Automation Systems and their Return on Investment

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Like many other phrases carelessly thrown around by economists and business consultants, Return on Investment has become the overused acronym ROI, and has gained popularity so quickly that engineers more accustomed to dealing with SMT, VOC, PTH and ICT now use ROI as part of their everyday working language.

But do those of us who use the acronym actually know what ROI really measures or captures in the manufacturing arena? Do we understand how can it be used to both justify and quantify investments in capital equipment? In fact, is ROI even an appropriate data point given the available manufacturing information flows?

Using a simple mathematical equation, return on investment in the terms of a company CFO can be described as:

$$\frac{\text{(Profit /Loss before extraordinary items + interest expenses)}}{\text{(Total assets – non interest bearing liabilities)}} \times 100$$

Needless to say ROI is an historic reference point. It cannot be determined as fact that any investment has made or lost money until after a period of time has passed. In reality, companies use ROI more as a target, a corporate goal and a measurement of management effectiveness. For those of us who are buying and selling machinery the term is misplaced. Other metrics that could be more relevant to a capital justification might be Positive cash flow, Payback period, Tangible quality improvements, savings in Floor space, and reductions in COG.

Each contributes to an increase in operational efficiency and therefore to future ROI of the business.

Within the electronics assembly industry, many avenues of competitive performance have been explored to the extent that there are very few areas left for tangible increases in efficiency. Finance options have brought cash flow and improved results, new SMT machinery has reduced footprint, AOI systems proliferate and allow QA to be validated at various points along a line. Costs of machinery have reduced significantly under an economic and supplier squeeze.

Yet, with all of these avenues explored, we as an industry, both supplier and customer, must continue to drive for newer and better solutions in an arena that has been the catalyst for some fantastic innovations in design over the last decade. Today it is obvious that we are in the midst of the worst downturn ever recorded. New technology drivers are seemingly few and customer demand for existing products lacks the impetus to propel us all back to 1999 levels. This year will be remembered as a year of reckoning. Those companies that had market momentum but no plan will fade.

So faced with margins of less than 3% in many cases and more capacity than you can swing a cat at, is capital expenditure a reasonable agenda item for the next management meeting?

Yes, it certainly is! To curtail investment would be a catastrophic error, resulting very quickly in technical obsolescence ultimately leading to a lack of competitive advantage.

One critical question begs for a finer focus: where should a company invest?

The last 12 months have taught us all many lessons, not least of which is the impact of labor on the efficiency of a company and on the COG of its products. In times of fervent demand, all manufacturing companies are faced with a necessity to profit while the demand exists, this in turn leads to large capital outlay for new plants and machinery, and increases in variable costs as labor is sought to support the machinery and fulfill the manual elements of the assembly process.

Much of the capital outlay is kept off the balance sheet through the use of lease companies and cash outflow is minimized via the same financing mechanisms. In essence, machinery is justified and supported through cash flow. Labor is a greater issue in that the costs of hiring are not inconsequential. Recruitment, Training, Retention, Quality, Productivity, infrastructure – all have costs associated with them that can be linked directly to the labor element of manufacturing.

The impact of increased labor has a double impact when, as this year, economic and technological drivers (or lack of) come together to fully arrest

consumer demand and the requirements of manufacturing accordingly.

Machinery is disposed of, moved around the world to other facilities, sold at auction or returned to the finance companies. The original cost is never realized if a machine was purchased, but some degree of return is ascertained. So in effect there is a cash inflow or cessation of cash outflow when cash is most important.

Labor that has cost so much in Recruitment, Training, Retaining, and necessary infrastructure is now also redundant. However, the cost of redundancy does not come without penalty. Most companies exercise severance programs that cover employees for periods of time employed. Benefits programs are often continually funded for a period after the employee has left the company. People take up space and that space quickly becomes vacant in a reorganized facility and the general overhead rate increases as a % of outbound product when the cost of the property is factored.

In short letting people go is a very expensive exercise, financially, emotionally and organizationally.

Here's the critical question: What could be done differently in the future and where should investments be made that allow a company to grow efficiently and at the same time protect themselves against the variable costs of fluctuating labor requirements?

Move to China???

