What we are expecting from this presentation:

A We want to inform you on the most important highlights from this topic

B We need you to take the time to explore the presentation carefully and with a critical mind

C We would like you to write down every comment or idea that emerges while reading this presentation

D We exhort you to share with us a constructive feedback for further improvements

E We invite you to dialog with us if you have any doubt or want to dive into some specific aspects

Flexible Manufacturing

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Content

- What is a Value Chain?
- Flexible Manufacturing
  - Definition and Benefits
  - Factors and technologies
  - Applications
  - Players and Market
- Flexible Manufacturing in the Automotive Industry
- Flexible Manufacturing Challenges
- Takeaways & Main Conclusions

Value Chain refers to the activities performed by a company to add value to a product or service

Primary Activities

Inbound Logistics	Operations	Outbound Logistics	Marketing & Sales	Service
Activities related to receiving, storing, and distributing inputs internally	Transformation activities that change inputs into outputs	Activities that deliver a product or service to the customer Collection, storage, and distribution systems	Activities used to get potential customers to purchase (channel selection, advertising and pricing)	Activities related to maintaining the value of the product; delivery, installation, repairs, service





Value

Procurement

Technology

Human resources

Firm Infrastructure

Support Activities

One of the goals of a Value Chain analysis is to identify areas and activities that will benefit from the use of new technologies in order to improve profitability and efficiency

Why is important to stay ahead in Value Chain trends?

- ✓ **More informed decision making**
- ✓ **Increased productivity**
- ✓ **Access to new technology & innovation**
- ✓ **Efficient times for manufacturers**
- ✓ **Better feedback from consumers and suppliers**
- ✓ **Be prepared for new markets**

How to improve the Value Chain?

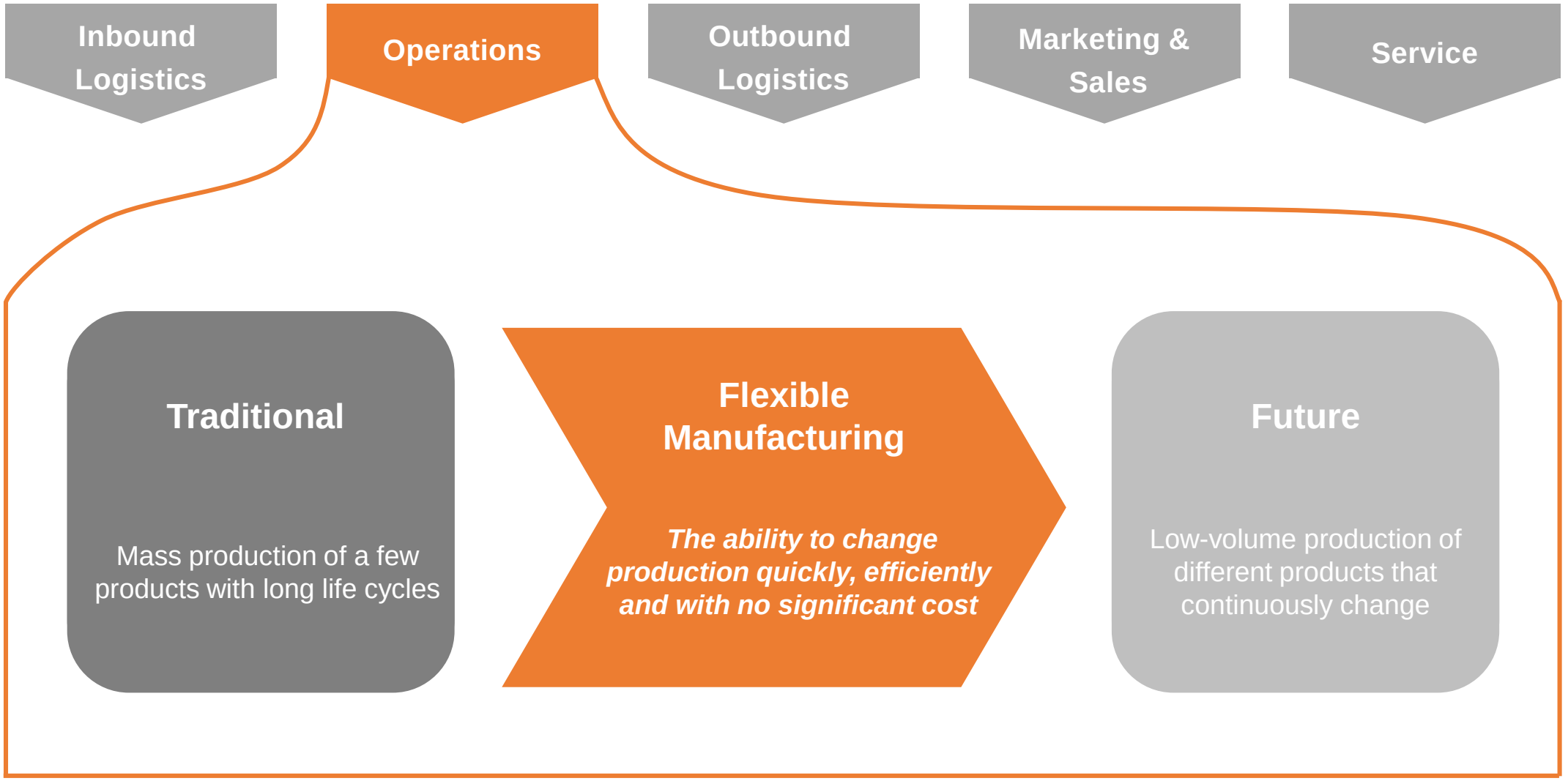
- Have good data and access to solid analytics tools

