Microfactories - The Next Big Thing in Manufacturing

Introduction

Microfactory is a small-to-medium scale, highly automated, and technologically advanced manufacturing setup, which has a wide range of process capabilities. Typically, it is a manufacturing facility whose output can be scaled up by replicating such setups in large numbers. Microfactory requires less energy, less material, and a small labor force, owing to the high-tech automated processes. The concept of microfactory also promotes the miniaturization of production equipment and systems according to the product dimension. This helps in reducing the size of the factory, which, in turn, needs less capital, as well as lowers operating expenses. Since the development of the first microfactory concept in 1990, it has witnessed technological advancements and has found applications in multiple commercial manufacturing processes.

Development of the Microfactory Concept

The concept of microfactory was first proposed in 1990 by the Mechanical Engineer Laboratory (MEL) of Japan. Post that, MEL worked for almost a decade on a project to downsize machine tools and manufacturing systems. MEL developed a microlathe smaller than a human palm in 1996. This encouraged MEL to create a prototype of an entire machining factory, which further resulted in the creation of the first desktop fabrication system for producing micro ball bearings in 1999. This system was made available to the international community at the start of the 20th century.
Following this, Japan’s Nidec Sankyo Corporation developed the “Desktop Factory” for assembly, consisting of various units with standardized sizes and interfaces.

Post that, the Fraunhofer Institute for Manufacturing, Engineering, and Automation (FhG-IPA), Germany, and EPFL, Switzerland, did intensive research to develop a unique mini-factory system with modular construction and desktop milling & drilling machine for micromachining applications, respectively.

With success in prototyping a variety of machines/manufacturing systems, a number of miniaturized standalone manufacturing systems were put to commercial use for various applications like prototyping, education job shops, etc.
In the decade 2000-10, with advancements in manufacturing technologies, such as 3D printing, along with other enabling technologies, microfactories found its use in commercial production. In 2010, Local Motors established its first microfactory for commercial operations in Phoenix, Arizona, manufacturing its Rally Fighter car.

The concept of microfactories has picked up real steam in the last five years, with a number of players establishing microfactories in various industries. Several new innovative start-ups have embraced this concept challenging the traditional way of manufacturing.

Traditional Manufacturing Model vs.
Microfactory

The traditional manufacturing concept advocates reducing costs by building a large factory to achieve economies of scale and mass production; however, it needs an extensive and costly distribution network to make products available to customers. Microfactory, on the contrary, challenges this concept by setting up multiple small, but high-tech manufacturing units, within close proximity to customers, which can function as retail outlets providing a customized product. Another difference between these two models is the sales strategy. In the traditional manufacturing model, products are first manufactured in large quantities and then pushed to the market through various distribution channels, whereas, in the microfactory concept, products are manufactured only after getting confirmed orders from the customer, thereby generating pull from the market.

Here is the example of a hypothetical business case of manufacturing 250,000 cars per annum, to compare traditional manufacturing versus microfactory. Both these setups are different and have several aspects that would lead to a complex comparison matrix. Exhibit 1 refers to the comparison matrix that is based on a few selected parameters.

<table>
<thead>
<tr>
<th>Description</th>
<th>Traditional Manufacturing</th>
<th>Microfactory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Capital Cost</td>
<td>Very High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Distribution System Cost</td>
<td>25–40% of the final price of the cars</td>
<td>5–10% of the final price of the cars</td>
</tr>
<tr>
<td>Profit</td>
<td>3–5% of the final price of the cars</td>
<td>20–25% of the final price of the cars</td>
</tr>
<tr>
<td>Risk</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Customization</td>
<td>Difficult to implement</td>
<td>Easy to implement</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Suited to investments in</td>
<td>Developed Market</td>
<td>Emerging Markets</td>
</tr>
<tr>
<td>Break-Even Volumes</td>
<td>High</td>
<td>Less</td>
</tr>
<tr>
<td>Delivery Time of Product</td>
<td>High</td>
<td>Less</td>
</tr>
</tbody>
</table>

Source: FuturEdge Analysis

Product Distribution

Traditionally, the time tested Henry Ford's method of mass production has been well accepted in the manufacturing industry. Manufacturers have been consolidating their manufacturing facilities to create a huge factory producing high rates of output. This has helped them achieve economies of scale by reducing costs; however, building a huge factory requires very high capital investment. At the same time, these mass-production factories
produce a very high quantity of output, which needs geographically extensive markets to absorb this large volume produced. This, in turn, requires an extensive distribution network of stockists, wholesalers, and retailers, to make products available to potential customers. In contrast, the concept of microfactory is based on having a technologically advanced, small-to-medium-sized manufacturing facility located very near to the customer, acting as a retail outlet, eliminating the need for the cumbersome and costly distribution network.