For some such a move makes sense; but for others it is simply not realistic -- local markets need to be served locally and not everyone can afford the time and or monies associated with an off shore manufacturing project. The dynamic between large scale manufacturing companies and smaller ones is changing and greater proportions of finished product and sub assembly parts are coming into the USA from China, but it is simply not possible for this trend to continue unabated. It does however provide yet another reason for USA manufacturing companies to be more efficient and more competitive than they are today. The US domestic market for electronics is massive and in the consumer area the costs associated with offshore manufacturing and importation are not inconsiderable -- providing an advantage for those companies that are USA based and particularly capable.

Where do the investment opportunities lie in automation that could possibly make a difference in the future?

Looking back 15 years, the advent of volume SMT was the sure downfall of the leaded component. No package type or electrical performance requirement would be left un touched by the newer, smaller, on the top phenomenon. As we are all too familiar, the leaded component is here to stay, either for mechanical or electrical performance reasons most every circuit board has some "Odd Form" content.

As the level of automation has increased and the application of technology made the SMT process faster and cheaper, the few components left with leaded terminations have been managed by most companies through the application of manual labor – which as we all know is a highly variable.

Opinion has consistently worked against the idea of automating the final stages of component assembly in favor of flexible manual operations -- even at the critical point when the added value of the SMT assembly is at its highest -- and the risk of mis insertion, mis orientation or simple wrong part insertion will cause the greatest impact to the cost of the product and the operating profits of a company.

The reasons for the avoidance of automation are well founded: The older Odd Form insertion systems lack flexibility, are large relative to the number of components that are being handled and are costly – plus there is the sub conscious belief that the few leaded components may be designed out at the next iteration of product design.

However, when all the elements of variable content are accumulated, the actual cost of not automating may in many cases be significantly higher than many manufacturers realize, including Labor, Floor Space, Rework, Product handling, Re-test, Cost of materials in circulation.

With the ever diminishing margins associated with electronics assembly and the drive to squeeze the very most from the process in terms of repeatability, reliability and consistency – automation may be the difference between breaking even and making a profit. The one area of machine technology that has very subtly been improving over the last 3-4 years and that does provide an avenue for further exploration when strategically planning the next 12 months is automated Odd Form equipment. Calling it Odd Form is misleading and conjures a completely inaccurate image in most people's minds. A far more accurate term would be *End of Line automation*. The term recognizes the end of the SMT line as the traditional break point in a manufacturing facility where automation gives way to multitudes of other operations from Test to manual assembly back to test and rework, and finally to box build.

The humble Odd Form machine has come a long way. Today it can succeed in doing a great deal more than is often recognized. Much in the same way that the MPS 525's and Siemens MS90's gave way to Fuji's and Siplaces – End of Line automation has transcended the Customized highly specialized Robotics Cells of yesterday and now are closer in specification to highly flexible placement machines – with the differences being in the array of picking, sensing, testing and placing options that are available to the end user, without the need for customization or specific software development (Figure 1).

Flexibility leads to complexity leads to redundancy is the most usual response to a suggestion that what was manual can now be automated. This would be true in the case of a Robotic cell being configured to meet a given products demands, Today EOL machines no longer center their technologies around Robotics systems -- quite the contrary, they have taken huge steps in departing such limiting architecture in favor of Windows OS and generic motion control, vision systems and feeding systems. (Used by many other machine types in SMT)

End of line automation has replaced the old Odd Form systems with up to date technology that goes a lot further than simply placing those parts the other machines could not handle. PCB parts assembly is an obvious start point followed by the capability to integrate test systems, labeling systems, depanelling systems and ultimately Final Assembly box build solutions -- All with the same basic gantry and software architecture. The basic premise being that familiarity breeds comfort breeds efficiency and reduced learning.

These new End of line automation systems represent a huge added value opportunity for the Electronics Assembly Industry and at the same time present a more favorable strategy to "lots of labor" in a growth period.