- Move processes and information to the cloud

- Stay current on technology trends that can improve efficiency

- Logistics electronic tracking

Flexible Manufacturing improves the value chain by closing the gap between the traditional and future needs of its Operations activity



Flexible Manufacturing will have fundamental impacts on traditional operations; benefiting many players

	Flexible Manufacturing	Main Beneficiary
Market Adaptability	Improvements and modifications to products can be easily and quickly made	Consumers
Lead Time	Using flexible manufacturing, a new product can be made on an existing line, cutting lead times	Consumers
Engineering Changes	Since production is built in a flexible way, changes can occur without much trouble	Employees / Engineers
Inventory	Production can be adjusted to the needed volume, no need to have extra inventory	Company

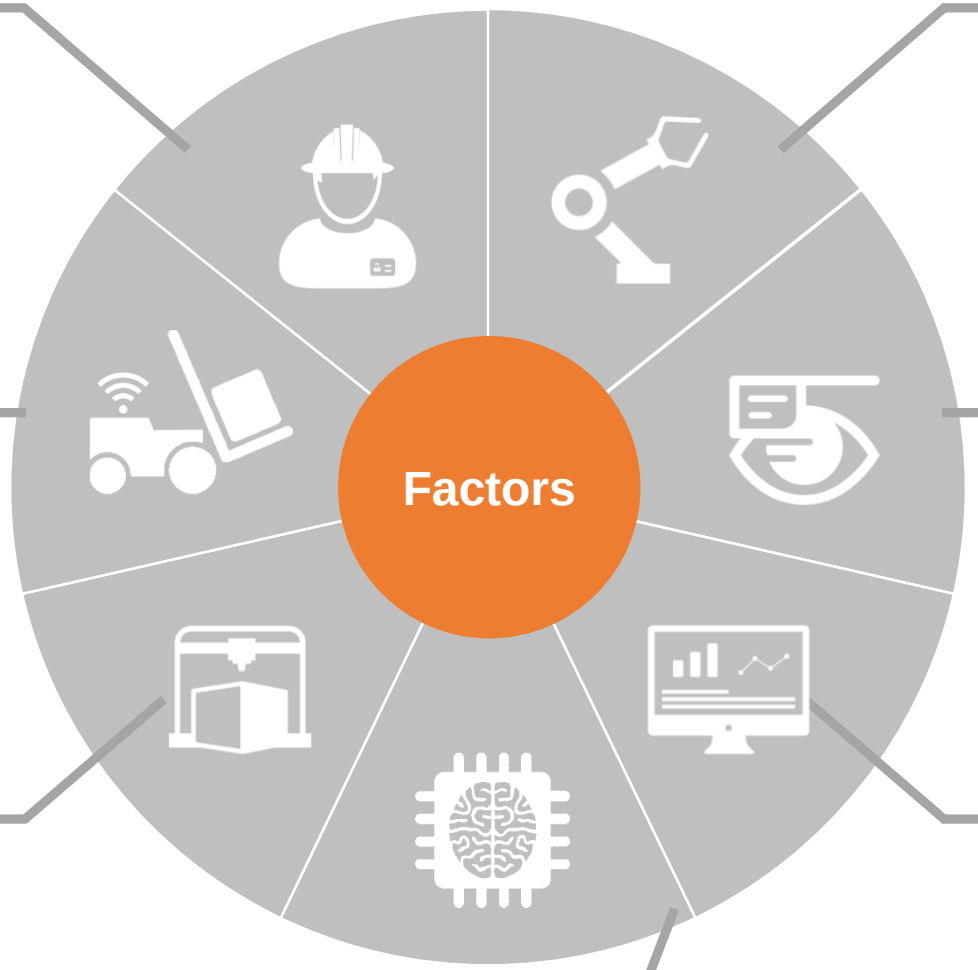
Several factors work together to give flexibility to a manufacturing plant

