SCHM6201: Operations and Supply Chain Management

Final Project

Inside Intel: Assessing Intel's Innovation Landscape and Proposing a Roadmap to regain Prominence

Lakshmi Sanjana Bhupathiraju
Teja Padarthi
Anam Siddiqui
Kathryn Uggerholt
Akash Valathappan

December 4th, 2023

Project Overview and Objective

Intel has a reputation and is seen as a market leader in the semiconductor and tech industries but has more recently been falling behind in terms of innovation. This paper will look at Intel's current strategy, processes, and capacity in place to deliver their final products to their customers. From the outside, we initially thought Intel was still dominant in its industry and through our research found they are struggling. Our objective is to see where Intel is struggling and why through macroeconomic forces as well as other forces internal to the firm itself. Through our analysis, we will be able to provide recommendations and an action plan for Intel to up their game with innovation to again be the market leader they once were.

Company/ Topic Overview

Founded in California the summer of 1968, Intel Corporation has made a name for itself in the semiconductor industry since. Their founders Gordon Moore, Robert Noyce and Arthur Rock were semiconductor pioneers with Noyce one of the inventors of the integrated circuit microchip. Moore is known for "Moore's Law" that observes that the number of transistors in an integrated circuit (IC) doubles roughly every two years which has been used for in the industry for long-term planning for decades. The company manufactures semiconductor chips and has developed other innovative technology such as microprocessors and created the x86 series of instruction sets found in most personal computers (PCs). Intel created the world's first commercial microprocessor in 1971 and as personal computers took off in the 1990s and early 2000s, Intel partnered with Microsoft Windows for "Wintel." In the partnership, the two teamed up in manufacturing PCs integrating Intel's x86 processors running Windows.

From 1992 to 2018, Intel was the biggest chip maker in terms of revenue and since that position has moved around between other competitors. The industry is very competitive with several competitors who are mostly pure-play foundries that offer fabrication plants based in Asia. As of 2022, more than 80% of the world's semiconductor manufacturing capacity is in Asia with limited capacity in the US. Presently,

Intel has nine manufacturing sites in production globally and uses third-party foundries for manufacturing. Intel considers their main competitors to be foundry vendors Taiwan Semiconductor Manufacturing Company (TSMC) and Samsung. TSMC is dominant with a market share of 55.5% in 2022, up 2.4% from 2021 and Intel is not even on the map as their revenue from its foundry system is presently only 1%. Part of TSMC's dominance is their partnership with Apple, manufacturing all their customer chips at a discount. Since 2018, Intel has also had three CEOs due Brian Krzanich being forced out due to breaking the company's anti-fraternization policy and his replacement's three-year stint during COVID was very rocky. Patrick Gelsinger has been in the position since 2021 and attempting to turn the company around as their revenue has been down at least 20% since FY21 when he stepped in. Other macroeconomic factors such as the war in Ukraine, shutdowns in the supply chain in China due to COVID and general slowing demand have been a factor in Intel's fall from grace.

Strategy Assessment

Intel's Strategic Themes

Intel's overarching strategic direction revolves around four pivotal themes: Product Leadership, Open Platforms, Manufacturing at Scale, and People:

- **Product Leadership:** Intel's unwavering dedication to innovation is evident in its substantial investment in research and development (R&D). This relentless pursuit has enabled Intel to consistently introduce groundbreaking products, reshaping the computing landscape.
- **Open Platforms:** Embracing open platforms and standards, Intel extends its products and technologies to collaborate with other entities. This approach not only broadens Intel's audience but also fosters innovation and sets industry benchmarks.
- **Manufacturing at Scale:** As a semiconductor manufacturing frontrunner, Intel's extensive global network of production facilities empowers it to deliver high-volume products at a competitive cost, providing a substantial edge in the market.

- **People:** Central to Intel's success is its commitment to attracting and retaining top-tier talent. Offering competitive compensation, benefits, and robust training opportunities has cultivated a highly skilled workforce, pivotal in maintaining Intel's industry leadership.

Supply Chain Strategy:

Apart from the core strategic themes, Intel's supply chain strategy focuses on globalization, advanced planning and optimization, automation and technology, and quality control and risk management.

