Seekjng Singularity

SINGULARITY INDEX

H2 2022

REBALANCING REPORT

The Singularity group

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Executive Summary

The Singularity Index is the **gold standard for innovation benchmarking**. Its composition reflects a real-time snapshot of global leaders that are **generating cash flows from major technology applications**. It is rebalanced semi-annually following a bottom-up, expert-led process that tracks technological developments within our Singularity Sectors.

Based on ongoing consultations with our Singularity Think Tank experts and our proprietary research, this rebalancing sees an **increased focus on renewable diesel and biofuel value chains in our New Energy sector, an expansion into diagnostic devices and kits in our Bioinformatics sector, a focus on applied innovation enabled by enzymes in our Advanced Materials sector, a concentration on advanced logic semiconductors, associated design and photolithography equipment within our Compute Power sector**, and a **departure from the application of Discriminative AI (the former AI generation) in digital advertising in our Artificial Intelligence sector**. Finally, we rename our Virtual Reality sector to **Extended Reality**, reflecting a broader focus on technologies that enable the blending of physical and virtual environments and the shift toward deeper user immersion in digital environments.

Overall, approximately 30% of the companies in the Singularity Index are replaced with 8% of the total weight made up of entirely new names, while leavers account for 20% of the index weight. The portfolio carries a weighted Singularity Score of 75, retaining a significant positive spread over the MSCI ACWI's score of 14.

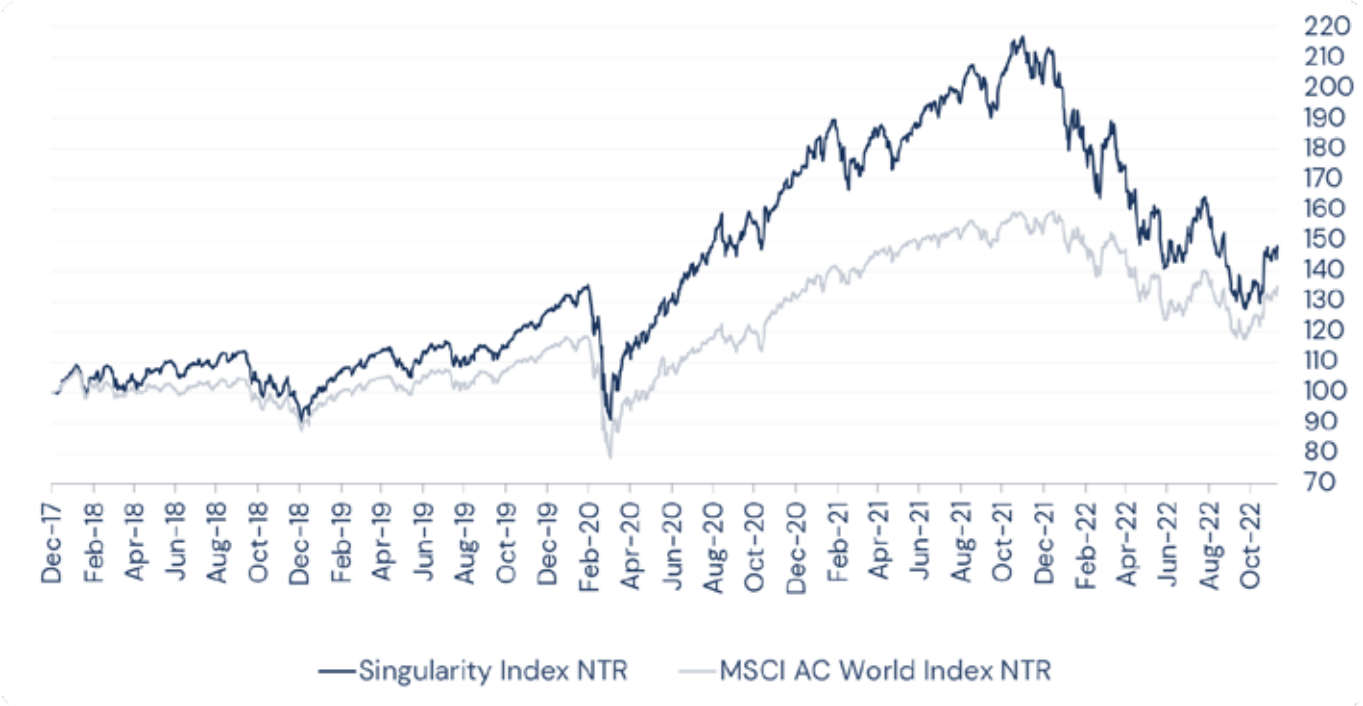
The top **Singularity Sectors** in the Index post rebalancing are **Big Data, Compute Power**, and **Robotics**. In **Artificial Intelligence**, Alphabet's (GOOGL US, Singularity Score: 7) portfolio weight declines considerably and Meta Platforms (META US, Singularity Score: 0) drops entirely from the index. **Advanced Materials** more than doubles year-over-year with an increased focus on enzymes as well as adhesives and sealants, leading to increased exposure to Materials and Consumer Staples. Core holdings include Albemarle (ALB US, Singularity Score: 57, Archer-Daniels-Midland (ADM US, Singularity Score: 17), and Givaudan (GIVN SW, Singularity Score: 54). In **Bioinformatics**, Abbott Laboratories (ABT US, Singularity Score: 53), and Roche (ROG SW, Singularity Score: 27) see significant exposure increases. In **New Energy**, Schneider Electric (SU FP, Singularity Score: 100), Eaton (ETN US, Singularity Score: 37), and Generac (GNRC US, Singularity Score: 100) foster our exposure to Industrials while the Energy sector exposure grows based on the addition of Neste (NESTE FH, Singularity Score: 37) and Verbio (VBK GY, Singularity Score: 71) among other names. Adobe (ADBE US, Singularity Score: 100), Trimble (TRMB US, Singularity Score: 39), and Tencent (700 HK, Singularity Score: 62) are among the holdings in **Extended Reality**.

