High Volume Manufacturing
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>HVM Overview</td>
<td>2</td>
</tr>
<tr>
<td>Strategy</td>
<td>3</td>
</tr>
<tr>
<td>• Manufacturing Competencies</td>
<td></td>
</tr>
<tr>
<td>• Manufacturing Strategies</td>
<td></td>
</tr>
<tr>
<td>• Best Practices</td>
<td></td>
</tr>
<tr>
<td>A Balanced Act</td>
<td>8</td>
</tr>
<tr>
<td>How Can Glovia Help?</td>
<td>9</td>
</tr>
<tr>
<td>• Product Management</td>
<td></td>
</tr>
<tr>
<td>• Manufacturing Management</td>
<td></td>
</tr>
<tr>
<td>• Supply Chain Management</td>
<td></td>
</tr>
<tr>
<td>• Tools &amp; Technologies</td>
<td></td>
</tr>
<tr>
<td>Conclusion</td>
<td>12</td>
</tr>
</tbody>
</table>
Introduction

“Railroads are not in the passenger-train business, they are in transportation.” - Professor Theodore Levitt makes this observation to highlight a specific point about business.

Organizations must evaluate their businesses to understand themselves, the market they are in, and the customers they serve. Especially true for high volume manufacturers, proper alignment is essential, otherwise they are destined for failure. Shrinking margins, limits in differentiation, excessive proliferation, endless uncertainty, the list goes on and on. Manufacturers need a strategic approach and a plan of action that will guide them through the uncertainty and minimize their time and costs in production. To compete, competitive advantages must be developed by concentrating on three areas: manufacturing competencies, strategic alignment and best practices. Before a manufacturer decides how to balance the three, they must first evaluate the current position of their business and the market and then determine which direction they are both heading.
HVM Overview

In the most simplistic view, high volume manufacturing transforms raw materials into finished goods by using capital intensive processing mediums and high machine to worker ratios.

For the purposes of this paper, continuous manufacturing will not be covered because of the simple nature of their production process. Instead, the focus will be on the more complex discrete manufacturing and its underlying approach.

Based on assembly and shaping, discrete manufacturing creates final products, such as automobiles and electronics, from prefabricated components. In the past, mass production of discrete products might have been able to succeed with bureaucratic systems and closely supervised divisions of labor. But as globalization grows, traditional manufacturing is being challenged by an evolving marketplace and economy, where obstacles continuously rise and rules constantly change. It is up to managers to meet the same goals and exceed past performance, while navigating through a myriad of danger and uncertainty.

A 2004 study of the European automobile industry showed that only half the cars built match a customer’s exact preferences, with an average waiting time of seven weeks for delivery. As the market gives way to customer demands, the automobile industry and other discrete manufacturers are expected to start producing their respective products in the same fashion as Dell does with it’s computers. In addition to the pressure of offering a wide array of custom products, manufacturers must also deal with short product lifecycles, massive proliferation, complex product mixes, technological obsolescence, and a number of other factors.

For manufacturers, certain objectives must be met in order to develop an efficient operation and produce a high quality product. From a high level, one of the clearest objectives in manufacturing is to improve the utilization of capital. As a central theme in most goals, the objective becomes incredibly dynamic when coupled with changes in market demands and threats of obsolescence. In addition, rather than viewing manufacturing as a major cost center, businesses are becoming more concerned with developing it into a competitive advantage through cross functional and company efforts. When a manufacturer creates this edge, they are able to produce higher quality goods at lower prices, modify equipment according to product changes with minimal cost and establish a flexible, long term strategy that is perfectly aligned with a company’s mission.

How can companies develop and maintain a competitive edge in light of all these challenges? Companies that dangle carrots just beyond their reach, are setting high goals and constantly completing objectives to achieve continuous improvement. The successful ones realize the journey itself is the real reward, not the carrot. A well planned strategy will map out a clear path for the journey and keep a company focused and on track to achieve the greatness it seeks.
Strategy

By offering the customized mix of products and features required by today’s market, high volume manufacturers have begun to take on some of the traits of complex production environments. Idealistically, although companies would like to provide customers with what they want and still profit, the reality is that there needs to be a solid strategy that provides the means and support. In spite of certain limits, flexible processes and organizational structures give businesses the best chance to produce individually customized products and still reap the cost benefits of a mass production system.

