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Production Migration:

Do the Numbers Add Up?

The continuing economic downturn has shaken the North American electronics assembly industry, leaving in its wake massive plant closings and layoffs. Many lines and assembly contracts have moved overseas, and the generally accepted cause for this is the high cost of domestic labor. Jim McElroy, executive director of NEMI (National Electronics Manufacturing Initiative) confirms this. "The migration (of electronics assembly) to China is incredible in its speed and intensity. We've seen migrations before: in the 1980s it was Japan, then to Mexico and Eastern Europe in the 1990s. Now we're seeing people migrating production just recently sent to Mexico, and Eastern Europe to China. The long term concern is that new product introduction, design and other functions may end up migrating, following volume manufacturing."

Mr. McElroy's concerns were echoed by respondents to an informal poll conducted on the IPC's "TechNet." The responses from the engineers "in the trenches" can be divided into two basic points of view. Several respondents felt that the U.S. simply cannot compete with China on labor costs and that high volume electronics assembly on the North American continent will soon be a thing of the past. Besides the obvious issue of labor costs, the reasons cited for production going overseas were the relative strength of the dollar, relaxed or no environmental standards, tax advantages, and very advantageous loans from host governments. Significantly, no one suggested that domestic assemblers could be beaten on the basis of quality or efficiency.

A slim majority of respondents, however, believed that domestic assemblers can compete in the global market. A common theme in these responses was that there are still many compelling reasons to keep production in North America. Francois Monette of Cogiscan wrote, "Many OEMs of high reliability products, like automotive, military and medical, are still reluctant to outsource their production or to move it overseas because they cannot afford to compromise on the quality and reliability of their products."

Can North America compete?

Is sending production overseas the best option for North American assemblers? McElroy is concerned that the full impact is not always considered in the business case development and sees a number of issues that aren't fully understood. "Rapid time to market and shorter product life cycles are a significant fac-

ProfitPro

Title of Run	USA Start						
Elements of Cost	**ECA Default**	**Overide Value I**	**Value Used**	**Elements of Cost**	**ECA Default**	**Overide Value II**	**Value Used**
Assembly Equipment Cost ($)	$2,200,000.00		$2,200,000.00	Cycle time (seconds)	20.00		20.00
Solder Paste ($/g)	$0.08		$0.08	Downtime (%)	8.00		8.00
Number of Grams	4.00		4.00	Setup (hours per week)	50.00		50.00
Components ($)	$25.00		$25.00	Maintenance (hours per week)	12.50		12.50
PWB ($)	$7.00		$7.00	Yield first pass (%)	97.00	90	90.00
Number of Direct Workers	10		10	Unit RW Materials Cost	$0.20		$0.20
Burdened Pay Rate per Hour	$18.00		$18.00	Minutes for each rework	20.00		20.00
Number of Indirect Workers	10		10	Percent Reworkable	100.00	98.5	98.50
Burdened Pay Rate per Hour	$36.00		$36.00	Years Equipment Depreciation	3.00		3.00
Selling Price ($) or	$45.00		$45.00	Interest Rate (%)	9.00		9.00
Hours per Shift	8.00		8.00	Simulation Length Weeks	52.00		52.00
Shifts per Day	3		3	Inventory Turns per Year	12.00		12.00
Days per Week	6.33		6.33				

Figure 1a. ProfitPro inputs of the "USA Start" case

Title of Run	Total Sales	Unit Profit	# Units	Total Profit	Δ to Baseline
USA Start	$32,491,710.00	$3.06	722,038	$2,210,488.55	

Figure 1b. ProfitPro results for "USA Start"

tor. The majority of product development is still domestic, which leads to the question of how rapidly can you ramp up to volume production and get your products to market if your production facilities are overseas."

Tony Hilvers, VP of industry programs for the IPC, agrees on the need for closer examination. "First, let me say the U.S. can compete in high volume electronics assembly. Relatively lower overseas labor rates, as well as, component costs are factors in some U.S. plant closing and layoffs. However, keep in mind that the EMS industry's two major customers, telecoms and PCs, are two of the hardest hit sectors in the current recession, and that the assembly volume is off worldwide. The key to competitiveness is innovation, quality, and speed, which in turn will yield greater quality and profitability."