Industrials becomes the third largest GICS sector exposure in the portfolio driven by New Energy and Robotics. Key focus areas include agritech robots for seeding, weeding and picking, as well as industry 4.0 factory automation, energy efficiency software and equipment for climate control, and new electric grid infrastructure and storage.

The Singularity Index's portfolio characteristics demonstrate strong growth and profitability, a healthy balance sheet with a solid liquidity profile, and low debt levels. Situated squarely at the center of applied innovation, constituent companies have been able to repeatedly surprise positively on sales and earnings while reinvesting back into the business to innovate and grow their topline.

Figure 1

Singularity Index Since Inception (December 21 2017 to November 30 2022)



Source: Bloomberg, TSG

I. PORTFOLIO CHANGES

On November 18, 2022, the Singularity Index was rebalanced according to its semi-annual cycle. The new composition of the Index came into effect following the market close. The rebalanced index excludes companies that do not pass our ESG criteria. **Roughly a third of the names in the Index were replaced (102 companies). In terms of weights, the names that dropped out of the Index accounted for 20% of the overall index weight** prior to rebalancing while entirely new positions make up 8% of the new index composition. The difference of 12% can be ascribed to a reweighting (increase) of current names. Portfolio turnover (one-sided) **was 32%. The weighted Singularity Score is 75 compared to 14 for the MSCI AC World Index (MSCI ACWI)**.

1.1 Sector Changes

The new Singularity Index weights were determined as of October 31, taking into account Singularity Sector and single position limits (max. 20% and max. 4% respectively). Accordingly, **Big Data**, with an unconstrained weight of 36%, was capped at the 20% sector limit. The largest positions in the index are **Taiwan Semiconductor Manufacturing** (2330 TW, Singularity Score: 97), Nvidia (NVDA US, Singularity Score: 98), and **Microsoft** (MSFT US, Singularity Score: 38).

Overall, **the biggest Singularity Sectors in the Index post rebalancing on November 18 are Compute Power (20.9%), Big Data (19.2%), and Robotics (13.8%)**. In terms of traditional sectors (GICS), Information Technology remains the largest sector, followed by Health Care and Industrials, which both increase in overall weight, whereas Communication

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Services sees a decrease. Viewed by region, Western Europe and Asia Pacific increase to 14.2% and 17.4% respectively, mostly at the expense of North America. Market cap exposure moves further away from mega (27.9%) and large cap (54.3%) to small cap (+3.4pp).

Table 1

Summary of Exposure Changes Post Rebalancing

Singularity Sector	post	pre	+/-
Compute Power	20.9%	20.9%	0.0%
Big Data	19.2%	21.0%	-1.8%
Robotics	13.8%	12.5%	1.3%
Bioinformatics	11.0%	5.1%	5.9%
Extended Reality	10.4%	7.7%	2.7%
Artificial Intelligence	7.1%	15.4%	-8.3%
Internet of Things	6.9%	9.8%	-2.9%
Advanced Materials	6.5%	4.6%	1.9%
New Energy	3.6%	2.2%	1.5%
Blockchain	0.7%	0.5%	0.2%

Region	post	pre	+/-
North America	68.0%	71.9%	-3.9%
Asia Pacific	17.4%	16.1%	1.3%
Western Europe	14.2%	11.7%	2.6%
Africa / Middle East	0.2%	0.2%	0.0%
South & Central America	0.2%	0.1%	0.0%

GICS Sector	post	pre	+/-
Information Technology	56.5%	55.7%	0.8%
Health Care	19.6%	13.5%	6.1%
Industrials	10.4%	7.5%	2.9%
Communication Services	6.4%	11.6%	-5.2%
Materials	2.6%	2.5%	0.1%
Financials	1.9%	3.2%	-1.4%
Consumer Discretionary	1.5%	2.6%	-1.1%
Consumer Staples	0.9%	0.9%	0.0%
Energy	0.3%	0.0%	0.3%
Utilities	0.1%	0.0%	0.1%
Real Estate	0.0%	2.6%	-2.6%

Market Capitalization	post	pre	+/-
Mega Cap	27.9%	31.4%	-3.5%
Large Cap	54.3%	54.4%	-0.1
Mid Cap	11.7%	11.5%	0.2%
Small Cap	6.1%	2.7%	3.4%
Micro Cap	0.0%	0.0%	0.0%

Source: Bloomberg, TSG

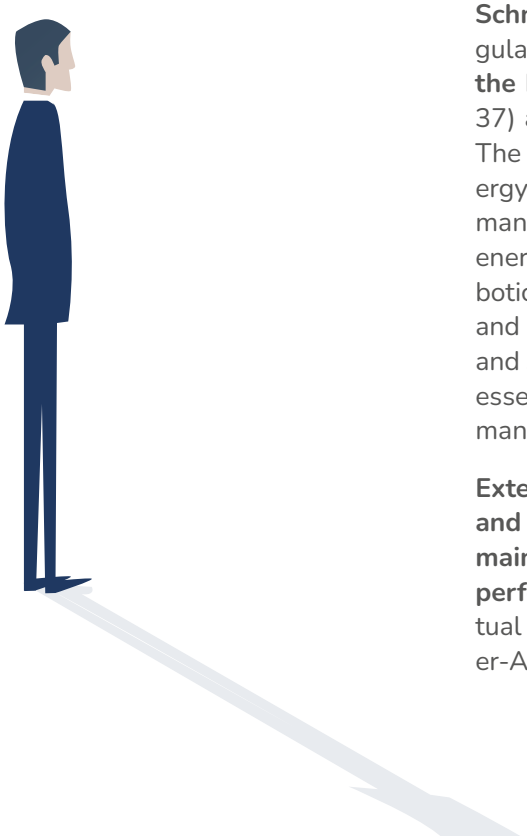
The shift away from Discriminative AI for online digital advertising leads to a decrease in portfolio exposure to AI in Communication Services as Alphabet's (GOOGL US, Singularity Score: 7) portfolio weight declines to 0.6% and **Meta Platforms** (META US, Singularity Score: 0) drops entirely from the Singularity Index (*see Section II for more details*). As a result, the regional weight for North America decreases. Another factor contributing to a decreased weight of AI in the portfolio is a move away from productivity software, where efficiency gains have been realized (e.g., video conference platforms are now part of daily working life) and Singularity Think Tank experts see only minor innovation improvements in the near future. Consequently, **Microsoft's** Singularity Score is reduced from 70 to 38. Nevertheless, it remains a top 3 holding. As most of its innovation revenues are generated in cloud computing and infrastructure-related activities, it is reclassified to Big Data (previously AI). Large pre-trained AI models are progressing at an accelerated pace but are not yet materializing in highly revenue-generative applica-

Advanced Materials continues to increase its standing in the portfolio with its weight more than doubling year-over-year to 6.5%.

tions. Once applicable, experts expect a major leap to be associated with the advancement of Generative AI, the technology underpinning headline-grabbing AI image generators like Dall-E and Midjourney.

