Overcoming the Challenges of Inbound Supply Chain for a US-Mexico Maquiladora

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Agenda

• Overview of the inbound supply chain for Mexican maquiladoras
• Overview of TRW inbound operations
• Areas of improvement opportunities
• Current projects within TRW supply chain operations
• Conclusions
Maquiladora

• A Maquiladora is a Mexican assembly or manufacturing operation that can be wholly or partially owned and managed by a non-Mexican company.

• A Maquiladora uses competitive priced Mexican labor to assemble, process or perform manufacturing operations.

• Maquiladora must temporarily import most components parts from the United States or other countries.

• Mexican law allows these operations to bring in most capital equipment and machinery from abroad.
Mexico’s Exports

1982

- Manufacturing: 15%
- Agricultural: 5%
- Oil & mining: 80%

2002

- Oil & mining: 89%
- Manufacturing: 8%
- Agricultural: 3%
Maquila Market Share

- Chihuahua: 24%
- Monterrey: 10%
- Saltillo: 4%
- Matamoros: 5%
- Nuevo Laredo: 3%
- Reynosa: 4%
- Cd. Juarez: 17%
- Mexicali: 6%
- Tijuana: 16%
- Nogales: 3%
- Nogales: 3%
- Torreon: 3%
- Others: 5%
Main Maquiladora States

January - August 1998

Total Maquila Exports
33,500 Millions of Dollars (1998)

Source: SECOFI

Baja California Norte 20%
Chihuahua 19%
Tamaulipas 13%
Sonora 6%
Coahuila 5%
Others 37%

Source: SECOFI
Most important segments of Manufacturing

March 1998

Metallic Products, Machinery and Equipment 30.5%
Basic Metallic Industry 6.1%
Mineral Products 7.1%
Paper Products 4.1%
Chemical Industry, and products derived from oil 15.1%
Wood Industry 2.4%
Textiles 8.1%
Alcohol, Tobacco and food Industry 23.8%
Other Industries 2.9%

Source: INEGI
# Statistics of Maquiladoras

<table>
<thead>
<tr>
<th>Item</th>
<th>1990</th>
<th>2000</th>
<th>2002 P/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of sites</td>
<td>1703</td>
<td>3590</td>
<td>3251</td>
</tr>
<tr>
<td>Number of sites on Border States</td>
<td>1523</td>
<td>2686</td>
<td>2362</td>
</tr>
<tr>
<td>% on Border</td>
<td>89.43%</td>
<td>74.82%</td>
<td>72.65%</td>
</tr>
<tr>
<td>Employees</td>
<td>446436</td>
<td>1291232</td>
<td>1081678</td>
</tr>
<tr>
<td>Operators</td>
<td>360358</td>
<td>1045401</td>
<td>860 04</td>
</tr>
<tr>
<td>Technicians</td>
<td>53349</td>
<td>153392</td>
<td>138020</td>
</tr>
<tr>
<td>Administrators</td>
<td>32 729</td>
<td>92439</td>
<td>83354</td>
</tr>
<tr>
<td>Supplies Used (000 pesos)</td>
<td>$29,958,614.00</td>
<td>$521,139,822.00</td>
<td>$539,042,007.00</td>
</tr>
<tr>
<td>Supplies Imported</td>
<td>$29,445,060.00</td>
<td>$505,147,039.00</td>
<td>$518,721,573.00</td>
</tr>
<tr>
<td>Mexican Supplies</td>
<td>$513,554.00</td>
<td>$15,992,783.00</td>
<td>$20,320,434.00</td>
</tr>
<tr>
<td>Added Value (000 pesos)</td>
<td>$9,918,504.00</td>
<td>$163,414,471.00</td>
<td>$181,758,729.00</td>
</tr>
<tr>
<td>Local Content</td>
<td>1.71%</td>
<td>3.07%</td>
<td>3.77%</td>
</tr>
<tr>
<td>Added Value wrt to supplies</td>
<td>33.11%</td>
<td>31.36%</td>
<td>33.72%</td>
</tr>
</tbody>
</table>

Source: INEGI
Supplies Used by Maquiladora

Imported Supplies
97.35%

Mexican Supplies
2.65%

Source: INEGI
TRW Automotive – Current Products
OUR CUSTOMERS
TRW Occupant Restraints de Chihuahua
Suppliers

Europe

[Map of Europe with stars indicating suppliers]
Our Customers LT

From Canada takes 8 days

Europe: 30 days in transit = 1 million dollars

US is 4 days LT

1 day from Mexican Suppliers
The Question?

Inventory or Freight?

