Industrial Revamp: Future of Manufacturing

Brian Wei

Executive Summary

The manufacturing industry is at a pivotal juncture due to several macroeconomic and technological tailwinds

- Although manufacturing output in the US rebounded, there has been a decline in new orders, production, and employment.
- The manufacturing workforce is aging with **~50% of manufacturing jobs** currently held by those within the ages of **45 to 65+**.
- The US manufacturing industry **lost ~1.4M jobs** during the onset of the pandemic. Today, **~45% of jobs** for durable goods manufacturing **remains unfilled**. Government policies are tailored to boost job opportunities within infrastructure, manufacturing, and clean energy.
- Breakthroughs in and widespread attention to AI/ML cultivate new companies that serve to disrupt the existing paradigm of manufacturing.

There exist ample investment opportunities within the manufacturing space

- The advanced manufacturing sector is at an **inflection point** where it is adopting novel technologies to **speed up product development** and **streamline processes**, such as adopting IoT platforms, robotics, AI/ML, big data applications, wearable devices and exoskeletons, AR/VR applications, and extensible, modernized software relating to the manufacturing space (e.g., ERP and MES).
- Key opportunities lie within the following areas:
    - Software for hardware engineers that speeds up innovation cycles
    - Vertical SaaS that creates a more resilient supply chain
    - Horizontal software to enable streamlined workflows in robotics
    - Enabling workplace safety through computer vision offers operational efficiency gains
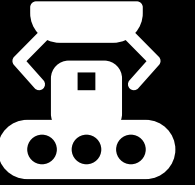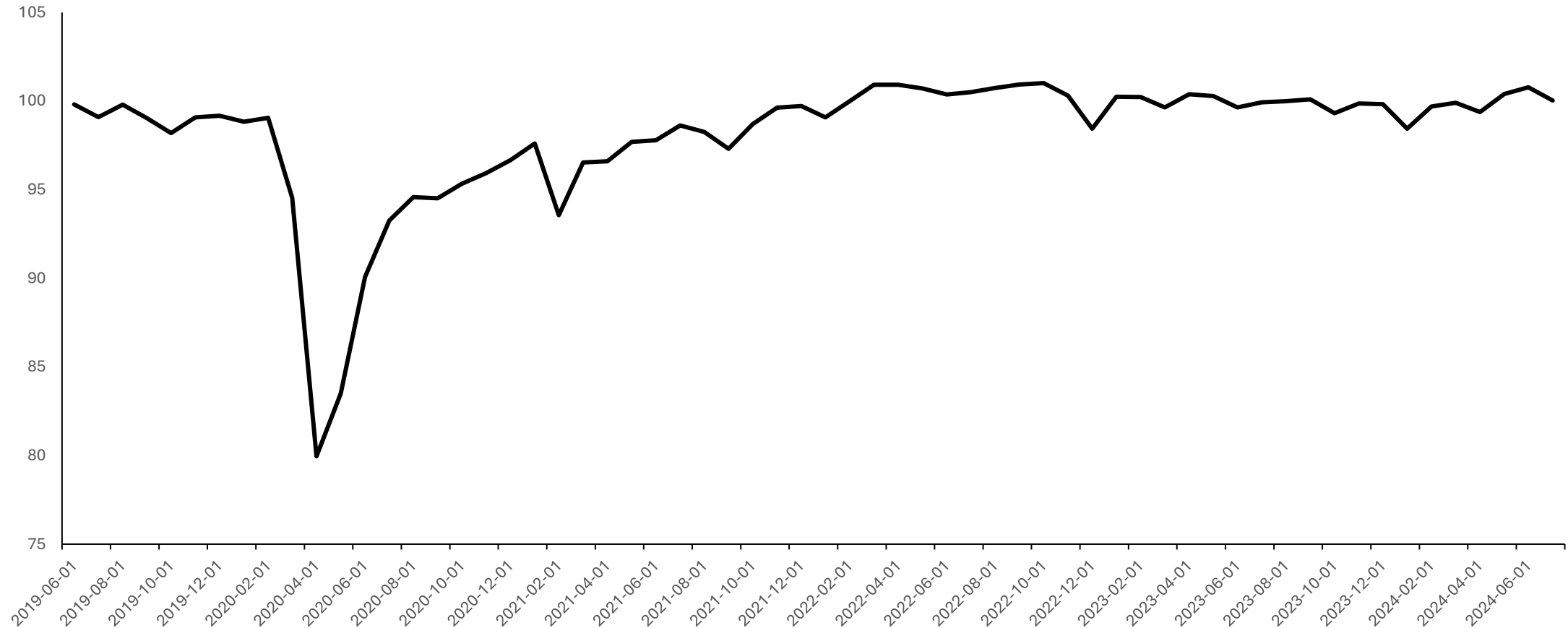
State of the Market
Market Landscape
Key Opportunities