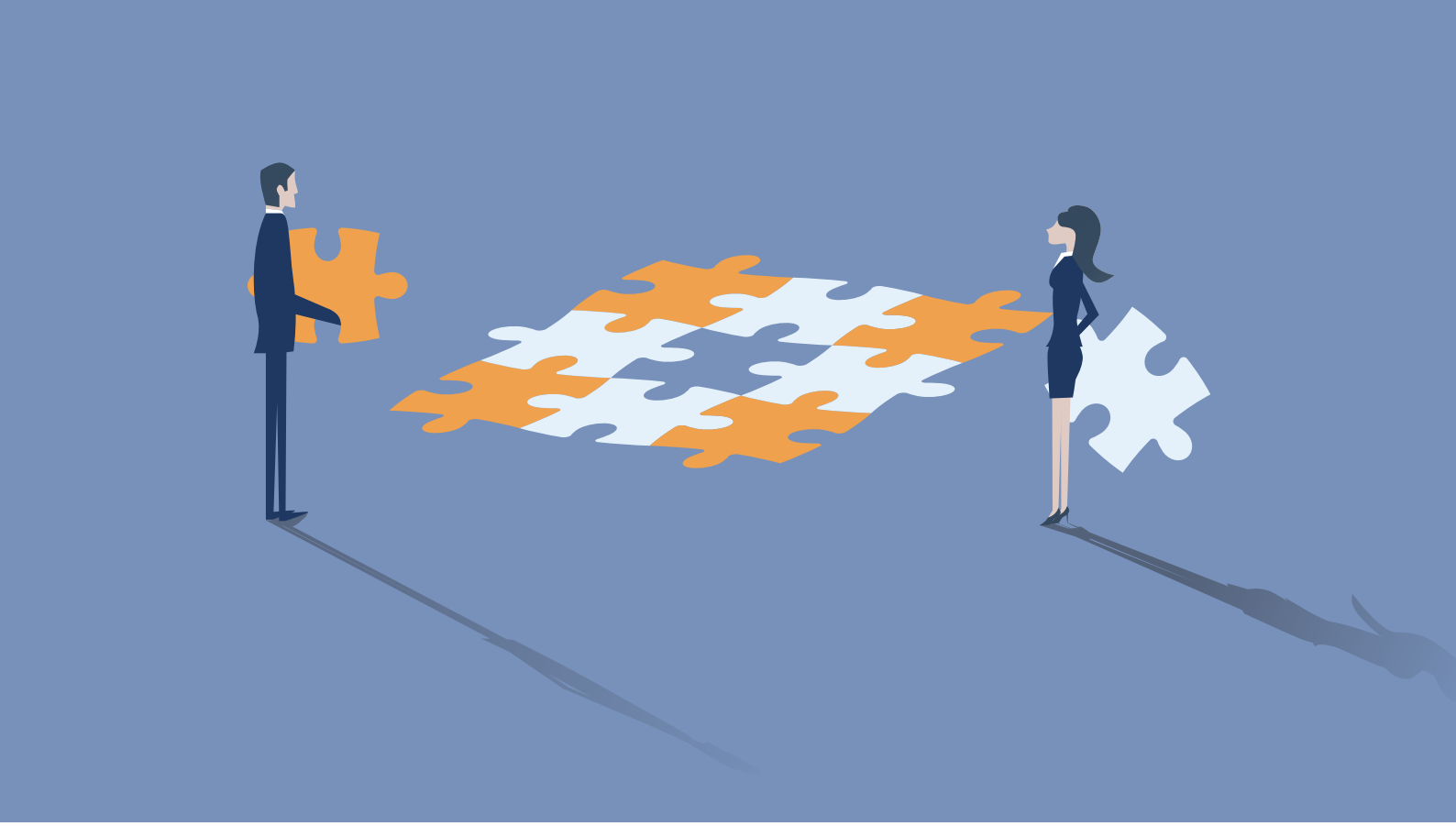
Advanced Materials continues to increase its standing in the portfolio with its weight more than doubling year-over-year to 6.5%. As described in detail in *Section II*, the importance of enzymes in the production process of flavors, fragrances, and alternative proteins for the growing Novel Food value chain leads to increased exposure to Materials and Consumer Staples with names including **Archer-Daniels-Midland** (ADM US, Singularity Score: 17), and **Givaudan** (GIVN SW, Singularity Score: 54). **Johnson & Johnson** (JNJ US, Singularity Score: 13), which was previously categorized under Robotics, is the largest holding in the sector. While the company retains exposure to both our Advanced Materials and Robotics sectors, the bulk of its innovation revenues are now related to applications of Advanced Materials around its activities in joint replacement and reconstruction, as well as orthopedic devices. Finally, the increased exposure to adhesives and sealants is worth noting. **Henkel** (HEN3 GY, Singularity Score: 48), a leader in this field, is benefitting from growth trends related to sustainability/circular economy, connectivity, and e-mobility. Adhesives containing chemical "switches" enclosed that allow for the disbanding of components into separate parts on demand after use are playing an increasingly important role (recyclability).

