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# AlphaCurrents

## AI Building Blocks

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Following the release of ChatGPT and other applications powered by large language models, stories about artificial intelligence (AI) seem to be everywhere. Most are about what roles people hope (or fear) AI will assume. Chatbot, internet search engine, software developer, songwriter and poet, to name a few, could potentially be roles for this exciting technology. It could also be an essential contributor to innovations such as self-driving cars. Beyond the potential use cases, however, many investors don't understand what's needed to make the technology work. We see five key pillars on which AI applications are built: 1) processing power; 2) memory; 3) chip design and manufacturing; 4) proprietary data; and 5) human capital.

In this *AlphaCurrents*, we examine the building blocks for AI and leading companies that make it possible.

## The AI Ecosystem

While the secular story in automation is easy to understand, the ecosystem that supports the development and use of AI models is more complex. Exhibit 1 breaks down how we view the five primary building blocks of AI and some of the core use cases. We left some slots for new use cases because the biggest opportunities for a new technology are often not identified until the second generation. We see secular investment opportunities around each building block: 1) processing power; 2) memory; 3) chip design and manufacturing; 4) proprietary data; and 5) human capital. We expect new companies that use AI to emerge and for some legacy tech companies to successfully pivot by developing cutting-edge use cases. It's too early to identify use-case winners, however. Notably, among operating systems, internet explorers, search engines, smart phones and social networks, it was often the second or third entrant that dominated the market. For the building block companies, AI is another fast-growing segment to serve.

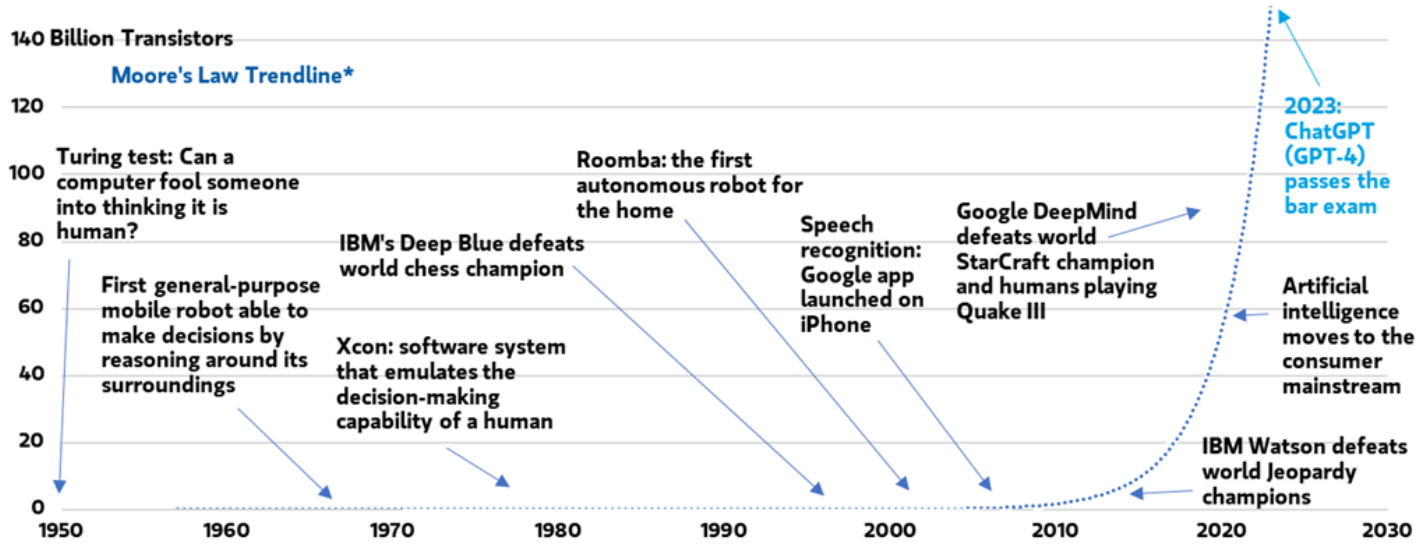
## AI 101

To understand the artificial intelligence building blocks, it is important to lay out the basics of how AI works. As one would expect, the process requires semiconductors for processing and memory, unique data sets and human know-how. AI was first developed in the 1950s when scientists tried to build machines that could mimic how humans think. In the 1970s and 1980s, machine learning emerged as the leading area of AI. Along the journey from the 1950s to today, many important milestones have been reached, as highlighted in Exhibit 2. Machine learning uses different mathematical concepts to make observations about relationships within data sets. On a simple level, it refers to programs that solve countless equations using vast amounts of data. There are all sorts of machine learning algorithms, with different strengths and weaknesses depending on the use case. That said, there are two core areas within machine learning: unsupervised learning and supervised learning.