Everyone has heard anecdotal evidence of quality issues with offshore assemblers, and several TechNet respondents replied off-line with stories of specific incidents. One case involved a product that passed in-circuit test but suffered solder joint failures in the field, and another involved an entire production run that had to be shipped back to the U.S. for rework. Incidents like this provide significant motivation for keeping production on domestic lines. The consensus is that currently we're ahead of China in building quality into products, and that quality may well be the driver that will bring domestic production back. The question then becomes: can North American assemblers increase quality enough to gain an edge in profitability?

The profit model

ProfitPro, a real-time cost estimating software program, takes verified process metrics and using an algorithm that allows costs to be added or modified, adjusts throughput and yield to determine the profit potential for a given line. The development of this model used costing metrics obtained from a major domestic EMS. Where metrics were lacking, assumptions were made based on long-term experience in the electronics assembly industry, then verified by comparing the model's profitability results to the actual company's profit and loss sheet.

The cost estimating program indicates that in many cases, the cost of labor is significantly lower than that of rework and scrap. The cost of labor vs. rework/scrap indicates that domestic electronics assemblers can be competitive in the world market if they focus on quality while keeping labor costs down with improved manufacturing efficiencies. It is important to note that the model does not take into account the additional costs of poor quality to the OEM: field failure costs, damage to corporate image, loss of market share and potential liability costs.

PREVIEW

BY IMPROVING PRODUCTIVITY AND QUALITY, NORTH AMERICAN ELECTRONICS ASSEMBLERS CAN BETTER COMPETE WITH CHINA. HERE'S HOW.

The competitiveness scenario

The scenario is a comparison of a typical domestic EMS facility to a Chinese facility owned by a similar North American EMS. "USA Start" (Figure 1) represents a typical assembly line's average profitability for one year.

ProfitPro

Title of Run	China						
Elements of Cost	**ECA Default**	**Overide Value I**	**Value Used**	**Elements of Cost**	**ECA Default**	**Overide Value II**	**Value Used**
Assembly Equipment Cost ($)	$2,200,000.00		$2,200,000.00	Cycle time (seconds)	20.00		20.00
Solder Paste ($/g)	$0.08		$0.08	Downtime (%)	8.00		8.00
Number of Grams	4.00		4.00	Setup (hours per week)	50.00		50.00
Components ($)	$25.00		$25.00	Maintenance (hours per week)	12.50		12.50
PWB ($)	$7.00		$7.00	Yield first pass (%)	97.00	90	90.00
Number of Direct Workers	10	15	15	Unit RW Materials Cost	$0.20		$0.20
Burdened Pay Rate per Hour	$18.00	$2.00	$2.00	Minutes for each rework	20.00		20.00
Number of Indirect Workers	10	12	12	Percent Reworkable	100.00	98.5	98.50
Burdened Pay Rate per Hour	$36.00	$5.00	$5.00	Years Equipment Depreciation	3.00		3.00
Selling Price ($) or	$45.00		$45.00	Interest Rate (%)	9.00		9.00
Hours per Shift	8.00		8.00	Simulation Length Weeks	52.00		52.00
Shifts per Day	3		3	Inventory Turns per Year	12.00	8	8.00
Days per Week	6.33		6.33				

Figure 2a. Inputs for the China analysis

Title of Run	Total Sales	Unit Profit	# Units	Total Profit	Δ to Baseline
USA Start	$32,491,710.00	$3.06	722,038	$2,210,488.55	
China	$32,491,710.00	$7.83	722,038	$5,655,057.33	$3,444,568.78

Figure 2b. A comparison of the USA and China cost analysis

Assume that this line is transferred to China, where the burdened labor rate is $2.00 per hour for operators and $5.00 per hour for engineers. Based on experience with Chinese facilities, five more operators and two more indirect workers are added, and inventory turns are reduced to eight. Note that the scenario is quite generous to the Chinese facility in assuming that it is roughly equivalent in the major productivity metrics to the U.S. facility. The major difference is labor rate and if this was the only concern, it would be a good move as shown in Figure 2.

