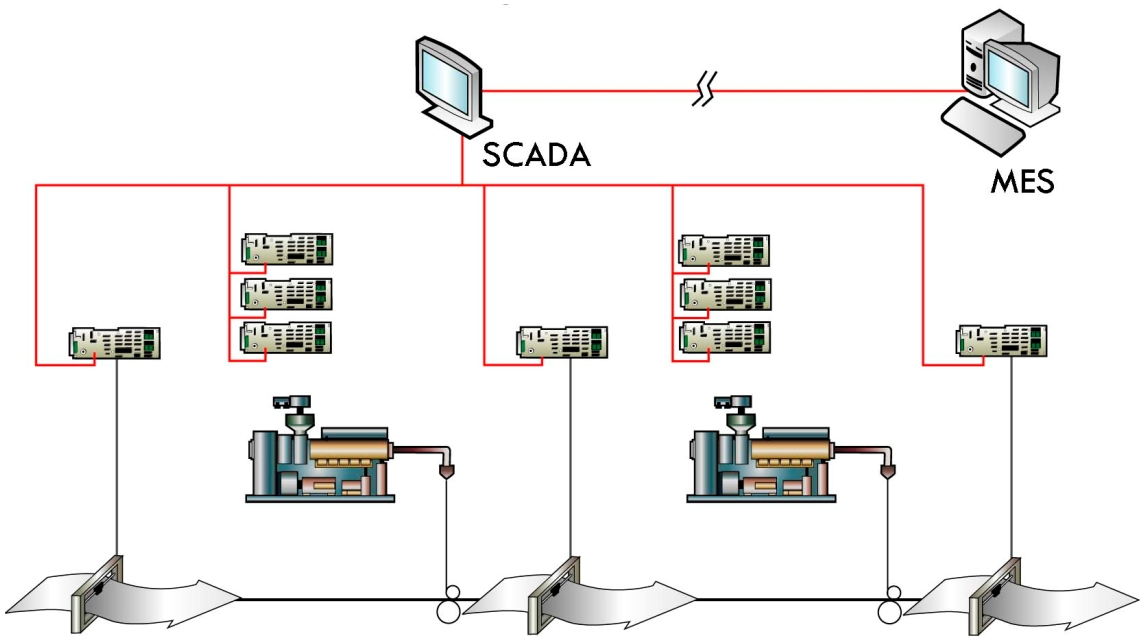


Figure 2. SCADA System

Many operations choose to implement a SCADA system during a rebuild or retrofit. Keeping in mind that “data is king”, too much data can also be as ineffective as no data. If too much information is presented, it can be confusing and of little value so it is critical to develop a philosophy as to what data is critical and how it is to be presented. In a fully integrated system, all the data is available that is on the network and management of that data is of utmost importance. The implementation of a SCADA system that is fully integrated plant wide and ultimately incorporated to the corporate wide systems may appear as follows:

