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How Reshoring Drives Profitability

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Abstract

For many years, manufacturing has sought to increase competitiveness by moving off-shore to countries with lower labour costs. Electronic manufacturing services (EMS) companies provided an essential element to make off-shore transfer happen more quickly, offering further cost reduction opportunities from load balancing. Fierce arguments were put forward to protect the loss of local jobs, although the result was, in almost all cases, inevitable. Today, however, the whole market of PCB-based electronics products has changed significantly. The “pros” of off-shoring are no longer what they once were, and the “cons” are becoming more significant because off-shore manufacturing can no longer satisfy the needs of the market.

Is reshoring really commercially viable, or are government incentives trying to push water uphill? Market demand patterns continue to change and evolve. As technology-based products become fashionable, the demand from customers becomes more volatile, and they are more heavily influenced by endorsements and trends. Getting the latest products into the market ahead of competitors, with a range of options to match people’s individual tastes, is essential. The trend of direct shipping of products, driven by Internet shopping and direct B2B ordering, brings these variations in demand directly to the factory door. The key for success in today’s market is being able to provide flexibility and agility without losing productivity.

Off-shore manufacturing has inescapable issues of delivery time and cost, as well as price depreciation and long response times while carrying some significant risks. Whereas, in theory, reshoring allows rapid time to market, the opportunity to meet customer needs, and eliminates many hidden costs of doing business.

In this paper, we expose the real costs of off-shore manufacturing, and put labour cost differentials into perspective. We demonstrate how practically, using existing technologies, re-shored manufacturing can yield better business return, either for an OEM, or through EMS providers.

How Reshoring Drives Profitability

Profitability is a key element and metric in the performance of any business. The suggestion that on-shore manufacturing is something that we should be considering has CFOs immediately requesting the proof in the form of a business plan. With the wide range of cases and conditions, sectors, and tiers involved in the electronics manufacturing industry, it is difficult to assess all cases in detail. Conceptually, however, let us consider the profitability of a new EMS company for starting up on-shore manufacturing at a reasonable volume for a range of consumer products, which could include handsets, computer devices, some industrial, as well as medical or automotive, focusing on the points that differentiate an on-shore operation from what is now regarded as the expected off-shore manufacturing operation.

Almost as a result of conditioning, the CFO’s first thought is operational cost. It may seem obvious that operational costs off-shore in countries like China, Vietnam, Brazil, or India are far lower than countries representing the major market opportunities, such as the United States, the United Kingdom, or western Europe, such that on-shore manufacturing could never be competitive for mainstream electronic products. This was after all the original premise behind manufacturing moving off-shore. At the time, many arguments were made about the pros and cons of doing so, some of which, with hindsight, seem rather short-sighted. The market has changed significantly over the years, which requires us to revisit those arguments. Let us start with the most significant change, which in recent years has become far more significant—the distribution chain.