- **Globalization:** Intel's global supplier network secures premium components at competitive rates, fostering timely deliveries and maintaining high standards while reducing expenses.
- **Advanced Planning and Optimization:** Leveraging cutting-edge software systems, Intel aligns production schedules with customer demands, ensuring optimal inventory levels and identifying potential enhancements in the supply chain.
- **Automation and Technology:** Streamlining shipping and inventory processes through automation and technology. Intel enhances delivery efficiency using RFID and barcode systems.
- **Quality Control and Risk Management:** Intel's stringent quality control processes and risk management strategies ensure products meet and exceed industry standards, safeguarding against disruptions in the supply chain.

Integration with Strategic Themes:

Intel's strategy reflects an unwavering commitment to innovation, collaboration, and operational excellence. These strategic pillars are instrumental in Intel's dominance in the fiercely competitive semiconductor industry. The synchronization between Intel's supply chain strategy and its core themes ensures efficient sourcing, production management, and timely product delivery, further solidifying its position as an industry leader. The global supplier network aligns with its quest for product leadership. Advanced planning and optimization systems meet customer demands, reinforcing Intel's commitment to people and enabling manufacturing at scale. Automation and technology streamline operations, supporting its overarching strategy.

IDM 2.0 Strategy:

Increase in Vertical integration by Original Equipment manufacturers and Cloud Service providers along with increase in costs of Research and Development and increasing demand in customizing chips tailored to specific tasks all propelled a fundamental shift in Chip Industry. To tackle this, Intel started a strategy called Open system Foundry, which is a late move by Intel compared to its competitors.

IDM stands for Integrated Device Manufacturing 2.0, represents Intel's innovative approach to manufacturing. This strategy centers on leveraging a synergy between Intel's in-house manufacturing facilities and external foundries. A key element of this strategy involves incorporating software and additional components to deliver comprehensive products. IDM 2.0 is characterized by three primary capabilities:

1. Most of Intel's products will continue to be produced within Intel's own fabs.
2. Intel anticipates an expansion of our utilization of third-party foundry capacity to manufacture a variety of modular tiles using advanced process technologies.
3. Intel is actively establishing a world-class foundry business through Intel Foundry system, which is expected to integrate cutting-edge packaging and process technology, along with dedicated capacity in the United States and Europe.

Process Design

As of 2022, Intel has nine manufacturing sites in production. There are five wafer fabrication facilities operating in Oregon and Arizona in the US as well as Ireland and Israel with plans to build more in Ohio and Germany. The four assembly and test facilities are located around the globe in Costa Rica, Chengdu, Malaysia, and Vietnam.

In a bid to regain its dominance in processor manufacturing by 2025, Intel has initiated the procurement of cutting-edge chipmaking equipment from Dutch specialist ASML. The newly ordered device, named the Twinscan EXE:5200, is slated for delivery in 2024, with operational deployment

scheduled for 2025. These machines, with an average cost estimated at a staggering $340 million each, play a pivotal role in advancing processor technology. The challenge of miniaturizing chips is becoming increasingly formidable, yet it remains essential for technology giants relying on advancements in smartphones, PCs, and data centers.

The production of computer chips entails one of the most intricate manufacturing processes ever devised by humans. Over the past 50 years, Intel's engineers and scientists have consistently confronted and surmounted the challenges posed by the physics of fitting billions of microscopic transistors onto progressively smaller computer chips. Fulfilling this commitment demands a substantial global team, state-of-the-art factory infrastructure, and a resilient supply chain ecosystem. You can find the production process steps involved in manufacturing semiconductor chips in **Exhibit 1**. This intricate procedure, comprising thousands of steps and spanning over three months, yields microchips that drive the functionality of devices such as smartphones and tablets. Each of these microchips is equipped with billions of transistors.

Sustainable Practices by Intel:

Water Conservation:

Intel is dedicated to maintaining the highest standards in semiconductor manufacturing, employing ultrapure water for its critical processes. Beyond its operational needs, the company is also deeply committed to responsible water management. Demonstrating this commitment, Intel not only utilizes fresh and reclaimed water for its facility systems but also sets ambitious goals for global water impact. With a vision to achieve net positive water globally, Intel aims to conserve a remarkable 60 billion gallons of water in the current decade. Since 2020, the company has made substantial strides conserving approximately 26.2 billion gallons of water and restoring an additional 6.6 billion gallons. These efforts underscore Intel's dedication to sustainable practices and environmental stewardship in its operations on a global scale.

