The Inventory Hub

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One of the strengths of the United States economy is the diversification of industries along with free markets that function well enough, if not always at 100 percent efficiency. The variety of products produced, ranging from branded consumer goods to energy resources, is truly impressive. Often Americans take for granted the scope of the United States economy.

When traveling in Asia, it becomes clear that many of the smaller countries in the region have highly specialized economies. If anything, the degree of specialization within Asia appears to be increasing, fueled by the impressive economic growth for nearly all nations in the region. Sometimes called the "Swiss Model," many small countries have directed the majority of public funds and development efforts toward several promising industries, as has been the

case in Switzerland (banking and pharmaceutical). This policy provides the best chance to maximize wealth for citizens.

Because of the level of specialization within Asian economies, business relations take a much different path as compared to common practice within the United States. For example, Taiwan has emerged as a center for contract manufacturing. In total, five producers supply a steady stream of notebook computers to the rest of the world. It is often the case that several Taiwanese producers supply a single company such as Dell, and use the same parts for assembly such as power sources or circuit boards. Going a step further, essentially all of the contract manufacturers in Taiwan source from the identical set of suppliers located in China. This presents an interesting opportunity for collaboration between competing Taiwanese contract manufacturers and a chance to apply some innovative information technology approaches.

Representing an important aspect of supply chain management, the idea of risk pooling has been a topic of study for many years within operations research. Made famous by Prof. David Simchi-Levi in his book *Designing and Managing the Supply Chain* (2000 – 1st edition), and as part of public lectures

addressed to industry, risk pooling is an effective way to reduce safety stock and increase customer service.

The concept is simple; a centralized approach for holding inventory decreases the need for safety stock. In the case of Taiwanese contract manufacturers, each currently places an order to the same supplier for the identical component. Given that orders depend on a forecast generated independently by each contract manufacturer, and that forecast error always exists, the variances between forecast and actual are additive. This means the supplier will experience a great deal of uncertainty concerning the level of production needed to satisfy future demand.

However, by pooling inventory of identical parts at a single location for all suppliers, the variance is much less, and a greater chance exists that demand can be satisfied with reduced safety stock. This is because forecast errors from different contract manufacturers tend to offset each other when pooled. Demand for the identical circuit board might be over the forecast for a specific contract manufacturer, while a different contract manufacturer might undersell the same component. Aggregation of inventory is nearly always better when

considering the investment in safety stock and the level of customer service (percentage of time in stock).

The trade-off is that centralized inventory means increased transportation cost and longer response time. However, for smaller countries, these impacts are minimal. In the computer manufacturing industry, the cost of the product is high and life cycles short. Centralized inventory has many benefits in reducing the amount of obsolescence that overshadow increases in transportation cost.

In the case of Taiwan, a single location, or inventory hub, would exist in the country where all five of the contract manufacturers share the inventory of identical components originating from China. Establishing this form of inventory management organization is possible through industry and governmental cooperation that is unique as compared to the United States, where price signals are often the primary mechanism to manage inventory between suppliers and manufacturers. For example, to reduce the risk of obsolete inventory, Intel has historically cut the price of existing microprocessors as part of a transition to a new product.

To enable a risk pooling system for Taiwanese notebook manufacturers requires the proper analytical approaches along with a means of achieving computer-to-computer communication between suppliers and contract manufacturers. The underlying success of an integrated supply chain system depends of the flow of data for effective management. Since the 1970's, the advent of low cost data collection systems such as the bar code have vastly improved the ability to integrate supply chains. Recent advances such as RFID will build on the success of the bar code. While integrating data obtained from bar codes, RFID, or other sources remains a challenge, initial efforts by the Global Data Synchronisation Network™ (GDSN, www.gs1.org) have highlighted the opportunities. The GDSN is a standards based approach used to for product data. It is used mostly in the retail industry. While the standards-based approach works well, it does require changes to legacy data systems to conform to the GDSN standard.

In contrast, research at the MIT Data Center Program focuses on the automatic conversion of legacy data into a XML form that is interoperable. Resembling an "synthetic language" the MIT approach (M Language) uses a high tech dictionary for words and noun phrases along with rules that structure XML. In many ways, the M Language is similar to existing approaches for using XML,

with the exception that the meaning of words used to describe data is know with certainty. There is no chance of semantic ambiguity as is the case with many other approaches to integrate data.

The added advantage of the M Language is the ability to integrate mathematical models with data across the Internet or private networks. Though this aspect of the M Language is in an early stage of development, the prospect of model integration within a network raises exciting possibilities in sharing models across traditional organizational boundaries.

Looking at the big picture, the M Language concentrates on 11 areas:

- Creating an interoperable data system (complete)
- Internet search using the definition of a word (prototype)
- Various forms of data visualization (prototype)
- Improved data quality (complete)
- Multi-lingual display of documents (complete)
- Linking mathematical models and data within a network (prototype)
- Aggregation of data (research topic)
- Standards for spatial data (research topic)

- Standards for data from sensors (research topic)
- Standards for location (research topic)
- Inclusion of proper nouns (complete)

The basic research work for the backbone of the M Language is complete. A pre Alpha version is at mlanguage.mit.edu. You can register as a user through "Login" located in the upper left corner of the homepage. The MIT Data Center Program is now moving into prototype development along with further research on the remaining elements of the M Language.

As a means of supply chain communication, the M Language is ideal for the example of inventory pooling in Taiwan mentioned above. It handles many-to-many communication, improves data quality and integration, and does basic human language translation. The Taiwanese are still in discussions concerning the inventory hub concept; however, there are clear advantages in using a semantic technology like the M Language to integrate several contract manufacturing companies with many suppliers located in China.

The idea of the M Language is essential for the future where marketing science, engineering technology, and supply chain management will merge into

a unified system. This development will no doubt change the way markets operate, and the ways we use information technology to improve productivity.