**Exhibit 1: The AI Ecosystem Should Benefit AI Building Blocks as Use Cases Change Over Time**


Source: Morgan Stanley Wealth Management Global Investment Office as of April 16, 2023

**Exhibit 2: Exponential Growth in Semiconductor Power Has Been Key to Unlocking Advanced AI Capabilities**




*Moore's Law posits that the number of transistors on an integrated circuit doubles every two years.
Source: Morgan Stanley & Co. Research, Morgan Stanley Wealth Management Global Investment Office as of April 16, 2023

Supervised learning models, regardless of algorithm type, examine a set of independent variables to understand their relationship with a dependent variable. Based on the size of the data set, number of variables and speed at which results are needed, different levels of computing power are required for the computer to understand relationships in the data. Unsupervised learning models look at a series of inputs in order to infer relationships among them, rather than their relationship with a dependent variable. For basic machine learning, most computers work, but for advanced machine learning, such as that pertaining to the types of large language models that power ChatGPT, specific hardware and components are required. In the following sections, we identify the building blocks of advanced AI.

## Processing Power

Processing power enables AI models to observe very large sets of data and understand relationships among the data points so that a model can ultimately make decisions based on future instances of the data. The first type of data processing, called "training," finds relationships among variables. The second type, called "inference," uses a variable and a relationship derived from training to make a prediction about the data. Three types of chips can be used for these two processes, each with its own strengths and weaknesses: graphical processing units (GPUs), field-programmable gate arrays (FPGAs) and application-specific integrated circuits (ASICs). Moving from GPUs, to FPGAs, to ASICs, the three chip types become less flexible, more expensive and more energy-efficient.

Chip companies compete on upfront cost, speed and energy consumption. All of these factors are enhanced by spending on research and development (R&D), which provides economies of scale that make the leading share provider more efficient.

- **GPUs**, given their power and flexibility, are critical for the training phase of advanced AI models. Traditionally used to process graphics for output onto a screen, they are often the preferred hardware for video games. Given their power and strength, they have increasingly become the standard hardware for other high-end computing functions such as AI. Mostly designed by Advanced Micro Devices (AMD) and NVIDIA (NVDA), GPUs require more power than FPGAs and ASICs but can process many data points at the same time and are more flexible in terms of the type of calculations they can process. While ASICs chips could emerge as a leading hardware for some aspects of the training phase of AI models, GPU chips are currently the most widely adopted for this use case.
- **FPGAs** are semiconductors that can be reprogrammed to fit a specific need. Given this, an FPGA can be customized to the exact needs of a machine learning algorithm so that it can either perform training tasks faster or consume less power than other hardware. FPGAs are often used in artificial neural networks because they can handle different algorithms focused on computing, logic and memory, given their programmable nature. Real-time machine learning models are the FPGA chip type's strongpoint. Applications, such as speech recognition, multimedia and self-driving vehicles, are typically time-sensitive. The two leading designers of FPGAs are Advanced Micro Devices and Intel (INTC). As more advanced AI models are developed, FPGAs could benefit given the customizable nature of the chips.
- **ASICs** are designed for one specific function—hence the name, application-specific integrated circuits. ASICs use a complicated physical design to perform one calculation very efficiently, resulting in lower energy requirements and higher manufacturing costs. Designers of ASICs compete on manufacturing volume and R&D in the design process. Designers often try to dominate market share for small niche markets where one particular calculation is used often. Importantly chips are specialized, so chips designed for one niche market cannot be used for other markets. Applications for these chips include those related to "deep learning"—a complex type of artificial neural network that fosters faster data relationship analysis while using less energy than other chips. Infineon Technologies (IFNNY), ON Semiconductor (ON), Samsung Electronics (SSNLF) and Advanced Micro Devices make ASICs for various AI and non-AI applications.

To put the hardware requirement for cutting-edge machine learning in context, Morgan Stanley & Co. Research semiconductor analyst Joseph Moore estimates that the most recently created version of ChatGPT (GPT-5), which has not been released yet, took several months to train the algorithm and requires nearly $1 billion of hardware, including $225 million from NVIDIA. Due to the time commitment, these large language models are only trained once. Earlier versions of ChatGPT (GPT-3 and GPT-4) were trained years ago. Given the high level of investment to run these programs, it is important to understand the chips that power them, such as GPUs, FPGAs and ASICs.