The profile for Bioinformatics is raised given our new focus on clinical diagnostics devices and kits and point-of-care testing leading to a material increase in the Singularity Index's Health Care exposure from 13.5% to 19.6% (*see Section II for more details*). **Abbott Laboratories** (ABT US, Singularity Score: 53) and **Roche** (ROG SW, Singularity Score: 27) are amongst the companies assigned higher portfolio weights in the process. The increase in Health Care exposure is to a lesser extent related to a new focus on minimally invasive surgical devices related to technology and procedures to perform "bloodless" interventions such as laparoscopic surgery, and micro-robots that perform intra-vessel procedures, or laser therapies.



The increased exposure to New Energy is driven by the additions of Schneider Electric (SU FP, Singularity Score: 100), **Eaton** (ETN US, Singularity Score: 37), **and Generac** (GNRC US, Singularity Score: 100) **in the Industrials sector, as well as Neste** (NESTE FH, Singularity Score: 37) **and VERBIO** (VBK GY, Singularity Score: 71) in the **Energy sector**. The products and services of **Schneider Electric**, the largest New Energy holding, play a central role in the digital transformation of energy management and automation and sit squarely in our focus areas of new energy infrastructure (New Energy), industry 4.0 factory automation (Robotics), and decision-making support systems. The electrical, industrial, and building automation products and services – which include sensors and software solutions within its integrated IoT system architecture – are essential for ensuring safe, efficient, and sustainable operations across manufacturing, building, and e-mobility applications.

Extended Reality's portfolio weight increases to 10.4%. Software and services drive value creation in this space while hardware remains a more challenging nut to crack in terms of form factor and performance. The creation and design of digital representations and virtual worlds are primarily facilitated by continued progress in Computer-Aided Design (CAD) and 3D simulation technology enabling design



Extended Reality's portfolio weight increases to 10.4%. Software and services drive value creation in the space while hardware remains a more challenging nut to crack in terms of form factor and performance.

applications across industries (see Section II for more details). Holdings include **Adobe** (ADBE US, Singularity Score: 100) and **Trimble** (TRMB US, Singularity Score: 39). Gaming software is a leading and major application area and driver of innovations in 3D simulation software and computer graphics. Technological innovation is the workhorse of the industry, where designing and delivering new experiences to gamers is paramount. This is increasingly leading to significant spill-over effects into other industries such as creating digital content in advertising where gaming engines (e.g., Unreal and Unity) are used to create more realistic and immersive advertising experiences including VR immersion that allow consumers to interact with their products in a realistic way.

The IoT sector weight decreases to 6.9%. Infrastructure operators and providers for the buildout of 5G networks had been a focus in the past but drop out in the recent rebalancing as the physical 5G infrastructure has largely been deployed. In addition, network infrastructure players involved in building the backbone of the internet such as high-speed fiber optics have moved out of focus. Companies that drop from the portfolio include **American Tower** (AMT US, Singularity Score: 0) and **Crown Castle** (CCI US, Singularity Score: 0).

1.2 Top Positions and Single Name Changes

Five companies push into the **top 20 holdings** in the Singularity Index in the latest rebalancing, namely **Danaher** (DHR US, Singularity Score: 84), **Accenture** (ACN US, Singularity Score: 62), **Abbott Laboratories** (ABT US, Singularity Score: 53), **Intuitive Surgical** (ISRG US, Singularity Score: 100), **Applied Materials** (AMAT US, Singularity Score: 92), and **Medtronic** (MDT US, Singularity Score: 64). The Index is well diversified with the top 5 positions summing up to 20.0% of the Index, the top 10 to 32.4%, and the top 20 to 46.2%.

1.3 Portfolio Characteristics

The portfolio characteristics of the Singularity Index continue to demonstrate an outstanding **growth and profitability profile, a strong balance sheet, and healthy liquidity at a reasonable valuation**: For instance, the portfolio boasts an operating margin of 25%, total debt to EBITDA of 1.8x, and a current ratio of 2.2x.

Table 2

Top 10 Holdings per Nov 18, 2022 Rebalancing

#	Company	Singularity Score	Singularity Sector	Weight (%)
1	Taiwan Semiconductor Manuf.	97	Compute Power	4.9
2	NVIDIA	98	Compute Power	4.3
3	Microsoft	38	Big Data	3.9
4	Apple	10	Internet of Things	3.6
5	ASML	100	Compute Power	3.4
6	Tencent	62	Extended Reality	3.1
7	Visa	100	Big Data	2.8
8	Danaher	84	Bioinformatics	2.3
9	Adobe	100	Extended Reality	2.2
10	Mastercard	100	Big Data	2.1

Source: Nasdaq, TSG

Table 3

Biggest Additions To / Removals From the Index

In	Company	Singularity Score	Singularity Sector	Wgt Chg (%)
1	Schneider Electric	100	New Energy	1.2
2	Eaton	37	New Energy	0.3
3	Rockwell Automation	75	Robotics	0.3
4	Insulet	92	Robotics	0.3
5	Neste	37	New Energy	0.2
6	Sysmex	100	Bioinformatics	0.2
7	Kubota	67	Robotics	0.2
8	CNH Industrial	44	Robotics	0.2
9	Hubbell	60	New Energy	0.1
10	DiaSorin	100	Bioinformatics	0.1

Out	Company	Singularity Score	Singularity Sector	Wgt Chg (%)
1	Meta Platforms			-1.6
2	Cisco	1	Internet of Things	-1.4
3	American Tower			-0.9
4	Samsung Electronics			-0.9
5	Crown Castle			-0.6
6	Micron Technology			-0.5
7	Equinix			-0.5
8	L'Oréal			-0.5
9	Intel			-0.4
10	SK hynix			-0.4