In Figure 3, let us assume a CIP (continuous improvement program) is implemented in the U.S. facility, or, alternatively, yields gains are realized from implementing process automation. By reducing direct labor to seven operators, indirect labor to five people, cycle time by two seconds to eighteen seconds, downtime to 6 percent, setup time to 42 hours/week, first pass yield to 97 percent, percent reworkable to 99.5 percent and inventory turns to eighteen, profit increases and unit profit is at parity. (It is important that unit costs remain equal or lower in the U.S., or else the solution will be to simply add lines in China.)

It is the authors' belief that the productivity improvements postulated in the "USA Improved" model are achievable in domestic electronics assembly facilities. In fact, these levels of productivity are currently being achieved in the best U.S. facilities.

Automation: the key to competitiveness

The implementation of automation offers significant improvements on the profitability numbers in the "USA Improved" scenario. Bjorn Dahle, president of KIC, believes, "Automation solutions for individual phases of the SMT process are currently being implemented in domestic EMS facilities, and where they have been implemented, we have seen significant increases in manufacturing efficiencies. Automated setup systems can dramatically reduce changeover and setup time, thereby increasing productivity. Continuous monitoring systems prevent defects, thereby increasing quality and decreasing rework, scrap, and warranty costs."

Joe Vilella, CEO of Vectron, makes a strong argument for the implementation of pre and post reflow AOI. "Vectron is a very strong proponent of closing the loop between AOI and the pick-and-place, the oven, and the screen printer. This approach is the ultimate answer to the competitive situation. Cost savings can be achieved in a short period by applying AOI pre and post reflow without closing the loop, but by closing the loop, the first pass yield is drastically increased."

Conclusions

North American electronics assemblers can more than make up for the difference in wages with China. This opportunity exists because of the stunning effect that productivity has on profitability. Hopefully, the domestic EMS industry will realize this before it is too late. The bottom-line is: it is cheaper (and more profitable) to improve at home than send production overseas.

EP&P

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Title of Run	USA Improved						
Elements of Cost	**ECA Default**	**Overide Value I**	**Value Used**	**Elements of Cost**	**ECA Default**	**Overide Value II**	**Value Used**
Assembly Equipment Cost ($)	$2,200,000.00		$2,200,000.00	Cycle time (seconds)	20.00	18	18.00
Solder Paste ($/g)	$0.08		$0.08	Downtime (%)	8.00	6	6.00
Number of Grams	4.00		4.00	Setup (hours per week)	50.00	42	42.00
Components ($)	$25.00		$25.00	Maintenance (hours per week)	12.50	8	8.00
PWB ($)	$7.00		$7.00	Yield first pass (%)	97.00	97	97.00
Number of Direct Workers	10	7	7	Unit RW Materials Cost	$0.20		$0.20
Burdened Pay Rate per Hour	$18.00		$18.00	Minutes for each rework	20.00		20.00
Number of Indirect Workers	10	5	5	Percent Reworkable	100.00	99.5	99.50
Burdened Pay Rate per Hour	$36.00		$5.00	Years Equipment Depreciation	3.00		3.00
Selling Price ($) or	$45.00		$45.00	Interest Rate (%)	9.00		9.00
Hours per Shift	8.00		8.00	Simulation Length Weeks	52.00		52.00
Shifts per Day	3		3	Inventory Turns per Year	12.00	18	18.00
Days per Week	6.33		6.33				

Figure 3a. Inputs for the U.S. facility after a CIP

Title of Run	Total Sales	Unit Profit	# Units	Total Profit	Δ to Baseline
USA Start	$32,491,710.00	$3.06	722,038	$2,210,488.55	
China	$32,491,710.00	$7.83	722,038	$5,655,057.33	$3,444,568.78
USA Improved	$43,421,625.00	$7.83	964,925	$7,556,294.29	$5,345,805.74

Figure 3b. Results for this facility