By instilling flexibility and responsiveness into the people, processes, technology, and environment, manufacturers will be more capable of giving customers exactly what they want, where they want it, when they want it and how they want it. Lower costs, higher quality, and improved cycle times are some of the benefits a flexible high volume manufacturer can expect.

With its GBL (global body line) manufacturing system, Toyota produces multiple models and styles from the same plant, making it a leader in flexible high volume manufacturing. A growing trend in HVM, flexibility enables companies to adapt to environmental uncertainty, move with customer needs, respond to competitive pressures and be closer to the market, without enduring any excessive costs, time, organizational disruptions, or performance losses. This strategic imperative provides the opportunity to make gains in responsiveness and performance by producing high quality products quickly and efficiently through set up time and cost reduction, reliable equipment, cellular manufacturing, preventative measures, and quality programs.

Some examples of flexible high volume manufacturing practices include:

- Using the same equipment for multiple products
- Standardizing manufacturing process elements
- Reconfiguring tools to perform multiple operations
- Standardizing critical points in product design
- Organizing floor space and working areas

These practices have been presented to manufacturers in various forms and at different times, all with the same message. Companies should recognize the absurdity of implementing these measures without a clear plan and expecting results in a short period of time. Creating flexibility successfully requires patience and a strong commitment of resources, anchored by a focused strategy. In the case of manufacturing, there are three components to consider when developing that strategy:

- Manufacturing Competencies- These competitive weapons must be aligned with the demands of the market and customer. Otherwise they are useless.
- Manufacturing Strategies- Can be viewed as having a wider, contingency based approach, requiring consistency between the business, product and marketplace.
- Best Practices- Based in large part on world class manufacturing, they promote the development of competitive advantages through the continuous improvement of infrastructure processes and consistent production of high quality products.
Manufacturing Competencies

When aligned with the capabilities and key success factors of manufacturing, flexibility can create an enormous competitive advantage for any firm. How flexibility is defined can vary depending on the context, because one could be referring to the strategic, tactical or operational levels of an organization. Also, within each “level,” there are different “types,” such as machine, tooling, labor, and product, all of which have respective aspects and ratings that consider potential, actual, required flexibility. Regardless of the level, type or aspect, flexibility is always measured in terms of range, mobility, and uniformity.

- **Range**: Measures the number of different products and the variance among those products. Producing a large number of very different products signifies great range.
- **Mobility**: Changeover flexibility allows a firm to change from one product to another, minimizing the need for long production runs and reducing time and cost.
- **Uniformity**: Measures the ability to maintain standards as a firm switches products. Maintaining performance and quality despite product changes shows high uniformity.

These three qualities can be used to characterize the various manufacturing competencies that exist in the production process:

**Machine**: To have equipment perform different operations economically and effectively, without major setbacks is very useful, especially when switching products along the same line. As a major factor in determining volume and product mix, machine flexibility is the number of part types the system can produce without major setups or the addition of major capital equipment. Range can be measured by how many different operations a machine can perform, including the speed at which it performs. During the product changeovers, if the time frame is short and the quality and efficiency are kept consistent, then both mobility and uniformity are high.

**Labor**: Another major determinant of volume and product mix, a talented and well trained workforce can perform numerous tasks economically and effectively. Range is defined as the number of tasks, and the speed at which they can perform them. During periods of uncertainty, if the workforce can recognize the need and execute a change in the process then mobility is high. Maintaining quality and efficiency across a variety of jobs is a sign of uniformity.

**Material Handling**: Whether transporting parts and components along various chains and over multiple paths or moving different parts for proper positioning and processing, material handling flexibility seeks to improve flow by eliminating bottlenecks, decreasing changeover time and improving processes. The number of paths and types of material define range, while the time or cost associated with adding those paths defines mobility. Material transfer time, cost, and quality are all measures of uniformity.