Source: Nasdaq, TSG

Table 4

Portfolio Characteristics as of Nov 18, 2022

	Singularity Index	MSCI ACWI	+/-
PROFITABILITY			
Profit Margin	20.8%	17.8%	3.0%
Operating Margin	24.9%	22.6%	2.4%
Return on Capital	19.6%	15.9%	3.7%
Return on Equity	22.9%	19.9%	3.1%
Return on Assets	11.0%	8.7%	2.4%
BALANCE SHEET			
Total Debt to Equity	91%	124%	-33%
Total Debt to Total Assets	24%	26%	-2%
Total Debt to EBITDA	1.8	2.6	-0.8
LIQUIDITY			
Quick Ratio	1.9	1.4	0.5
Current Ratio	2.2	1.6	0.6
GROWTH RATES (3yr CARG)			
Revenue	16.6%	10.1%	6.4%
EBITDA	19.6%	14.3%	5.2%
EPS	23.5%	15.9%	7.6%
VALUATION			
EV/EBITDA	20.6	12.7	7.9
P/E Ratio (LTM)	31.0	17.5	13.5
P/FCF Ratio	30.8	14.8	16.0
Dividend Yield	1.0%	2.2%	-1.2%

Source: Factset, TSG

II. INNOVATION RESEARCH UPDATE

2.1 Key Sector Changes

The current rebalancing includes a number of significant sector changes in Artificial Intelligence, New Energy, Compute Power, Advanced Materials, Bioinformatics, and Robotics. We also rename our Virtual Reality sector to Extended Reality, reflecting a broader focus on technologies that enable the blending of physical and virtual environments.

Artificial Intelligence

Out of Focus: Discriminative AI for online digital advertising. Over the past years, online digital advertising has been one of the fastest-growing segments in our Artificial Intelligence sector. Based on expert consultations and internal research, **we see such growth plateauing in the mid term.**

Between 2017 and 2021, Singularity Revenues for Digital Advertising grew with a CAGR of 22 percent from close to USD 145 billion to USD 317 billion in 2021. **Alphabet** (GOOGL US, Singularity Score: 7), one of the largest players in the space, has been applying AI algorithms for years to power its targeted ads, using its troves of data on user search queries to quickly and accurately analyze user data, adjust digital advertising campaign parameters, and serve up relevant ads. Similarly, yet

The Index is well diversified with the top 5 positions summing up to 20.0% of the Index, the top 10 to 32.4%, and the top 20 to 46.2%.

While the combination of discriminative AI and access to Big Data has proven effective in penetrating the ad market, key players seem to have reached limitations with current applications and formulas of discriminative AI. Indeed, by now, AI-based ad targeting is largely integrated into all major social networks and search platforms.

relying on social network data, **Meta Platforms** (META US, Singularity Score: 0) has also applied advanced data analytics to study user behavior across different websites and devices, providing advertisers with valuable insights into consumer preferences and trends. With the help of AI, digital advertising has quickly become more effective and efficient, enabling businesses to reach their target audiences more precisely.

While 2022 has seen significant revenue growth as an after-effect of the COVID-19 pandemic, we see the main driver for continued growth and margin expansion diminishing. While the combination of discriminative AI and access to Big Data has proven effective in penetrating the ad market, key players seem to have reached limitations with current applications and formulas of discriminative AI. Indeed, **by now, AI-based ad targeting is largely integrated into all major social networks and search platforms**. Alexander Stumpfegger, Singularity Think Tank Expert and Chief Sales Officer at CID notes: ***"Web search ads continue to be a big cash cow, but the improvements that AI offers are more minor these days. It's unlikely to be the game changer any time soon and investments in AI are now directed more to non-search related fields such as robotics, autonomous driving, and workforce automation."*** AI expert Dr. Donnacha Daly adds: ***"We're all micro-targeted on the web every time we do a search, I think that's quite a mature technology. Companies have basically thrown everything but the kitchen sink at that. They're extracting and exploiting everything that can be done in that market."*** In the longer term, we see a next generation of Generative AI, Metaverse advertising, and localization technologies enabling another leg up for digital advertising. However, the rollout of such advancements faces both technological and ethical hurdles that will have to be ironed out in the coming 2-3 years.

Another major challenge for AI-based digital advertising lies in the access to the detailed user data that online advertisers rely on to create value. Industry incumbents are facing a changing regulatory landscape on data protection and a push towards greater privacy-preserving practices from consumers. Moreover, increased industry competition driven by new entrants puts ad margins under further pressure.

New Energy

In Focus: Renewable and biofuel technologies positioned to penetrate energy markets. A growing focus area within the New Energy sector of the portfolio is the value chain for renewable- and biofuels, capturing manufacturers of biodiesel, renewable diesel, bioethanol, and bio naphtha, as well as companies supplying the renewable feedstock streams for these production processes. Singularity Revenues for this product category saw a CAGR of 10 percent from USD 8.6 billion in 2017 to USD 15.1 billion in 2021, reflecting the increasing economic viability of manufacturing technologies. In the years ahead, we see a **high potential for second-generation renewable diesel and biofuels**, i.e., fuels based on feedstock sourced from reused by-products of industrial and agricultural production processes (e.g., agricultural and forest waste) rather than feedstocks competing with animal and human food streams (e.g., corn, sugarcane, and rye).

While interest in renewable fuels is steadily picking up, the economics of these products are complex, explains James Khedari, STT energy expert and Portfolio Director for Low Carbon fuels and services at Viva Energy Australia: ***"Currently, the European diesel pool is fully saturated with***

the maximum biodiesel (FAME) allowed in the fuel pool (7 percent). To keep lowering tailpipe emissions, producers now have to turn to renewable diesel, increase the use of alternative fuels (biomethane/H2), or risk paying penalties for non-compliance with CO2 emission regulations. Regulators are conscious of this and there has been a proposed change to the European Fuels Quality Directive (FQD) to allow for up to 10% biodiesel content in retail diesel. Absent a change in regulation, we tend to see that the price for renewable diesel trends consistently above biodiesel and is capped by the cost of non-compliance."

The Singularity Index includes several key industry players. **Neste** (NESTE FH, Singularity Score: 37) is a global leader in biodiesel and renewable diesel fuel manufacturing, which has been expanding its refining capacity in Singapore, the US, and The Netherlands to meet the growing demand for renewables. The Neste Singapore refinery expansion creates additional production capacity of 1 million tons of sustainable aviation fuel and renewable raw materials for polymers and chemicals by 2023.

