How emerging technology trends may lead to impacts and opportunities for entrepreneurial start-ups

Robert J. Lahm, Jr., Ph.D.
Western Carolina University

Madelynn Duffield
Western Carolina University

ABSTRACT

Innovation is an essential activity in a dynamic environment, which is simultaneously developing new technologies while also being driven by them. Although many start-ups may be founded in incumbent industries with well-established products, services, processes, and business models, even some of these may be facing unforeseen challenges to traditional ways of conducting business. Robots, for instance, are already being deployed in the food service industry and they can perform such tasks as flipping burgers and making French fries; bartending, salad-making, and automatic pizza-making robots are also emerging[1]. Businesses like Costco are installing kiosks for ordering and payment processing in their food service areas. While these technologies may threaten traditions, they also present entrepreneurial opportunities. The global COVID-19 pandemic, while shuddering some types of businesses, also led to new innovations entirely. It propelled enhancements and implementation of preexisting ideas – telemedicine being a prime example of a concept that rapidly accelerated in the wake of social distancing strategies. This research explores innovation strategies generally and addresses some constraints, as well as approaches that may be taken by entrepreneurial start-ups as they seek to innovate.

Keywords: creativity, innovation, future trends, small business, entrepreneurship.

Copyright statement: Authors retain the copyright to the manuscripts published in AABRI journals. Please see the AABRI Copyright Policy at http://www.aabri.com/copyright.html

[1] Feller, C. (2021, June 21). *10 robots automating the restaurant industry*. Retrieved February 26 from https://www.fastcasual.com/blogs/10-robots-automating-the-restaurant-industry/

INTRODUCTION

As stated by Demir (2018), the only way to create sustainable growth is to innovate new products, services, and business models. This conceptual research explores innovation strategies at large while focusing on their applicability to entrepreneurial development, e.g., new product development (NPD) methods for start-ups. Innovation in the context of new products (inclusive of services: hereinafter these two terms shall be treated as synonymous) involves making significant improvements to previous products or introducing entirely new offerings on the part of a given firm (Carvalho & Madeira, 2021). However, while NPD professionals may have high hopes in "developing 'the next big thing' in their respective industries, most product development efforts focus on incremental innovations" (Veryzer, 1998, p. 304). Hence, new products may practically be regarded on an infinite scale of sorts. One end would represent modest variations from prior offerings in a marketplace, while the other more "radical" (O'Connor & Ayers, 2005; Veryzer, 1998) end may be "responsible for creating entire new industries and dramatically enhancing living standards" (Golder et al., 2009, p. 166). Innovation in most business contexts, often entails new or improved technologies, products, and/or processes (Bezhovski et al., 2021, p. 308). Entrepreneurs may innovate in several ways, including initial idea generation, a.k.a., ideation, developing new production methods, organizing (or re-organizing) business operations differently, opening new markets, and implementing new business models (Bruni et al., 2019).

LITERATURE REVIEW

The topic of interest in this present paper is part of a continuing research stream, including innovation generally, but also unique responses on the part of small businesses, i.e., entrepreneurs (and larger ones, too) in relation to COVID-19. The purpose of such efforts is to add to the literature of the entrepreneurship discipline. This research is undergirded by data held in several preexisting (local) databases, each of which having the ability to be queried, and further supported by new searches in scholarly literature. Jerome Katz (2019) has compiled and maintained updated versions of a list entitled "*Core publications in entrepreneurship and related fields: A guide to getting published,*" and Version 9.1 is being regarded as authoritative in determining existing coverage in the scholarly literature that is associated with present efforts. Clearly, there is an abundance of literature on new product development (NPD) and innovation at large.