Skilled Labor

- Know how to operate complex machinery
- Able to adapt to different situations

Collaborative Robots

- Easy to program
- Can work alongside humans
- Adapt to different situations



Autonomous Movers

- Move objects around without humans
- Removes conveyors and lets products move through different paths

Augmented Reality (AR)

- Operators have a virtual view of the production processes
- Get step by step instructions
- Prevent human errors

3D Printing

- Quick production of tooling & special parts
- Rapidly prototype of a new piece
- Produce many different objects with one machine

Simulation

- Detection of problems before they arise
- Trial and error without stopping production

Artificial Intelligence (AI)

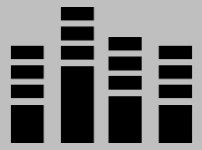
- Take decisions augmenting the human
- Reduces errors and optimizes production

Source: McKinsey & Company. Automation, robotics, and factory of the future

There are six main applications of flexibility in manufacturing

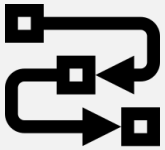
Volume Flexibility

- Ability to produce significantly different volumes of output at a similar cost



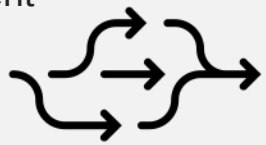
Process Flexibility

- Capacity to manufacture a given set of product types in a variety of ways
- If an assembly line is faulty, a another one can take over production



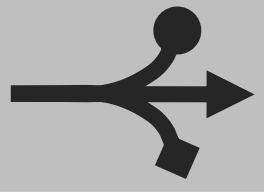
Routing Flexibility

- Capacity to produce parts on alternate workstations
- Production can keep going in case of breakdown, by bypassing the faulty equipment



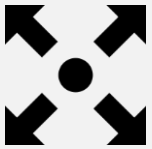
Product Flexibility

- Ability to produce different products in the same manufacturing line without impacting operational efficiency



Expansion Flexibility

- The ease with which the system can be expanded
- Factories can easily grow and scale without a big need to redesign



Machine Flexibility

- The ability for a machine to work on different parts
- A small number of different machines can work with most product. There is no need for single function machines

Source: Flexible Manufacturing System. Modeling and Analysis of Manufacturing Systems

We see Volume and Product Flexibility as the starting point into Flexible Manufacturing

Volume Flexibility

With this type of flexibility you can increase or decrease production without impacting production cost

Why use it

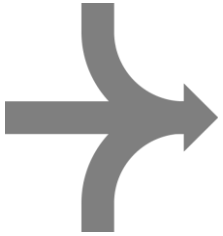
- Adapt to customer demand
- Last minute orders
- Unknown demand

How to achieve it

- Robotic line
- Flexible worker schedules
- Multi-skilled labor
- Flexible supply chain

Product Flexibility

In one assembly line different products can be produced, either concurrently or individually with small change-over times



Why use it

- Production of different products
- Customization of products
- Low change-over time
- Lower cost

How to achieve it

- Automation
- Adaptable equipment
- Multi-skilled labor
- Plant designed for flexibility

The future of manufacturing is flexible and the biggest companies know it

Automotive

- First industry to implement flexible manufacturing
- Some are centered on producing different products on the same line, while others offer customization to clients