Finnish **UPM-Kymmene Oyj** (UPM FH, Singularity Score: 20), the world's second-leading producer of paper and board, has developed a new type of biofuel, called UPM BioVerno. This fuel is made from crude tall oil, a wood-based residual raw material from sustainably managed forests. UPM BioVerno can be used in any diesel engine, without the need for modifications, thus significantly reducing emissions of carbon dioxide and other greenhouse gases. The company also produces a renewable naphtha with the potential of replacing fossil raw materials in various products such as plastics, glues, and films.

Compute Power: Meeting the growing demand for Compute Power in Cloud and Artificial Intelligence/Machine Learning (AI/ML) applications

In Focus: Design tools and software, front-end equipment, and advanced compute chips. Earlier this year, we introduced our new Compute Power sector to more effectively track the technological evolution in the semiconductor value chain and identify major value-creating innovations in computing across industries and domains of application. In the current rebalancing, **Compute Power remains the largest sector** in the Singularity Index, with a weight of 20.9% (second-largest by unconstrained weights). Our focus is on the value chain activities benefiting most from the growing demand for Big Data processing solutions in Cloud computing, specialized chips, and AI/ML-based applications.

Covered in the portfolio are the **producers of electronic design automation software used in the process of creating and verifying the design of complex integrated circuits**. Such tools are critical for enabling rapid creation and testing of new chip designs. One company leading the pack in this space is **Synopsys** (SNPS US, Singularity Score: 100). Manu Nair, CEO and founder of Synthara, comments: ***"Chip design has become increasingly difficult and cost-intensive as the complexity of the designs increases and the node size decreases. The producers of these design tools have cornered the market with very specialized and sophisticated tools. No designer would be comfortable switching to an untested new provider."***

Another focus area concerns the manufacturers of **front-end process equipment for wafer fabrication**, which include technologies for photolithography, photomask fabrication, layer deposition, etching, stripping,

"The Compute space is moving faster and faster and becoming more fragmented. Different use cases and industries need different chips with specific architectures."

Manu Nair
Singularity Think Tank expert

and cleaning, as well as the inspection, review, and metrology technologies that enable monitoring and control of core semiconductor wafer manufacturing steps. Key players in the portfolio servicing this space include **LAM Research** (LRCX US, Singularity Score: 100).

New technologies in front-end equipment drive innovation in the adjacent value chain both upstream and downstream: Upstream, innovations are creating new design opportunities that enable faster, smaller, and more energy-efficient chips. In logic technology (i.e., microprocessors), for example, the past few years have seen a steady shift in demand away from general-purpose Central Processing Units (CPUs), which have become largely commoditized, toward special-purpose chips and System-on-Chip IC designs (SoCs) that integrate multiple computer components. As Manu Nair comments, ***"the Compute space is moving faster and faster and becoming more fragmented. Different use cases and industries need different chips with specific architectures."*** Examples include **Nvidia's** (NVDA US, Singularity Score: 98) custom designed **Graphics Processing Units (GPUs)** for image processing, computer graphics, and Machine Learning functions and its **Data Processing Units (DPUs)** for hybrid cloud, high-performance computing, and 5G wireless networks. Given the fragmentation in the logic landscape, this rebalancing marks a move away from commoditized and largely standard CPU manufacturing and a focus on highly advanced, specialized, and custom chip production. Downstream, the production of such chips requires advanced foundry process technology to realize the full potential of the equipment and desired yield. Only a handful of advanced foundries are able to produce chips designed on the latest node, among which is **Taiwan Semiconductor Manufacturing Company** (2330 TW, Singularity Score: 97), the world's largest semiconductor foundry.

Advanced Materials

In Focus: High value-added enzymes for cleaner value chains. The current rebalancing sees an increased focus on the complex and high-value-added production of enzymes. Enzymes are proteins that are found in all living cells and are essential for metabolism. They play a vital role in many biochemical processes such as digestion and respiration by "catalyzing" (i.e., speeding up) chemical reactions in a resource- and energy-efficient way – without being consumed in the process. In recent years, key technological innovations in enzyme production pertaining to precision fermentation, protein engineering, and CRISPR CAS genome editing have allowed enzymes to be engineered for greater stability and activity, robustness, substrate specificity, and increased yield, resulting in significant cost reduction and novel applications.

"Enzymes are best seen as a platform technology," explains STT biotechnology expert Dr. Juergen Eck. ***"The enzyme business involves both the biocatalysts side – where enzymes are used in industrial production processes but aren't part of the end product – and a side where enzymes are the actual part of the end product, such as in a laundry detergent."***

In the process of precision fermentation, enzymes play a critical role in the production of flavors, fragrances, and alternative proteins for the Novel Food value chain. Similarly, in the pharmaceutical industry, enzymes are applied in the creation of chiral molecules with specific medicinal properties, and thus enable new and more effective drugs. ***"Enzymes are a ver-***

"Enzymes are a versatile and extremely important tool in modern industry. By the time you're done with breakfast, you've already been in touch with dozens of different types of enzymes."

Juergen Eck
Singularity Think Tank expert

satile and extremely important tool in modern industry. By the time you're done with breakfast, you've already been in touch with dozens of different types of enzymes," notes Eck.

Because enzymes offer opportunities for r**eplacing harmful chemicals** in production processes and consumer products, they increasingly find application in a wide range of industries pushing for a transition towards more sustainable processes and products. For example, as the world seeks to move away from fossil fuels, enzymes have come to play an increasingly important role in the industrial **production of renewable fuels such as biodiesel**. In these applications, enzymes offer efficiency, cost, and sustainability advantages over traditional methods of fuel production.

Novozymes (NZYMB DB, Singularity Score: 41) is a world leader in the production of innovative enzymes and a licenser of enzyme technologies. The company's technologies enable it to identify enzymes with desirable characteristics, optimize the genes responsible for its production, and transfer genes to microorganisms with suitable growth characteristics. Its products find use in over 700 different industrial applications including food processing, animal feed, detergents, and biofuels, as well as a range of diagnostic and therapeutic purposes.