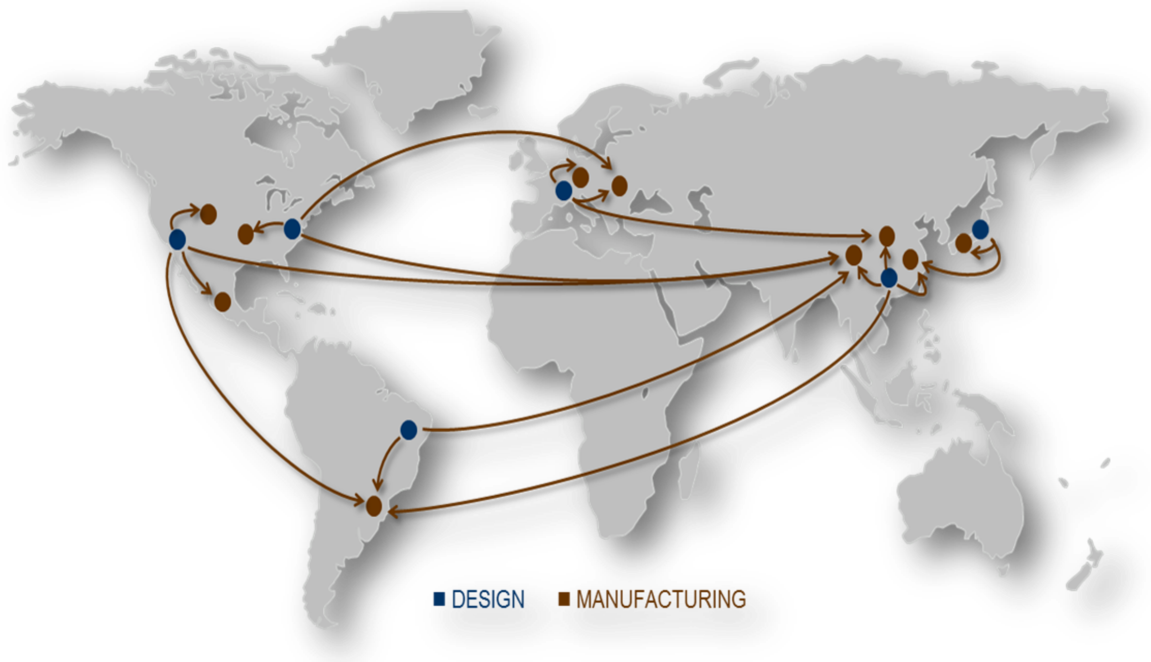

Figure 1: Off-shoring took manufacturing away from the market, increasing lead-times, distribution stocks, and limiting the response to the short-term demand changes

For the Love of Distribution

When the flood of off-shoring took place, the Internet was in its infancy, and the traditional distribution chain was firmly in place. It may seem a simple action to take products from a factory where they have been produced to the store for the end customer to buy, but actually, this is one of the key governance processes for the business and the industry. After leaving the factory, the distribution chain starts with a series of journeys between warehouses and hubs that the products must go through. It is like an hour-glass, many types of products coming in, combining with other products from other manufacturers, even from different industries, shipped together on a cargo ship for example from China to the United States. Then the distribution fans out again as the logistics local to the market take over, shipping into more hubs and warehouses, until the product finally arrives at the stock room of the local shop. This then is multiplied by the number of regions that each receive their own shipping and logistics services. All of these stages in the distribution chain contribute cost and take their profit, as of course does the final shop in the chain, which is usually then also obligated to take a further portion of the selling prices as tax.

As complex as the distribution process is, it has historically provided fundamental value to the business that it serves, which continues today, for example:

1) The Sales Team: Having enough stock available to sell with a reliable replenishment flow satisfies a key need of the sales team. A customer going into a store to buy a product, and finding it to be sold out, will likely be driven by the shop's salesman to buy an alternative product. Retail never wants to turn customers away. The distribution chain must be able to replenish stock at the point of sale to prevent this erosion of sales opportunity of the product that the customer wanted. The sales team knows that customer demand will fluctuate significantly. Should a competitor release a product into the market with slightly better specification, or with a slightly lower price, demand can dip suddenly until tools such as advertising, promotions, and price adjustment are used, to restore sales volume back to targeted levels. A significant amount of stock in close proximity to all stores ensures that this will happen. Without

the distribution chain, the sales team would have a far higher risk of short-term shortages that would lead to loss of sales opportunity.

2) The Factory: Stable, high-volume mass production has always meant that factories have the minimal disruption in their day-to-day operations and so can achieve excellent levels of productivity. The number of products made in each factory, however, usually exceeds the number of production lines available. At some point, changes in the production flow need to be made. The larger the buffer of finished goods stock is, the less often the factory needs to make changes. Without the distribution chain, factories would need to change products much more often to avoid exhausting stocks as they are taken by customers, thereby reducing productivity.
3) Business Planning: The enterprise resource planning (ERP) tools use the distribution chain as a key part of the whole product planning cycle. Typically, the sales and marketing teams predict and forecast the likely demand for each product going forward. ERP logic then assesses how much of this demand can be satisfied with the currently produced stock in the distribution chain, plus the committed production at the factory where raw materials have already been ordered. The remaining demand is then converted into future production work-orders for the factory and then on to the orders of additional raw materials. Some of these materials require a significant lead-time. If say this lead-time is three months, then it means that the adjustment of the overall flow rate of production can only be adjusted on a three-month basis. The current production and distribution chain stock will be needed to buffer the flow of products against demand fluctuation in the interim period. Without the distribution chain, ERP would not be able to re-plan the factory effectively in time to meet changing demand.

