Littelfuse: Designing a Global Manufacturing Footprint

From a financial standpoint, 2010 was a tremendous bounce-back from 2009. Sales of $608 million increased 41% from 2009. Diluted earnings per share were $3.52 in 2010, compared to $0.43 for 2009. Our balance sheet is stronger than ever. The major drivers behind our improvement in 2010 were the market rebound and the extensive restructuring project we began four years ago to rationalize our manufacturing footprint and improve our cost structure. With the restructuring program nearing completion and additional capacity on line, we believe we are well positioned for strong growth and higher margins for the foreseeable future.

- *Gordon Hunter, Chairman, President and Chief Executive Officer*[i]

As Philip Franklin (Tuck '79), Vice President, Operations Support, Chief Financial Officer and Treasurer of Littelfuse Inc., prepared for the November 2011 Investor Presentation, he reflected on Littelfuse's manufacturing transformation over the past five years. Beginning in 2006, the company had restructured its global manufacturing footprint and embraced lean manufacturing principles. Phil believed the transformation provided Littelfuse with a lean cost structure that would help Littelfuse deliver strong financial returns in the following years.[ii]

Company Overview and History

Power surges and other electrically-harmful events such as short circuits are a threat to any product that uses electrical energy. Headquartered in Chicago, and with manufacturing and R&D facilities spanning the globe, Littelfuse, Inc., designs and manufactures circuit-protection devices for thousands of end products such as media players, TVs, medical equipment, cars, industrial switches, and heating systems. Littelfuse's customer base includes iconic consumer brands such as Apple, BMW, and Sony; contract manufacturing giants such as Flextronics and Foxconn; and global distributors such as Arrow Electronics. See Exhibits 1 and 2 for a picture of some Littelfuse devices and a selection of its major customers. Littelfuse's devices fall into three major segments depending on their end-use: electronics, automotive and electrical. In addition to design and manufacturing, Littelfuse also provides application testing services to customers through its global network of labs.

Founded in 1927 by Edward Sundt who developed a fuse for protecting test meters, Littelfuse soon expanded into the automotive-fuse market. By the 1960's Littelfuse was also manufacturing fuses for use in televisions, in commercial and defense aviation, and in the emerging United States space-exploration program. Acquired by the international defense-equipment company, Tracor, Inc., in 1968, Littelfuse continued to grow over the following two decades; opening manufacturing facilities in England (1968) and Mexico (1973), introducing new products, and acquiring the Dutch fuse-manufacturer, Olvis Smeltzeringenfabriek B.V., in 1981. Littelfuse's parent company, Tracor, was purchased by Westmark

This case was prepared by Brian Tomlin, Shavonne Howard and Carlos Mendez at the Tuck School of Business, with the support of the Tuck School's Center for International Business. The case was written for the purposes of class discussion and is not intended to illustrate effective or ineffective management practices.

Systems in 1987 for $694 million in a highly-leveraged buyout. Tracor soon ran into financial difficulties and filed for bankruptcy in 1989. As part of the bankruptcy restructuring, Littelfuse emerged as an independent company in 1991.[iii]

Fueled by new product introductions and international expansion, the newly-independent Littelfuse enjoyed six consecutive years of record sales and earnings, with sales reaching $275.2 million in 1997.[iv] All three market segments experienced strong growth from 1992 to 1997; electronics sales grew at a compounded annual rate of 15%, automotive sales at 12% and electrical sales at 10%.[v] International markets were the engine of growth, with international sales growing at a compounded annual rate of 23% as compared to 8.25% for U.S. sales. By 1997, international markets accounted for 40.6% of net sales. The Asia-Pacific region was a particularly important market, delivering $63.7 million of Littelfuse's $111.6 million in international sales. Most of the rest of the international sales were generated in Europe. Overall, in 1997 electronics accounted for 49.2% of sales, automotive for 37.4% and electrical for 13.4%.

The company's year-on-year sales and income growth hit a wall in 1998, with sales declining by 2% and net income by 22%.[vi] Volume and pricing pressure in the electronics and automotive market segments were the culprits. Faced with this challenge, Littelfuse committed to reducing its costs, primarily by reconfiguring its global manufacturing footprint. By the start of 1999, in addition to its U.S. manufacturing base, Littelfuse had sites in England, China, Korea, Mexico, the Philippines and Switzerland. See Exhibit 3 for the Littelfuse global footprint as of the start of 1999. Littelfuse set itself a goal of decreasing the percentage of production carried out in high-cost regions, the U.S. and Europe, from 60% to 30% by 2003. It was determined to "retain high-tech manufacturing in the United States and Europe, while focusing low-cost manufacturing at our locations in Mexico, China and the Philippines."[vii] By 2003, Littelfuse had closed the plant in Centralia, Illinois, the plant in Washington, England, and the plant in Grentchen, Switzerland.