Consumer Electronics

- Use flexible manufacturing to cut lead times and make product cycles shorter
- This practice gives the ability to quickly adapt to the changing market

SONY SAMSUNG DELL TOSHIBA

Other Companies

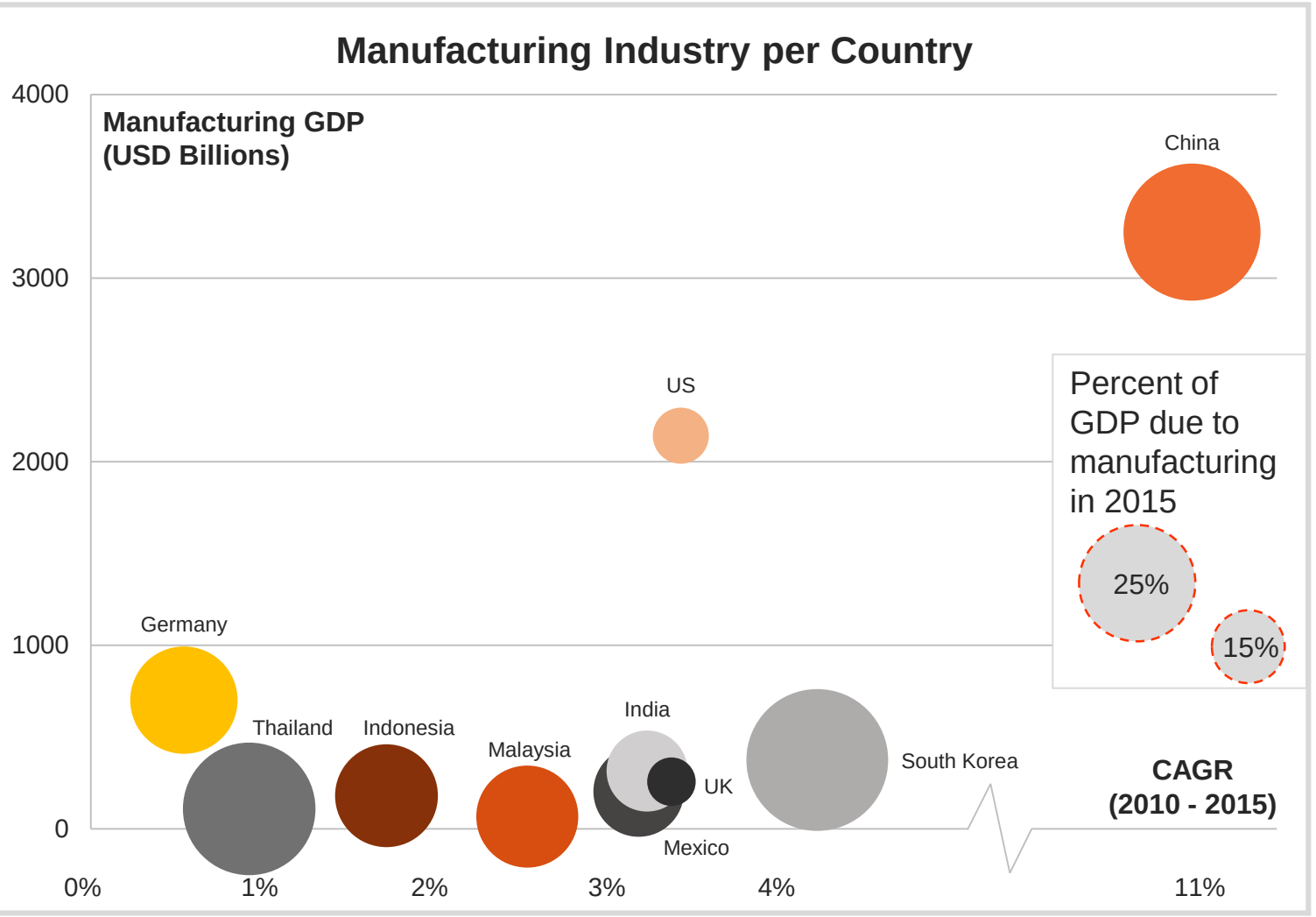
- Many other businesses use this practice to cut lead times, produce several products seamlessly in the same line, customizations of parts, small volume runs, etc

PEPSICO BOEING Roche

Manufacturing is an essential component of GDP and flexible manufacturing is becoming the evolution of this sector