Manufacturing Output Rebounded

The US manufacturing sector rebounded to February 2020 output levels in Q4 2021
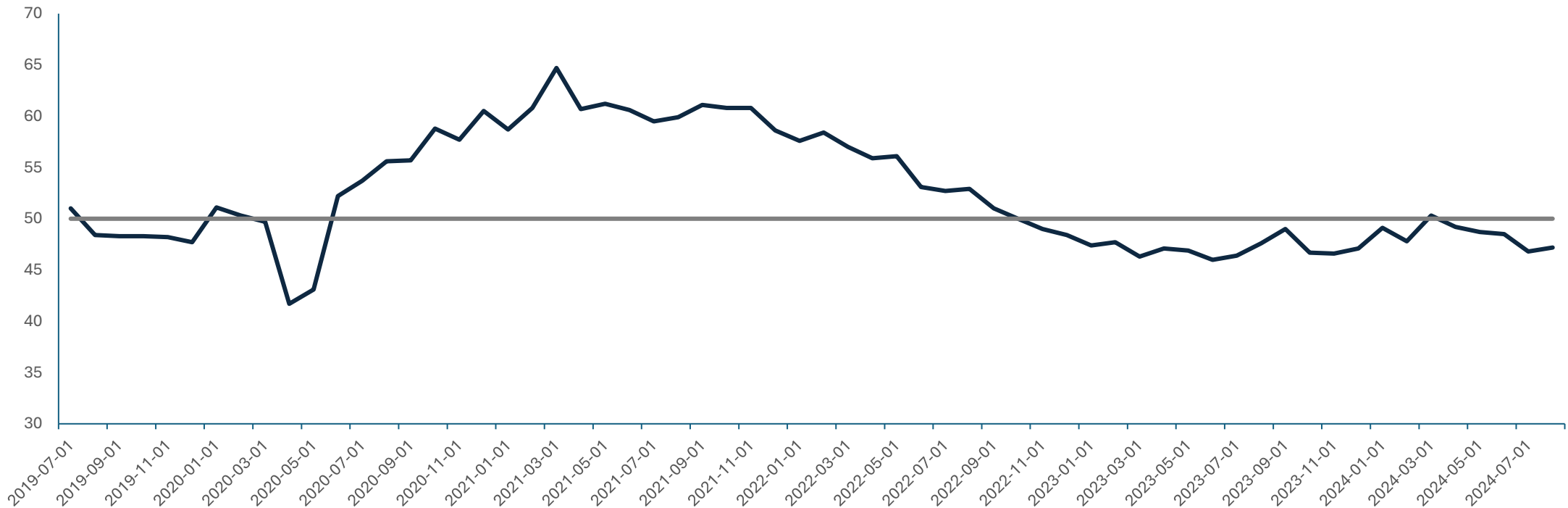

US Manufacturing Output Volumes[1]

Manufacturing Faces Recent Headwinds

Despite rebound, manufacturing largely stalled since 2022

Manufacturing PMI[1]

