The Changing Role of the Guadalajara (Jalisco State) Mexico Electronics Cluster in a Modular Global Value Chain

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Elements of Modularity

- Modular product designs (e.g., the PC)
- Modular value chain linkages (the hand-off)
- Modular value chains (internal)
- Modular value chains (external)

✓ Only modularity in external value chains leads to capacity pooling and external economies of scale
✓ Modular product designs make value chain modularity easier, but only one break point is needed — full product design modularity is not required
Deverticalization (Outsourcing)

A) Vertical Integration

Traditional Manufacturing Firm

- Product strategy
  - Product R&D
  - Process R&D
  - Functional design
  - Form design
- Prototype fab.
- Parts purchasing
- Manufacturing
- Testing
- Packaging

Market Channel
- Dist.
- Sales Reps.
- System Int.
- Retail

End

User

B) Value Chain Modularity

Lead Firms (Brands and Retailers)

- Product strategy
  - Product R&D
  - Functional design
  - Form design
  - Prototype fab.

Full Package Supplier

- Admin.
  - Process R&D
  - Design for mfg.
  - Parts purchasing
  - Manufacturing
  - Testing
  - Packaging

Market Channel
- Dist.
- Sales Reps.
- System Int.
- Retail

End

User

Codifiable transfer of specifications (CAE, CAD, CAM, MRP, ERP) at inter-firm link. What Baldwin and Clark (2000) call a “pinch point” in the chain of activities.
Elements of Value Chain Modularity

- Codification of complex information eases the hand-off at the inter-firm link—information technology and widely recognized standards are key.
- Highly competent suppliers with multiple locations and customers
- An adequate number of suppliers to allow lead firms to switch
- Generic capacity
  - Allows lead firms to add and subtract capacity on short notice
  - Allows large suppliers to substitute locations

✓ Benefits for lead firms: lower costs and risk
✓ Risks for lead firms: IP leakage, creation of competitors, attenuated learning by manufacturing, forecasting and inventory distortions, decodification with technological change, ceding of value to suppliers
Performance Benefits of Modular Production Networks

Preconditions
- Information Technology
- Standards
- Suppliers Provide Base Processes
- Generic Capacity

Codified Network Linkages
- Attenuated Interdependence
- Open Character of Network
- Lower Barriers to Network Entry and Exit
- Greater Organizational Flexibility
- Greater Geographic Flexibility
- Product/Customer Flexibility

Network Performance
- Lower Factor Costs
- Higher Capacity Utilization
- Lower Total Cost and Risk

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Lead firms with captive supply bases

End users

Lead firm A

Supply base A

Supply base B

Lead firm B

Value Chain

Supply Chain

First tier

Second tier

Materials

Competition

Co-evolution

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Lead firms with shared, modular suppliers

Co-evolution (including competition)

Lead firm A

Codifiable transfer of specifications (CAE, CAD, CAM, MRP, ERP) at inter-firm link.
What Baldwin and Clark (2000) call a “pinch point” in the chain of activities.
Value chain modularity with supplier consolidation; the rise of a new, global supply-base

Global Supplier Examples:

**Electronics contract manufacturing**: Flextronics, Solectron, Sanmina-SCI, Celestica, Jabil, Hon Hai, Quanta, Compal

**Auto parts**: Magna, Delphi, Visteon, Bosch, Denso, Yazaki, Lear, Johnson Controls, TRW, Continental

**Call Center Services**: Accenture, SNT Group, Atento, Convergys, SR Teleperformance, Wipro BPO, Bertelsmann

**Clinical Trials and Contract Medical Research**: Quintiles, Covance, IMS Health, Parexel

**IT Services and Enterprise Computing**: IBM, Accenture, PriceWaterhouseCoopers, McKinsey, Cognizant

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Revenues (US $M)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flextronics</td>
<td>$211</td>
<td>$1,808</td>
<td>$13,615</td>
<td>$15,355</td>
<td>14%</td>
<td>54%</td>
</tr>
<tr>
<td>Solectron</td>
<td>$1,642</td>
<td>$8,391</td>
<td>$12,261</td>
<td>$12,205</td>
<td>11%</td>
<td>22%</td>
</tr>
<tr>
<td>Sanmina-SCI</td>
<td>$2,364</td>
<td>$8,624</td>
<td>$10,168</td>
<td>$11,638</td>
<td>11%</td>
<td>17%</td>
</tr>
<tr>
<td>Celestica</td>
<td>$1,989</td>
<td>$5,297</td>
<td>$8,272</td>
<td>$8,840</td>
<td>8%</td>
<td>16%</td>
</tr>
<tr>
<td>Jabil Circuit</td>
<td>$404</td>
<td>$2,400</td>
<td>$3,729</td>
<td>$6,577</td>
<td>6%</td>
<td>32%</td>
</tr>
<tr>
<td>Top 5</td>
<td>$6,610</td>
<td>$26,520</td>
<td>$48,045</td>
<td>$54,615</td>
<td>51%</td>
<td>24%</td>
</tr>
<tr>
<td>Top 100</td>
<td>NA</td>
<td>$46,029</td>
<td>$68,149</td>
<td>$107,534</td>
<td>100%</td>
<td>NA</td>
</tr>
</tbody>
</table>

Employment

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2002</th>
<th>2004</th>
<th>Share of Top 100, 2004</th>
<th>CAGR '94-'04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flextronics</td>
<td>18,147</td>
<td>95,000</td>
<td>90,000</td>
<td>18%</td>
<td>38%</td>
</tr>
<tr>
<td>Solectron</td>
<td>37,963</td>
<td>73,000</td>
<td>48,721</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Sanmina-SCI</td>
<td>37,470</td>
<td>46,030</td>
<td>57,000</td>
<td>11%</td>
<td>9%</td>
</tr>
<tr>
<td>Celestica</td>
<td>18,000</td>
<td>40,000</td>
<td>47,000</td>
<td>9%</td>
<td>21%</td>
</tr>
<tr>
<td>Jabil Circuit</td>
<td>12,000</td>
<td>26,000</td>
<td>43,469</td>
<td>9%</td>
<td>29%</td>
</tr>
<tr>
<td>Top 5</td>
<td>123,580</td>
<td>280,030</td>
<td>286,190</td>
<td>56%</td>
<td>18%</td>
</tr>
<tr>
<td>Top 100</td>
<td>262,938</td>
<td>446,386</td>
<td>511,384</td>
<td>100%</td>
<td>14%</td>
</tr>
</tbody>
</table>

Note: All Celestica revenues in 1994 were from IBM.
Sources: Company annual and quarterly reports; Electronic Business Top 100 Contract Manufacturers, 2003.
Product Mix for the largest five electronics contract manufacturers, 2001


Facilities inside and outside North America

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>% total</th>
<th>2004</th>
<th>% total</th>
<th>CAGR '99-'04 Top 100, 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Top 100</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total facilities</td>
<td>644</td>
<td>100%</td>
<td>663</td>
<td>100%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Facilities in NA</td>
<td>404</td>
<td>63%</td>
<td>302</td>
<td>46%</td>
<td>-5.7%</td>
</tr>
<tr>
<td>Facilities outside NA</td>
<td>240</td>
<td>37%</td>
<td>361</td>
<td>54%</td>
<td>8.5%</td>
</tr>
<tr>
<td><strong>Top 2-5</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total facilities</td>
<td>180</td>
<td>100%</td>
<td>198</td>
<td>100%</td>
<td>1.9% 30%</td>
</tr>
<tr>
<td>Facilities in NA</td>
<td>97</td>
<td>54%</td>
<td>68</td>
<td>34%</td>
<td>-6.9% 23%</td>
</tr>
<tr>
<td>Facilities outside NA</td>
<td>83</td>
<td>46%</td>
<td>130</td>
<td>66%</td>
<td>9.4% 36%</td>
</tr>
</tbody>
</table>