Bioinformatics: Growing demand for diagnostic devices and kits for an aging population

In Focus: Clinical diagnostic devices and kits and point-of-care testing. *In vitro* diagnostics constitutes one of the major segments and growth drivers in the medical devices market, accounting for roughly 20 percent of worldwide medical device revenues.[1] *In vitro* diagnostics includes medical devices and diagnostic procedures for the detection and measurement of biomolecules, microorganisms, and cells taken from the human body. Such devices and procedures find application in hospitals, laboratories, and point-of-care settings for disease diagnosis, detection, and management.

In the current rebalancing, **we expand our focus on clinical diagnostic devices and kits and point-of-care diagnostic devices** in light of **growing demand and a strong impetus for innovation. Total Singularity Revenues for in vitro diagnostic devices and testing kits increased at a CAGR of 21%** between 2017 and 2021 to USD 115 billion. We see this growth continuing in the mid term driven by an upward trend in global life expectancy: The population aged over 80 years is set to triple to 426 million and the population aged over 60 years to double to 1.4 billion by 2050.[2] Further impetus comes from the rising prevalence of chronic and lifestyle diseases such as Type II Diabetes, and growing public health awareness for early disease diagnosis.

Companies monetizing these developments include **Abbott Laboratories** (ABT US, Singularity Score: 53) which reported 45% sales growth in its Diagnostics segment in 2021, including a contribution of 95% sales growth in its Rapid Diagnostics customer area from USD 4.4 billion in 2020 to USD 8.6 billion in 2021. Operating earnings for its Medical Devices segment increased even faster in 2021 (49%), with a comfortable

1. Statista Health Market Outlook 2022
2. The World Health Organization (WHO), Ageing and Health fact sheet 2022.

"Weeding robots, for example, need to very rapidly decide whether something is a weed or crop and to remove the weed to have a real use case. Speed of image recognition and processing is essential there and this is an area that has seen important enabling innovations in recent years."

Matthias Erb
Singularity Think Tank expert

operating margin of 31%. These developments were primarily driven by increasing revenues in its Diabetes Care customer area (+33%), mostly from the continuous glucose monitoring (CGM) system, FreeStyle Libre. The third generation of the company's CGM system features a thin glucose sensor that can be worn for up to 14 days and provides real-time glucose reading on the user's smartphone, delivering significant benefits to patients over devices with a shorter renewal span.

Robotics, Big Data, & IoT: Digitization of connected AgriTech

In Focus: Farming robots. For the medium term, our expert-led process has us foreseeing revenue growth opportunities from innovations in agricultural technology (AgriTech). Recent years have seen a rise in the feasibility and adoption of robotization and other forms of agritech innovation in the farming industry, involving new machinery and smart automation methods that aim to make farming more efficient and less labor-intensive, and decrease the risk of injuries.

Matthias Erb, co-founder of Boum AG and Professor of Plant Sciences at Bern University explains: ***"People in the industry are very excited about robotic machines in this space because you have a very pesticide- and labor-intensive step of weeding and a labor-intensive step of harvesting certain crops. Weeding robots, for example, need to very rapidly decide whether something is a weed or crop and to remove the weed to have a real use case. Speed of image recognition and processing is essential there and this is an area that has seen important enabling innovations in recent years."***

With our increased concentration on farming machinery and robotics, innovation leader **Deere & Co** (DE US, Singularity Score: 56) sees its Singularity Score rising from 29 to 57. The company develops and manufactures cutting-edge "Precision Ag" machines that apply advanced image recognition and processing technologies, sensors, and network connectivity technology for critical farm operations such as weeding, planting, and harvesting, and applying fertilizers and pesticides to crops. By combining robotics, IoT, and Big Data technologies in its machines and data management solutions, the company enables farmers to improve fuel and input efficiency, document and optimize yields, remotely manage equipment, and accurately guide machines.

From "Virtual-" to "Extended Reality"

Extended Reality (XR) is an umbrella term for the wide spectrum of technologies on the Reality-Virtuality continuum. These range from the real environment to the fully digital environment of Virtual Reality (VR), and the "mixed reality" (MR) variations in between, including virtually augmented real environments known as Augmented Reality (AR) (think of a digital bird projected on a real sky), and virtual environments augmented with real-life elements known as Augmented Virtuality (AV) (think of a real human hand appearing in a virtual world). To many, the terms VR and AR conjure up images of gamers wearing bulky headsets, failed Google glasses, and mysterious Apple projects. To technology insiders, transformative opportunities lie ahead, yet significant challenges remain in creating seamless extended reality experiences.

AR and VR experiences already find applications in training and education, where immersive simulations of real-world settings such as flight simulation and surgery enable more effective learning experiences.

In Focus: CAD and 3D simulation software. More broadly defined, Extended Reality is rapidly materializing with new applications in CAD (Computer-Aided Design) and simulation software tools. Such tools empower designers to create 3D designs and **digital twins** based on **LiDAR and photogrammetry point-cloud technologies** to provide realistic and engaging environments for media and entertainment, product design and manufacturing, and architecture, engineering, and construction. In the construction industry, for example, companies such as **Autodesk** (ADSK, US, Singularity Score: 100) enable designers to create advanced 3D simulations for virtual prototypes of products and buildings, allowing creations to be tested in different scenarios, and ensuring safety and efficiency before being built, resulting in higher quality and efficiency.

Future Focus: Understanding the technological challenges in AR. When it comes to developing the critical technology required to unleash the potential of AR, Dr. Tomas Sluka, CEO and co-founder of AR start-up CREAL, stands at the front lines. His company targets the core technological challenges to bring natural vision into AR. ***"One of the main frontiers for full-scale AR is currently in the development of a display technology that gives true depth at any distance of an object with better immersion and a natural user experience. The sensors are there, the compute power is there, but the display is the weakest link. I believe we can unlock the full potential of AR with our light-field technology."*** CREAL's alternative AR technologies are met with high interest and large investments by the likes of **Meta Platforms** (META US, Singularity Score: 0) and **Apple** (AAPL US, Singularity Score: 10). ***"But the technology is not ready yet," notes Sluka. "I see consumer-ready AR glasses appearing earliest by 2026. Apple and others might release high-end AR devices earlier but these won't be truly glasses, rather headsets and smart glasses that will be fashion items with the performance of a hands-free smartwatch, not truly AR glasses."***

As for the future, Sluka predicts that in 10 years, once the technological problems have been solved, this industry will be all about software and services, whereas the hardware may even have to be subsidized. ***"As an eyewear product, fashion and branding will certainly play a critical role too. For now, the technology doesn't need to be perfect. In work settings where the cost of errors is high and the advantages of AR and VR are more immediate, the hardware can be poor and still provide significant advantages,"*** he notes.