Littelfuse was not singularly focused on improving its bottom line through cost reductions. Starting in 1999, the company also embarked on a long-term strategy of driving top-line growth by investing in new product development and actively pursuing targeted acquisitions. According to then Chairman and CEO Howard Witt, "Our customers have told us they would like us to be a "one stop" resource for their circuit protection needs."[viii] In response, Littelfuse made a number of strategic acquisitions in the following years. See Exhibit 4 for Littelfuse's revenues and selected acquisition history from 1993-2006. Sales by business segment and geographical region for the years 1999-2006 are given in Exhibit 5.

Acquisitions 1999-2006

In August 1999, Littelfuse acquired the Suppression Products Group of the Harris Corporation for $24.8 million in cash.[ix] Commenting on this acquisition, William S. Barron, then Vice President of Sales and Marketing, said:

> The addition of these transient voltage technologies provides growth opportunities for Littelfuse's electronic and automotive businesses and enables us to offer our customers the most comprehensive line of circuit protection devices in the market. Because of the common customer base of Littelfuse and the Harris Suppression Products Group, the addition of these

> new overvoltage products will position Littelfuse as a single source for our customers' circuit protection needs.[x]

The Suppression Products Group had annual sales of approximately $38 million and manufactured its devices in a plant in Dundalk, Ireland.[xi]

Littelfuse waited three years before acquiring another company. During what was a difficult year for its electronics business, in July 2002 Littelfuse acquired Semitron Industries, a U.K.-based manufacturer of voltage suppression devices with $12 million in annual sales.[xii] Discussing the $12.6 million all-cash deal, Chairman and CEO Howard Witt commented:

> With the acquisition of Semitron Industries in July, Littelfuse is now the only company in the world that can offer all of the major circuit protection technologies. Semitron's semiconductor core competency complements our established polymer technology base and the ceramic technology we added through the acquisition of the Harris Suppression Products business in 1999. Littelfuse offers more than twice as many circuit protection technologies as our closest competitor and, in the past three years, we have nearly doubled the market we serve to approximately $2 billion.[xiii]

The acquisition did not simply broaden the Littelfuse product portfolio. As part of the deal, Littelfuse also acquired a semiconductor wafer fabrication facility in Swindon, England that already supplied the company. This provided Littelfuse with a crucial competency: the ability to manufacture products from silicon wafers. Littelfuse believed that "this facility [would] provide both cost and technical advantages as we leverage and extend our circuit protection product offering."[xiv] While 2002 was a challenging year, Littelfuse generated $32.4 million in free cash flow, a record for the company, and it was intent on continuing its acquisition strategy.

With semiconductor devices becoming increasingly important to the electronics circuit-protection business, in July 2003 Littelfuse acquired Teccor Electronics from Invensys PLC for $44 million in cash, with an additional $5 million dependent on future sales.[xv] Teccor, headquartered in Irving, Texas, produced two lines of semiconductor-based circuit-protection devices. With $75 million in annual sales, Teccor was number one in US market share and in the top three globally for both of its product categories. In his annual letter to shareholders, Chairman and CEO Howard Witt wrote:

> [The Teccor acquisition] was a strategic move that adds an industry-leading line of overvoltage protection products to our already strong portfolio of circuit protection technologies. Teccor's products complement our existing product lines, giving Littelfuse an even stronger technology platform for our future growth. With the addition of Teccor's wafer fabrication capabilities, we are well positioned to meet the growing need for semiconductor-based protection components as products become continually smaller and handle an ever-increasing volume of data at faster and faster speeds. In addition, Teccor's successful technical solution selling approach will serve as a "best practice" company-wide, as our sales strategy evolves from supplying components to becoming a strategic partner that can provide complete circuit protection solutions for a customer's specific application.[xvi]

Along with a semiconductor fabrication plant in Irving, Texas, the Teccor acquisition provided Littelfuse with a semiconductor assembly and test facility in Matamoros, Mexico.

In May 2004, Littelfuse acquired a majority ownership of Heinrich Industrie for $47.2 million in cash.[xvii] Based in Witten, Germany, Heinrich manufactured and sold circuit-protection devices in the electronic, automotive and electrical market segments. Although the Heinrich acquisition provided Littelfuse with the one major fuse technology that it did not already produce (a technology used in power supplies for portable electronic devices), the acquisition was more about consolidation than technology. When the acquisition was announced, Howard Witt noted that:

> [Heinrich] has excellent customer relationships and strategically located manufacturing facilities. We serve many of the same markets with complementary products and both companies have a commitment to technology, quality and customer service. Together we are a powerful combination that can further enhance the value we bring to our customers.