With these main voices controlling the business operation, moving production off-shore was not an issue. The increase made to the distribution chain was only around three to eight weeks for global shipping, which could even be spun as being a benefit to sales, ensuring long-term stability for sales, for the factory, and to give the business planners more time. Arguments against the extension of the distribution chain were made, but they never gained the strength needed to overturn the off-shoring decision in most cases.

Strengthening Opposition

Our new on-shore manufacturing operation today is located close to the market and has the opportunity of working without a significant distribution chain. Before we look into how that could work, let us look at the other side of the distribution chain argument, at the perhaps less tangible, but also more significant, costs as they have evolved over the years into the situation we have today.

1) End of Life: All products eventually come to an end of life, hopefully one that is predicted, but it can all end suddenly. For instance, a competitive product launches in the market against which the current product cannot compete. A “refresh” model is in the pipeline. The volume of goods in the distribution chain can suddenly for the sales team become a huge liability, when sudden depreciation occurs. These products must be sold or scrapped. Selling them is of course preferable, but to do so, the price must be reduced to increasingly lower levels, often to the point at which they are sold at a loss. What profit was once made earlier in the product’s life is now being lost. To limit this risk, business planners need to make sure that there is a minimum of stock in the distribution chain, that ideally the chain should be as short as possible in terms of the number of products. This is working counter to the sales team’s product flow strategy. Seeing the increasing trend of competitiveness with technology based products, product lifecycles have shortened dramatically. The end-of-life scenario becomes increasingly common and increasingly significant.
2) Time to Market: Every end of life has a start of life. The majority of all profits made on a product occur in the earliest stages of introduction to the market. The introduction of many competitive products with the latest technology has become a key business strategy for market leaders. If a key product launch is delayed, the period of exclusivity and dominance in the market decreases, directly reducing profits earned against premium sales pricing. An example was the launch of the iPhone 6, which broke records for pre-orders on the first day, before anyone had

even seen the phone itself, double the number previously for the iPhone 5, all sold at premium prices. How long before rivals launch their iPhone 6 “killer? iPhone 7 to be sure is not a long way off.

Design systems for electronic products have come a long way in recent years to ensure that modular design elements can be tweaked and re-used, such that each new technology can be integrated far more rapidly into a new product. The market-leading PCB layout tools today offer the opportunity for layout designers to work concurrently, reducing lead-time significantly. Material selection and manufacturing constraints are accounted for during the layout process, with the completed PCB design ready for fabrication and then on to assembly with a hugely reduced risk of re-spins and delays. The focus in the new product introduction (NPI) process now shifts to the factory and the distribution chain. How quickly can the factory change to support the ramp to volume for the new product? How long will it take and how much will it cost to fill the entire global distribution chain with products before sales can start?

3) Fashion: This short-cycle continuous product reinvention trend makes the market for electronics exhibit similar sales patterns associated with the fashion industry. However, people look to purchase the best product that they can afford and do not want to pay for something they do not need. Knowing this is a key factor for success for product managers, seeing market demands for many revisions and version of each product, such that consumers can get the best value for money they are seeking. Factoring in global geographical variants, the result has been that the number of products and variants that the factory needs to produce has increased between ten and a hundredfold since off-shoring started. Even if the number of products increase were only tenfold, to retain the same low level of change in the factory, the stock in the distribution chain would have to be 10 times higher because the manufacture of each product would come around 10 times less often. There is also, however, 10 times the number of individual products to stock, so in theory the stock in the distribution chain needs to be 100 times larger. Of course, it will be less than that because the sales expectation of each variant will be lower, but which models will prove the most popular? It is more difficult to predict trends across variants of products. In the case of at least one key mobile handset manufacturer, a factory in China was purposefully located near to an airport. The finished goods come off the production line and are almost immediately air-shipped to the end customers. The cost of air freight was more than justified by the avoidance of depreciation issues and other costs associated with the traditional distribution chain. This is no longer a one-off example.