Answer: Both
Strategies to meet TRW Goals

6 Sigma
- Dev. local Suppliers
- Customs
- Inventory Reduction

Lean
- Line Balance to takt time (all cells)
- Transportation

ASU & Georgia Tech.
- Supply Chain
Strategies to Meet Materials Goals

Here we are Starting Point

$5M

Third Party Warehouse

Inventory Reduction

Consignment

Six Sigma Projects

Inventory Consolidation

Logistics Redefinition

Local Suppliers

Have 1 year to reduce 5 M USD of inventory
Third Party Process

<table>
<thead>
<tr>
<th>TRW</th>
<th>Supplier</th>
<th>TRW</th>
<th>TPW</th>
<th>TPW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Send weekly releases to Supplier &amp; TPW</td>
<td>Send ASN &amp; Ship material to El Paso TPW</td>
<td>Pays freight</td>
<td>Customs Paperworks &amp; clearance</td>
<td>Ship material To TPW Chihuahua</td>
</tr>
</tbody>
</table>

In Transit
- US
- MEX
Rec’g
- TRW
- TPW
Storage
- TPW
Rec’g
- TRW
Mfg
- Product
Finished Goods

Supplier
- Emit sales invoice 24 hr prior to delivering material

TPW
- Send weekly inventory report to TRW & Deliver material to TRW with a Packing slip
- Generate a Customs invoice
- Import through a monthly bases virtual pedimento
- Send to TRW Mex services invoice

TRW
- Pay services to TPW and chargeback to Supplier
- Pay services to TPW and 50 %

Supplier will pay TPW services?

YES

NO

TRW pay services to TPC

TPW

50 %
Cash Flow, the target
Projects with ASU/Georgia Tech

• During the Summer of the year 2002 an analysis of the in-bound logistics procedures was performed and the following areas of opportunities/projects were identified
  – Improvement of inbound transportation strategies
  – Consolidation center closer to suppliers
  – Vendor managed inventory
  – Integrated decision systems for transportation/inventory decisions
  – Development of metrics to monitor and improve in-bound logistics
Preexisting Transportation Situation

• The raw material from the different suppliers is consolidated in El Paso, TX
• Around 13 different milk runs used to pick up raw materials
• Most of the raw material suppliers located in the mid west
• We estimated that the average truck utilization (excluding fabrics) for the milk runs is around 60%
• The average utilization for cross border transportation is over 80%
• Problem: TRW was paying a lot of money to move “air”
• TRW using a third-logistics party. Question: is this company doing a good job?
Analysis of in-bound Logistics

• Possible problems:
  – Inventory/ordering decisions drive movement of material without regarding transportation costs
  – Milk runs that do not take into consideration inventory trends/policies
  – El Paso might not be an efficient consolidation point (too far from gravity center)

• Some Possible solutions
  – Use an integrated supply chain policies (devise an ordering/milk run scheduling policy that minimizes total cost)
  – weekly/monthly dynamic generation of milk runs
  – Investigate the economic feasibility of a consolidation center closer to the the center of gravity of suppliers that will ship directly into Mexico
  – Investigate the economic/technical feasibility of multimodal transportation
Transportation vs. Holding Costs

Single Product Example

<table>
<thead>
<tr>
<th>Demand (Yearly)</th>
<th>1,291,200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per Part</td>
<td>$18.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inventory On hand ($)</th>
<th>Holding Rate</th>
<th>Holding Cost per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>$353,354.53</td>
<td>20.00%</td>
<td>$70,670.91</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost of Materials</th>
<th>Transportation Costs</th>
<th>Transportation per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>$23,254,512.00</td>
<td>3.50%</td>
<td>$813,907.92</td>
</tr>
</tbody>
</table>

Transportation vs Holding Costs
$743,237.01
## Transportation Efficiency

### Sample of Trucks Hired in April 2002

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>$ / (52 Loads)</th>
<th>Trailers Demand</th>
<th>Cost per month</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>59%</td>
<td>$2,367.69</td>
<td>64</td>
<td>$151,532.06</td>
<td>-</td>
</tr>
<tr>
<td>60%</td>
<td>$2,360.31</td>
<td>64</td>
<td>$151,060.00</td>
<td>$472.06</td>
</tr>
<tr>
<td>70%</td>
<td>$2,023.12</td>
<td>64</td>
<td>$129,480.00</td>
<td>$22,052.06</td>
</tr>
<tr>
<td>80%</td>
<td>$1,770.23</td>
<td>64</td>
<td>$113,295.00</td>
<td>$38,237.06</td>
</tr>
<tr>
<td>90%</td>
<td>$1,573.54</td>
<td>64</td>
<td>$100,706.67</td>
<td>$50,825.39</td>
</tr>
</tbody>
</table>

- Possible Savings by increasing efficiency.
- Sample of 107 trucks (April)
## Transportation Efficiency