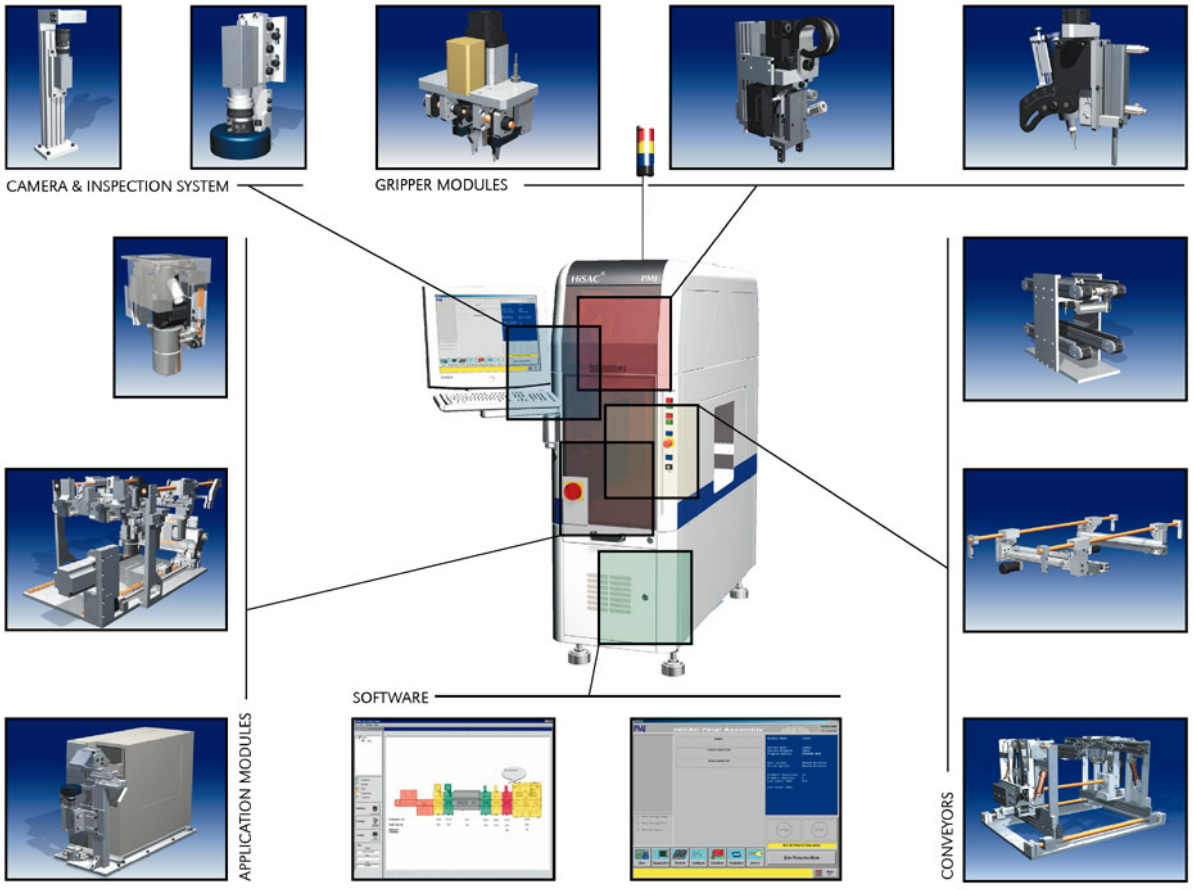

Figure 1 - High Levels of Configureability and Reconfigureability Exist with Today's Automation Systems. This is Facilitated by a Move Away From Robotics Style Controllers and Toward Standard Operating systems and hardware

Figure 2 - A Typical EOL Automation System Today Consists of One or More Cells of 0.5 Meters each in Length - Typically each Cell can Provide the Output Equal to 3 Operators

The old prejudice toward automating processes that have traditionally been manual is out molded. The benefits of today's technology are the normal and expected attributes of machines over people. But new to the roster of benefits in this area are Small Footprint, Flexibility and Reconfigure ability; All major advances when faced with the issue of a fickle customer who may not want his current version of product in 3 months time. A typical automation cell today is 500mm in length; productivity can be enhanced through the use of multiple cells in a line.

One cell typically will cover the output of 3 operators per shift in an area $1/6^{th}$ of that required by the same manual workforce (Figure 2). And it is here we get back to justification be it ROI, Payback, Cash flow.