4) The Internet: The major blow to the distribution chain has been Internet shopping. Rather than going to a store for a product, we now search on-line for the best price among shopping sites that have the product in stock. Orders are placed electronically, and the customer expects timely delivery. Now, of course, traditional local retailers are a part of Internet shopping, they simply ship from their local store or warehouse. More modern retailers, however, have realised that they can undercut the high street stores, by shipping directly from the manufacturer to the customer, bypassing a major part of the distribution chain, enabling lower prices while retaining profit. This business model has now spread back to the point of origin of manufacturing. Common consumer items, such as the latest designs of LED light bulbs, are now available through Internet shopping sites such as Amazon, eBay, or Alibaba, sourced directly from China at a fraction of the cost of those coming to the United Kingdom through the regular distribution chain. Entrepreneurs are creating small companies, each with some arrangement for sourcing local new and exciting technology. Even with the addition of the cost of international direct shipping by air for individual items, the price does not come close to that otherwise asked for a similar product that went through the traditional distribution chain. Shipping by land or sea makes direct purchase even cheaper if the customer is prepared to wait. Not only is this practice undercutting traditional retailers, but the factory is now operating in a situation where, a small part, at least for the moment, of their output is being sent to customers directly without any significant distribution chain.

An interesting question at this point is whether the same thing could be done if manufacturing were on-shore. Could the benefit of virtually zero distribution chain cost be realized, and if so, how would this saving compare to the projected increase in the cost of manufacturing on-shore?

The Actual Cost of Manufacturing

As time has passed over the 20 years or so that off-shore manufacturing has been going on, there is an unpopular but strengthening opinion that manufacturing and assembly cost itself is overrated in context with the final cost of the product the customer pays. Consider the contributors to the price of a product that you might find on the shelf at your local electronics store. There is the cost of the raw materials, the cost of the manufacturing process, the distribution cost, plus, it is expected, some profit and sales tax, as well as an allocation of fixed costs from the company operation overhead including the cost of the design of the product itself. Looking into the cost of the actual manufacturing process, this, in many cases, represents only around 10% of the finished goods price, though of course there are significant variations between products. The proof of this lies with the rates that EMS companies charge for manufacturing. It is then only a portion of this cost that is contributed by the differential labour cost, with costs of machines and automation remaining fairly consistent. The contribution of the fixed operational cost of labour in manufacturing probably in most cases represents about 6% of the end price of the product. This is actually far smaller, again in most cases, as compared with the portion of cost associated with the distribution chain.

Factory Operation without a Distribution Chain?

The shorter the distribution chain between the factory and the customer, the fewer the quantity of products acting as a buffer for short-term changes in customer demand. This brings a higher risk and incidence to the factory in receiving sudden changes of delivery requirements following short-term consumer demand changes. The factory has then two choices. The first is of course to augment the dwindled distribution chain by holding greater quantities of products as finished goods on site. This defeats the purpose, however, simply shifting the costs to a different location. The better alternative is to create a factory operation designed to be more directly responsive to short-term delivery demand changes. This has to be implemented without any significant reduction in capacity or productivity, requiring a whole new style of factory operation.