The August 2024 Manufacturing ISM Report On Business indicates that the U.S. manufacturing sector contracted for the fifth consecutive month, with a PMI of 47.2%. Key points include a decline in new orders, production, and employment. Inventories grew slightly, but prices continued to rise. Demand remained weak, and uncertainty around federal policies and the upcoming election impacted investments. Overall, economic activity in manufacturing showed slower contraction compared to previous months.
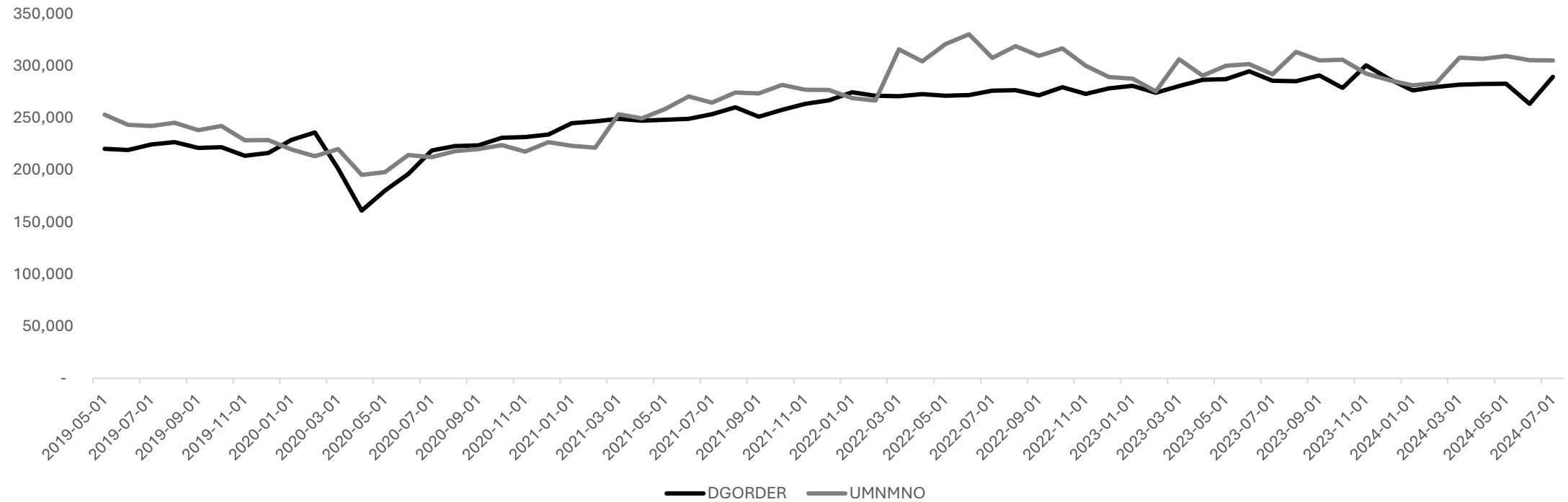
Manufacturing Orders are Flat at Best

Durable goods orders and nondurable goods increased slightly on a yearly basis

US Manufacturing Orders[1]

New orders for durable goods increased by 1% YoY and new orders for nondurable goods increased by 5% YoY. Despite the slight growth ISM's New Orders Index contracted for the fifth consecutive month as panelists noted a continued level of uncertainty about a lack of new order activity.

VC Funding for Advanced Manufacturing Demonstrates Steady Growth

Advanced Manufacturing VC Funding[1]

Legend: Capital Raised ($B) ■ — Deal Count ▬
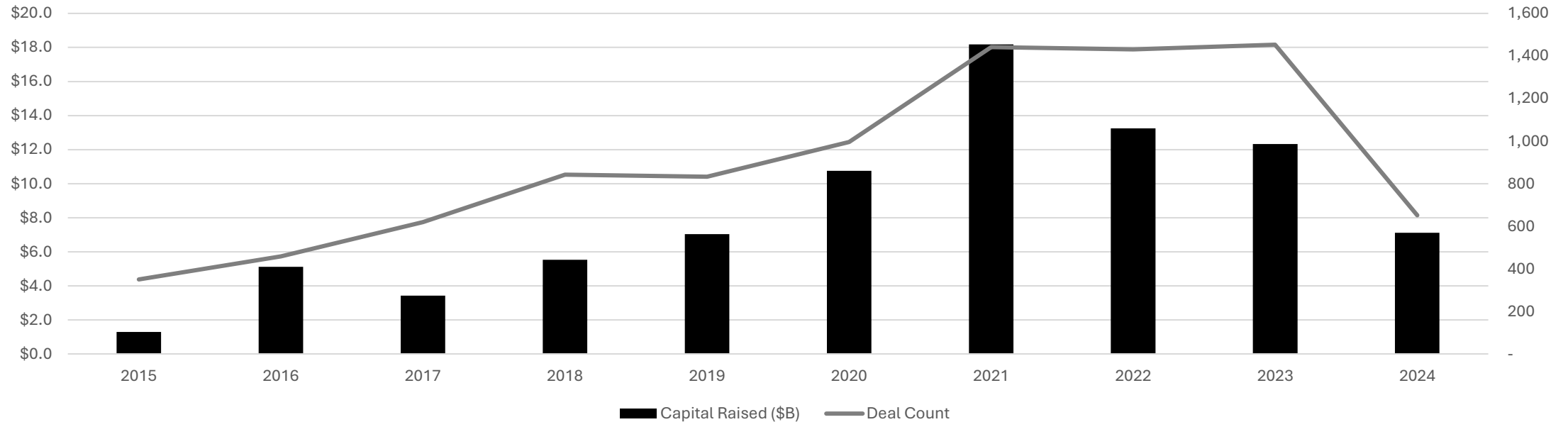
The advanced manufacturing sector is at a crucial crossroads where it is adopting novel technologies to speed up product development and streamline processes. This encompasses technologies such as IoT platforms, automation and robotics, AI/ML, big data applications, wearable devices and exoskeletons, AR/VR applications, and software relating to the manufacturing space (e.g., ERP and MES).