As resources, databases including ABI/INFORM, ProQuest, and Ebsco, have been consulted. A search on the term "innovation <u>and</u> entrepreneurship" produced thousands of results in a university library (available to researchers pursuing this present paper). However, these included results generated across other disciplines, such as engineering, sciences, and fields of endeavor that might not be consumed by the typical entrepreneurship scholar or practitioner. To narrow these results, limiters were applied to full text (available); scholarly (peer reviewed), in the past year, and finally, in the engineering literature. Such limitations could appear as excessive (and perhaps even misdirected). With this acknowledged, tools associated with a digital revolution (Marion et al., 2020) are altering the innovation landscape at a rapid pace. Arguably, not since Edison effectively modified the process of invention itself by applying methods of mass production, whereby "skilled scientists, machinists, designers, and others collaborated at a single facility to research, develop, and manufacture new technologies" (*Thomas Edison and Menlo Park*, 2023), have we seen such dynamism and change.

We seek to cross pollinate what is happening now within the spheres of science and engineering, to further decipher what that might mean for entrepreneurial start-ups. To this end, 277 artifacts have been aggregated to support this present paper. Software has been used to manage the databases. Individual entries can be associated with accompanying files in various popular formats (e.g., Excel, PDF, and images). Thus, the technology in use for this research can support both the indexing of artifacts, and their access, storage, and retrieval for further analysis. Multiple search terms and strategies have been employed to populate the local databases discussed above, while data collection for these has taken place in connection with research projects that have been conducted over a period of several years. Under a qualitative researcher's framework, artifacts are to be considered synonymous with data, and vice versa.

To better inform data collection methods, several qualitative research resources have been consulted. Under a qualitative research paradigm, any/all artifacts may be subjected to analysis (Creswell, 1994; Glesne & Peshkin, 1992; Huberman & Miles, 1994; Strauss & Corbin, 1994). From sources besides well-known library databases, reports from research organizations, such as the NFIB Research Foundation and publications from government agencies, have also been curated. Finally, because innovations are developing at what seems to be breakneck speed, and scholarly research (typically with a long publication cycle) can be slow to emerge, popular press venues are sometimes useful.

RESEARCH METHOD

The use of a qualitative research frame is appropriate when phenomena of interest are emergent. It can be used to "uncover and understand what lies behind any phenomenon about which little is yet known" (Strauss & Corbin, 1990, p. 19). Entrepreneurship and innovation unto themselves are not new, of course, but digital tools like artificial intelligence (A.I.), robotics, and some developments in materials science – as examples – are certainly foreshadowing innovations that are predictably on the horizon. A further example can lead to rather astonishing implications: self-replicating 3D printers, i.e., 3D printers that make other 3D printers (Pultarova, 2017). One may also expect unintended consequences, which throughout history have presented themselves as both good and bad. Qualitative approaches are useful in a dynamic environment, with rapidly arising technological developments being a contributor. In the wake of many problems prompted by COVID-19 (some of which persist, e.g., supply chain, labor shortages), innovation was also spurred on many fronts (Lahm Jr., 2021). Qualitative inquiry may aid researchers in developing contextual findings (Barry, 1996; Schwandt, 1994). These contextual findings may also provide stepping-stones for future research.

TIMES ARE CHANGING

New technologies have always had a combinational affect: a book of matches could lead to desired warmth or an uncontrolled fire, which produces a need for fire extinguishing technology (and with forethought, a smoke detector could be desirable as well). "Technology and digitalization [also] come as new entrepreneurship opportunities and bring new solutions and possibilities for innovation (3D print, IoT, Artificial Intelligence; Blockchain, etc.)" (Carvalho & Madeira, 2021, p. 2). Ferasso et al. (2018), observed that, where certain industries have increased potential for new business opportunities (nanotechnology, biotechnology, and aerospace were indicated, but there are many more, such as A.I. and robotics as applied to myriad uses from services to manufacturing), highly skilled workers, using knowledge and resources from around the globe, may also be required. When introducing new technologies into organizations, it is important to select qualified personnel and to support them in their roles (Iakovets et al., 2023). Software 2.0, or machine-written code (Van Kuiken, 2022), is also arising in connection with A.I.; with Software 1.0, human programmers wrote code.