Commenting on the deal, Chief Financial Officer Phil Franklin stated that "While Heinrich is currently operating at lower margins than Littelfuse; we expect that over the long term we can achieve the same level of profitability with Heinrich as we have in our core business." Littelfuse obtained manufacturing facilities in Dünsen, Germany and Witten, Germany as part of the acquisition. It also acquired a number of other production facilities in Germany and Hungary, but divested of these when it sold the electrical-product segment of Heinrich's business to Switzerland's Weber AG the following year.[xviii]

On January 1, 2005, Littelfuse announced that Howard Witt was retiring and that Gordon Hunter would assume the role of Chairman, President, and Chief Executive Officer. Hunter had joined Littelfuse as its Chief Operating Office in October 2003. With a B.E. in electrical engineering from the University of Liverpool and an MBA from London Business School, Hunter had more than twenty years experience in the electronics industry prior to joining Littelfuse. After becoming CEO, Hunter committed to continuing the company's focus on strategic acquisitions based on technology, cost, and consolidation.

Along with this focus, Asia was rapidly becoming a strategic imperative for Littelfuse. As described by Gordon Hunter at the time:

> There is no question that Asia is the center of the entire electronics industry. All of the major electronics manufacturers are now located in Asia, prompting partners like Littelfuse to expand their design and manufacturing capabilities in this region. Leading global original equipment manufacturing (OEM) companies located in Asia are now designing and producing electronic products for the growing local market, as well as for export to the U.S. and Europe. Asia is also home to the fastest growing segment of the electronics market — Original Design Manufacturers (ODMs), who provide outsourced design and manufacturing services to the OEMs. Our strategy is to expand our organization and facilities in Asia to be closer to our existing customers, add new customers and participate in the growth of the entire region.[xix]

Enhancing its capabilities in Asia was a motive for two of Littelfuse's five acquisitions during 2006. In February of that year, Littelfuse announced that it would acquire Concord Semiconductor, a Taiwanese designer and manufacturer of over-voltage circuit protection products, for $25 million in cash and the assumption of $1.4 million of debt. Concord had annual sales of $16 million, but more importantly the

acquisition provided Littelfuse with a wafer fabrication facility in Yangmei, Taiwan and a back-end assembly facility in Wuxi, China. Following on quickly from the Concord acquisition, Littelfuse announced in June 2006 that it would acquire the assets of Song Long Electronics Co., Ltd for $5.5 million in cash. Song Long, also headquartered in Taiwan, had been a long-time supplier and manufacturing partner of Littelfuse and had two manufacturing facilities in close proximity to each other in Dongguan and Humen, China.

Littelfuse paid $13 million in cash for three other acquisitions in 2006.[xx] To expand its technology portfolio, it acquired the California-based SurgX Corporation for $2.5 million in February. Littelfuse acquired the assets of Catalina Performance Accessories for $4.5 million in June. Based in Mountainburg, Arkansas, Catalina produced automotive fuses. In August, Littelfuse paid $6 million to acquire the gas discharge tube assets of SRC Devices. As part of this deal, it acquired SRC's manufacturing plant in Guadalajara, Mexico.

Choosing a New Global Manufacturing Footprint

By the end of 2006, Littelfuse had 15 manufacturing facilities in 9 countries. See Exhibit 6. With eleven of the facilities having been obtained through its acquisitions during 1999 to 2006, it was time to revisit it global manufacturing footprint with a view to strategically designing the right footprint for the Littelfuse business. Leading the initiative were Phil Franklin, Vice President, Operations Support and Chief Financial Officer, and Dave Heinzmann, Vice President, Global Operations.[xxi] See Exhibit 7 for executive biographies. Working with key stakeholders, Phil and Dave would have to determine the right global manufacturing footprint and also manage the transformation over what would become a five-year journey.

Doing so would first require an understanding of Littelfuse's current operations.[1] Its manufacturing footprint could be divided into two categories:

- SEMI: Semiconductor-Based Electronic Product Segment. These products are manufactured in two stages across two different types of plants: wafer fabrication plants and back-end assembly plants. Chips are produced in a wafer fabrication plant and the final product is produced by assembling the chip with other components in a back-end assembly plant. These plants can only be used to produce the semiconductor-based products.
- AE&PE: Automotive, Electrical and Passive Electronic Product Segments. This category constitutes the remainder of the product portfolio. The AE&PE products do not require a multi-plant production process. Each product is manufactured from start to finish in a single plant. Some of the plants are capable of producing more than one product type, e.g., Des Plaines produces automotive and passive electronic products, but most plants are dedicated to a particular product segment, e.g., Humen only produces passive electronic products.