Waste Management and Circular Economy:

Looking ahead to 2030, One of its key objectives is achieving zero total waste to landfill, reflecting a commitment to minimizing its environmental footprint. Intel recognizes the importance of collaboration and has outlined plans to implement circular economy strategies for 60% of its manufacturing waste

streams, working closely with suppliers to ensure a comprehensive approach. To achieve this, the company is concentrating efforts on upcycling waste through enhanced segregation practices, emphasizing the value of recycling and repurposing materials. Furthermore, Intel is at the forefront of exploring cutting-edge technologies for waste recovery, aligning its practices with innovation to meet its waste reduction targets. These initiatives exemplify Intel's proactive stance toward fostering a circular economy and reducing the environmental impact of its manufacturing processes.

Products:

Intel's diverse portfolio of products offers comprehensive solutions that cover the entire spectrum, ranging from edge computing to 5G networks, the cloud, and the evolving domains of artificial intelligence (AI) and autonomous driving. It has six main divisions, and the products are listed in **Exhibits 2 and 3**.

Demand Forecasts and Planning

Intel employs a multifaceted approach to demand forecasting, blending quantitative and qualitative methods. This includes analyzing historical sales data, engaging in market research, incorporating customer feedback, and leveraging advanced technologies such as machine learning and artificial intelligence. The company continually updates forecasting models to align with emerging trends and market dynamics.

AI-powered Demand Forecasting:

AI-powered demand forecasting involves intricate deep learning, and memory-intensive processes to analyze actual time-series data for precise future demand modeling. Intel's AI reference kit plays a pivotal role in enhancing demand forecasting accuracy. Their software products not only expedite the training of complex AI deep learning models but also ensure higher accuracy, thereby reducing inventory and forecasting errors. This efficiency extends to optimizing stock replenishment management.

In collaboration with Accenture, Intel introduced an AI reference kit designed for the company and retailers. This kit employs a sophisticated time-series prediction technique, CNN-LSTM, utilizing a convolutional neural network (CNN) to extract data features and a long short-term memory (LSTM)

network to predict daily demand. This collaborative effort underscores Intel's commitment to advancing AI solutions for robust demand forecasting in retail contexts. A more detailed explanation of how forecasting model of Intel works is displayed in **Exhibit 4**.

Supply Chain Optimization:

Intel employs advanced planning and optimization software systems to manage production schedules, monitor inventory levels, and align with customer requirements. This ensures a streamlined production process and enables timely responses to change in demand. The company employs analytics to identify potential bottlenecks and enhance supply chain efficiency. While Intel's supply chain is globally expansive, efficient, and complex, it faces challenges associated with global supplier management, quality standards, market competition, and potential disruptions.

Moore's Law and Strategic Implications:

Historically, Intel has relied on Moore's Law for demand planning, a principle stating that the number of transistors on a microchip doubles every two years. However, as of 2022, the CEO of Nvidia declared Moore's Law as 'dead,' challenging its ongoing relevance. This development prompts reconsideration of Intel's demand planning strategies considering evolving industry dynamics.

Assessment of Forecasting Accuracy:

Despite Intel's historical prowess in demand forecasting, there has been a perceptible shift in performance following the change in CEO and the impact of the COVID-19 pandemic. Acknowledging these challenges, Intel, in its 10K report, recognizes recent shortcomings in predicting market trends and sales. This admission underscores the critical need for Intel to recalibrate its forecasting, innovation, and market alignment strategies to regain a competitive edge in the semiconductor industry.

Quality Practices

Quality is one of Intel's 7 core values. Intel employs a rigorous quality control process to ensure its products meet the highest standards. The company's quality assurance team regularly inspects products at all supply chain stages to ensure that they meet Intel's stringent standards. In addition, Intel employs risk management strategies to minimize the impact of possible disruptions in the supply chain.

Intel faces diverse quality risks, including product defects, deviations from specifications, and issues related to design, manufacturing, and testing processes. Components from third-party suppliers and acquisitions may introduce defects, while interactions with third-party products can lead to additional challenges. The company is also exposed to risks of personal injury or property damage, independent of product defects. Effectively managing this complex landscape of quality risks remains crucial for Intel.

Intel has encountered notable quality control challenges in recent years, as illustrated in **Exhibit 5**. These issues have underscored vulnerabilities and had impacts on performance.