Outside the SMT space, there has been a solution for this for some time. The application of “lean manufacturing” introduced cell production, which became popular some years ago to deliver output flexibly and efficiently. Although cell production can be applied to manual PCB assembly and test stages, it certainly does not work for SMT, which has strongly inhibited the adoption of lean thinking in PCB-based electronics manufacturing with SMT. We know, as a result of our direct experience that productivity declines as flexibility increases in SMT. Even though SMT machines are themselves very flexible, there are intrinsic elements related to the setup of hundreds, or even thousands of discrete SMT materials that are needed to make each electronic product. Solutions to overcome this issue, such as by putting additional machines in line to have enough material feeder locations permanently set up that are able to produce any product at any time, has been tried already. The result was that for each product variant, significant time is lost as for each machine and line, the optimization was severely compromised. The inevitable reduction of capacity and the decrease of productivity meant that this model does not work. We have to look at a level above the machines and lines themselves, toward the integration of planning, to get a truly flexible solution.

Another Level of SMT Optimization

With today’s planning tools for SMT, however, a chicken-and-egg situation exists because generic shop-floor planning tools cannot consider complex material grouping requirements of SMT for efficiency, and SMT-based tools cannot perform decisions related to the selection of products into groups according to dynamic shop-floor delivery needs. Both end up being separate steps, and when doing either step first, it places restrictions on the second. Optimizing both steps in one would affect far more flexible schedules, while retaining productivity as near to that of running high volume, creating a profound effect on the operation of the factory. The optimization of SMT is a multi-level operation that has challenged the most brilliant of software developers for many years. Introducing another level of simultaneous optimization seems impossible to achieve. Let us therefore look again one more time at each of these levels.

1) Machine Program Optimization: Each SMT machine program is optimized to ensure that the machine is adding value for as much of the operating time as possible, without needless excess movement that slows performance. For

software developers, the challenge is to find the single best sequence, but to put just this into perspective, if every possible sequence of SMT placement path were calculated by today's fastest super-computer, it could take weeks of processing to find. SMT optimization algorithms, therefore, we have to be very clever to avoid having to consider every possible permutation, to be able to find a path close enough to the best in a reasonable amount of time. It is when this optimization is performed that the cycle time for the specific machine can be known to a high degree of accuracy.

2) Line Optimization: The number of SMT placement materials for each surface of a PCB is usually more than one machine can handle, and so they have to be divided between multiple SMT machines, modules, and other processes in a line. Line optimization is the process to allocate materials to the most capable machine in the line depending on material size, shape, type, and packaging, ensuring that the most effective and capable machines are used, reducing overall processing time and ensuring quality. It is almost impossible however that considering this element alone will evenly divide the materials. Some level of compromise then has to be made to ensure that the execution times of all the machines in the line will be the same. After all, the line is only as fast as the slowest machine. The times for each machine can only be known, however, by doing a machine program optimization for each machine. Invariably, after allocation and machine program optimization, many iterations of material re-allocation are needed until a low-loss line balance can be realized.
3) Changeover Optimization: This is the consideration of the line down-time needed to change material setups at the machine between products. This can represent more operational loss time than any other optimization factor in higher mix manufacturing. Given a range of products to group, creating a feeder setup common to the group on the line where few if any changes are needed, means that the line can produce any quantities of any product within the group at any time without changeover loss. The material requirements of all products within the group have to be considered, and an allocation of total materials across the line is made, which is then optimised in a similar way as line optimization, above. The critical issue, however, is that when running each of the products, because there are more materials set up on the machines than needed and the positions may not optimised for that specific product, the machine program optimization will suffer as a result of having to perform additional excess travel that would otherwise not be necessary. Depending on the commonality of the different materials and the number of components used of each across the different products in the group, additional feeders or even additional machines may be needed in the line, reducing the machine program optimization and also the line optimization. Again, several iterations are required to find the best position of each material and any trade-off between materials that are completely common across all products, as well as those that may be allowed to change, usually restricted to one area of one machine, where for example a trolley can be exchanged to implement a slightly different setup. It takes many optimization cycles before the right balance of compromise is reached.
4) Product Grouping Optimization: This is traditionally the separate step, in which the products to be grouped are selected, optimized in accordance with the completion requirements of the factory. Simply grouping products that are similar usually produces acceptable changeover optimization, but grouping products simply by what the factory is required to deliver will most likely put together groups of products with little commonality, and therefore poor machine and line optimization. The cleverness of this level of optimization is to be able to consider the total delivery requirements across the whole shop-floor where there is then a choice of many combinations for products on different lines at different times. Each of these selected potential combinations, however, should in theory then have to go through all of the other three optimization stages to be assessed. This would, for modern computers, be an impossible task.