7

Advanced Manufacturing is Driven by Key Macroeconomic and Technological Shifts

| Driver	Description
Workforce challenges	Labor market tightness is expected to continue into 2024 and a survey conducted by the National Association of Manufacturers (NAM) reveals that almost three-quarters of surveyed manufacturing executives feel that attracting and retaining a quality workforce is their primary challenge. In addition, the manufacturing workforce is aging with ~50% of manufacturing jobs currently held by those within the ages of 45 to 65+.[3]
Geopolitical and environmental challenges	The COVID-19 pandemic caused a major disruption in the American labor force, with the manufacturing industry losing ~1.4M jobs during the onset of the pandemic.[1] Today, ~45% of jobs for durable goods manufacturing remains unfilled. Adding natural disasters and geopolitical tensions, companies seek to reduce dependence on distant suppliers and minimize risks associated with the supply chain. In addition, rising wages in traditional offshore manufacturing hubs (e.g., China) reduces the cost advantage of offshoring. Furthermore, the Biden-Harris administration's Investing in America agenda encouraged $860B in business investments to electric vehicles, clean energy, and semiconductors.[2]
Breakthroughs in applied AI	Significant improvements in ML models enable companies with unique datasets to support manufacturing across a good portion of the value chain, such as speeding design cycles, enabling robots to perform at a better cost profile, and optimizing supply chain procurement. Given manufacturing generates a massive amount of unstructured data (through video, telemetry, thermal, and other sensors) and reconciles external sources to create a product, large language models (LLMs) can streamline knowledge management without introducing more applications or web browser tabs.

Labor Shortage is Pronounced

An aging workforce and a striking skills gap contribute to a profound labor shortage in manufacturing

US Manufacturing Employment by Age[1]

- 16-19
- 20-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+
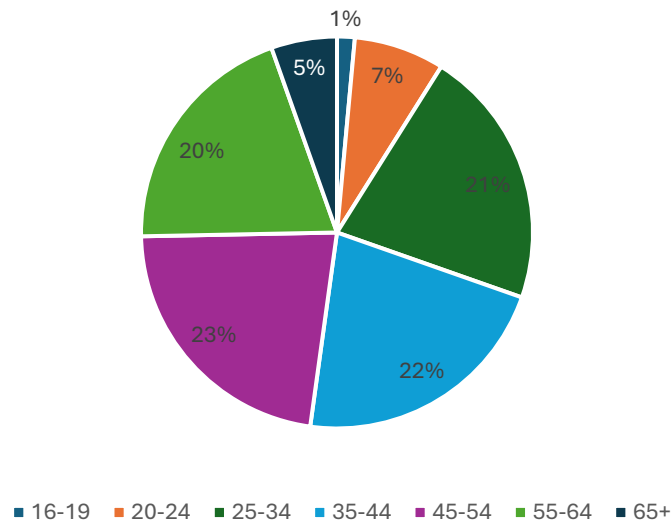
Approximately 50% of Jobs Could Remain Unfilled[2]

3.8M manufacturing jobs created from 2024 to 2033

1.9M manufacturing jobs could remain unfilled due to skills gap
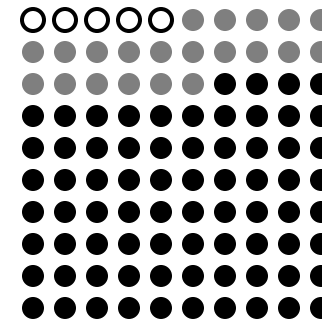
○ **0.23M** jobs from IIJA, IRA, and CHIPS and Science Act