Intel's Quality Management System

Intel's Quality Management system includes 5 major processes that work together to deliver industry leading products, quality outcomes for our customers, and business success. These processes are product development, technology development, manufacturing, supply chain and customer support. The flowchart of Intel's Quality Management System can be seen in **Exhibit 6**.

Quality Practices of Intel

Intel Corporation, a leader in the semiconductor industry, implements various quality practices across its operations to ensure the integrity and reliability of its products.

- **Centralized Technology and Manufacturing Group:** Intel's approach to supply chain risk management is comprehensive, spanning many business units and coordinated through a centralized Technology and Manufacturing Group (TMG). This group oversees all wafer fabrication factories, assembly and test plants, warehousing, shipping, and commodity management. Key practices include developing long-term relationships with top-tier vendors,

periodic joint audits, and implementing corrective actions as needed. Intel also focuses on sourcing new technologies and materials while ensuring quality, availability, and security.

- **Security Development Lifecycle (SDL):** Intel has developed a set of policies, procedures, tools, indicators, and consulting practices known as the Security Development Lifecycle (SDL). This framework helps ensure that products meet technical specifications, adhere to security objectives, protect privacy, and are free from malicious software or hardware. Intel benchmarks its SDL against industry peers, global standards, and specific regulations, aligning with standards like ISO/IEC 27001, 27002, 27034-1, and 27036-3.
- **Enterprise and Manufacturing Processes:** Intel's manufacturing processes are guided by the "Copy Exact!" methodology, ensuring consistency across development and manufacturing environments. The company uses the ISO 9001:2008 International Standard as a baseline for its quality system, regularly auditing its sites to maintain product uniformity. Key processes in wafer manufacturing mitigate risks of counterfeit ingredient infiltration and unauthorized modifications to IC design. Intel's common mode yield analysis helps detect and correlate changes in yield to specific batches, thereby enhancing quality control.
- **Transparent Supply Chain (TSC):** To mitigate the risk of counterfeit products, Intel introduced the Transparent Supply Chain (TSC) initiative. TSC services include capturing and archiving component identity data, linking component data to sourcing information, and providing Platform Certificates. This transparency helps detect counterfeiting and ensures that components are sourced from authorized channels, significantly reducing the risk of counterfeit infiltration in the supply chain.

Recent Expansion demands more Quality Control Measures

Intel is expanding manufacturing capacity across multiple sites. Intel’s disaggregated design strategy poses increased logistical risks and challenges, particularly where it decides to manufacture different product components on different process technologies, including third-party foundries.

To seamlessly integrate components into a single package, the manufacturing process must occur on a timely basis and in sufficient quantities. However, challenges arise due to differing yields, throughput times, and capacity constraints inherent in the manufacturing processes. This necessitates the safe storage of certain components while awaiting the manufacture of others. Potential delays or quality concerns in one component can significantly impede the overall product manufacturing process. Additionally, the utilization of packaging technologies to unite these components may contribute to increased costs and introduce additional complexity, further accentuating potential quality issues.

Recommendations and Action Plan

CEO Consistency and Continuity:

We are hoping that Intel has confidence in its newly appointed CEO Patrick Gelsinger since he has stepped in in 2021. Under his guidance, the company has had to make tough decisions regarding layoffs but has also put in to play the IDM 2.0 Strategy and brought Intel back into competition within the semiconductor industry. We recommend retaining the CEO several years so that his vision can really be seen through. Prior to Brian Krzanich's reign as CEO from 2013 to 2018, only five CEOs had been at the helm of Intel with a significant lack of CEO experience which may have led to CEO Paul Otellini passing on the opportunity to work with Apple on its iPhone and other products. Counting Krzanich and his two predecessors, the company has nearly doubled its numbers of CEOs in its history that has clearly had an impact on the company's revenue, direction, and ability to compete in its space. Gelsinger is certainly suited for the job as he started his career back at Intel in 1979 until he was CEO of VMware from 2012 to 2021.

Gelsinger has not just the familiarity with the company but also has seen the changes it has gone through in both its growth as well as falling out of the top spot. His leadership is transformative in nature so with his experience in different positions as well as CEO provide him great knowledge in how to move Intel into the space it needs to be in competing with other foundry services. To keep Gelsinger in place as CEO, they should continue to heavily focus on transforming their manufacturing capabilities and expanding

or assessing the needs of the new foundry services business unit to ensure it is going to succeed. Under one leader instead of multiple, the company will be able to grow relationships they have in the company and support a common vision to keep everyone on the same page in terms of communications and the different systems needed to support this expansion.