Revenue per facility

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2002</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solectron</td>
<td>$603</td>
<td>$549</td>
<td>$799</td>
</tr>
<tr>
<td>Sanmina-SCI</td>
<td>$585</td>
<td>$460</td>
<td>$851</td>
</tr>
<tr>
<td>Celestica</td>
<td>$563</td>
<td>$909</td>
<td>$1,424</td>
</tr>
<tr>
<td>Jabil Circuit</td>
<td>$571</td>
<td>$839</td>
<td>$1,175</td>
</tr>
</tbody>
</table>

* The #1 ranked firm in terms of revenue, Flextronics, did not report facility locations.
Sources: Author’s calculations from company annual and quarterly reports and Electronic Business Top 100 Contract Manufacturers, various years.
The new global supply-base; Celestica’s global footprint

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The Flextronics Model: 88 facilities, seven huge industrial parks with full package capabilities

Guadalajara, Mexico
698,438 square feet

Sárvár-Zalaegerszeg and Nyiregyháza, Hungary,
542,410 square feet each

Gdansk, Poland,
229,273 square feet

Sorocaba, Brazil
381,574 square feet

Doumen, China
1,299,347 square feet

Full Package Capabilities:
• PCB fabrication
• PCB assembly
• Cable assembly
• Box build and final test
• Packaging
• Outbound logistics

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Global suppliers offer “total geographic flexibility” in a shared global supply-base; coordination is internalized.
The Central Role of Guadalajara Cluster in the Electronics Global Value Chain: Assembly Hub

United States

Lead firms (design, marketing, and sales)

Guadalajara

Contract manufacturers (circuit board and final assembly)

Asia

Component and equipment suppliers

Finished products

Orders, designs, bill of materials

Components, equipment
Upgrading at an electronics contract manufacturing plant in Guadalajara, Mexico, February, 2001 – July, 2004 (Jabil Circuit)

<table>
<thead>
<tr>
<th></th>
<th>February 2001- July, 2002</th>
<th>March, 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>3,500 down to 1,750</td>
<td>3,900</td>
</tr>
<tr>
<td>Number of customers served</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Number of products made</td>
<td>215</td>
<td>600</td>
</tr>
<tr>
<td>Number of parts used</td>
<td>5,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Employee turnover rate (monthly)</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Average production run</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>Number of engineering changes</td>
<td>Few</td>
<td>Many</td>
</tr>
<tr>
<td>Representative products</td>
<td>• personal computers • video game consoles • mobile phone handsets • communications switches • specialized hand-held credit card processing machines • Internet firewalls • electronic controls for washing machines</td>
<td></td>
</tr>
</tbody>
</table>

Main Findings of the Research

1. Prior to 2000/2001 contract manufacturing plants specialized in high volume, low value-added products. Examples include mobile phone handsets, video game consoles, and “personal digital appliances.” With increased price pressure, plants in Jalisco were unable to compete with plants in China.

2. In the first half of 2001 – in some firms beginning in 2000 - the orders fell sharply.

3. In response the electronic industry in Jalisco State has gone through massive and a profound process of industrial upgrading.
# Employment Trends at Seven Electronics Production Facilities in Guadalajara, Mexico

<table>
<thead>
<tr>
<th>Firm</th>
<th>June, 2006</th>
<th>Lowest</th>
<th>Before crisis</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4,500</td>
<td>2,000</td>
<td>3,500</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>7,000</td>
<td>4,000</td>
<td>10,000 (2001)</td>
<td>10,000 predicted “soon”</td>
</tr>
<tr>
<td>C</td>
<td>2,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>300</td>
<td>190</td>
<td>2,500</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>30 (end of 2006)</td>
<td></td>
<td></td>
<td>Local supplier</td>
</tr>
<tr>
<td>F</td>
<td>5,000</td>
<td>1,400 (opened 2003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>9,600</td>
<td>7,600 (2002)</td>
<td>11,000</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Around 7,000</td>
<td>6,000</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>5,000</td>
<td></td>
<td>10,500</td>
<td>8,500 predicted in two months</td>
</tr>
<tr>
<td>TOTAL</td>
<td>41,000</td>
<td></td>
<td>47,000</td>
<td></td>
</tr>
</tbody>
</table>
Continued Competitive Risks for Jalisco State’s Electronics Industry

1. Labor cost competition. Jalisco State, and Mexico more generally, can no longer compete with Asia/China in the area of labor costs. This applies to production, engineering, and management personnel.