## Memory

Memory building blocks are used in the process of inference —where an AI model focuses on taking the relationships identified in the training process and making decisions based on new data. While the training occurs in data centers or in the cloud, once it is done, the inference step can occur in the cloud, in the data center or on the end-device. Ultimately, memory building blocks allow for the storage and transfer of data from physical computers to data centers and over cloud-based networks where the actual AI takes place. The storage and transfer of data are enabled by semiconductors that provide memory functions for computers. While processing and training data are computationally intensive processes, the equipment that supports the transfer and storage of data that is used in AI is just as important. In memory, companies compete on costs pertaining to volume production. Memory chips are much less expensive than the logic chips used in processing; as a result, companies that can effectively scale their production and selling costs ultimately have a competitive advantage that is similar to that enjoyed by some commodity producers. In addition to other data-related components, such as hard disk drives, there are three types of memory semiconductors—dynamic random access memory (DRAM), static random access memory (SRAM) and flash memory (NAND and NOR).

- **DRAM** is volatile memory, which means that if the power source is removed the data is lost. DRAM is typically used directly with a computer's central processor for temporary data storage. It is important because it allows large amounts of data that can be refreshed quickly to be stored. The downside to DRAM is that the data it stores must be continuously refreshed. Micron (MU) is a leading company in the DRAM market.

- **SRAM** is like DRAM in that it allows a computer to temporarily store data as long as it is connected to a power source, but it does not need to be continuously refreshed. This leads to lower power usage and better performance. The debate around whether to use DRAM or SRAM comes down to cost, with DRAM significantly less expensive than SRAM. Companies involved in SRAM design and production include Intel and IBM (IBM).

- **Flash memory** is nonvolatile memory storage that can be erased or reprogrammed but retains the data even if a power source is disconnected. Within flash memory there are two primary types of chips—NAND flash and NOR flash. NAND flash chips are typically found in memory cards, flash drives and smart phones. They are used for the general storage and transfer of data. NOR flash is primarily used for storing small amounts of data. These types of memory components are popular because they are very inexpensive. Micron (MU) is a key player in the flash memory market.

## Chip Design and Equipment

Chip design and equipment building blocks are companies involved in the production of design tools, manufacturing equipment and manufacturing facilities, and in semiconductor testing. Given the importance of processing and memory, and the increasing demand for semis in various products as technology becomes more diffused, we need more chips. These companies benefit from scale in R&D and their position as industry-standard suppliers. Their production of specialized tools used in the chip design and manufacturing ecosystem makes it more likely that workers will continue using those same tools—even if they move to a different company—instead of learning how to use new tools. This competitive advantage allows producers of these tools to continue to invest in R&D, which, in turn, assures that their tools continue to be the best, thereby further insulating them from the possibility of end-users switching to different suppliers.

- **Design** encompasses the tools that semiconductor companies use to design chips. The chips are used by companies in the processing and memory enabler categories, as many of those companies do not produce their own. Autodesk (ADSK) is a software company that provides design tools for electronic system design, though that is not its primary market. Although not covered by Morgan Stanley & Co. Research, several additional companies are involved in the design space.

- **Manufacturing** is the process whereby semiconductors are built. It occurs in fabrication facilities or foundries. When a fabrication facility is separate from a semiconductor design company, it is referred to as a foundry. Most semiconductors are built in foundries, as physical manufacturing has moved outside the US to lower-cost areas in the past few decades. Two important companies in the foundry segment are Taiwan Semiconductor Manufacturing Co. (TSM) and GlobalFoundries (GFS). Foundries rely on equipment and software produced by front-end capital equipment firms such as Applied Materials (AMAT), Lam Research (LRCX) and KLA (KLAC). There are two other non-US, front-end capital equipment firms—one based in the Netherlands and the other in Japan.

- **Testing** takes place once the manufacturing has been completed to make sure semis perform according to their intended specifications. Teradyne (TER) is focused on packaging and testing semiconductors.

Many of the firms that design semiconductors are based in the US. However, most high-end semiconductors are manufactured in Taiwan. Given the strategic importance policymakers are placing on semiconductors, firms with a US presence could benefit as domestic production grows.