**Routing/Operation**: This competency refers to processing a set of parts, using multiple routes, alternative operations or sequence of operations within the system to manufacture a product. High flexibility in this area not only creates processing alternatives in the event of machine breakdowns or system overloads, but it also provides options for increasing volume and mix flexibility. Range looks at the number and the variance of all the alternate routes available. Mobility looks at the time and cost accounted for when making changes to a route. Uniformity measures differences in processing time and quality for each alternate route used.
Volume/ Expansion- Operating at various batch sizes and or production output levels economically and effectively, volume flexibility allows a manufacturing system to increase capacity and capability whenever needed and still be profitable. Range is concerned with keeping profitability as the level of output is increased, but manufacturers must remember to look at mobility, the time required to change output, and at uniformity, the affect on cost and quality.

Mix/ Market- The ability to add or substitute new parts for existing ones and to produce a wide array of products is a sign of high flexibility, especially if done effectively and at a profit with a given capacity. By providing the products requested by customers in a timely manner and being responsive and adaptive to the changing market environment, a manufacturer can boost customer satisfaction. Range looks at the number of different products and the degree of differentiation amongst them. Mobility is concerned with keeping the time and cost involved with changing a product mix low, while uniformity seeks to maintain product quality and system productivity.

While this list may not be complete, it does cover major areas in manufacturing, especially the ones that should be considered when developing competencies and building competitive advantages. However, advantages are not sustainable if developed indiscriminately, one by one. If a firm simply decides to build a competitive edge around volume flexibility, the advantage won’t last unless it is a part of an overall plan. It is only a matter of time before a competing firm picks up on the success. Whether it’s volume, machine or routing flexibility, the competency is easily attainable, given the right amount of time and resources. To maximize and protect developing competencies, companies must follow a steady approach and aim for long term success by establishing a solid infrastructure.

Ferdows and DeMeyer’s Sandcone model prioritizes the various competencies and lists them in a specific order so that a strong foundation can be established and the competencies themselves can grow and accumulate. There are four areas the competencies can fall into: quality, dependability, speed and cost. The base of the Sandcone model consists of quality and is then followed by dependability, but the latter can only be added as the former is expanded. It is quality that gives firms the ability to compete on a high level and improve in the long term. After dependability is added, the two must grow together before speed is added, which is then followed by cost. These dimensions must come in this order and the base must continuously grow as additions are made. This approach to competitive dimensions dictates the choices firms must make when developing their manufacturing competencies, specifically in terms of levels, types, aspects, and measures of flexibility.
Manufacturing Strategies

The benefits of flexibility continue to make it a focal topic for high volume manufacturers. Enticed by the thought of having better product availability, decreases in cycle time, increases in productivity and the ability to perform with uncertainty, manufacturers have taken a closer look. However, they must realize that the choices they make in regards to developing flexible competencies or strategies must be aligned with the overall organization's strategy and business. By understanding the business and the market, a manufacturer is in a better position to make decisions about what strategy to approach. The following is an organizational tool for making strategic choices in flexibility and manufacturing. Definitions and terms may not be consistent with those found in other sections of this paper and are not to be applied anywhere else.

The model is concerned with four specific types of flexibility:

- **Product**: Ability to introduce new products or to modify existing ones
- **Mix**: Ability to change the range of products within a given time period
- **Volume**: Ability to change level of output
- **Delivery**: Ability to change planned delivery dates

For each specific type of flexibility there are two dimensions:

- **Range**: The range of states within a production system is considered high, when the manufacturer can exhibit the ability to make a large number of products, manufacture at different output levels and operate under different delivery lead times. Range usually requires extra or improved resources and thus is viewed as a long-term affair.
- **Response**: Response is great when a production system can move quickly, smoothly and cheaply from one state to another, thereby minimizing any costs, time requirements or organizational disruptions and resolving issues such as machine changeover time, new product lead times and purchasing lead times. Viewed as a short-term solution, managers usually seek to improve response first and then range.
In the figure above, variety and uncertainty determine the types of flexibility and the dimensions of those types. Variety can be defined in terms of products, processes and activities that are present in the system and uncertainty is the system’s ability to predict and perform under suboptimal situations. In an environment with high uncertainty and low variety, there must be a short term and long term approach. In the short term, firms will look to improve their ability to respond to changing demand levels (volume/response), create new or modified products quickly (product/response) and meet certain dates as promised (delivery-response). In the long run, if the uncertainty persists and or is the nature of the market, a company must then be able to predict or forecast production (volume/range), evaluate current technology and labor’s capabilities (mix-range) and the extent of order cycle time (delivery-range). Depending on the manufacturer’s environment, there is a set of short and long-term needs that must be addressed when developing a strategic manufacturing approach towards flexibility.
**Best Practices**