Although the four segments each contain hundreds of different products, it was decided that the initial analysis would be conducted at an aggregate level. For example, all automotive products were aggregated into one representative automotive product. The same was done for the electrical, passive electronic and semiconductor-based product segments.

[1] All data has been masked to protect confidentiality. The footprint design process described here reflects a simplified version of what actually occurred.

Working together, the finance, human resource and operations departments estimated the production costs, transportation costs, and plant capacities for the three AE&PE products and the SEMI product. For each plant, they also estimated the annual fixed operating cost; that is, the annual cost incurred by the plant regardless of its production volume (assuming the plant remains open). The marketing and finance departments estimated the annual demand and per-unit selling price for each product for each of the three major regions: Americas, Asia and Europe. All this data can be found in Exhibit 8. It is also available in a spreadsheet.

Having gathered the data, Phil and Dave had to decide which plants to keep open and which plants to close.

End Notes

[i] Source: 2010 Letter to Shareholders
[ii] Source: Littelfuse Investor Presentation, November 2011.
[iii] Sources for Littelfuse history from 1927-1991: Company website (accessed December 13, 2011) and miscellaneous press articles (Los Angeles Times September 12, 1987 and December 28, 1989 and New York Times December 20 1993.)
[iv] Source: Littelfuse Annual Report 1997.
[v] At this point in time the electrical market segment was referred to as power fuses.
[vi] Source: Littelfuse Annual Report 1998.
[vii] Source: Littelfuse Annual Report 2001.
[viii] Source: Littelfuse Annual Report 1999.
[ix] Source: Littelfuse Annual Report 1999.
[x] Source: Littelfuse Press Release August 25, 1999.
[xi] Source: Littelfuse Press Release August 25, 1999.
[xii] Source: Littelfuse Press Release July 19, 2002
[xiii] Source: Littelfuse Annual Report 2002.
[xiv] Source: Littelfuse Annual Report 2002.
[xv] Source: Littelfuse Press Release July 8 2003.
[xvi] Source: Littelfuse Annual Report 2003.
[xvii] Source: Littelfuse Press Release May 5 2004.
[xviii] Source: Littelfuse Press Release December 8 2005.
[xix] Source: Letter to Shareholders in 2005 Annual Report
[xx] Sources: Littelfuse Press Releases February 3, June 13, August 1, 2006.
[xxi] Dave Heinzmann was Vice President and General Manager of Automotive Business Unit in 2006. He became Vice President of Global Operations in 2007.