While some robots can simply be programmed (Gottlieb & Leech Anderson, 2011), e.g., in the robot arms (Articulated category), and are not necessarily associated with A.I., going forward it appears that most will be; and that means, in consideration of Software 2.0, self-programming may increasingly occur. Further, robots may be deployed as interconnected "swarms" (Arnold et al., 2019), communicating with one another, e.g., through Bluetooth, wireless networks (LANs), or infrared LEDs (*Swarm communication*). Types of robots and their uses across industries are illustrated (including an early domestic service robot, a Roomba) in Figure 1, Appendix.

Along the lines of items labeled "Enablers" in Figure 1, Golder et al. (2009) discussed the relevance of core technologies. Examples would include vacuum tubes in early radios, televisions, and computers, which were then superseded by new ones: first transistors, and next, microprocessors, i.e., (CPUs).

The Future of Processing

In an interview conducted by *Semiconductor Engineering* (Sperling, 2022) with Mark Papermaster, chief technology officer (CTO) and executive vice president of Technology and Engineering at Advanced Micro Devices (AMD), a leading computer processor developer, he stated (while addressing what the future of processing would look like in five years):

> There is no question that the future of processing is heterogeneous. It's multiple compute engines working in tandem, because massive data and graphics processing is needed everywhere. It's needed in data centers and in PCs, and the explosion of data from the Internet of Things requires analysis and visualization across that whole food chain.

It should be mentioned that applications for microprocessors have expanded exponentially, far beyond where they started (mostly computers). In 1971, Intel Corporation claims credit for introducing the world's first commercially available microprocessor (*Intel celebrates 40 years of digital revolution*, 2011). They are now ubiquitous and can be found in not just computers, but phones, tablets, TVs, digital cameras, appliances (both large and small), planes (trains and other vehicles), even chain saws for engine monitoring and control (*Intelligent engine management: Built-in intelligence*).

The Future of IoT

Bezhovski et al. (2021) researched some of the opportunities that have presented themselves as enabled by a new Information and Communications Technology (ICT) environment. The evolution to 5G wireless network speeds, and following that 6G (starting in 2030, according to goals and estimates) portends to enable dramatic changes in speed and connectivity. These will usher in a host of technological enhancements, in particular, the mass proliferation of sensors embedded in IoT (Internet of Things) and IIoT (Industrial Internet of Things) processes. As explained in a call for papers for an upcoming special edition of the academic journal, *Sensors*, "IoT is an evolution of the Internet from the 'Internet of People," to the 'Internet of Things,' and further to the 'Internet of Everything'" (Cristina Gaitan & Ungurean, 2023). Figure 2 (Appendix) illustrates a part of the ICT environment in relation to wireless network speeds, which to be clear, is one communication modality that may be used for connectivity among IoT devices and corresponding sensors.

Data and Storage Growing "at an Exponential Pace"

"The volume of data being created, shared, and stored is increasing at an exponential pace" (*How third-party information can enhance data analytics*, 2019). By 2025 projections indicate that the amount of global data that will be created will reach 181 Zettabytes. To provide further perspective, in five year increments from 2010 the amounts were 2; 2015/15.5; and 2020/64.2 Zettabytes, respectively (Taylor, 2022). As many readers here may be accustomed to hard drive and SSD storage devices with increments in Terabytes, one Zettabyte is equivalent to a billion Terabytes, or a trillion Gigabytes (Barnett, 2016). The popular website, Techradar.com, reports that as of November 2022, the largest single-drive unit (as compared to multiple drives in an array) on the market was 22 Terabytes (Cassia & Probst, 2023). In addition to Taylor's (2022) reported projections for data creation, storage capacity is also projected to increase at a compound annual growth rate of 19.2 percent from 2020 to 2025.