## Proprietary Data

Ultimately, proprietary data is what should enable users of advanced AI to adopt industry and company-specific solutions that will not only save costs but provide meaningful barriers to entry. Three key segments within proprietary data are database software, data centers and proprietary data owners. Each segment exhibits different competitive dynamics. Database software industry leaders often benefit from industry-standard network effects. Once database software is embedded in a company's operations, switching costs become elevated. Furthermore, employees are more likely to continue using what they know if they leave for a competitor. Employees also prefer to learn the industry standard and make software that is compatible

Data centers, meanwhile, benefit from geographic advantages, as they are typically located near important communication lines and have access to cheap energy. They also may enjoy information hub network effects if customers need operations in the same data center in order to talk to one another.

Large data centers may benefit from buying large volumes of equipment at bulk discounts and/or before smaller competitors. Some data centers are part of larger organizations, and some are stand-alone companies. Lastly, data owners typically have access to some source of useful, hard-to-aggregate proprietary data. Examples of proprietary data are consumer preferences, financial transactions and images.

- **Database software** allows users to insert new data into storage and retrieve stored data. Data can be stored in two forms—structured and unstructured. Unstructured data includes several types, such as emails and images, while structured data is neatly organized and can be read in a similar manner as a spreadsheet. Once someone has stored data, they must organize it into a structured form that can then be analyzed by an AI algorithm. It takes time to process and clean unstructured data, which is why providers of database software, such as Snowflake (SNOW) and MongoDB (MDB), are likely to benefit. Snowflake, which has been growing revenue faster than MongoDB in the past three years, offers both unstructured and structured solutions, whereas MongoDB primarily focuses on unstructured data. While Snowflake recently entered the unstructured data market, switching costs can be high, and there is no reason both companies cannot continue to excel as AI adoption grows.
- **Data centers** offer large-scale distributed data storage. They are essential AI building blocks, as they support the flow of data throughout cloud computing networks, where AI is being created, and because the amount of data used in advanced AI is too large to store on a single computer. Data centers are the focus of select real estate investment trusts (REITs), such as Equinix (EQIX) and Digital Realty Trust (DLR), and hyperscalers that provide cloud computing and data storage on an enterprise scale. The latter include Microsoft (MSFT), Amazon.com (AMZN), Alphabet (GOOGL), IBM (IBM) and Oracle (ORCL). While beyond the scope of this report, cloud computing is one of the key secular trends that has propelled the US economy over the last cycle, and it is experiencing exciting changes as new leaders emerge.
- **Data owners** are the companies that possess proprietary data that gives them an advantage in terms of either their customer base or other core drivers of their business. In the world of big data and instant transfer of information, only unique proprietary data that's hard to collect is valuable. Any data set that is free or easy to obtain likely does not provide a competitive advantage to a data owner even if it's useful for AI. Companies with proprietary data are better positioned in their industries to use advanced AI. For example, advertisers are always interested in what the consumer is interested in, and internet browsing data has long been a key, albeit controversial, target for these types of companies. Who has greater insight into what consumers are spending money on—banks and credit card companies or an internet search engine firm? Proprietary data also provides an economic moat, making it difficult for a startup or competitor attempting to branch into a new industry to take an incumbent's market share. Given the importance of access to data, companies that provide database solutions are well positioned as AI usage grows. Companies like Meta Platforms (META), with consumer preference data, Pinterest (PINS), with curated collections of images, Amazon.com, with purchase histories, and Tesla (TSLA), with self-driving data, may become more valuable in the future.

While much excitement has been generated over ChatGPT, understanding which data sets are more valuable than others is important and will likely separate the leading users of AI from the pack. ChatGPT has demonstrated its impressive ability to generate fast and sometimes accurate answers to all sorts of questions. One of the shortfalls of this type of model, however, is that the application is trained on publicly available information obtained freely over the internet, and "bad data in" can result in "bad data out." This is why ChatGPT often supplies answers that appear correct to many users but are soon identified as wrong by subject matter experts. Such answers are referred to as "hallucinations."