**Examples: Consolidation**

<table>
<thead>
<tr>
<th>City</th>
<th>Weekly Demand (Pallets)</th>
<th>Current Route (to El Paso)</th>
<th>New Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEVELAND</td>
<td>25</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>BROOKLYN</td>
<td>8</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>CELINA</td>
<td>3</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>BLACKSTONE</td>
<td>4</td>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>SOUTH HILL</td>
<td>8</td>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>GRAND BLANC</td>
<td>11</td>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>ARCHBOLD</td>
<td>6</td>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>BOWLING</td>
<td>2</td>
<td>C</td>
<td>3</td>
</tr>
</tbody>
</table>

### Current Routes

<table>
<thead>
<tr>
<th>Route</th>
<th>Ocupation</th>
<th>Number of Pallets</th>
<th>Cost per Route</th>
<th>Cost/Pallet</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>69.23%</td>
<td>36</td>
<td>$2,238.00</td>
<td>$62.17</td>
</tr>
<tr>
<td>B</td>
<td>23.08%</td>
<td>12</td>
<td>$2,200.00</td>
<td>$183.33</td>
</tr>
<tr>
<td>C</td>
<td>36.54%</td>
<td>19</td>
<td>$1,926.26</td>
<td>$101.38</td>
</tr>
</tbody>
</table>

**Total cost per week** $6,364.26

### New Routes

<table>
<thead>
<tr>
<th>New Routes</th>
<th>Number of pallets</th>
<th>Cost per route **</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36</td>
<td>$412.00</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>$655.82</td>
</tr>
<tr>
<td>3</td>
<td>19</td>
<td>$524.83</td>
</tr>
</tbody>
</table>

**Total pick up cost** $1,592.65

Storage & handling $134.00

Cost for CIN-ELP $3,152.00

**Total Cost per week** $4,878.65

**Savings =** $1,485.61

% of savings = **23.3%**

**Keeping the original routes (Not Likely)**
Route: Cleveland-Brooklyn- Celina- El Paso
Route: Blackstone - South Hill - El Paso
Route: Grand Blanc-Archbold-Bowling Green
Proposed: Consolidation of routes in Cincinnati
Coordination of inventory

• Currently the plant in Mexico and its counterpart in the US maintain independent inventories of the same product
• Sharing information to reduce inventory levels at both plants should be explored
• The coordination of inventory-transportation decisions between both plants should be explored
• The consolidation of both inventories should be explored
  – Vendor managed inventory
• Problem: How to set costs to be attractive to both Plants?
Possible Implementation of Vendor Managed Inventory

- US Plant responsible of POC inventory under prearranged rules regarding minimum and maximum inventory and information sharing
- US Plant to manage inventory to seek the minimization of total costs of inventory, transportation as well as production leveling at their plant
- Implement an internal costing system that will encourage both parties to seek the overall optimization of the system
VMI Formulas for Coordination

\[
\min_{R_w, R_r, F} nC_w(R_w, R_r) + NF
\]

\[
s.t. C_r(R_w, R_r) - F \leq C_r^* - \frac{\gamma}{N} (N(C_r^* - C_r(R_w, R_r)) + C_w^* - C_w(R_w, R_r)),
\]

\[
C_w(R_w, R_r) + NF \leq C_w^*
\]

- The optimal cost policy is dependant on the values of \( R_w \) and \( R_r \).
- There is also a transfer between suppliers and customers of some of the benefits from the optimal policy, called: \( F \)
- As long as the firms are willing to share the benefits of VMI and they are willing to accept fixed transfer payments, all firms can be better off with VMI, and VMI coordinates the Supply Chain
- Cachon 2001
### Supply Chain Phases

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Receive firm releases from customers for next week shipments, together with an update of the forecast for the next 12 weeks.</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Enter information from releases into Excel Worksheet that works as an MPS for the Plant.</td>
</tr>
<tr>
<td>Thursday</td>
<td>Planner gets a report on inventory of Finish goods on hand. Calculate the amount of production needed to accomplish customer requirements and also keep the safety stock at normal level. From the file “Management Inventory” Report the production program to the Production supervisors so they can schedule production for next week.</td>
</tr>
<tr>
<td>Friday</td>
<td>Upload the information from “Management Inventory” into the MRP system using it as the MPS.</td>
</tr>
</tbody>
</table>
# Supply Chain Phases

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Run MRP system in the morning using the module BOM explosion for calculating the requirements, the information from order releases is the requirements from the week entered on Friday. Along with the start of orders, the production of the customers requirements and shipment of these ones is also done during this week.</td>
</tr>
<tr>
<td>Tuesday-</td>
<td>After the planners get the information of the requirements from MRP, then they determine how much to order and when to schedule the shipment from suppliers.</td>
</tr>
<tr>
<td>Friday</td>
<td>The suppliers are managed by different planners and they schedule the orders to each one of them on fixed days.</td>
</tr>
</tbody>
</table>
Supply Chain Phases

Monday - Friday

Production Planning

Chihuahua Plant

Production Plan

Upload MPS to Maxcim

Production Planners: Take the information from releases and forecast to plan the production for weeks ahead (MPS).