R&D Investment for Technological Advancements:

Increasing investment in R&D is pivotal for Intel to drive innovative breakthroughs that optimize its supply chain. This initiative aims to develop novel technologies and processes that enhance efficiency and reduce costs in semiconductor manufacturing. Previous R&D investments by Intel have led to significant advancements, such as the development of smaller chip architectures, driving improvements in performance and energy efficiency. By doubling down on R&D, Intel can explore cutting-edge manufacturing methods and software systems tailored to streamline supply chain operations. Unlike previous endeavors, this renewed focus on R&D specifically targets supply chain optimization, harnessing advancements in materials science, process engineering, and software solutions. Intel's expertise in semiconductor innovation positions them well to leverage R&D for supply chain enhancement, potentially surpassing prior achievements.

Elevate Supplier Collaboration and Support:

Improving relationships with suppliers involves providing comprehensive support and training programs. This collaborative effort aims to enhance component quality and reduce supply chain risks. While Intel has historically maintained strong supplier relationships, intensifying these collaborations with focused training on quality standards and manufacturing processes can yield substantial improvements. Previous initiatives focused primarily on quality control; however, this recommendation emphasizes mutual growth through supplier capacity building. Financial assistance to suppliers for technology upgrades and equipment investments could mark a departure from standard practices, incentivizing suppliers to align closely with Intel's supply chain objectives.

Speed up the Intel Foundry Services of IDM 2.0 Strategy and start an alliance with Apple:

Intel has opened its Foundry services to third parties at a much later stage when all the others have started way ahead. Among the five major semiconductor foundries—Taiwan Semiconductor Manufacturing Corporation (TSMC), Samsung, Global Foundries (GF), United Microelectronics Corporation (UMC), and Semiconductor Manufacturing International Corporation—only Samsung operates as both an Integrated Device Manufacturer (IDM) and a foundry. Global Foundries is the sole company headquartered in the United States. TSMC and Samsung stand out as the leaders with advanced technologies below 10nm, capturing 53% and 18% of the market share in 2021, respectively. Notably, both TSMC and Samsung, the primary players in advanced semiconductor technology, currently confine the offering of their most advanced nodes to Asia. Additionally, their advanced-node capacity in the United States is limited. This is why Intel must pitch in and game up.

Apple's dominance in the consumer electronics market, with hundreds of millions of devices powered by its proprietary chips, grants the company considerable influence over its suppliers. While Apple typically holds considerable leverage due to the sheer volume of its annual device shipments, this isn't the case with TSMC (Taiwan Semiconductor Manufacturing Company), a crucial partner responsible for producing Apple's chips.

In most supplier relationships, Apple can dictate terms and prevent price hikes, given its ability to switch to alternative suppliers or even develop its own chips. For instance, Apple is developing custom chips for tasks such as cellular connectivity, Wi-Fi, and Bluetooth. However, TSMC stands out as a unique case. Apple's need for cutting-edge manufacturing technology at massive scales has made TSMC the sole go-to option, surpassing competitors like Samsung.

The absence of a viable alternative gives TSMC a distinct advantage. When TSMC raised wafer prices last year, Apple had little choice but to comply with the increased costs. The lack of competition has limited Apple's negotiation power in this specific partnership.

The landscape could shift if Intel successfully launches its Intel 18A process by late 2024, surpassing TSMC technologically. In such a scenario, not only would more advanced manufacturing

capacity become available industry-wide, but Apple would gain the upper hand in negotiations. With the potential to split orders between TSMC and Intel, or at least threaten to do so. This is how Intel can gain a significant customer and be back as a strong player to deal in the Semiconductor industry.

Transparent Supply Chain (TSC) Expansion:

Expand the Transparent Supply Chain (TSC) initiative to cover a broader range of components and materials used in Intel's products. Continuously update and enhance TSC services to detect counterfeit products and unauthorized modifications effectively.

Timely Manufacturing of Components:

Intel should implement a comprehensive scheduling and planning system to coordinate the manufacturing of different components efficiently. It should also employ statistical process control (SPC) software such as Minitab for continuous monitoring and efficiency improvement and deploy radio-frequency identification (RFID) systems to enable precise scheduling and accurate tracking of materials and components in real-time.