The popularity of Japanese manufacturing, process based approaches and benchmarking has qualified MRP, World Class manufacturing, JIT, TQM, and Lean as sources for best practices. However, in a 2005 study of some the best performing companies around the world, researchers reviewed various programs implemented over the years. Each program consists of a number of initiatives, some of which are unique and some that overlap. The results of the study showed that only a few of these initiatives were evident in a majority of the companies and had positive impacts in key areas such as flexibility, quality, dependability, speed and cost. Directly correlated initiatives were deemed as the “true” best practices, while the others were labeled as being possible best practices. Initiatives that fell into these two categories were included in the following table:

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<th>Initiative</th>
<th>Purpose</th>
<th>Best Practice?</th>
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<tr>
<td>e-business</td>
<td>Reorganize the company towards e-commerce or e-business</td>
<td>Possibly</td>
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<tr>
<td>Supplier Strategy</td>
<td>Redevelop the company’s supply strategy through restructuring, organizing and managing the portfolio of suppliers.</td>
<td>Possibly</td>
</tr>
<tr>
<td>Outsourcing</td>
<td>Develop the company’s core activities, while outsourcing all other support processes and activities.</td>
<td>Possibly</td>
</tr>
<tr>
<td>New Product Development</td>
<td>Improve new product development through platform design, product modularization, standardization, concurrent engineering, and quality functions.</td>
<td>Possibly</td>
</tr>
<tr>
<td>Pull Production</td>
<td>Employ kanban systems and reduce set up time and batches to implement pull production systems.</td>
<td>Yes</td>
</tr>
<tr>
<td>Process Focus</td>
<td>Restructure manufacturing processes and layout to focus on streamlining, and more importantly, the process itself.</td>
<td>Yes</td>
</tr>
<tr>
<td>Equipment Productivity</td>
<td>Improve equipment productivity, whether it's through maintenance or machine flexibility.</td>
<td>Yes</td>
</tr>
<tr>
<td>Environmental Compatibility</td>
<td>Improve the manufacturing environment, creating a safe and compatible workplace.</td>
<td>Yes</td>
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With respect to responsiveness, JIT and Lean are examples of best practices that help firms focus on flexible high volume manufacturing goals such as: reduction in uncertainty, controllable processes, time compression, greater productivity, lower costs, improved quality and increased customer value and satisfaction. Though proven to be extremely powerful tools with the potential to produce results and provide limitless benefits, implementing best practices does not guarantee improved performance. Partial implementation, abandonment, failure to reach goals, poor performance metrics, weak communication and a lack of support are a few of the obstacles this component faces.
A Balanced Act

Relying and focusing on only one of the three competencies is not enough. This is especially true in today’s market, where manufacturers must provide products with perceived value that is higher than the price paid.

The only way for the manufacturer to do this is to make sure there is a balance in the system and all the competencies, strategies and best practices work together like a smooth, well-oiled machine. The connection between the three components is evident in the strengths, weaknesses and the nature of each component. Manufacturing competencies and manufacturing strategies are closely connected as capabilities are directly influenced by strategic choices made in the organization. In the case of flexibility, the strategy requires specific processes and competitive capabilities in order to succeed. The only way to maximize the processes and capabilities employed is to use best practice programs, which in turn need to be supported by strategic choices.

