Integrating the North American Electronics Industry Supply Chain: IC Packaging in Mexico

Honors Thesis by:
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I. Background
II. Problem Description
PART I: Background

- Importance of Industry
- Manufacturing Processes
- Supply Chain
Importance of Electronics Industry

- 3% of the world’s GDP ($1,026 Billion)*
- 2.6% of US’s GDP
- Higher in Asia:
  - 12% in Singapore
  - 8% in China

* Applied Materials. May 27, 2004
Manufacturing Processes

- IC Fabrication
- IC packaging & test (AKA assembly & test)
- PCB and final assembly
Process 1: IC Fabrication

- Turning high-grade silicon wafers into thousands of integrated circuits

- Layering processes:
  - Adding
  - Altering
  - Removing (etching)
Process 2: IC Packaging & Testing

- Transforming a wafer with thousands of ICs into thousands of usable components
- Purposes of encapsulation processes:
  - Protect IC from “dirty room” environments
  - Provide interface to PCB
Process 3: PCB & Final Assembly

- Building even larger integrated circuits on PCBs and creating the final product.
Electronics Industry Supply Chain

- Asia centric

<table>
<thead>
<tr>
<th>Exporter</th>
<th>Asia</th>
<th>Europe</th>
<th>NAFTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>75.35%</td>
<td>8.65%</td>
<td>15.30%</td>
</tr>
<tr>
<td>Europe</td>
<td>30.52%</td>
<td>53.93%</td>
<td>13.77%</td>
</tr>
<tr>
<td>NAFTA</td>
<td>53.40%</td>
<td>9.13%</td>
<td>28.50%</td>
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</table>

Origin of Electronics Imports by Region
North American Electronics Industry Supply Chain

- IC Fabrication – US & Asia
- IC Packaging and Test – Asia
- PCB & Final Assembly – World
- Final Product Demand – World
North American Electronics Industry Supply Chain

Wafers

Components

Finished products & PCBs
Part II: Problem Description

- Industry Segment
- Current Deficiencies
- Proposed Solution
- Methodology
- Delimitations
Industry Segment

- Wafers
- Components
- Finished products & PCBs

$23.7 Billion
Current Deficiencies

- **Distance**
  - Transportation, travel, level of control, language barriers
- **Reduced manufacturing in North America**
- **Intellectual property infringements**
- **Not viable for defense (aerospace, military)**
- **Risk from lack of geographic diversification**
Proposed Solution

IC Packaging & Test in Mexico
Methodology

- Research
  - Understand industry and supply chain
  - Investigate why this has not been done in grand scale yet
- Assess feasibility of establishing a plant
- Draw conclusions from this plant
Part III: Packaging in Mexico

- Package types
- Packaging Operations Currently in Mexico
- Product selection
- Costs
- Other factors of competitiveness
- Mexicali vs Juarez vs Guadalajara
Package Types

FIG. 5.7: Gull wing SOP

FIG. 5.9: PQFP with gull wing leads

FIG. 5.14: BGA
IC Packaging Processing

- Dicing
- Die bond
- Wire bond
- Mold
- Ball attach
- Singulation

- Testing!
  - Ask Hugo!!!!
Who’s already there?

- Motorola (ON Semi) (Guadalajara)
  - Closed in 2002
- TI (Aguascalientes)
  - No info
- Skyworks (Mexicali)
  - COO loves it
  - Manufactures 85% of all Skyworks components
Product Selection

- Desired characteristics:
  - High tech
  - Future growth
  - Demand in Mexico

- Product chosen:
  - BGA 128 IO, 10mm X 10mm
## Costs: Capital

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<tr>
<th>Machine</th>
<th>Quantity</th>
<th>Tot Cost</th>
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<tbody>
<tr>
<td>Saw</td>
<td>3</td>
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<tr>
<td>Die Bond</td>
<td>5</td>
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<tr>
<td>Wire Bond</td>
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<td>$4,800,000</td>
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<tr>
<td>Automold</td>
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<td>$400,000</td>
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<tr>
<td>Ball Attach</td>
<td>1</td>
<td>$400,000</td>
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<tr>
<td>Singulation/Sort</td>
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<td>$1,000,000</td>
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<tr>
<td>Testing</td>
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<td>3,000,000</td>
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<td>Extras</td>
<td>10</td>
<td>$1,000,000</td>
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<tr>
<td><strong>TOTALS</strong></td>
<td>90</td>
<td><strong>$13,100,000</strong></td>
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## Costs: Labor (monthly)

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<th>Type</th>
<th>Monthly Salary</th>
<th>Quantity</th>
<th>Total Cost</th>
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<td>Operators (skilled)</td>
<td>$432.86</td>
<td>100</td>
<td>$43,286.00</td>
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<tr>
<td>Technicians</td>
<td>$1,588.00</td>
<td>35</td>
<td>$55,580.00</td>
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<tr>
<td>Engineers</td>
<td>$1,935.50</td>
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<td>$1,935.50</td>
</tr>
<tr>
<td>Plant Manager</td>
<td>$5,153.00</td>
<td>1</td>
<td>$5,153.00</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>$105,954.50</strong></td>
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</table>
Costs: Raw Materials (monthly)
## Costs: Miscellaneous (monthly)

<table>
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<th>Cost</th>
<th>Unit</th>
<th>Monthly Quantity</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td>Power</td>
<td>$0.11</td>
<td>$/Kwh</td>
<td>114,336 Kwh</td>
<td>$12,600</td>
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<tr>
<td>Land</td>
<td>$5.05</td>
<td>$/sq.ft.</td>
<td>14,000 sq. ft.</td>
<td>$70,700</td>
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<tr>
<td>Transportation</td>
<td>-</td>
<td>-</td>
<td>14.4 mil BGA</td>
<td>$43,233</td>
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<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$126,533</strong></td>
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Costs: Still Missing

- Purchase land (option)
- Machine maintenance
- Taxes, incentives
Where in Mexico?

- Juarez: $332,366.89
- Guadalajara: $431,765.50
- Mexicali: $313,213.98

Taken into account:
Transportation, rent, labor, electricity
Other stuff to add

- 2 day lead times
- Customer Service
- Time to market

- Supply Chain Optimization, not plant-centered
Part IV: Conclusions

- Conclusions
- Recommendations for Future Research
Conclusions

TBD!