2. A shallow local supply-base. Nearly all components, from bare circuit boards to semiconductors, are imported. With a few exceptions, local procurement is limited to packaging, cable, labels, metals, plastics, etc. This has not changed substantially since the 1990s. Weak upstream linkages make it easier to shift work out of Guadalajara.

3. High labor turnover. Turnover rates from 1.5% to 10% monthly were reported. High labor turnover makes it difficult for firms to develop advanced work organization systems and new capabilities.
During this transformation process the firms following undertook the following measures

1. Employment and new investment were dramatically cut.
2. Remaining workers and managers went through an intensive period of re-training.
3. New systems were developed to maintain product quality in the context of higher product complexity and diversity. These changes impacted procedures for product testing, inventory management, and work processes.
4. New systems were developed to configure and customize products for small orders. This required an increase in engineering employment.
5. The re-training and new process development took place in 2001-2002 for a small number of old and new products that fit the target profile of the plants. These new capabilities in turn provided a platform to win new low volume, high mix business in the period 2003-2005.
6. “Hard” tooling, that is inflexible tooling dedicated to a single product, was replaced with “soft tooling.” This transformation often meant less automation and greater labor intensity and worker skill, especially in final assembly.
Products suitable for production in Mexico have the following characteristics

1. Products with high transport costs. Three variables play a role here in comparison to Asia/China: volume, weight and response time for last minute configuration, rapid replenishment of retail outlets, and quick response to market changes. For example, 20% of the final costs of video game consoles are transportation costs. Large and heavy products, obviously, are well suited for production in Mexico. Transportation costs also rise with low volume shipments.

2. Products that require last-minute configuration, very responsive logistics, and short transit times.

3. Products that have requirements for intense interaction between design, R&D, engineering, configuration, testing, and prototype development. Such products typically require intense engineering collaboration and have difficult new product introduction requirements. Cases were mentioned where lead firms needed to contact the production facility every 4 hours and even every hour. Vastly different time zones, as is the case with Asia/China, makes this very difficult.

4. Extremely dynamic products with rapid product cycles. Because of rapidly changing engineering, production, and material management requirements, proximity to the US for engineering changes and speed to market is required for such products.

5. Capital-intensive products, in which labor is not a determinant cost.

6. Regulated products. Regulations, such as the contaminant law of 2008, favor production in Mexico over China. Another example is the 18% tariff for cellular phones produced outside of NAFTA, which has kept some cellular phone production in Mexico even though they are typically produced in high volumes.
Possible Future Trends

1. **Deeper direct relationships with facilities in the U.S.** (intra- and inter-firm) and an increased focus on co-development of products and rapid response. In such circumstances, it is common for engineers to spend time in each other’s facilities. At least so far, it is very difficult, though not impossible, to engage in such close collaboration with plants in Asia/China.

2. **Increased demand for rapid logistics**, configure to order, and direct ship to retail distribution. This may increase demand for air freight services.

3. **Increases in advanced prototype development** and services such as design for manufacturability, quality, power efficiency, test, and parts availability. This may increase the demand for trained engineers.

4. **The migration of more complex products** currently assembled in the U.S., such as medical and optical goods. This may require additional competencies in areas such as optical assembly and new certifications for highly regulated product categories.

5. **Mexican start-ups** that use global contract manufacturers in Guadalajara. This will require start-up assistance and the facilitation of linkages to between local firms and foreign contract manufacturers.

6. **New tariffs and regulations** that favor production in Mexico. This may require new certification and other services and capabilities (e.g., clean rooms) for specific product categories.

7. **Increasing activities in design** and R&D in Guadalajara. A few firms have started in this direction, but it is not yet possible to generalize these experiences.