Digital Economy Turned "Autonomous Economy"

Arthur (2017) describes the emergence of a digital economy and the precursors to it with attribution given to three periods of technological morphing. The first, took place in the 1970s and 1980s, during which integrated circuits (i.e., microprocessors) were introduced and enabled the emergence of personal computers, with accompanying software that could support mathematical calculations, data analysis, computer-aided design (CAD), and other tasks (with vast efficiency improvements). During the 1990s and 2000s, the second morphing brought a networked environment comprised of LANs (local area networks) and WANs (wide area networks) the Internet, webservices, cloud storage, and sharing on an almost universal scale. This sharing also erased numerous constraints, including geography, and ushered in a more interconnected global economy.

The third morphing, beginning in 2010, arose with "cheap and ubiquitous sensors. We have radar and lidar sensors, gyroscopic sensors, magnetic sensors, blood-chemistry sensors, pressure, temperature, flow, and moisture sensors, by the dozens and hundreds all meshed together into wireless networks." These, in-turn, generated massive amounts of data (and as previously discussed, the number of sensors and data generated will continue to grow exponentially). All these information touch points did and still do prompt the development of tools and techniques for broader and deeper analysis, e.g., using applied A.I. (computer vision, natural language processing, and speech recognition technologies). Professor Arthur has more recently suggested that we are now seeing an "Autonomous Economy" (B. W. Arthur, personal communication, March 6, 2023).

“Smart” Sensors

Another category of sensors known as “smart,” consists of sensors that are integrated into IoT systems. Legacy sensors are still valued in many applications and processes. Many relatable examples can be found in automobiles: temperature sensors detect eminent radiator overheating conditions; pressure sensors are used to detect low oil and engine cylinder compression; many later model vehicles have TPM (tire pressure monitoring) systems that may alert drivers to arising issues. Even if certain measures only signal operators to a check engine light, the circuitry is responding to sensors that trigger associated relays for the trouble condition. Smart sensors can communicate with one another, e.g., via RFID (Radio Frequency Identification Devices), Wi-Fi networks, operate remotely, and have on board computing power (Sehrawat & Gill, 2019). Examples of smart technology (devices) that can be integrated into an IoT environment (working in concert with the sensors), include those that are familiar to many consumers, such as Amazon’s Alexa virtual assistant platform, which can be accessed using Amazon’s Echo line of speakers, Amazon’s line of Fire tablets, and Fire TV devices; Apple’s Siri (which is included in most Apple devices: smart watches, iPads, and computers) and Google Assistant offer competing platforms.

Internet of Medical Things (IoMT)

In healthcare a plethora of IoT devices (with connected sensors) is transforming patient care (Al-Kahtani et al., 2022; Alshamrani, 2022; Yang et al., 2022). According to an article on the company website, Ordr, a business that recently announced its collaboration with GE HealthCare, one of the fastest growing sectors of the IoT market is health devices, so much so that it is known by some as the Internet of Medical Things (IoMT) market (*10 Internet of Things (IoT) healthcare examples*). Examples given include remote patient monitoring to collect heart rate, blood pressure, and body temperature; continuous glucose monitoring (periodic sampling may not be sufficient); continuous cardiac monitoring (a difference from other methods, such as those with a patient admitted into a hospital, is the mobility afforded by small portable devices); hand hygiene monitoring; advanced IoT devices for patient depression and mood monitoring; Parkinson’s disease monitoring (this another one where continuous monitoring affords freedom from extended stays for observation in a hospital) – most of the above examples fall into a wearables category.

The Ordr site article continues to list more examples, which go beyond patient monitoring and provide treatment interventions. Included are connected inhalers (e.g., for asthma or COPD patients) that can monitor attacks, the environment in which they occur, and issue alerts; ingestible sensors (which may eliminate the need for more invasive probing); smart contact lenses; and IoT robots (i.e., small Internet-connected robots that are deployed inside the human body). As a company, Ordr specializes in addressing security issues associated with these IoMT technologies – the point being is that innovations tend to lead to both new acronyms and new entrepreneurial challenges and opportunities.