● **0.76M** open jobs from industry growth

● **2.8M** jobs from retirement
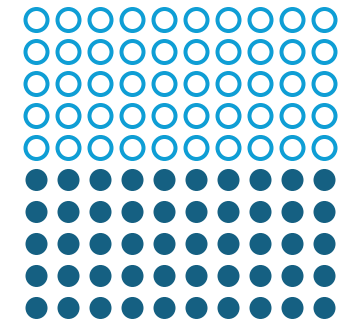
○ **Over 50%** open positions remain vacant due to skills shortage

● **1.9M** jobs expected to be filled

Over 65% of manufacturers identify the challenge of attracting and retaining talent as their top concern. As the industry grows, there is a need for more workers for every type, including entry-level associates, skilled production workers, and engineers. The skill requirements, however, are evolving and are spread across technical manufacturing skills and digital skills.

Government Policies Benefit Manufacturing

Legislations boost demand of manufacturing and labor
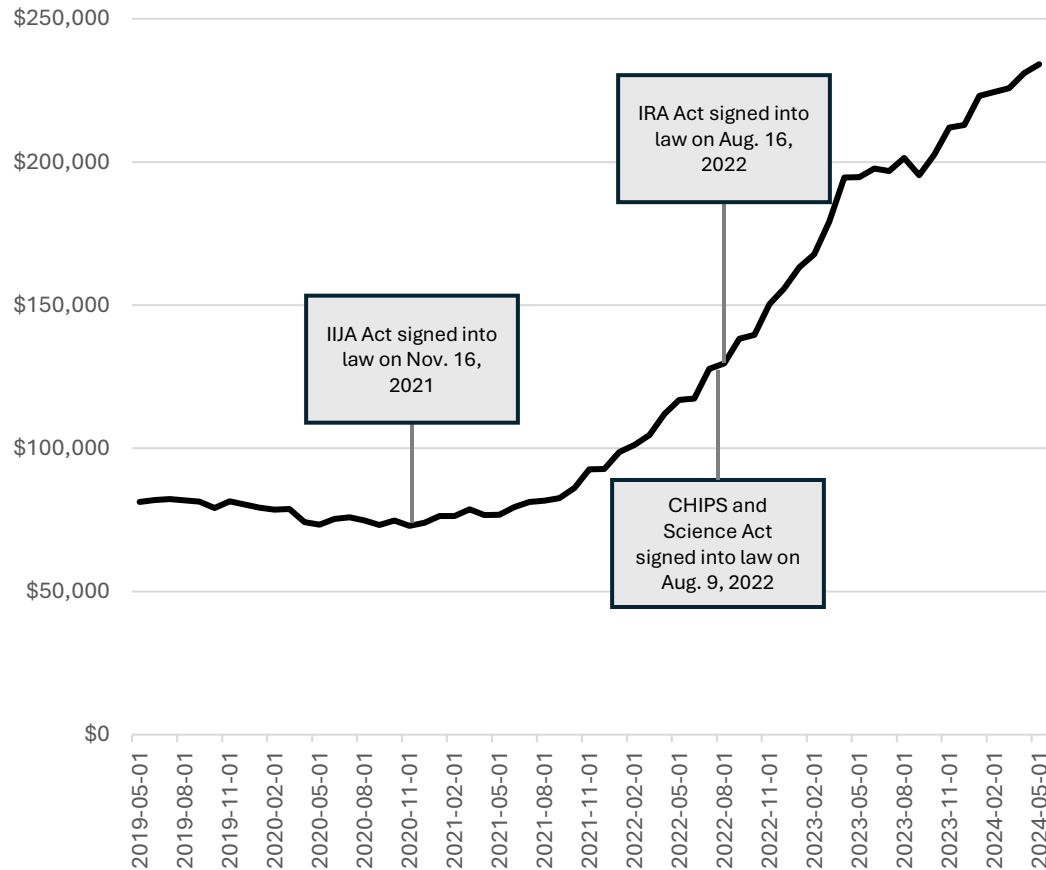
Manufacturing Construction Spending[1]