**Exhibit 3: AI Building Blocks Could Benefit from Secular Support While Leading Use Cases Will Likely Shift over Time**

| AI Building Block Segment | Key Companies |
|---|---|
| Processing | NVIDIA (NVDA) Advanced Micro Devices (AMD), Intel (INTC), Infineon (IFNNY), ON Semiconductor (ON), Samsung Electronics (SSNLF) |
| Memory | Micron (MU), Intel (INTC), IBM (IBM) |
| Chip Equipment and Design | Taiwan Semiconductor Manufacturing (TSM), GlobalFoundries (GFS), Teradyne (TER), Applied Materials (AMAT), KLA (KLAC), Lam Research (LRCX), Autodesk (ADSK) |
| Proprietary Data | Snowflake (SNOW), MongoDB (MDB), Equinix (EQIX), Digital Realty Trust (DLR), Microsoft (MSFT), Amazon.com (AMZN), Alphabet (GOOGL), IBM (IBM), Oracle (ORCL), Pinterest (PINS), Meta Platforms (META), Tesla (TSLA) |
| Human Capital | Accenture (ACN), Cognizant Technology Solutions (CTSH), Gartner (IT) |

Source: Morgan Stanley Wealth Management Global Investment Office as of April 5, 2023

## Human Capital

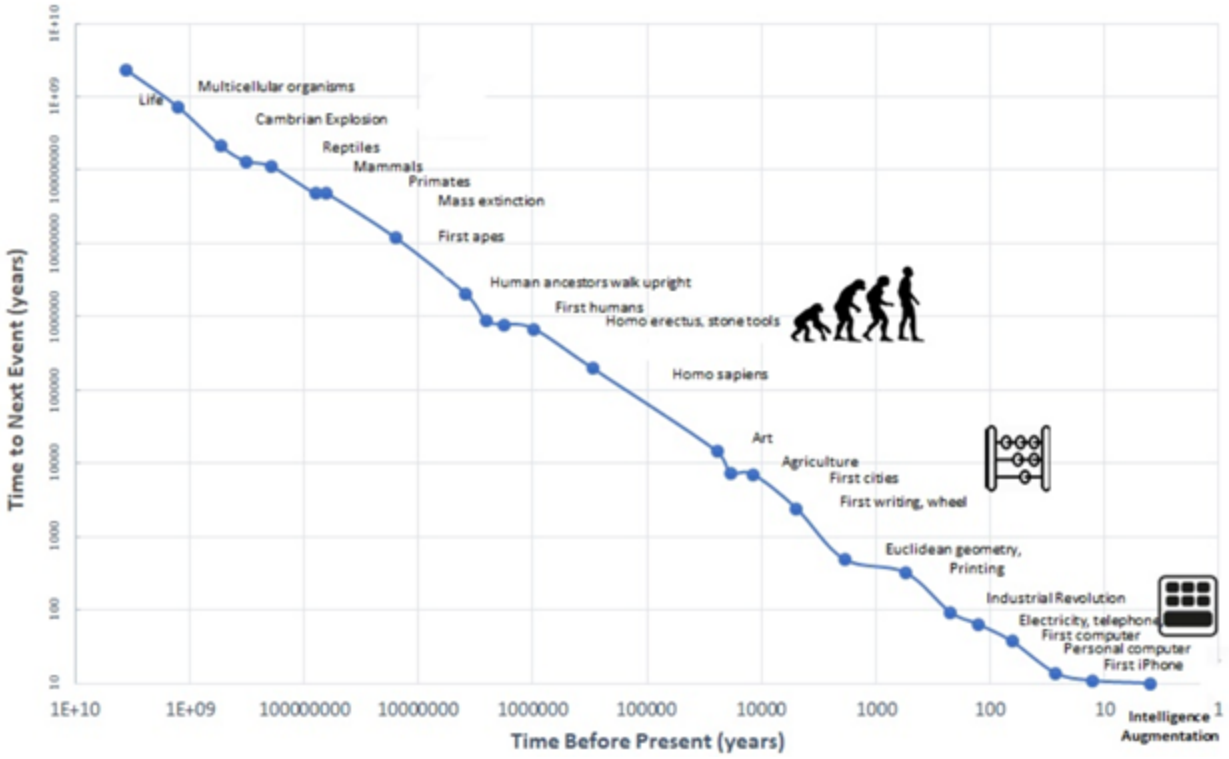
The final building block, human capital, should allow for AI to be incorporated broadly across corporate sectors and industries, not just in the technology sector. While Big Tech can rely on its skilled workforce and ability to attract the most talented software developers and data scientists, much of corporate America will likely rely on consulting firms to drive their adoption of AI. Two areas of focus in the human capital building block are how to use AI and how to implement it. Human capital building blocks benefit from their standing as industry-standard consultants. While other consultants are considered the leaders in select areas, such as management and accounting, information technology (IT) consulting firms are the AI industry-standard consultants. In Exhibit 3, we lay out key AI building block companies.