Exhibit 1: A Selection of Littelfuse Products

Source: Littelfuse Investor Presentation August 2011

Exhibit 2: A Selection of Littelfuse Customers

Source: Littelfuse Investor Presentation August 2011

Exhibit 3: Littelfuse Global Manufacturing Footprint as of beginning of 1999

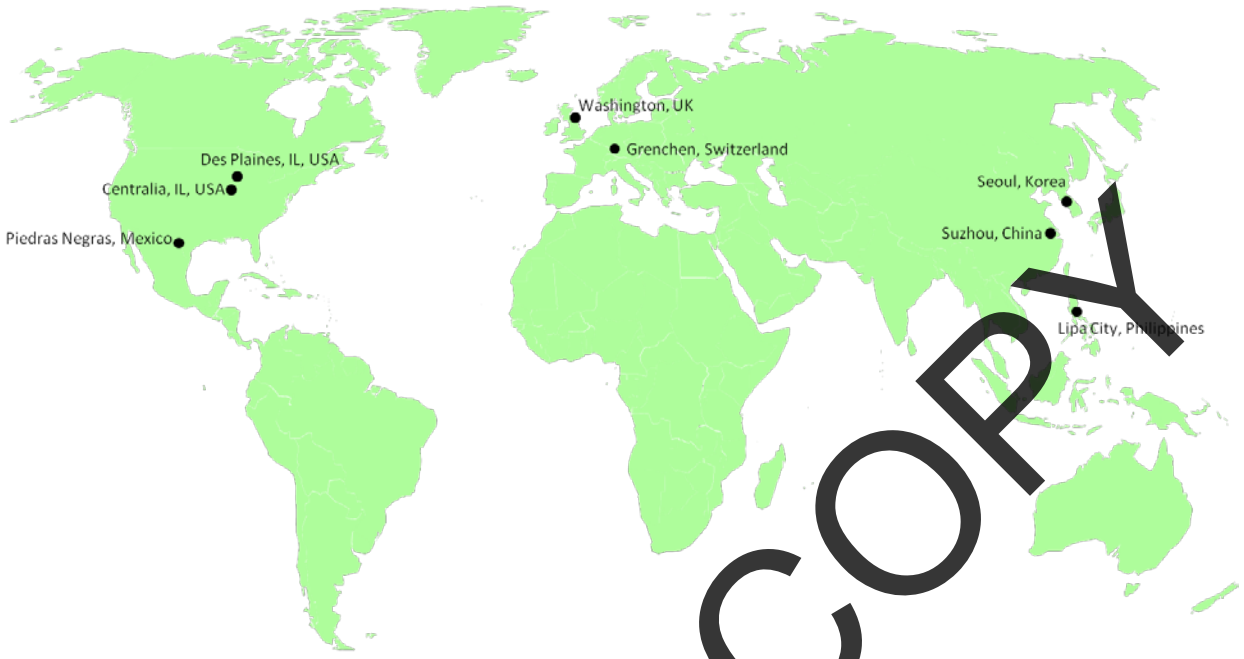
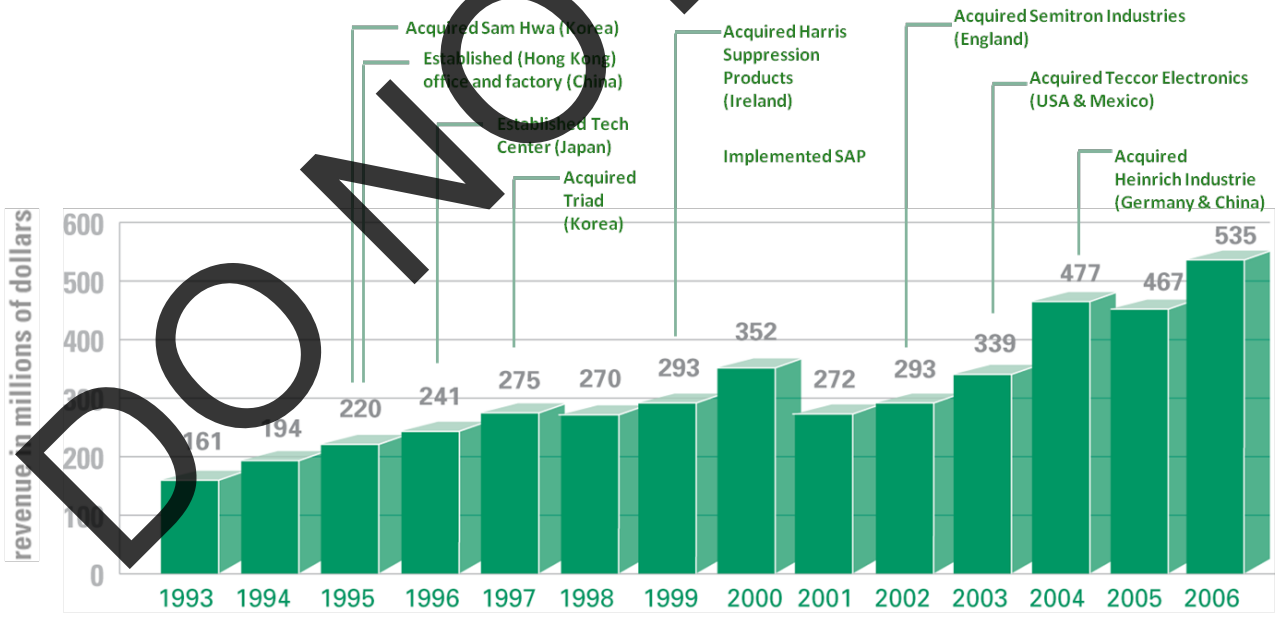