Demand from Customers

Enter Information to Excel worksheets

Receipts their Releases From: Mon - Wed Also receives forecast for 12 weeks

Production Planners: Send production schedule to Production Department.

Week 1

Monday Tuesday Wednesday Thursday Friday

MPS Explosion

Materials Planners: Analyze releases generated by the MRP system. Then develop and schedule the releases to suppliers, using an approach of contacting every supplier by an predetermined day.

By this time all orders are shipped to Customers

Week 2

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

Material Planners: MRP Runs with the requirements from MPS that come from Production Planners

Orders sent to Suppliers By this time all suppliers have their requirements for next week, and start preparing their shipments
Supply Chain Phases

Mesa Plant

Production of Orders

Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday

Demand from Customers
Production Plan

Week 2

Take the information from releases and determines the production plan for present and next week

Shipment

Transportation Mesa-El Paso-Chihuahua

Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday

Week 3

Shipments: Send inflators to Chihuahua Plant

Inflators received at Chihuahua
Supply Chain Phases with Information Sharing

Week 1

Benefits: Mesa will have 2 weeks in advance the demand for shipments, also an expected reduction in variability, tending to reduce safety stock in both plants.
Supply Chain Phases with Vendor Managed Inventory

**Mesa:**
- Discounts Production from current week.
- Discounts Demand received demand for next week, and determines Inventory Level

**Chihuahua Plant**
- Production Plan
- Upload MPS to Maxcim

**Production Plan**
- Production Planners: Take the information from releases and forecast to plan the production for weeks ahead (MPS).
- Send to Mesa: Production Plan for next week

**Mesa Calculates the Inventory Position and determines when to produce and send merchandise to Chihuahua, using Q,r policies.**

**Weeks 1 & 2**

**Inflator Inventory (Proposed):**
- FGI Mesa = Q/2
- Chihuahua=Q/2 + Material in Transit + Safety Stock

**Inflator Inventory (Current):**
- Mesa (FGI) = Q/2 + Safety Stock
- Chihuahua=Q/2 + Material in Transit + Safety Stock

**Production Planning**: Monday - Tuesday
- Receives their Releases From: Mon - Wed
- Also receives forecast for 12 weeks
- 7/3/02
- Send to Mesa:
  - On Hand Inventory
  - Demand for next week
Areas of Opportunity

• Improvement of systems
• Integrated logistics decisions
• Coordination of inventories
• Improvement of transportation strategies
• Production scheduling decisions based on “historical” and experience with production. Can we take a look at how materials and production are influencing each other? What is their combined performance? Can it be improved?
• Both inventory and transportation costs seem to be a small portion of the total “added cost”. Setting metrics, efficiency goals and continuous benchmarking and improvement programs on the “labor burden” component of cost is recommended to strive for “overall” improvement of the supply chain
Some Recommendations for improvement

• Increase truck utilization by:
  – modifying the current milk run routes
  – Modifying the frequency of ordering raw materials according to minimize total costs (or at least making the buyers aware of the cost implications of their ordering policies)
  – Consolidating orders from different buyers/companies
  – More collaboration/communication across Materials Departments from the plants

• Decrease total inventory by:
  – Revise current ordering policies to minimize the variability observed by Mesa
  – Reduce the information lag between plants
  – Sharing information between plants
  – Move to Vendor Managed Inventory
Some problems common to Maquiladora Industry

- Bottlenecks caused by international crossing points
- Under performing transportation system
- Increased use of third party logistic companies
- Effective management of inventory
- Use of paradigms that might not apply to reality of maquiladoras
- Over reliance on low cost labor
- Lack of effective measures of performance
Some Points

• The Mexican content of supplies is still very low (below 4%)

• The overwhelmingly majority of supplies for the maquiladoras still come from the USA and other countries → the maquiladoras usually keep their original supplier base when they move to Mexico

• As the maquiladora industry matures more plants have migrated to the interior of Mexico making the procurement and transportation of supplies both more complex and more important

• Very often the inbound supply chains for maquiladoras lack the sophistication to face the challenges of moving to border/interior of Mexico
Conclusions

- When a plant (maquiladora or otherwise) is relocated to Mexico a careful look at the preexisting inbound (and outbound) supply chain practices should be taken.
- The solutions that might have worked well for the original plant may not work well for the new plant, particularly if the new plant is located in the interior of Mexico.
- Opportunities for improvement include better transportation practices, integrated inventory/transportation decisions, judicious use of third party companies, relocation and/or identification of new suppliers, better coordination throughout the supply chain.