- **AI educators** are crucial to accelerating broadscale adoption of this technology. While many corporate leaders are aware of the importance and potential of AI, finding individual use cases that will benefit their specific businesses is more nuanced. As a result, IT consulting firms such as Gartner (IT), which are well positioned to identify emerging industry standards in a rapidly changing market, are likely to benefit. In the long run, there may be opportunities to train employees to use new technologies.
- **AI implementors** are companies that are engaged to automate specific tasks within the corporate sector. While some AI educators are consulting firms that educate about AI, AI implementors are the firms contracted to roll out the automation of corporate America. Companies such as Accenture (ACN) and Cognizant Technology Solutions (CTSH) are examples of this.

## Use Cases and Potential Drawbacks

While the foremost use cases of AI will shift over time, we identify several areas where advanced AI is currently undergoing significant adoption. Some of these include chatbots, internet search engines and self-driving cars. With ChatGPT becoming a household name in recent months, Microsoft stands out as a leading player, given its large stake in OpenAI, the company that created ChatGPT. Alphabet, with its Bard product, has been focused on creating its own competitor to ChatGPT. Finally, companies such as Tesla and General Motors (GM) use advanced AI for their self-driving cars. With the innovation curve accelerating faster than ever (see Exhibit 4), it's easy to understand why investors are excited about the potential these technologies can unlock.

## Exhibit 4: AI Is the Latest Significant Event in a Long History of Significant Events, with Recent Major Events Occurring at an Exponentially Faster Pace




Source: Ray Kurzweil, Morgan Stanley & Co. Research, Morgan Stanley Wealth Management Global Investment Office as of March 6, 2023

The use cases cited above are only a few of the many current ones for AI, but some questions are starting to emerge given how fast advanced AI models have been deployed and developed, including whether a strategic pause is necessary to identify risks. While much of the hype about AI replacing jobs is likely overdone, given the necessity to maintain and grow gross domestic product (GDP) amid shrinking global working-age populations, ethics questions have emerged. In Exhibit 5, we highlight potential AI-related environmental social and governance (ESG) benefits, as well as risks, identified by Morgan Stanley & Co.'s Sustainability Research team. For more information on AI and ESG, refer to the team's April 3, report, "AI & ESG: Our Thoughts on Benefits, Risks, Investing, and Regulation."

## Exhibit 5: AI Can Offer ESG-Related Benefits, Though It Involves Risks

| ESG-Related Benefits of AI | ESG-Related Risks of AI |
|---|---|
| Power grid optimization and resilience | Employment and recruitment |
| Agriculture production and efficiencies | Human bias and unfairness |
| Health care access and efficient drug development | General safety concerns |
| Energy efficiencies in manufacturing | Data selection bias and unfairness |
| Air pollution and quality | Data privacy and security |
| ESG investing approaches | Carbon footprint and emissions |
| ESG-related corporate disclosures | |
| Biodiversity protection and monitoring | |
| Conservation of limited water resources | |
| Education access and outcomes | |
| Air quality improvement | |
| Weather prediction and natural disaster mitigation | |
| Carbon emissions verification | |

Source: Morgan Stanley & Co. Research as of April 3, 2023

## Exhibit 6: Opportunities in Proprietary Data and Human Capital May Offer Relative Value Versus Other AI Building Block Segments at Current Valuations