Exhibit 4: Littelfuse Revenues and Selected Acquisition History; 1993-2006



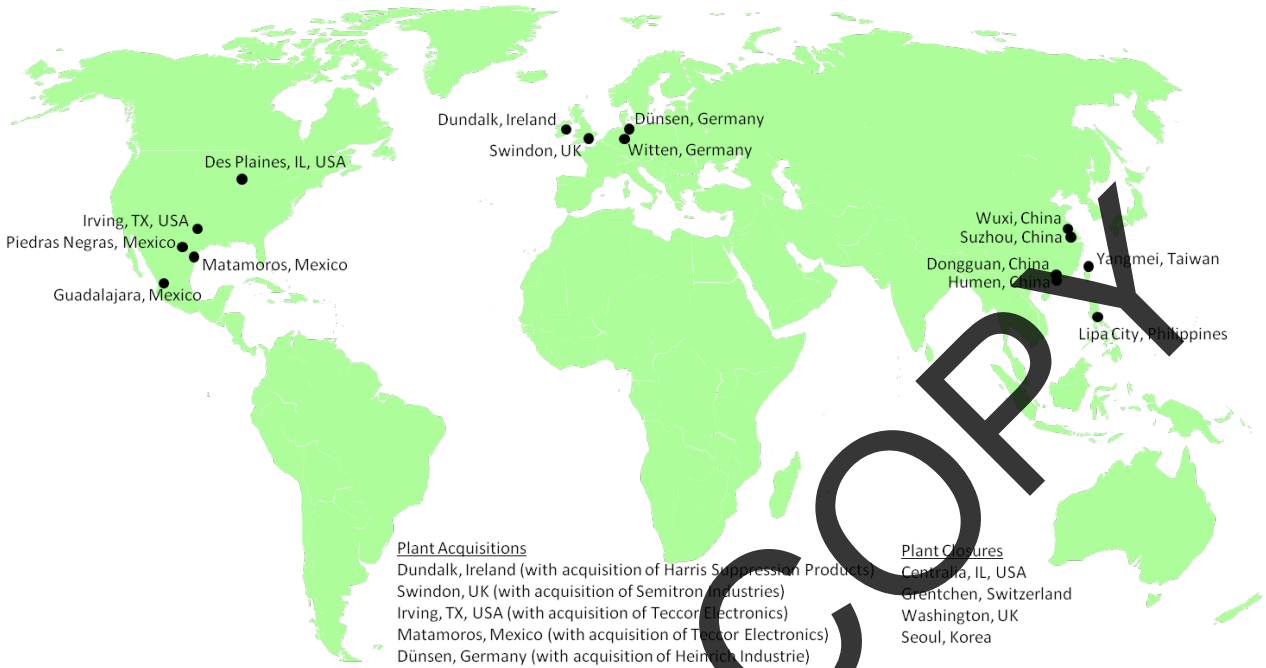
Source: Littelfuse Investor Presentation March 2007

Exhibit 5: Littelfuse Sales by Business Unit and Geography; 1999-2006

	1999	2000	2001	2002	2003	2004	2005	2006
Total Sales ($ in millions)	296.4	371.9	272.1	283.3	339.4	476.8	467.1	534.9
Sales by Business Unit (%)								
Electronics	52%	63%	54%	53%	61%	68%	65%	68%
Automotive	34%	27%	33%	35%	29%	24%	25%	23%
Electrical	14%	11%	13%	12%	10%	8%	9%	9%
Sales by Geography (%)								
Asia-Pacific	25%	26%	28%	30%	33%	34%	36%	39%
Europe	17%	17%	19%	18%	18%	21%	21%	21%
Americas	58%	58%	53%	52%	49%	45%	43%	40%
Sales by Business Unit and Geography								
Electronics Sales by Geography (%)								
Asia-Pacific	45%	39%	49%	53%	50%	48%	53%	54%
Europe	13%	15%	16%	13%	14%	16%	16%	15%
Americas	42%	46%	35%	34%	36%	36%	31%	31%
Automotive Sales by Geography (%)								
Asia-Pacific	4%	5%	4%	5%	6%	6%	6%	9%
Europe	30%	27%	31%	31%	33%	41%	42%	45%
Americas	66%	68%	65%	64%	61%	53%	52%	46%
Electrical Sales by Geography (%)								
Asia-Pacific	1%	1%	1%	1%	1%	3%	0%	1%
Europe	0%	0%	0%	0%	0%	34%	0%	0%
Americas	99%	99%	99%	99%	99%	63%	100%	99%
Sales by Business Unit ($ in millions)								
Electronics	154.1	232.7	146.3	150.9	206.5	325.6	305.9	365.5
Automotive	101.3	100.0	91.1	98.2	98.3	113.7	118.6	123.6
Electrical	41.0	39.2	34.7	34.2	34.6	37.5	42.6	45.8
Sales by Geography ($ in millions)								
Asia-Pacific	73.8	96.1	76.2	85.0	110.9	162.0	168.9	207.3
Europe	50.4	61.9	51.7	51.0	61.1	98.3	98.3	111.6
Americas	172.2	213.9	144.2	147.3	167.4	216.5	199.9	216.0
Sales by Business Unit and Geography								
Electronics Sales by Geography ($ in millions)								
Asia-Pacific	69.3	90.8	71.7	80.0	103.3	156.3	162.1	197.4
Europe	20.0	34.9	23.4	19.6	28.9	52.1	48.9	54.8
Americas	64.7	107.0	51.2	51.3	74.3	117.2	94.8	113.3
Automotive Sales by Geography ($ in millions)								
Asia-Pacific	4.1	5.0	3.6	4.9	5.9	6.8	7.1	11.1
Europe	30.4	27.0	28.2	30.4	32.4	46.6	49.8	55.6
Americas	66.9	68.0	59.2	62.8	60.0	60.3	61.7	56.9
Electrical Sales by Geography ($ in millions)								
Asia-Pacific	0.4	0.4	0.3	0.3	0.3	1.1	0.0	0.5
Europe	0.0	0.0	0.0	0.0	0.0	12.8	0.0	0.0
Americas	40.6	38.8	34.4	33.9	34.3	23.6	42.6	45.3