Managing Delays and Quality Issues:

Establish a Quality Issue Resolution Team composed of experts from different departments, equipped with tools like Lean Six Sigma methodologies for swift issue resolution. It should also implement a risk assessment framework to proactively identify potential issues and develop contingency plans for critical components. Implement a digital dashboard powered to provide real-time visibility into production delays and quality metrics, enabling quick decision-making.

Exhibits

Exhibit 1: Production Process Steps

1. **Deposition**: Thin films of conducting, isolating, or semiconducting materials are deposited on a silicon wafer to enable the first layer to be printed.
2. **Photoresist Coating**: The wafer is coated with a light-sensitive material called photoresist. Positive resist, most used, changes its structure when exposed to light, making it ready for etching and deposition.
3. **Lithography**: The chip wafer is exposed to ultraviolet light through a reticle, determining the size of transistors. Computational lithography may optimize the pattern to correct defects.
4. **Etch**: The degraded resist is removed, revealing the intended pattern. Etch processes must precisely form conductive features without compromising the chip structure. Wet and dry etching methods are used.
5. **Ion Implantation**: Positive or negative ions are bombarded into the wafer to control the electrical conducting properties, allowing the creation of transistors.
6. **Packaging**: The completed wafer is sliced into individual chips, placed on a substrate with metal foils for input/output signals, and covered with a heat spreader for cooling.

Exhibit 2: Intel's Division List with Examples, Competition and Revenue Generated

Division	Explanation	Example	Competition	Revenue
Client Computing Group (CCG)	Manufacturing chips for Personal Computers market	Intel Core 13thGen	AMD, Apple	50%
Data Center and AI (DCAI)	Workload optimized solutions to Cloud Service partners	Intel Xeon Processors	AMD, Nvidia	30%
Network and Edge (NEX)	Solutions for Cloud networking and telecommunications	Mount Evans IPU, Intel Xeon Processors	-	14%
Mobileye	Autonomous driving solutions	ADAS – Advanced driver assistant systems	Tier 1 automotive suppliers and silicon providers	3%
Accelerated computing systems and Graphics (AXG)	High performance computing to create immersive virtual worlds.	Intel Xeon Processors, Ponte Vecchio GPU	AMD, Nvidia	1%
Intel Foundry System (IFS)	Open System foundry	-	TSMC, Samsung	1%

Exhibit 3: Intel's Product Line and portfolio of chipsets the company produces

Exhibit 4: Demand Forecasting Process

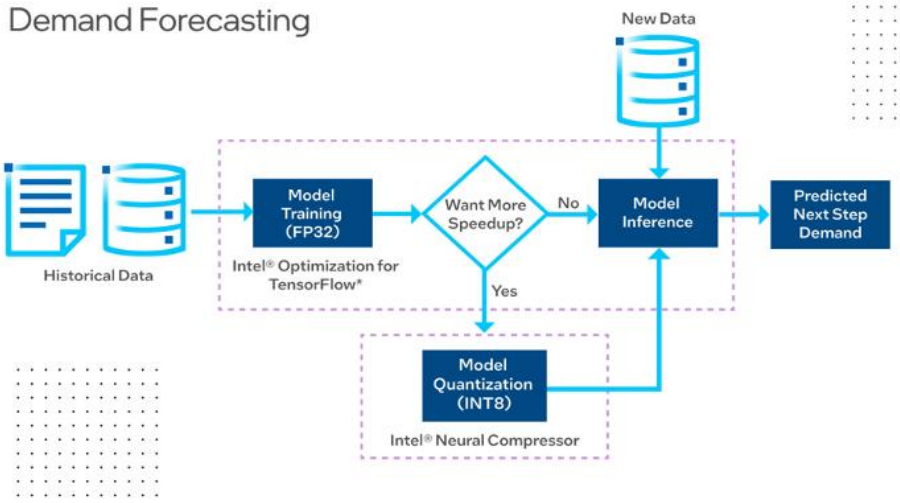
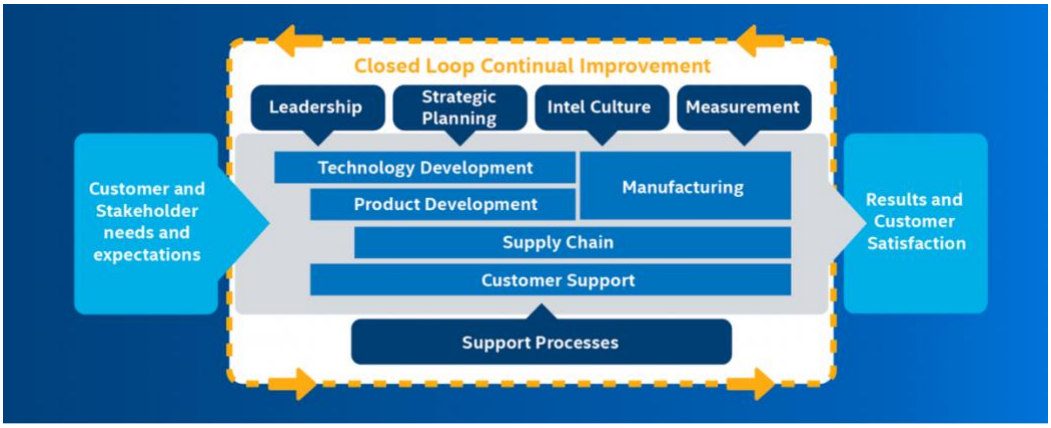