**Standardized Design vs. Customized Product**

Another aspect is that in the mass production setup, products manufactured are standard, and any changes in the product design add to the cost significantly, to change over the dies and tooling. A typical microfactory setup is very flexible and one can change product design at no or bare minimum cost. Microfactories are ideal for production in small batches with different designs/specifications without any hassle. In fact, some of the microfactories in the garment industry are producing each piece customized by the user. For instance, customers can send their favorite customized designs to the manufacturer using the app provided by them and can receive a perfectly-fitted and styled cloth the next day. This aspect of customization also helps in creating consumer demand, and production happens only when the manufacturer has received a confirmed order from the customer. This ability to provide personalization creates pull from the
market for manufacturers’ products. In addition, manufacturers produce each customized product and sell it then and there, without the need for carrying any inventory of manufactured products. The traditional model believes in manufacturing large quantities of standard products and emphasizes the need to push products in the market for sale. It also needs ample space to store products, which, in turn, incurs the cost of inventory.

**Benefits and Drivers of Microfactories**

Microfactories are capable of providing high-mix, low-volume customized products with a high return on investment. Hence, the transition of manufacturing players from using larger manufacturing facilities to smaller, agile, and highly-automated microfactories is not very far. Some experts believe that the manufacturing technology is getting ready to embrace the microfactory concept, and the industry would witness the development of a number of new microfactories over the next 10 years.

Some of the major benefits of microfactories are displayed in *Exhibit 3*.

![Exhibit 3: Benefits of Microfactories](image)

*Source: FutureBridge Analysis*

**Increased Innovation** - Microfactories are versatile, highly-automated factories that enable lean manufacturing and boost the rate of innovation by integrating several functions, including crowdsourcing and crowdfunding. Being a small automated setup, microfactories enables several tests and iterations to be performed on a small scale without impacting the time and cost. Whereas, in a traditional factory establishment, the impact of time and cost on several iterations would be huge.
Lower Costs - Microfactories are small-sized factories that require less floor space compared to traditional large factories. Hence, the energy consumption and raw material consumption of the factory is less, thus creating reduced waste and emissions. This positively impacts the operating energy, environmental energy, and processing energy of the factory, ensuring cost savings. In addition, microfactories also cuts down on labor costs, as the factory is highly automated with the support of artificial intelligence and robotics.

Increased Productivity - Microfactories require a small team of skilled workforce for functioning and does not depend on huge manual labor. In addition to the agility and high automation levels of microfactories, the engagement level of workers is also very high, which naturally boosts their morale towards work, thereby increasing productivity. Workers in the factory have the freedom to try out new methods apart from the standardized ones, due to the small-scale investment nature both in terms of time and cost.

Supports Mass Customization/Personalization - Customization/personalization of products is becoming a new trend in the manufacturing sector, both in the industrial and commercial space. This trend is driving manufacturers toward small factory space, such as microfactories, as it provides high-mix, low-volume manufacturing capability, wherein products can be customized and manufactured on-demand. The level of customization could range from small-batch with the current trend to individualization, where an individual can design the product via a consumer website.

All these benefits, along with some drivers mentioned in Exhibit 4, are helping the adoption of microfactories for commercial production.
Local Motors was one of the pioneers in establishing a microfactory for automotive production. Post that, many companies from different industries have started adopting and establishing microfactories. Automotive, garment, consumer appliances, and electronic waste treatment are some of the leading application industries currently using microfactories for commercial production. Several companies are also investing in the development of new and advanced technologies required for establishing microfactories. Some companies such as Bright Machines and Buhler are providing necessary equipment and technologies for setting up microfactories.
Conclusion

Manufacturing technologies have evolved significantly over the years. Presently, most of the products are manufactured in large factories achieving economies of scale, and most of these factories are located in low-cost regions, primarily in Asia, and a few in Eastern Europe and South America. This has helped customers getting products at a better price; however, there are signs that this might not be the case forever. Either the
low-cost labor is getting exhausted in these countries as the younger population is not willing to perform repetitive low skilled jobs or the cost has started going up significantly. In addition, the delivery delays, as well as the demands and preferences for indigenous products, are increasing worldwide. This will eventually make it difficult for manufacturers to get products manufactured at distant low-cost locations and bring them to the local market.

Another important aspect that should be considered is changing the customer requirement. More and more customers are seeking products that are personalized/customized. A survey conducted a few years back showed that more than 50% of consumers in developed countries prefer personalized products and are ready to pay a slightly higher price for it.

Considering the changing consumer dynamics, along with limitations to get products sourced from low-cost countries, large organizations will need to rethink their manufacturing strategies. Organizations worldwide will have to understand that opportunity lies in opening multiple distributed manufacturing operations. This can be done by setting up a network of small, technologically advanced, flexible manufacturing facilities, similar to a microfactory, within close proximity to the customer location. It will not only help manufacturers to produce small batches of customized products suitable for local taste but also would save logistics and transportation costs to the tune of 25% to 40% of the product cost.

Many younger technologically advanced organizations have already started investing in this concept, along with a few established market players such as GE, showing great interest in establishing multiple microfactories. According to FutureBridge, microfactories can be an answer to the changing consumer dynamics, which will overpower the limitations of low-cost sourcing destination. Not only this, but microfactories can also be the real solution to the possible threat of a new wave of global protectionism.