| AI Building Block Segment | Company Name | Morgan Stanley & Co. Research Rating | Price ($) | Price Target ($) | Market Cap ($B) | P/E Ratio | Sales Growth (%) | EPS Growth (%) |
|---|---|---|---|---|---|---|---|---|
| Processing | Advanced Micro Devices (AMD) | OW | 92 | 87 | 149 | 21 | 17 | 30 |
| | NVIDIA (NVDA) | OW | 268 | 304 | 660 | 46 | 24 | 41 |
| | Intel (INTC) | EW | 32 | 28 | 134 | 18 | 16 | 263 |
| | Infineon (IFNNY) | EW | €34 | €35 | €44 | 13 | 1 | 15 |
| | ON Semiconductor (ON) | EW | 70 | 89 | 33 | 13 | 12 | 28 |
| | Samsung Electronics (SSNLF) | OW | 65,100 KRW | 70,000 KRW | 272 | 14 | 13 | 186 |
| Memory | IBM (IBM) | EW | 128 | 143 | 115 | 12 | 4 | 6 |
| | Intel (INTC) | EW | 32 | 28 | 134 | 18 | 16 | 263 |
| | Micron (MU) | UW | 63 | 46 | 68 | 92 | 38 | -115 |
| | Samsung Electronics (SSNLF) | OW | 65,100 KRW | 70,000 KRW | 272 | 14 | 13 | 186 |
| Chip Design and Equipment | Applied Materials (AMAT) | EW | 113 | 125 | 95 | 16 | -3 | -3 |
| | Autodesk (ADSK) | EW | 195 | 245 | 42 | 24 | 12 | 15 |
| | GlobalFoundries (GFS) | OW | 66 | 85 | 36 | 21 | 13 | 37 |
| | KLA Corp (KLAC) | EW | 376 | 420 | 51 | 20 | -15 | -22 |
| | Lam Research (LRCX) | OW | 499 | 550 | 67 | 18 | -16 | -16 |
| | TSMC (TSM) | OW | 510 | 700 | 450 | 13 | 20 | 23 |
| | Teradyne (TER) | EW | 102 | 101 | 16 | 20 | 26 | 66 |
| Proprietary Data | Alphabet (GOOGL) | OW | 107 | 135 | 1,370 | 16 | 7 | 20 |
| | Amazon.com (AMZN) | OW | 102 | 150 | 1,032 | 28 | 12 | 42 |
| | Digital Realty Trust (DLR) | EW | 92 | 92 | 27 | 40 | 4 | -9 |
| | Equinix (EQIX) | EW | 708 | 702 | 66 | 69 | 8 | 21 |
| | IBM (IBM) | EW | 128 | 143 | 115 | 16 | 4 | 6 |
| | Meta Platforms (META) | OW | 221 | 250 | 568 | 15 | 11 | 22 |
| | MongoDB (MDB) | OW | 229 | 270 | 16 | 1153 | 22 | 35 |
| | Oracle (ORCL) | EW | 95 | 90 | 256 | 17 | 7 | 10 |
| | Pinterest (PINS) | EW | 29 | 22 | 20 | 31 | 19 | 48 |
| | Snowflake (SNOW) | OW | 143 | 215 | 47 | 137 | 37 | 75 |
| | Tesla (TSLA) | OW | 185 | 220 | 585 | 33 | 29 | 41 |
| Human Capital | Accenture (ACN) | OW | 284 | 325 | 188 | 23 | 6 | 8 |
| | Cognizant Technology Solutions (CTSH) | EW | 61 | 60 | 31 | 12 | 6 | 9 |
| | Gartner (IT) | EW | 320 | 366 | 25 | 29 | 11 | 16 |

Source: Bloomberg, Morgan Stanley Wealth Management Global Investment Office as of April 5, 2023

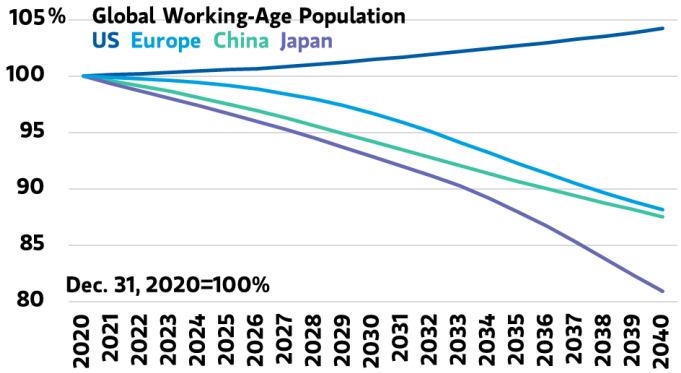
## What's in the Price?

While the opportunity surrounding AI is secular, the market may have gotten a bit ahead of itself in the short term due to the excitement. We see opportunity in allocating to companies involved in the human capital and proprietary data building block verticals (see Exhibit 6). For investors seeking to allocate to AI, we believe these companies offer value, broadly, relative to other areas of AI enablement. That does not mean they are immune to a wider economic slowdown, and in the event of one, their earnings and valuations would likely be impacted. While AI is an exciting theme that is likely to be implemented across the economy, we remind investors that secular opportunities do not cancel out cyclical weakness, and any investment should factor in near-term macroeconomic and company-specific risks, in addition to long-term tailwinds and headwinds.