Manufacturing trends

- The global manufacturing GDP is **$12.1T USD** with a **3.1%** CAGR (2010-2015) and accounts for **17%** of the global GDP
- About **35%** of the top manufacturers have already implemented flexible manufacturing and that number is expected to grow
- We see a market opportunity in flexible manufacturing of **$5.7T USD** in 2025
- The US, UK and South Korea are using flexibility to grow and bring manufacturing back to developed countries
- The more a country is able to adapt, the more opportunities it will have



Note: It was considered that the flexible manufacturing sector was 35% of the manufacturing market

Source: World Bank (2015). Manufacturing

Several established companies and startups are helping manufacturing plants become flexible, either by providing engineering services or enabling automation

	Engineering companies	Automation Enablers
Established Companies	Industrial, multi-material **3D printers** **Simulation** software for industry	**Advanced robot** manufacturer **Autonomous movers** solutions
Startups	**AR** hardware and software for industrial use **AI** for manufacturing	**AI** based software for robots **Autonomous movers** producer

Some manufacturing startups are using technology to become flexible, while others are creating that technology

DIVERGENT3D

Founded: 2014
Headquarters: Los Angeles
Total Funding: USD $88M

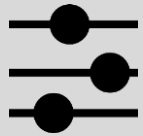
- Developed a platform for 3D printing of several structural car parts
- Designed and manufactured a supercar in order to prove that their platform works
- Their purpose is to enable small manufacturers to produce a small batch of vehicles
- They print several metal parts and connect them using carbon fiber tubes

rethink robotics

Founded: 2008
Headquarters: Boston
Total Funding: USD $150M

- Manufacture collaborative robots, the software and the tools n<ecessary for them to work
- These robots use a computer vision system embedded in them to adapt to different situations
- Their robot training software is easy to use and allows for flexibility and quick deployment
- Rethink Robotics has a system of plug-and-play end effector, giving it more flexibility

Trends in the auto industry will make flexible manufacturing more important for both OEMs and Tier 1 suppliers

Customization	OEMs will need to be able to customize their vehicles to each drivers demand	
Product Flex	Need to change production from one vehicle to another depending on the market	
Plant Design	Build plants from the ground up and cars around the manufacturing, not a plant around only one model	
Lead Times	Auto manufacturers will cut their lead time in order to more quickly meet customers demands	
Inventory	Instead of buying parts from suppliers in big bulks, OEMs will use many smaller orders that will need to be filled faster	
Collaboration	OEMs and suppliers will work with close collaboration to make the supply chain more efficient	

OEMs and Tier 1 suppliers are both using a combination of technologies and skilled manual labor to implement flexible manufacturing and enhance their production

- Uses Big Data, AI and machine learning to make their assembly lines flexible and adaptable
- The company is using autonomous forklifts to transport product parts from one cell to the other
- They are also using COBOTs along with their employees to increase flexibility
- For complicated manual labor, workers are guided with a screen and checked by computer vision system
- Audi also uses 3D printing for prototypes

- Magna has a special unit that uses flexible manufacturing to make front-end modules (FEM) and fascias
- The FEM consists of up to 50 components and can have up to 15,000 variants depending on customization
- Before assembling a part, workers scan each component to make sure that it goes in that particular variant
- Instead of conveyors, they use an automated guided cart system since they can easily be reconfigured
- The plant is able to reduce production without a significant cost impact

Flexible manufacturing brings many benefits, but there are some challenges in implementing the system

High Initial Investment

Changing a whole production line to be flexible means removing many of the current machines and replacing them with newer and flexible ones. This represents a high investment

Substantial Planning

A flexible manufacturing system needs to be correctly planned in order for it to work properly. The factory needs to be accurately designed so that flexibility can be achieved

High-Skilled Workers

The flexible machines and robots are more complex than traditional ones. So while fewer workers are needed, those that remain will need to be highly trained to use the new equipment

Flexible manufacturing brings many opportunities in new ways of production

Takeaways

- Flexibility will be a key ability in order to compete in the future in many industries
- Flexible manufacturing is great for companies with different kinds of products or uncertain demand
- The automotive market will see a shift towards a more variable and customized demand
- Flexible manufacturing makes production more efficient
- Flexible manufacturing gives a company resilience against problems and opens up new opportunities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