In creating this balanced attack, there needs to be a strategic vision with established reference points for adjustments and revisions. Developing specific competencies will require changes in strategies, which will then drive the need for best practice implementation. Continuous improvement in best practices will eventually lead to further development of the capabilities, completing an upward spiral. The cyclical process will lead to continuous incremental improvements and occasional step changes, an organic competitive weapon that no other manufacturer can duplicate.
How Glovia Can Help

Glovia International, a wholly owned subsidiary of Fujitsu International, has been in existence for over 35 years. During that time, Glovia has gone from being a solutions provider for manufacturers to serving the entire operation, bringing visibility, flexibility, responsiveness and improved efficiency to all aspects of business.

Glovia’s extended ERP suite, which consists of over 70 seamlessly integrated modules, is geared towards providing high volume manufacturers with tools they need to support their operations in an effective and profitable manner. Glovia’s wide array of solutions can be applied to each component mentioned, whether it is the development of competencies, the decision-making in strategic choices or the implementation of best practices.

To this day, manufacturing remains the unmatched strength of Glovia in the ERP market. High volume manufacturers can be confident that the system is not only tailored for them specifically, but that the system is incredibly flexible and scaleable. As the business and needs grow, functionality can be added so there are never any excess functions, but also never a lack of capabilities. Whether you are managing an enterprise, a subsidiary, or a single location business, Glovia’s solution links you to customers and suppliers, manages the entire operation through a real time database and allows for step changes to processes and strategies, which are necessary in a constantly evolving environment. These are some of their proven manufacturing modules:

**Product Management**

Engineering- As the cornerstone of the Glovia solution, Engineering is geared towards creating a flexible manufacturing system by allowing businesses to define and document products and services and to respond quickly to product and service changes demanded by the marketplace. Detailed access and control of the latest information allows engineering to be more productive and efficient when designing new products, configuring old products, updating BOMs and routings and accurately calculating the cost to manufacture a product.

Engineering change- Changes to the product usually result in the revision of the BOM, routing, configuration and other impacted areas. Engineering Change allows businesses to increase their flexibility by providing a cost effective solution that simulates and analyzes the effects of a specific, group or mass change. Once that change is made, files are updated, adaptations are made and operational schedules are tweaked.

Tool & Gauge- The Tool & Gauge module manages tool and gauge inventory, tracking and calibration. By viewing tools and gauges as assets and resources, this module acts in the same way as the inventory module by tracking and controlling every tool and gauge used in manufacturing process. Inquires and reports allows the user to monitor tool usage, issues, history, current demand, time and place of use, calibration, etc.
Master Production Scheduling (MPS)- As denoted by its name, MPS is all encompassing and takes into account all the functions of a business, notably marketing, manufacturing, and finance, and aligns it with the marketplace and customer demand. Effectively allocating materials and resources, MPS makes the necessary adjustments a flexible organization needs to make in order to be profitable. By consolidating planning and scheduling functions onto one workbench screen, creating immediate access to sales, demand, production, and supply, and reacting to disruptions quickly, a business creates complete visibility when planning current and future production. “What If” scenarios and performance metrics are some of the tools MPS uses to adapt to changing market conditions.

Material Requirements Planning (MRP)- Working closely with MPS, MRP focuses on the materials aspect of production to create a process flow, reduce inventory, increase productivity and enhance customer service. In order to have complete visibility when managing materials, real time information about inventories, work orders, projects and production is essential. Glovia provides the ability to plan, track and revise the movement of materials so that maximum efficiency and flexibility are reached.

Repetitive Manufacturing- Because of the minimal paperwork required, the ease in making changes to capacity, the mass customization function, the repetitive manufacturing module makes the scheduling system extremely flexible. This flexibility is critical when accounting for changes in flow rates, demand patterns, and other intervening patterns or patterns of performance. It provides the essential characteristics of flexibility of range, mobility and uniformity by tracking production progress, employing advanced alert processes and timely corrective actions, creating and maintaining lists of BOMs and routings for each part used. The last characteristic is especially important because it is based on the JIT principle to optimize inventory, which uses pull techniques and issues materials on an as needed basis. As a result, the modifications to BOMs and routings, tailored product configurations and increased visibility helps companies respond to changing production conditions and unique customer requirements.