Source: Littelfuse Annual Reports

Exhibit 6: Littelfuse Global Manufacturing Footprint as of 2006



Plant Acquisitions
Dundalk, Ireland (with acquisition of Harris Suppression Products)
Swindon, UK (with acquisition of Semitron Industries)
Irving, TX, USA (with acquisition of Teccor Electronics)
Matamoros, Mexico (with acquisition of Teccor Electronics)
Dünsen, Germany (with acquisition of Heinrich Industrie)
Witten, Germany (with acquisition of Heinrich Industrie)
Wuxi, China (with acquisition of Concord Semiconductor)
Yangmei, Taiwan (with acquisition of Concord Semiconductor)
Guadalajara, Mexico (with acquisition of SRC's gas discharge tube assets)
Dongguan, China (with acquisition of Song Long assets)
Humen, China (with acquisition of Song Long assets)

Plant Closures
Centralia, IL, USA
Grentchen, Switzerland
Washington, UK
Seoul, Korea

Exhibit 7: Selected Executive Bios

Gordon Hunter was elected as the Chairman of the Board of Directors of the company and President and Chief Executive Officer effective January 1, 2005. Mr. Hunter served as Chief Operating Officer of the company from November 2003 to January 2005. Mr. Hunter has been a member of the Board of Directors of the company since June 2002, where he has served as Chairman of the Technology Committee. Prior to joining Littelfuse, Mr. Hunter was employed with Intel Corporation, where he was Vice President, Intel Communications Group, and General Manager, Optical Products Group, responsible for managing the access and optical communications business segments, from 2002 to 2003. Mr. Hunter was CEO for Calmar Optcom during 2001. From 1997 to 2002, he also served as a Vice President for Raychem Corporation. His experience includes 20 years with Raychem Corporation in the United States and Europe, with responsibilities in sales, marketing, engineering and general management.

Philip G. Franklin, Vice President, Operations Support, Chief Financial Officer and Treasurer, joined the company in 1998 and is responsible for finance and accounting, investor relations, mergers and acquisitions, and information systems. Prior to joining Littelfuse, Mr. Franklin was Vice President and Chief Financial Officer for OmniQuip International, a private equity sponsored roll-up in the construction equipment industry, which he helped take public. Before that, Mr. Franklin served as Chief Financial Officer for both Monarch Marking Systems, a subsidiary of Pitney Bowes, and Hill Refrigeration, a company controlled by Sam Zell. Earlier in his career, he worked in a variety of finance and general management positions at FMC Corporation.

David W. Heinzmann, Vice President, Global Operations, is responsible for Littelfuse's manufacturing and supply chain groups for all three of the company's business units. Mr. Heinzmann began his career at the company in 1985 and possesses a broad range of experience within the organization. He has held positions as a Manufacturing Manager, Quality Manager, Plant Manager and Product Development Manager. Mr. Heinzmann also served as Director of Global Operations of the Electronics Business Unit from early 2000 through 2003. He served as Vice President and General Manager, Automotive Business Unit, from 2004 through August 2007 and then was promoted to his current position.

Source: Littelfuse Annual Report 2010

Exhibit 8: Manufacturing Footprint Data

THIS ENTIRE EXHIBIT (NOTES AND DATA TABLES) IS AVAILABLE IN A SPREADSHEET. YOU DO NOT NEED TO ENTER THIS DATA WHEN CONDUCTING ANALYSIS.

All data has been masked to protect confidentiality.

Manufacturing Footprint Data for the Automotive, Eletrical and Passive Electronic Product Segment

Important Notes

All references to the electronic product in this section relate to the passive electronic product and not the semiconductor electronic product.
All prices and costs are given in $.
Demands and prices are forecasts of what a "typical" year will look like. Treat these forecasts as being perfect, i.e., ignore any uncertainty in forecasts.
Demands and capacities are given in 1000'S of units. Prices, Variable Production and Transportation Costs are given per 1000 units.
Capacity refers to the total number of units a plant can produce annually. Assume that production of one unit of a product uses one unit of capacity regardless of the product type.
Fixed Plant Cost is the operating cost incurred by the plant (if kept open) regardless of how many units (or what products) the plant produces.
Variable Production Cost refers to the cost to make one unit of a product and includes raw material and inbound logistics costs. Cost below is expressed per 1000 units
Transportion cost refers to the cost to ship one unit from a plant to a market destination. Cost below is expressed per 1000 units

Annual Demand by Region and Product Segment

	Auto	Electrical	Electronic
Americas	10000	20000	16000
Asia	2000	200	40000
Europe	9000	0	8000

Demands are given in 1000's of units.