The solution to our planning conundrum is to turn the problem on its head. Instead of a serious compromise being made that separates the product grouping optimization as is done today, let us consider instead separating the machine program optimization. This would mean that the actual machine program time for each optimization cycle could not be calculated accurately, but this could be argued as being acceptable, as long as a close estimate of the capability and cycle time for the machine can be made. This is not the same level of estimation as, say the ERP systems make, of a certain time per placement, but an intelligent estimation based on machine operational modelling principles. Even so, it is likely that there will be some degree of error, but this will be a very small sacrifice compared to the losses incurred by the existing practice of the exclusion of the optimization of product grouping.

This type of specialist SMT shop-floor planning optimization software is now available today, enhanced by the access to key information about the operational status and progress of the shop-floor, materials availability, the engineering setup requirements of each product, as well as the current customer delivery requirement. Having this information available electronically means that planning is not something that is done perhaps once every month or three months, but something that can be incremental, a rolling plan repeated every day or more often if necessary, bringing the flexibility to respond to changes in short-term delivery requirements almost immediately. Limitations in the availability, accuracy, and timeliness of data on the shop-floor have very much thwarted the creation of such live planning optimization technology in the past. It has led to the momentum of the machine-centric optimization model that actually does not make sense, because it is rarely an optimization of the factory based on what the customer needs. This is the critical issue that now has been solved.

Other Issues to Consider

Any move to on-shoring will not happen overnight, any more than the move off-shore did. There are some other key issues to consider, including:

1) Materials Sourcing: With the majority of manufacturing currently off-shore, most of the high-volume raw material manufacturers and suppliers are also off-shore. It is possible to ship the raw materials in, and it should be cost-efficient because most raw materials are common to many products and assembly manufacturers, especially with the use of distributors. The major change happens, however, once onshore raw materials manufacturers get back into gear. Many of these companies still exist, as some manufacturing never went over to lower cost areas, significantly suppliers to the safety critical areas of aerospace, military, some medical, and automotive. The key question is whether there is a critical mass remaining to once again ramp up volume for regular electronics manufacturing.
2) Materials Lead-Time: With any sourcing of materials, somewhere there will be a lead-time issue, often related to key components. If our factory is going to respond directly to customer delivery requirements, how is the ordering of materials going to be managed and controlled? The answer is actually quite simple. Nothing changes. Although the manufacturing location has changed and the distribution chain is a mere fraction of what it was, the product, and the market remain as they were. Product management, sales, and marketing are still working together to plan and manage the medium and long-term life of the product based on advertising promotions and price control. All that has changed is how the short-term fluctuations in demand are dealt with. There is no replacement of any of the key business functions, in fact, this solution can be thought of as an enhancement to those ERP systems.

The New World Orders

This change in the way that SMT optimization is done may seem like a fairly insignificant change, not really something grand enough to trigger a change in the way that the manufacturing market works. This solution, however, brings the ability to model and optimize the SMT factory based on live customer needs, It is the solution to the case where factories are required to work without long distribution chains. The saving of costs from the distribution chain in a way that allows the factory to remain efficient dramatically exceeds in most cases the incremental costs of labour when comparing on and off-shore locations. This is the compelling factor to encourage manufacturing to come back on-shore. Whether OEM companies take this initiative, or once again, competitive EMS companies provide the opportunity, we can at least start now to consider a new paradigm of on-shore manufacturing.

The whole industry could be re-born and can become a very attractive place to work again. There is a great deal of labour now coming from the distribution side of the industry that has already been waning. With government incentives on offer to help, it seems as though now we are beginning to see the “perfect storm” for on-shoring.