Advanced Capacity Manufacturing- A constraint based module, Advanced Capacity Manufacturing determines the most effective way to execute production schedules generated by MRP and MPS, with respect to material, capacity and tooling. Increasing production throughput, reducing changeover, identifying and eliminating bottlenecks, maximizing time efficiency, reducing production disruptions, increasing production and work order visibility are some of the benefits that this module has to offer. “What If” scenarios and analysis, real time synchronization and contingency plans are also built into the system to make sure production is operating at maximum efficiency and flexibility.

Seiban- Translated roughly from Japanese into “manufacturing number,” Seiban is basically an MRP system within an MRP system because it is designed to take a product line, batch, production run or individual item and trace all the activity and costs associated with it. By separating inventories and assigning ID numbers to related parts, materials, orders, an operation can manage with extreme efficiency, becoming more responsive and competitive. Glovia’s system improves visibility, coordination and synchronization, all of which are keys to developing a “capable to promise” position. Scheduling, assembling and delivering quality products to customers as promised can be a great advantage, as shown in the sandcone model.
Work Orders- As a large part of manufacturing, work orders manage the costs and scheduling of all work related information and activities. Glovia’s flexible work orders structure is completely integrated with the rest of the system, allowing for various builds (prototypes, finished products, and subassemblies), alternative BOM and routings, and product configurations tailoring. In addition to backflushing and issuing materials by operations, the system is also capable of making substitutions based on material availability, capacity, and individual customer specifications.

Electronic Kanban- Triggered by purchasing and backflushing, Electronic Kanban is able to keep excess inventory to a minimum, eliminating the chance of shortage and increasing efficiency. This fully automated demand driven process, is not only capable of reducing the planning purchase order cycle, but is also able to greatly increase responsiveness and enhance customer relationships.

Kanban- Kanban is a process that automates the flow of materials using containers and pull techniques. A powerful tool for world-class manufacturing and best practices, especially in the areas of JIT and Lean, Kanban allows organizations to eliminate excess inventory, avoid overproduction and respond to changes quickly.

Inventory & Physical Inventory- Inventory is planned for and controlled on an enterprise level. Its movement can be tracked, while maintaining visibility within and between locations in real time. This accurate up to date inventory information is also available in Physical Inventory, which is an automated process that minimizes disruptions during physical counts, takes frequent comprehensive counts, and avoids costly mistakes with great accuracy.

Supply Chain Management

Factory Planning- Performs a number of Lean functions such as eliminating waste related to excess inventory, motion and waiting. Factory planning is able to respond to machine breakdowns and unexpected inventory shortages by running a number of “what if” scenarios and then choosing the optimal plan to eliminate bottlenecks, maximize machine and resource utilization, achieve accurate capable to promise, reduce cycle time and improve customer service. In short, it is a constraint based planning tool, designed to optimize all aspects of production. Also, real time production planning enhances responsiveness within the supply chain, by quickly communicating accurate data and immediately enabling informed decision-making.

Tools & Technologies

Shop Floor Data Collection- A powerful tool for capabilities and best practices, SFDC provides real time data collection for analysis, real time monitoring of cells for reporting, defect and breakdown analysis, disruption signals sent downstream, and real time feedback from the factory floor to make sure production can meet demand.
Conclusion

High volume manufacturing is realizing that traditional techniques and strategies are not sufficient anymore. Customers and the market are making discrete manufacturing exponentially more complex, demanding increased responsiveness to customer requests and improved flexibility internally and externally.

In order to develop and maintain a competitive edge in manufacturing, businesses need to rethink and evaluate their strategy. A three-pronged approach of developing manufacturing competencies, making informed strategic choices and implementing best practices is recommended, with the stipulation that they are aligned with the business, the product and the market. Being flexible drastically increases the chances of success in high volume manufacturing, but it requires the ability to manage cost and uncertainty. With the rise of globalization and product proliferation, the ability to manage the entire operation becomes increasingly difficult. With a progressive strategy, an articulate message communicated by upper management and the necessary technology to facilitate the processes, a manufacturer can be confident in developing the competitive advantages they need to succeed.
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