Big Data and Business Intelligence

Corporations (at least those with the wherewithal to collect and leverage big data) have also been increasingly focusing on business intelligence (Demir, 2018, p. 13), with many using systems incorporating A.I. (Marion et al., 2020; Thiel & Masters, 2014). A business intelligence system is comprised of tools and technologies that are used to collect data for analysis (Nazari et al., 2022). It is not necessarily the case that only large organizations can leverage business intelligence. Rather, it can be purchased from third parties. "If companies want to avoid flying blind, they have to master data analytics, and increasingly, this requires tapping into data from outside an organization's four walls" (*How third-party information can enhance data analytics*, 2019). Many people using the Internet, for instance, become aware that they and their web-browsing behaviors are being tracked (this is often evident while shopping for goods and services). "As advanced economies transition through various phases of economic value creation, e.g., from products to processes, from tangible goods to intangible experiences, they can leverage technological innovations to improve efficiency and enhance effectiveness" (Raj & Athaide, 2022, p. 487).

START-UPS AND NEW PRODUCT DEVELOPMENT (NPD)

According to Demier (2018), most start-ups lack a clear strategy, or the processes to execute one, in their beginning stages. Also, new ventures are typically confronted by severe resource scarcity, "as they often consist only of the entrepreneur herself. When nascent ventures are of such small size, the entrepreneur herself needs to be a jack-of-all-trades" (Herrmann et al., 2022, p. 479). As observed by Kim and Lim (2018), not only is it necessary to recognize opportunities to innovate, entrepreneurs must also be able to exploit these effectively if they are to realize any benefits (financial or non-financial). One possible way for entrepreneurs with limited time and resources is to engage in cocreation activities. Doing so would be considered a collaborative method among various potential stakeholders including customers, suppliers, academic institutions (researchers) to develop solutions to problems, and possibly produce products as well (Carvalho & Madeira, 2021).

Further, utilizing modern tools may help: "digitally advanced small businesses were [in authors' findings] twice as likely to have employees that collaborate regularly, as compared to businesses at a basic level of digital engagement" (O'Mahony & Ma, 2018, p. 1). O'Mahony and Ma also found improved productivity, value creation, and increased levels of innovation among employees who collaborate with greater frequency (p. 1). Similarly, Weiss et al., found that organizations that are adopting and implementing are changing "the way innovators communicate, collaborate, and coordinate" (Weiss et al., 2022, p. 284).

Bezhovski et al. (2021) noted that while traditional means of developing business ideas (e.g., brainstorming, design thinking) are well represented in published scholarly literature, new opportunities have arisen due to information and communication technologies (ICT). Examples they regarded as the most prominent included "entrepreneurial communities, online marketplaces, social networks (as bases of customers), random idea generators, surveying tools and services, tools based on search engine data, competition analyzing tools, idea crowdsourcing, idea mining techniques, idea management systems, etc." Also, several e-commerce (e.g., store) platforms are available for business start-ups (Raj & Athaide, 2022), such as Etsy, Shopify, Google Play Store, eBay and Amazon; these have made it easier than ever to establish a business presence and engage in transactions through their respective search, shopping cart, and payment processing systems.

As noted above, there seems to be a mix of advantages and disadvantages based on experience. While Grilli (2022) observed that, "on theoretical grounds, it is possible to assert that entrepreneurs, characterized by great 'business acumen,' should be more prone to NPD than inexperienced entrepreneurs" (p. 666). But perhaps there is a point of saturation wherein one becomes unable to see other possibilities (consistent with Kuhn).