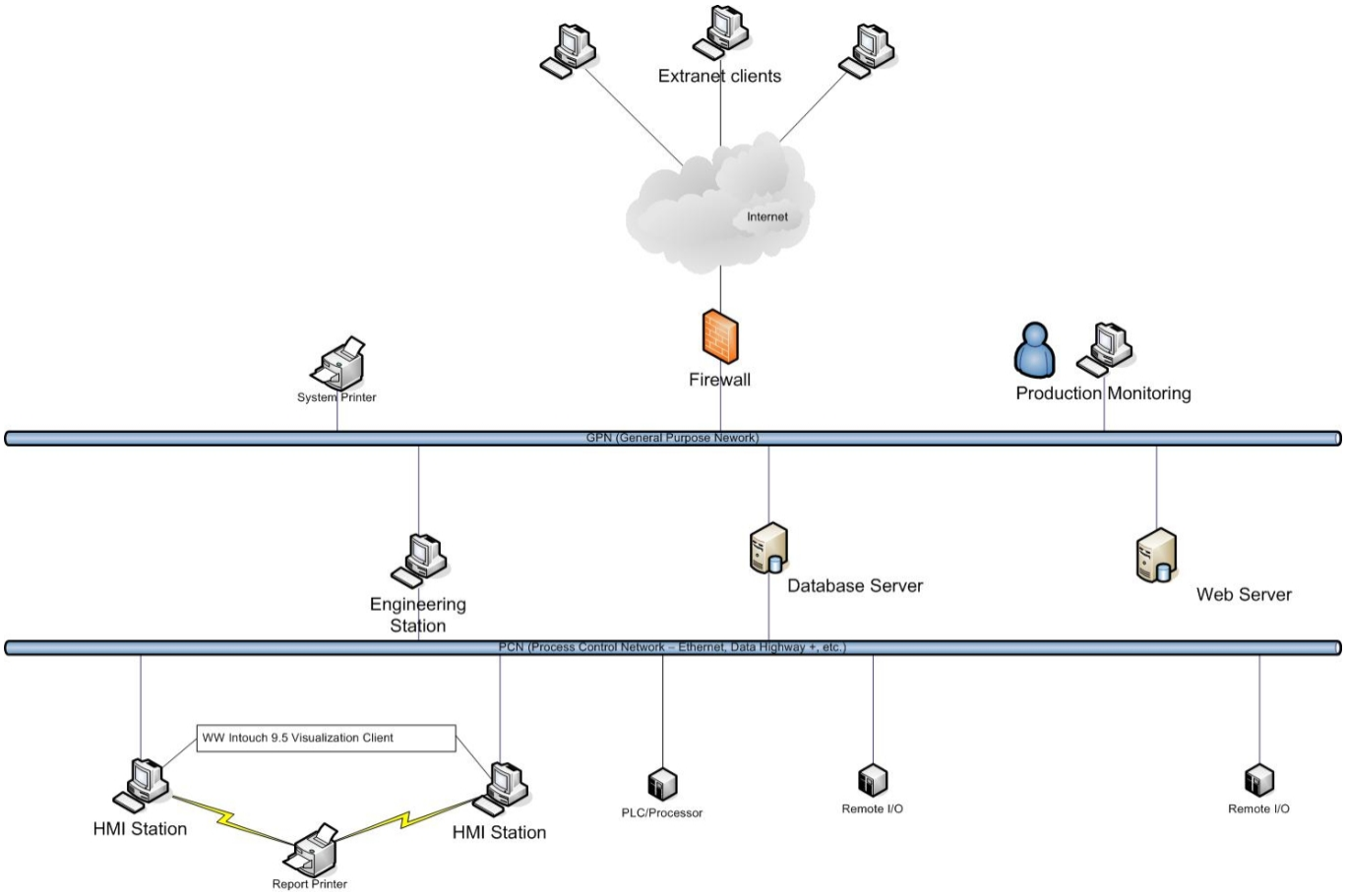


Figure 3. Fully Integrated SCADA System

The addition of these systems can be an invaluable tool for averting production of scrap, troubleshooting problems and evaluating OEE. In addition to the availability of huge amounts of data, other benefits of a properly integrated SCADA system include:

- Reporting (Shift, Roll, Event logs, OEE, Statistical data, etc)
- Recipe management
- Alarming
- Real-time and historical trending
- Statistical Quality analysis
- Machine setup and control screens

Although a retrofit or rebuild may not require SCADA systems, if operational improvements can be made via implementation of such systems, it may be worth consideration during the retrofit process. Ultimately, deciding what is necessary versus nice may not be so easy.

7. What technology options are necessary or required for production?

Armed with an understanding of what options and features are available, the manufacturer can then decide what is required to run the production equipment versus what is a nice feature that does not benefit the process significantly. There are many factors involved including:

- Available capital
- Available staff (IS, Production, Engineering, etc)
- ROI
- Competitive pressures
- Market demands (quality, product formats, etc)
- Growth expectations (Marketing/Business Plan)
- Infrastructure to support the equipment (IS, communications, etc)
- Operational and maintenance costs
- Quality processes
- Safety requirements

These and other considerations may have a very distinct impact on the decision. It is quite possible that what is determined as necessary may not fit within the capital budget of the current year. That being said, a phased approach to retrofit / rebuild can be considered and is yet another reason to consider this option over new equipment.

Now that the decision has been made to move forward with a rebuild / retrofit, the question of who to use arises.

8. How do I get started, where do I look?

Once the decision has been made to buy and rebuild / retrofit the existing equipment, selecting partners are extremely important. These partners will be a major contributor to the success or failure of the project. It is most essential to stress the importance of having a detailed specification prior to making any decisions regarding upgrading or replacement of equipment. An engineer or consultant who has expertise in the industry can develop this document, and provide valuable insights. Oftentimes, integration partners also offer these services and can become an integral part of the manufacturers engineering staff during the developmental and ultimately the implementation phase.

There are many sources for production equipment, including OEM's and machine resellers and brokers but finding an integration partner is rife with many dangers. Anyone looking for a partner for a rebuild / retrofit should look for a partner that is experienced in your industry and processes. Many integrators exist that are knowledgeable and efficient in the automation technology but quite possibly not the application. Risk abatement is of utmost importance in any project, especially a rebuild or retrofit. Finding a partner with knowledge in 'what you do and how you do it' should be the first criteria. A good source for this type of information can be found by talking to other manufacturer's in the industry, industry affiliations such as AIMCAL, CEMA, SPE, TAPPI, etc.

Finally, when evaluating a partner, once the list is narrowed it is important to fully understand not only their competencies but also factors such as:

- Company stability
- Length of time in the industry
- Support infrastructure
- Training programs
- Project management capabilities.

Their skill, knowledge and competency will greatly impact the final results. Therefore, deciding WHO is best suited for the task, WHAT will be accomplished and WHEN it will happen are very vital questions.

Conclusion

At the end of the day, a retrofit / rebuild may be the most cost and time effective solution and should be a serious consideration when deciding to improve, upgrade or answer a market need.