The tangible factors affecting COG include:
- Materials
- Labor
- Plant Overhead

The Intangible (or difficult to conclude) are:
- Rework
- Quality impacts
- Rework Inventory (Cash flow)
- Customer satisfaction

(This is a partial summary.)

It is obvious that these arguments are subject to every customer's own interpretation and investigation, but it is our experience that many companies fail to recognize the end of SMT as an opportunity for further efficiency gains (Figure 3).

What Automation does for Payback?
- It is predictable (no vacations or sick time)
- It is repeatable
- It is more productive per unit of space
- It offers a higher degree of process repeatability
- It offers multi shift ramp up or ramp down with a minimal incremental cost
- It offers better floor space utilization
- It replaces a large percentage of manual operatives and their associated high degrees of variability

Consequentially:
- Quality improvements are expected
- Rework requirements are diminished
- Inventory management is improved
- Actual costs are reduced
- Increases in productivity can be realized instantly (assuming shift increases are a possibility)

When looking objectively at the advantages, it may seem they are "Too good to be true." And of course, there are obstacles that need to be recognized -- and the earlier the better.

- Component packaging is often an issue, as few standards exist.
- When considering a Fully Automated Assembly solution the product design must account for the methodology of assembly. It is not realistic to take a product that presents difficulties to an operator and expect machinery to overcome those issues.
- Incoming materials inspection must be able to pick up the variances in batches of materials. Simply accepting variability in the supply of materials frustrates an otherwise straightforward process.

It is often cited that the failure of automation leaves behind it a company with better operational procedures. This may be true. However the failure is invariably the result of a product's untimely demise and an Automation system that lacked the ability for reconfiguration. The same control of procedures and process are required in today's environment, but these are an innate requirement in any competitive situation. The equipment's evolution to facilitate multiple products and component types is the key advance that begs a re-evaluation from many Electronics manufacturing companies (Figure 3).

The cost per placement and actual increases in Quality, reduction in labor and floor space requirements are all measurable, (Figures 4, 5, and 6) and can be quantified with some degree of accuracy to help management determine whether End of line investment makes sense for a company. Many companies can provide EOL facilities such as those described and have capability to assist in process evaluations.