Another challenge to NPD for resource-deficient entrepreneurs may be protecting intellectual property when it is developed. With more limited management teams, smaller firms may have weak (or non-existent) patent research skills and specialized understanding, as compared to larger firms (Athreye et al., 2021). "The sufficient condition for patenting is a function of perceived costs and benefits" (Athreye et al., 2021, p. 517). The high costs associated with obtaining (much less protecting) patents pose a barrier among SMEs. One possible alternative is to *not* pursue (one or more patents), opting instead to keep trade secrets. Another strategy, for products with a very short product life cycle, which certainly applies to many technology-based categories, is to enjoy the benefit of the lower cost to file a provisional patent application, and use the time granted (12 months) under that form of protection (*Provisional application for patent*, 2022). Finally, while engaging in the new product development process, nascent entrepreneurs may gain access to crucial resources by establishing external linkages, thereby substantially contributing to a new venture's performance (Herrmann et al., 2022).

Creativity and Blinders

Creativity is regarded as a skill that can be learned, but like many such character traits and abilities, attribution is often given to innate talent, i.e., natural-born talent. In the context of business innovation, creativity enables idea generation by individuals as well as groups, and may also serve to aid in the identification of worthwhile business opportunities (Bezhovski et al., 2021). In his seminal work, Kuhn (2012) brought to bear his views on science as usual (which he referred to as normal science), how paradigms arise, and how they may gradually be challenged to a point of collapse and replacement by new paradigms.

Exhaustively conducted research by Edison scholar, Paul Israel (1998), repeatedly showed that the prolific inventor did not always immediately recognize all of the potential applications of some projects, at least not immediately. For instance, Edison's original motivation for working on sound recording technology was so that telegraph transmissions could be captured and later transcribed (by lower-paid, lesser-skilled workers – thereby saving railroad operators money). Later, musical recordings (and cinema, after that) came to be a dominant application of recording (and playback) technology. "When a new product introduction is significantly different from prior innovations, industry participants cannot adequately assess its impact because the information surrounding the innovation is more uncertain and difficult to understand" (Lee et al., 2003, p. 764).

In surpassing these blinders, entrepreneurship, and innovation can be referred to as incongruent terms. Entrepreneurship entails change that is considered both new and different and evokes radical venture creation; with this, greater resource and fund acquisition is required (Kahn, 2022). Relying on preexisting human capital is another pitfall of entrepreneurship, as entrepreneurs become narrow-minded, as they bind to the foregoing knowledge (Marvel et al., 2020). Further eliminating some of these blinders is attributed to innovation, which is seen as a gradual change that occurs across a greater range of specific activities, as well as a longer period (Kahn, 2022). The incremental characteristic of innovation allows individuals to actively pursue new knowledge and expand their cognitive abilities (Marvel et al., 2020). Heightened firm success within a preexisting and pre-tapped market increases the innovation potential, as it presents a positive environment (Mahto et al., 2020).

Flops and Failure

"New product development (NPD) projects tend to fail, either in the last stage of the development process or in the later commercial stage" (Florén et al., 2018, p. 412). It has long been recognized in business literature (e.g., NPD, marketing, strategy) that novelty, for instance, can be a double-edged sword. Too much of it, and prospective customers may not understand an offering, and too little may cause the product to be undifferentiated (Bianchi, 1998; Fritsch, 2022; Wang et al., 2022). "The underlying causes of failure can often be traced to the beginning stage, in what is often called the front end of NPD" (Florén et al., 2018, p. 412). Authors further suggested that for an idea to lead to new product development, those who are key actors in the firm must recognize its potential; as noted above, Edison (as well as many throughout the history of business) may fail in recognizing such potential. "Two major reasons explain a no-go decision. First, an idea is 'killed' if decision-makers conclude the proposed product has no or low commercial potential. Second, an idea is abandoned if it does not fit with the firm's current business model even though the idea may, in some respects, have commercial value." (p. 414).