Per-unit Price by Region and Product Type

	Auto	Electrical	Electronic
Americas	$6,000	$2,400	$4,200
Asia	$5,700	$2,200	$3,500
Europe	$6,100	$2,600	$4,300

Prices are given per 1000 units.

Plant Capacity and Fixed (Annual) / Variable (per-unit) Costs

Region	Plant	Capacity (in 1000s of units)	Fixed Plant Cost ($)	Variable Production Cost ($/1000 units)		
				Auto	Electrical	Electronic
Americas	Des Plain.	70000	$25,000,000	$4,000		$3,200
	P. Negras	45000	$15,000,000	$3,500	$1,800	
	Guadal.	30000	$10,000,000		$1,750	
Asia	Humen	20000	$9,000,000			$2,500
	Donguan	10000	$6,000,000			$2,400
	Suzhou	20000	$9,000,000			$2,500
	Lipa City	26000	$10,500,000			$2,600
Europe	Dundalk	40000	$20,000,000			$3,100
	Dünsen	150000	$25,000,000	$3,900		
	Witten	30000	$25,000,000			$3,300

If variable cost cell is empty, this means the plant **cannot** produce the product.

Transportation Costs

Plant	Auto (from plant to region ...)			Electrical (from plant to region ...)			Electronic (from plant to region ...)		
	Americas	Asia	Europe	Americas	Asia	Europe	Americas	Asia	Europe
Des Plain.	$2	$200	$100				$2	$200	$100
P. Negras	$2	$200	$100	$2	$200	$100			
Guadal.				$2	$200	$100			
Humen							$200	$2	$200
Donguan							$200	$2	$200
Suzhou							$200	$2	$200
Lipa City							$200	$20	$200
Dundalk							$100	$200	$2
Dünsen	$100	$200	$2						
Witten							$100	$200	$2

Transportation costs are given per 1000 units. Costs are only given for products that a plant can produce.

Manufacturing Footprint Data for the Semiconductor-Based Electronic Product Segment

Important Notes

This section gives data for the semiconductor-based electronic product.
Semiconductor products are produced in two stages. 1. Chips are produced in wafer fabrication plants. 2. The final product is produced by assembling the chip with other components in a back-end assembly plant.
This is a simplified description but is sufficient for our purposes.
The wafer fabrication production and transportation costs below are measured in final product units. Equivalently, you can think of a final product requiring one chip for the purposes of the analysis
All prices and costs are given in $.
Demands and prices are forecasts of what a "typical" year will look like. Treat these forecasts as being perfect, i.e., ignore any uncertainty in forecasts.
Demands and capacities are given in 1000'S of units. Prices, Variable Production and Transportation Costs are given per 1000 units.
Capacity refers to the total number of units a plant can produce annually. Assume that a final product requires one chip.
Fixed Plant Cost is the operating cost incurred by the plant (if kept open) regardless of how many units the plant produces.
Variable Production Cost (Wafer Fabrication) refers to the cost to make one chip and includes raw material and inbound logistics costs. Cost below is expressed per 1000 units
Variable Production Cost (Back-end Assembly)refers to the cost to assemble a product and includes all non-wafer (chip) related component and inbound logistics costs. Cost below is expressed per 1000 units
Chip Transportion Cost refers to the cost to ship a chip from a fabrication plant to a back-end assembly plant. Cost below is expressed per 1000 units
Final Product Transportion Cost refers to the cost to ship a final product from a back-end assembly plant to a market destination. Cost below is expressed per 1000 units

Annual Demand and Per-unit price by Region

	Demand (in 1000s of units)	Price ($/1000 units)
Americas	2200	$16,000
Asia	5000	$15,000
Europe	1200	$15,500

Plant Capacity and Fixed (Annual) / Variable (per-unit) Costs

Production Stage	Plant	Capacity (in 1000s of units)	Fixed Plant Cost ($)	Variable Production Cost ($/1000 units)
Wafer Fabrication	Irving	4000	$20,000,000	$7,000
	Swindon	3000	$15,000,000	$7,500
	Yangmei	7800	$12,000,000	$5,000
Back-end Assembly	Matamoros	3000	$3,000,000	$1,200
	Wuxi	7200	$5,000,000	$1,000

Transportation Costs ($/1000 units)

Transp. Chip from Fabrication Plant to Back-end Assembly Plant

Production Stage	Plant	Matamoros	Wuxi
Wafer Fabrication	Irving	$1	$100
	Swindon	$50	$100
	Yangmei	$100	$1

Transporting Final Product from Back-End Assembly Plant to Market Region

Production Stage	Plant	Americas	Asia	Europe
Back-end Assembly	Matamoros	$2	$200	$100
	Wuxi	$200	$2	$200