## Automation by Necessity

Over the past few years, we have addressed the importance automation will play in helping to maintain global economic activity, as many major economies are experiencing declines in working-age population (see Exhibit 7). While the US is insulated from this, even before the COVID-19 recession, there was a shortage of workers available relative to job openings—a gap that widened during and after the pandemic as baby boomers decided to retire. While the case for automation is clear, it is important to understand the drivers of the technology that enables automation, of which artificial intelligence is a major pillar. For more on automation, refer to our December 2022 report, "Revisiting 'Automation by Necessity' in Light of Recent Developments in Artificial Intelligence." For more information on AI or any of the companies mentioned in this report, contact your Morgan Stanley Financial Advisor.

**Exhibit 7: Working-age Populations Outside the US Are Forecast to Decline**




Source: World Bank, Morgan Stanley Wealth Management Global Investment Office as of Dec. 16, 2022

## Securities Mentioned in Report

Accenture (ACN; $271; MS & Co. Rating: Overweight/In-Line)

Amazon.com (AMZN; $103; MS & Co. Rating: Overweight/In-Line)

Advanced Micro Devices (AMD; 84; MS & Co. Rating: Overweight/In-Line)

Alphabet (GOOGL; $104; MS & Co. Rating: Overweight/In-Line)

Applied Materials (AMAT; $111; MS & Co. Rating: Equal-weight/In-Line)

Autodesk (ADSK; $190; MS & Co. Rating: Equal-weight/Attractive)

Cognizant Technology Solutions (CTSH; $58; MS & Co. Rating: Equal-weight/In-Line)

Digital Realty Trust (DLR; $98; MS & Co. Rating: Equal-weight/In-Line)

Equinix (EQIX; $710; MS & Co. Rating: Equal-weight/In-Line)

Gartner (IT; $295; MS & Co. Rating: Equal-weight/In-Line)

General Motors (GM; $33; MS  & Co. Rating: Equal-weight/In-Line)

GlobalFoundries (GFS; $58; MS & Co. Rating: Overweight/In-Line)

IBM (IBM; $126; MS & Co. Rating: Equal-weight/In-Line)

Infineon Technologies (IFNNY; $37; MS & Co. Rating: Equal-weight/Attractive)

Intel (INTC; $29; MS & Co. Rating: Equal-weight/In-Line)

KLA (KLAC; $358; MS & Co. Rating: Equal-weight/In-Line)

Lam Research (LRCX; $500; MS & Co. Rating: Overweight/In-Line)

Meta Platforms (META; $208; MS & Co. Rating: Overweight/In-Line)

Micron (MU; $58; MS & Co. Rating: Underweight/In-Line)

Microsoft (MSFT; $275; MS & Co. Rating: Overweight/Attractive)

MongoDB (MDB; $213; MS & Co. Rating: Overweight/Attractive)

NVIDIA (NVDA; $262; MS & Co. Rating: Overweight/In-Line)

ON Semiconductor (ON; $70; MS & Co. Rating: Equal-weight/In-Line)

Oracle (ORCL; $94; MS & Co. Rating: Equal-weight/Attractive)

Pinterest (PINS; $28; MS & Co. Rating: Equal-weight/In-Line)

Samsung Electronics (SSNLF; $41; MS & Co. Rating: Overweight/Attractive)

Snowflake (SNOW; $135; MS & Co. Rating: Overweight/Attractive)

Taiwan Semiconductor Manufacturing (TSM; $82; MS & Co. Rating: Overweight/In-Line)

Teradyne (TER; $94; MS & Co. Rating: Equal-weight/In-Line)

Tesla (TSLA; $161; MS & Co. Rating: Overweight/In-Line)

Note: Prices as of market close on April 25, 2023.

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### Closed-End Fund Ratings Distribution

(as of date **March 31, 2023**)

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| | CEF Coverage Universe | | Investment Banking Clients (IBC) | | |
|---|---|---|---|---|---|
| Closed-End Fund (CEF) Rating Category | Count | % of Total | Count | % of Total IBC | % of Rating Category |
| Overweight/Buy | 27 | 35.5% | 12 | 41.4% | 44.4% |
| Equal-weight/Hold | 35 | 46.1% | 11 | 37.9% | 31.4% |
| Underweight/Sell | 14 | 18.4% | 6 | 20.7% | 42.9% |
| Total | 76 | 100.0% | 29 | 100.0% | |

Data includes CEFs currently assigned ratings. An investor's decision to buy or sell a fund should depend on individual circumstances (such as an investor's existing holdings) and other considerations.

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