IRA Act signed into law on Aug. 16, 2022

IIJA Act signed into law on Nov. 16, 2021

CHIPS and Science Act signed into law on Aug. 9, 2022

Government Policies

Legislation	Impact
Infrastructure Investment and Jobs Act (IIJA)	Aims at expanding the construction of public roads, EV infrastructure, broadband, water, etc. The IIJA is expected to spur more construction activities through 2026 and should **boost manufacturing of required materials**.
CHIPS and Science Act	The CHIPS and Science act spurred economic development domestically. Semiconductor investments have grown exponentially and drew foreign investment (e.g., TSMC announced a $40B investment in an Arizona plant). Securing the semiconductor supply chain offers **resilience** or the availability of critical components for various end markets.
Inflation Reduction Act (IRA)	The IRA provides various tax credits and incentives for manufacturers involved in the production of renewable energy technologies, such as solar panels, batteries, and electric vehicles. In addition, investments in clean energy and manufacturing are expected to **create numerous jobs in the green economy**.

AI Streamlines and Enhances Manufacturing

Innovations in AI/ML enables improvements for digital and physical workflows in manufacturing

| Digital Use Cases		Physical Use Cases	
Making sense of disparate sets of data to enable resilient supply chain	By integrating data siloes, manufacturers can have a more informed view on their components, bill of materials, and demand expectations. auba Altana	**Enabling optimized programming for automated systems**	Automated systems like robots can now be configured with the correct specifications through prompts. ALTITUDE AI SKILD AI
Automating design processes	AI enables a magnitude improvement in the speed of hardware design, including schematics and layouts of PCBs. Quilter Flux	**Orchestration of robots**	AI can enable the orchestration of a heterogeneous mix of the data and devices moving within the manufacturing plant. Formant
Enabling knowledge management	Sharing knowledge will become easier as platforms that connects a company's people, processes, and parts will save employees 20% of their time finding, sharing, and synthesizing technical data. Apiphany	**Process optimization**	AI can optimize manufacturing processes by analyzing data from production lines and identifying areas for improvement. This can include adjusting machine settings, optimizing workflow, and reducing energy consumption, leading to more efficient operations. Guidewheel AMPER
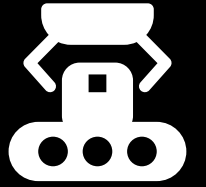
State of the Market
Market Landscape
Key Opportunities

Broad Manufacturing Workflows

Research & Development

- **Design**: Development of new products or improvement of existing ones, including conceptual design, prototyping, and testing.
- **Product development**: Includes detailed engineering, material selection, and creation of the manufacturing processes
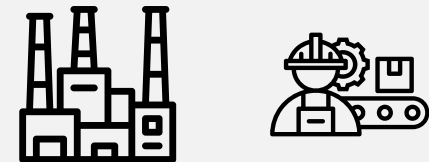
Supply Chain & Logistics

- **Sourcing**: Identify and contract suppliers for raw materials, components, and services
- **Inbound Logistics**: Reception of raw materials and components, management of inventory, and moving materials to and from storage and production areas
- **Outbound Logistics**: Packaging finished products for shipment and distribution

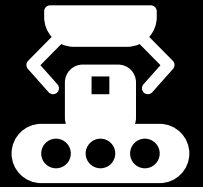## Manufacturing Execution

- **Production Planning**: Scheduling production runs and managing the flow of materials through the production process
- **Manufacturing Operations**: Transforming raw materials and components into finished products through various processes including machining and assembly
- **Quality Assurance**: Ensuring products meet specified standards and customer requirements

Future of Manufacturing Market Map
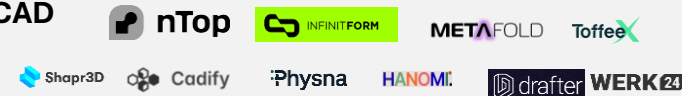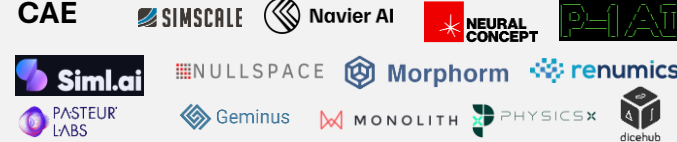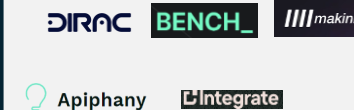
Logistics

Supply Chain Management
cofactr · amplio · Diagon · FACTOR · Catena CLEARING · Aitana
Makersite · cogbase · prewave · Procurable · LightSource · auba · conduit