Exhibit 5: Reports of quality control issues at Intel in recent years

Year	Issue	Description	Fix
2017	Meltdown Vulnerability	Intel discovered a vulnerability (Meltdown) allowing data theft from affected processors.	A delayed fix release led to months of potential exploitation.
2018	Spectre Vulnerability	Intel identified the Spectre vulnerability, enabling data theft from affected processors.	A fix was delayed, like the Meltdown incident.
2018	Skylake Manufacturing Defect	A manufacturing defect in Skylake processors exposed kernel memory data.	The fix was released timely.
2019	Foreshadow Vulnerability	Intel found the Foreshadow vulnerability, enabling execution of malicious code on affected processors.	A prompt fix release followed its discovery.
2020	MDS Vulnerability	Intel identified the MDS vulnerability, allowing data theft from affected processors.	A fix was released shortly after discovery.

Exhibit 6: Intel's Quality Management System



References

https://www.intc.com/filings-reports/annual-reports/content/0000050863-23-000006/0000050863-23-000006.pdf

https://www.investopedia.com/articles/markets/012216/worlds-top-10-semiconductor-companies-tsmintc.asp

https://www.idc.com/getdoc.jsp?containerId=prAP50994023

https://www.forbes.com/sites/aarontilley/2017/03/10/microsoft-intel-divorce/?sh=5f79ccdf285f

https://www.chiphistory.org/intel-ceo-history

https://law.stanford.edu/wp-content/uploads/2023/01/Intel-Convertible-Note-220920.pdf

https://www.intc.com/filings-reports/annual-reports##document-5321-0000050863-23-000006-2

https://www.fool.com/investing/2023/09/09/could-intels-mystery-foundry-customer-be-apple/

https://www.intel.com/content/www/us/en/developer/articles/reference-kit/demand-forecasting.html

https://www.jstor.org/stable/40931166?seq=1

https://www.intel.com/content/www/us/en/newsroom/resources/moores-law.html#gs.1ngjmt

isk%20management. https://www.intc.com/filings-reports/annual-reports/content/0000050863-23-000006/0000050863-23-000006.pdf

https://dfreight.org/blog/an-insight-into-intel-supply-chain-strategy/#:~:text=Intel%27s%20supply%20chain%20strategy%20focuses,quality%20control%20and%20r

https://cdrdv2-public.intel.com/730511/Intel%20Quality%20Manual.pdf

https://csrc.nist.gov/CSRC/media/Projects/Supply-Chain-Risk-Management/documents/case_studies/USRP_NIST_Intel_100715.pdf

https://www.wired.com/story/intel-meltdown-spectre-storm/

https://www.forbes.com/sites/davealtavilla/2018/01/03/intel-processor-bug-leaves-all-current-chips-vulnerable-and-its-fix-saps-performance/?sh=447c41cd570a

https://www.helpnetsecurity.com/2020/03/12/load-value-injection/

https://cyware.com/news/crosstalk-another-intel-exclusive-vulnerability-worries-security-researchers-a39bc2fe

https://www.scmagazine.com/news/downfall-flaw-leaves-most-intel-cpus-open-to-nearly-undetectable-attack