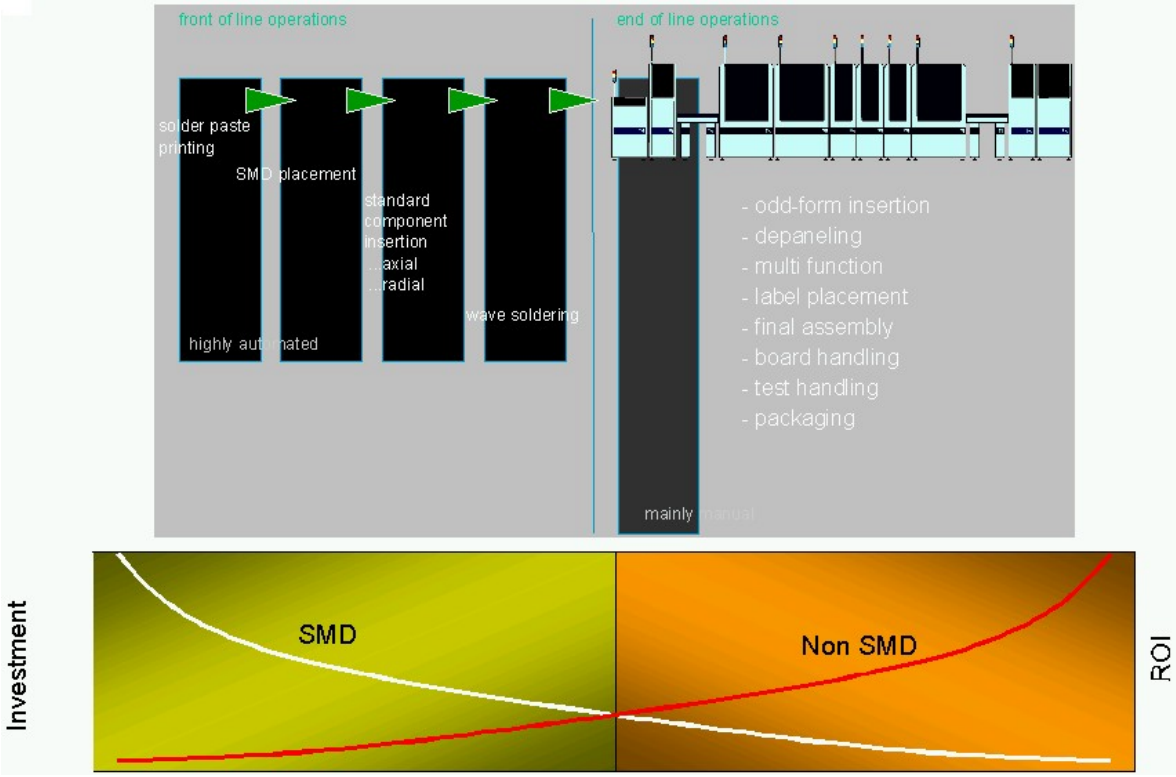

Figure 3 - The Relationship Between Payback/ROI in the SMT and EOL Situation Can be Best Described this Way: Millions of Dollars in SMT Equipment Buys You a Line Similar if not Identical to Many Others - It Pays Back at a Rate Well Described by Industry Norms - A Significantly Smaller Investment in EOL Automation Allows New Operational Practices to be Realized that Differentiate and Drive High Levels of Return

Figure 4 - Familiar Line Above Measuring 16m in Length was Replaced with a Machine Solution 3.5M in Length that Required 1 Operator Per Shift