R&D

EDA
Quilter · Flux · jitX · AutoPCB
CELUS · SnapMagic

CAM
CloudNC · Dyndrite · Pictorus · ModuleWorks · Manukai

CAD
nTop · INFINITFORM · METAFOLD · ToffeeX
Shapr3D · Cadify · Physna · HANOMI · drafter · WERK24

CAE
SIMSCALE · Navier AI · NEURAL CONCEPT · P—1AI
Siml.ai · NULLSPACE · Morphorm · renumics
PASTEUR LABS · Geminus · MONOLITH · PHYSICSX · dicehub

Execution

MES
PICO MES · FIRST RESONANCE
TULIP

ERP / MRP
fulcrum · katana
MRPeasy

PLM / System Engagement
AllSpice.io · Synera
COLAB · duro · bild
Rollup · FiveFlute

Knowledge Management / Integrations
DIRAC · BENCH_ · makini
Apiphany · Integrate

Production Monitoring
Guidewheel · AUGURY · leela.ai
machinemetrics · AMPER · xemelgo
datanomix · SCW.AI · RAVEN

QMS / Inspection & Testing / Compliance
lumafield · COPIA · fusaware
AXION RAY · LITMUS · Advex
DiploAI · INSTRUMENTAL · SOFTWARE DEFINED AUTOMATION
LINCODE

Safety
VOXEL · Intenseye
EVERGUARD.ai · VERVE MOTION

Cybersecurity
CLAROTY · NOZOMI NETWORKS
DRAGOS
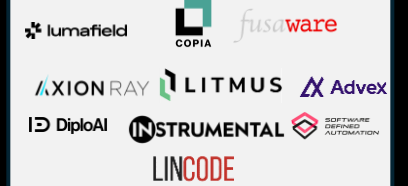
Industrial Control Systems
phaidra · Fortress
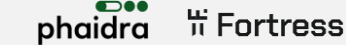
Financial Operations
Hardfin

Simulation Compute
SIMR · rescale
TRACE MACHINA

Robotics Enablement
Formant · SKILD AI · π · JACOBI ROBOTICS
RGo Robotics · TANGRAM · Xaba · ALTITUDE AI
slamcore · T · ReSim

Note(s):.This market map is a selection of companies that I have tracked over time and is by no means a comprehensive list
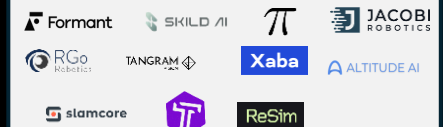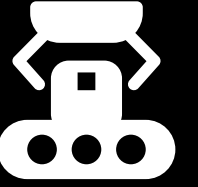
State of the Market
Market Landscape
Key Opportunities

Manufacturing Theses

Thesis	Description
Software for hardware engineers to accelerate time to market	Pushing out novel hardware requires a retooling of software solutions used by engineers today. Engineers today use disconnected software solutions for CAD, CAE, and PLM workflows, leading to lack of collaboration among stakeholders and an absence of cloud support. This creates an opportunity for modern solutions to provide streamlined workflows that integrate native hardware design software and extensibility through APIs or SDKs. These solutions will enable quicker time to market, version control, and asynchronous review cycles.
Vertically defined SaaS to create a more flexible supply chain	Despite the proliferation of SaaS companies, there is ample opportunity to build integrated software workflows that are defined well for different markets of the supply chain, such as the warehouse, dock, or yard. Opportunity is also created by focusing on the supply chain of various products, such as metals and electronic components. Much of these portions still rely on outdated tools, such as emails, spreadsheets, and walkie talkies. An end-to-end offering provides a stickier solution as customers receive comprehensive functionality.
Horizontal software to enable automated workstreams in robotics	The robotics industry has evolved from companies building vertically integrated solutions to outsourcing various portions of its technology stack (e.g., data infrastructure and autonomy function). As robot vendors increase deployment from tens of devices to hundreds of devices, they require horizontal layers to enable a scalable method of deploying robots rather than feeding headcount into the mix.
Enabling safety leads to productivity gains	Workplace safety is typically handled manually, with shift supervisors patrolling floors with a clipboard, leading to inaccurate feedback within a manufacturer's environment. As such, computer vision platforms can minimize or eliminate unsafe working conditions by proactively shifting behaviors while improving a manufacturer's operations. Companies that can integrate with existing camera systems within a facility offers a scalable, low-friction solution to adopt.