"For entrepreneurship educators and practitioners, a central question is how to best prepare students to successfully discover and exploit an opportunity" (Marvel et al., 2020, p. 12). According to authors Al-Samarraie and Hurmuzan (2018), there are three ways to implement brainstorming (BS) techniques: these include verbal/traditional brainstorming (TBS); nominal brainstorming (NBS); and electronic brainstorming (EBS). With TBS, group members actively engage in creating a dialogue and interact, sharing ideas as they are generated one at a time. Other benefits of adopting the technique include ruling out criticism, reducing inhibitions, and generating a large quantity of ideas, with some of these being a result of combining ideas. NBS entails members generating ideas individually, instead of in a group setting. EBS is a means of exchange using online tools such as email, chat, and file sharing (e.g., Google Docs). The authors concluded that EBS (a more modern means of brainstorming) may be more useful in certain settings by reducing participants' apprehensiveness. Finally, since a document trail is created in the process, individuals may reference this resource as necessary.

CONCLUSION

Entrepreneurs starting new ventures may develop new products that "can be either successful or not" (Grilli, 2022, p. 663). However, firms must be prepared to constantly innovate due to marketplace dynamism, i.e., evolving customer needs for new products in consideration of competitors (Homfeldt et al., 2019). Also, it takes more than just an idea and an entrepreneurial spirit (Demir, 2018, p. 18). Ventures must engage in planning, set clear (and attainable) goals, establish defined processes and models, and manage teams effectively; further, they must be willing to engage in revisions to an idea when striving to develop "high-impact innovations" (p. 18). One particular advantage for start-ups is a lack of entrenched routines, which can cause barriers to innovation; start-ups are often also able to perceive and react to needs with greater agility (Homfeldt et al., 2019). At the same time, the volume and pace of new pace of innovations will call for continuous learning to ensure that necessary skills are deployed at the touchpoints where they are needed (Van Kuiken, 2022).

Van Kuiken's observations, given his affiliation with McKinsey & Company, are presumably focused mainly on an audience of organizational managers and leaders. They seemed to address continuous learning in the context of adaptation in the workplace, i.e., to changing integrations of new technologies and ways of managing. In our context here, it should be submitted that would-be or practicing entrepreneurs must be on a constant vigil to remain aware of arising core technologies, at least try to guess the implications, and to engage in environmental scanning across many fields of endeavor.

After all, there are myriad opportunities to develop products that one could extrapolate from any given offering. Although the stakes may be higher in the latter arena, ideas about battery technology for construction tools transfer readily to medical tools (Newmarker, 2017). New smart phone designs beget a case (likely aftermarket) – including those that might be presented as fashion accessories, Apps, product demonstrations (often in the form of an "unboxing" presented in YouTube videos), and almost every time, how-tos, and troubleshooting tips (not to mention some of these might be needed in multiple languages). Package design might be considered an artform, as well. Besides avoiding a risk of falling behind or worse, being blindsided, an entrepreneur's scanning to remain aware, may serve as the catalyst for getting ahead.

REFERENCES

10 Internet of Things (IoT) healthcare examples. Retrieved March 6 from https://ordr.net/article/iot-healthcare-examples/

Al-Kahtani, M. S., Khan, F., & Taekeun, W. (2022). Application of Internet of Things and sensors in healthcare. *Sensors*, *22*(15), 5738.

Al-Samarraie, H., & Hurmuzan, S. (2018). A review of brainstorming techniques in higher education. *Thinking Skills and creativity*, *27*, 78-91.

Alshamrani, M. (2022). IoT and artificial intelligence implementations for remote healthcare monitoring systems: A survey. *Journal of King Saud University-Computer and Information Sciences*, *34*(8), 4687-4701. https://www.sciencedirect.com/science/article/pii/S1319157821001385

Arnold, R., Carey, K., Abruzzo, B., & Korpela, C. (2019, 10-12 Oct. 2019). What is a robot swarm: A definition for swarming robotics. 2019 IEEE 10th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON), New York, NY.