8. **Increased co-development of software and hardware** increases the importance of proximity. Some of these activities may move to Guadalajara.
Policy Suggestions (I)

1. Anticipate ongoing change and plan for the future of the electronics industry in Jalisco State. It is likely that the recent changes in the Jalsico electronics industry will not be the last. It is important to consider the experiences of firms that have disappeared, firms that are still are struggling to restructure, and firms that have been able to succeed in this process.

2. Develop an aggressive program to encourage the formation of “fabless” lead firms that use the global contract manufacturers currently located in Guadalajara. Guadalajara has very recently developed world-class low-volume manufacturing capabilities. These capabilities are well suited for small start-up firms seeking to launch advanced products on local and world markets without the expense and risk of building in-house manufacturing capacity. Start-up capital, incubator space, and linkages to contract manufacturer’s new product introduction personnel will all be important elements of this policy.

3. Strengthen the local supply base. Local suppliers have not recovered from the recent crisis and have not adapted to the low volume, high mix, rapid-response manufacturing environment that now characterizes electronics production in Guadalajara. Seminars should be arranged to bring managers and engineers of foreign and local firms together to specify the new requirements for local suppliers and develop targets for the development of the required capabilities.
Policy Suggestions (II)

4. **Make a pro-active assessment of the supply of engineers in Jalisco State.** Our interviews generated no evidence of labor shortages at any skill level. However, if the upgrading process in Guadalajara continues, or accelerates, it will be important to ensure a continued adequate supply of skilled labor, especially machine technicians, test engineers, design engineers, and materials managers. Firm managers should be surveyed about their near, medium, and longer term labor needs. When this study is complete, local universities should be provided with the results and their progress closely monitored. Skilled labor shortages are a real risk for the continued success of the Guadalajara electronics cluster.

5. **Engage in constant monitoring of the freight transport and hospitality systems in Jalisco State.** Our interviews generated no evidence that transportation systems have been a barrier to the upgrading of the Guadalajara electronics cluster so far. However, if the upgrading process in Guadalajara continues, or accelerates, it will be important to ensure that the transportation system is adequate to support rapid shipment of parts into Jalisco State, and finished products out. Truck, rail, and especially air freight transportation systems should be assessed for their continued viability in the face of increased demand, both in terms of volume and service quality. Deficiencies should be proactively addressed and improvements made in advance of demand. Because visits from foreign engineers will probably increase, hotel guests should be surveyed to insure that service is adequate.

6. **Market the new capabilities of Guadalajara:** rapid response, fast logistics, complex products, new product introduction, and engineering and design assistance are all new features of the Guadalajara electronics cluster. Development a brand identity that captures these new capabilities should be a priority.
No, all production will not move to China.
The Role of “Proximate Production Platforms” (Mexico, East Europe) in GVCs

- Rapid order fulfillment for “lean retailing”
- Last minute customization for pull-through ordering
- Medium technology products and processes that require moderate degree of design/production co-location
- Product categories that require in-region production (autos, medical, military and security-related)
- Pass through production location as newer products shift from US to China
Lessons for Industrial Upgrading Theory

- Product upgrading complementarities include process and functional upgrading
- Best practices came from headquarters
- Implementation happened locally, not a given, local managers were very important
- Being part of a modular GVC came with huge risks, and huge opportunity
- Local firms, industry organizations, and state agencies, played almost NO role
- Good quality labor a key asset (nine universities in Jalisco)
- Competition can be with developed country plants, not with other low cost locations
- Regional integration needs to move beyond trade and the integration of production, to the integration of innovation, and security regimes
Supplier Upgrading (and Downgrading) in Global Value Chains

Few customers
Few capabilities
- More customers
  - Product upgrading
  - Inter-sectoral upgrading
  - Base process focus

CAPTIVE

De-codification and reduced competence through technological change, new requirements, and new competitors

RELATIONAL

More capabilities
- Process upgrading
- Functional upgrading
- Functional bundling

FULL PACKAGE SUPPLIER

Many customers
Many capabilities