Indeed, AR and VR experiences already find applications in training and education, where immersive simulations of real-world settings such as flight simulation and surgery enable more effective learning experiences. In the near future, applications are likely to expand to remote servicing and the upskilling of less qualified workers operating remotely in complex service and manufacturing activities. More radically, the widespread adoption of virtual interactions in the Metaverse will provide a host of opportunities for replacing physical interactions in the workplace and in private life. We continue to monitor these applications closely so as to identify their potential transition into sources of innovation-enabled growth and value.

THE SINGULARITY INDEX

The Singularity Index™ ("Index") is a global equity index and gold standard for innovation benchmarking. Based on continuous consultation with expert advisors from the Singularity Think Tank, our methodology screens for value creation from innovation across sectors and industries, resulting in a metric that reflects a company's ability for survival, adaptability, and progress. The Singularity Index offers an antidote to typical technology equity indices in that it selects only companies that are capable of creating **cash inflow linked to applied innovation** (current exposure ex-tech of 43%). We call such areas 'Key Focus Areas' while we steer away both from areas of innovation whose time has not come yet ('Future Focus') and those that have run their course and are tapering off ('Out of Focus'). The key metric used in building the Index is the **Singularity Score**, which measures the degree of innovation of companies globally and across sectors, and represents the percentage of revenue associated with viable, relevant innovation.

Singularity Score

The Singularity Score represents the percentage of a company's revenues associated with innovation. It reflects a company's ability to create innovation revenues vs base/commoditized business and cash flows, and its ability to participate in technological evolution. Changes in the Singularity Score are just as important as the absolute value. A company's Singularity Score relative to its overall GICS sector Singularity Score can say a lot about the company's competitive standing and ability to gain and maintain market share. Regional Singularity Scores can be used to evaluate a market's innovation power, as well as gauge companies' standings in different regions.

The Methodology

From a universe of 48'000 stocks to the Singularity Index™ of 300 stocks

A global all-cap universe is filtered for exposure to Singularity Sectors, whilst applying a thorough ESG screening and trade-friendly market cap and liquidity filters. Market cap is multiplied by Singularity Exposure (% Revenue) to define the weighting and ranking of constituents. This methodology reduces the weight of large-cap companies with little exposure to Innovation and allows for **higher weighting of companies with higher growth in innovation.**

Global Equity All-Cap Universe — ~ 48'000

- Liquidity Restriction: 3 month ADTV minimum $1mn
- Market Cap Restriction: Free Float Market Cap minimum $100mn
- Total revenue exposure to Singularity Sectors: > 0
- ESG filter: exclusion screens for controversies, global norms, and business involvement
- May not be issued by an issuer currently in bankruptcy proceedings
- May not have entered into a definitive agreement orother arrangement which would likely result in the security no longer being Index eligible
- One security per issuer is permitted

Singularity Universe — ~ 5'000

- Singularity % > 10% to get in; < 5% to drop out
- Singularity % x market cap in $ defines ranking
- ESG Best-in-Class: Exclusion of ESG laggards (bottom quintile)

Singularity Index™ – Singularity Fund™ — 300

- Singularity % > 10% to get in; < 5% to drop out
- Singularity % x market cap in $ defines ranking
- ESG Best-in-Class: Exclusion of ESG laggards (bottom quintile)

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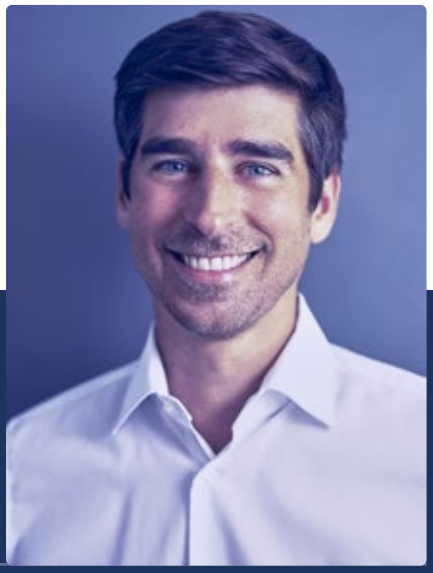

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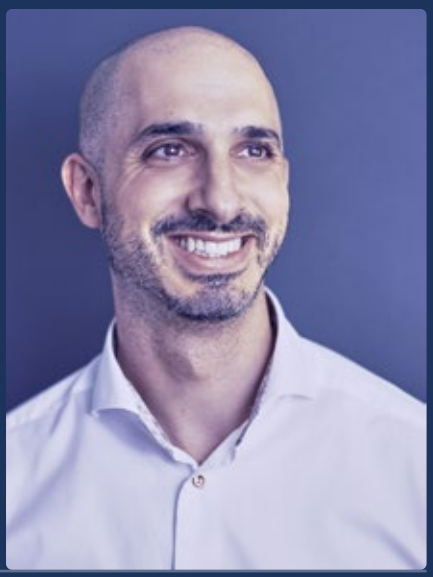

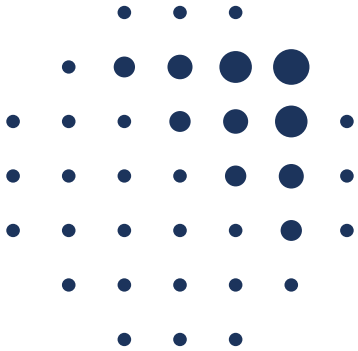

More information & Contact

The next rebalancing is scheduled for May 2023. For more information and questions please contact us at **info@singularity-group.com**

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