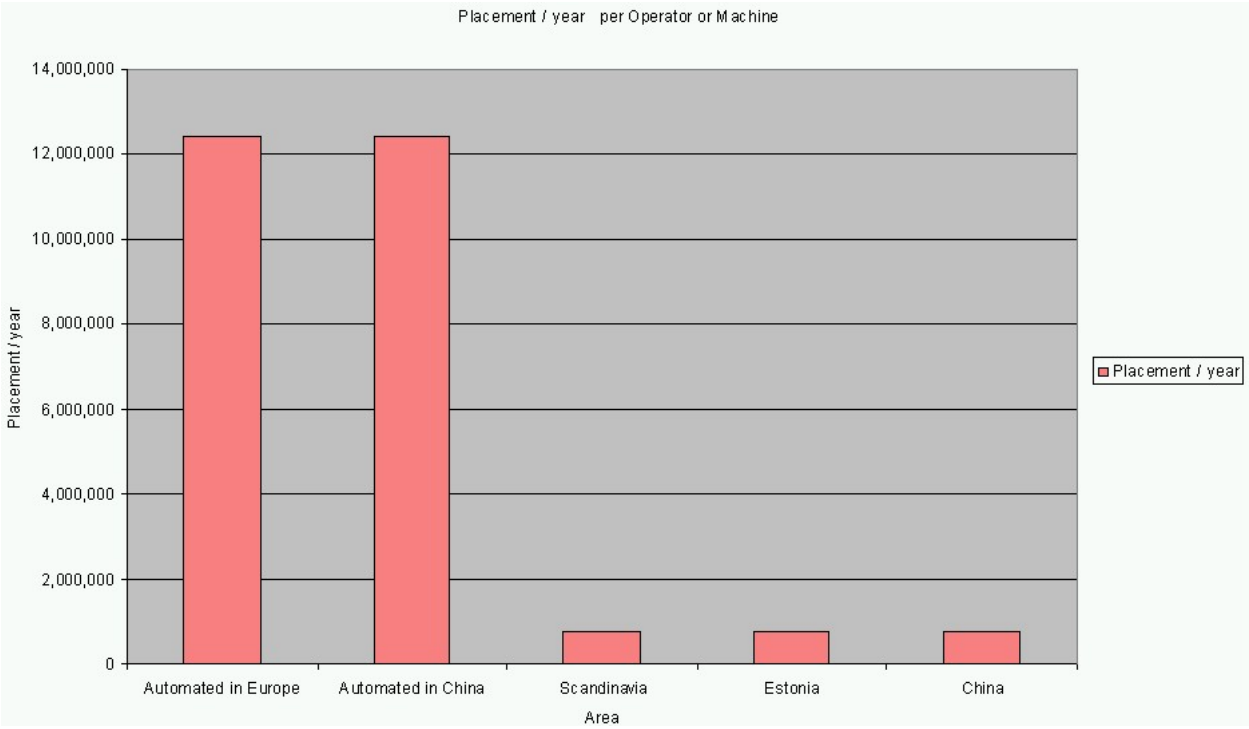

Figure 5 - Parts Placed Per Year by an Operator vs. AUTOMATED SYSTEMS is a Fraction, Further Illustrating the Impact of Fast Ramp Up or Down and the Impact that it has on a Companies Performance and Cost

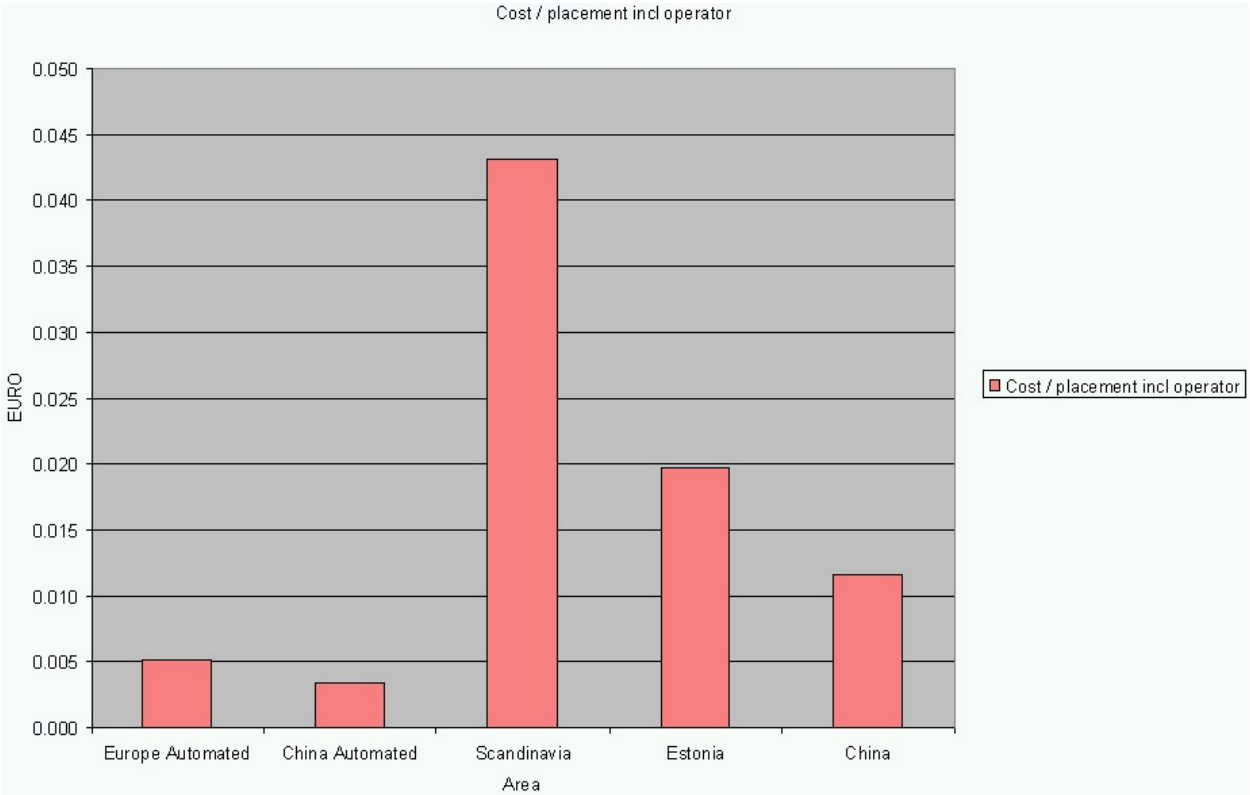

Figure 6 - Actual Cost Per Part Placed is an Extreme Unit Cost Expense when Considered Against Automated Alternatives.