Arthur, W. B. (2017, October 5). *Where is technology taking the economy?* Retrieved March 6 from https://www.mckinsey.com/capabilities/quantumblack/our-insights/where-is-technology-taking-the-economy#/

Athreye, S. S., Fassio, C., & Roper, S. (2021). Small firms and patenting revisited. *Small Business Economics*, *57*(1), 513-530. https://doi.org/10.1007/s11187-020-00323-1

Barnett, J., Thomas. (2016, September 9). *The Zettabyte Era officially begins (how much is that?)*. Retrieved March 4 from https://blogs.cisco.com/sp/the-zettabyte-era-officially-begins-how-much-is-that

Barry, D. (1996). Artful inquiry: A symbolic constructivist approach to social science research. *Qualitative Inquiry*, *2*(4), 411-438.

Bezhovski, Z., Janevski, Z., Apasieva, T. J., & Temjanovski, R. (2021). From traditional to online methods for generating business ideas. *Management Dynamics in the Knowledge Economy*, *9*(3), 307-329. https://doi.org/10.2478/mdke-2021-0021

Bianchi, M. (1998). Consuming novelty: Strategies for producing novelty in consumption. *Journal of Medieval and Early Modern Studies*, *28*(1), 3.

Bruni, E., Bonesso, S., & Gerli, F. (2019). Coping with different types of innovation: What do metaphors reveal about how entrepreneurs describe the innovation process? *Creativity and Innovation Management*, *28*(2), 175-190. https://doi.org/10.1111/caim.12312

Carvalho, L. C., & Madeira, M. J. (2021). Innovation management and entrepreneurship—Introduction. *Administrative Sciences*, *11*(3), 73. https://doi.org/10.3390/admsci11030073

Cassia, F., & Probst, C. (2023, February 19). *Best external hard drives of 2023*. TechRadar.com. Retrieved March 4 from https://www.techradar.com/news/best-external-desktop-and-portable-hard-disk-drives

Creswell, J. W. (1994). *Research design: Qualitative & quantitative approaches*. Sage Publications.

Cristina Gaitan, N., & Ungurean, I. (2023). *Special issue "evolution of IoT and IIoT: Opportunities, challenges, and applications"*. Retrieved March 6 from https://www.mdpi.com/journal/sensors/special_issues/Evolu_IIoT#info

Demir, F. (2018). A strategic management maturity model for innovation. *Technology Innovation Management Review*, *8*(11), 13-21. https://doi.org/10.22215/timreview/1196

Ferasso, M., Wunsch Takahashi, A. R., & Prado Gimenez, F. A. (2018). Innovation ecosystems: A meta-synthesis. *International Journal of Innovation Science*, *10*(4), 495-518. https://doi.org/10.1108/IJIS-07-2017-0059

Florén, H., Frishammar, J., Parida, V., Wincent, J., Institutionen för ekonomi, t. o. s., Luleå tekniska, u., & Innovation och, D. (2018). Critical success factors in early new product development: A review and a conceptual model. *International Entrepreneurship and Management Journal*, *14*(2), 411-427. https://doi.org/10.1007/s11365-017-0458-3

Fritsch, R. (2022, July 19). *5 tips for product innovation: Balancing novelty and necessity*. Retrieved March 5 from https://www.forbes.com/sites/forbesbusinesscouncil/2022/07/19/5-tips-for-product-innovation-balancing-novelty-and-necessity/?sh=1b5074677aae

Glesne, C., & Peshkin, A. (1992). *Becoming qualitative researchers*. Longman.

Golder, P. N., Shacham, R., & Mitra, D. (2009). Innovations' origins: When, by whom, and how are radical innovations developed? *Marketing Science*, *28*(1), 166-179.

Gottlieb, J., & Leech Anderson, D. (2011). *Pre-programmed robots*. Retrieved March 5 from https://mind.ilstu.edu/curriculum/medical_robotics/prepro.html

Grilli, L. (2022). Entrepreneurship and new product development: Exploring the "advantage of youth" and "business acumen" views. *The Journal of Product Innovation Management*, *39*(5), 662-685. https://doi.org/10.1111/jpim.12625

Herrmann, A. M., Storz, C., & Held, L. (2022). Whom do nascent ventures search for? Resource scarcity and linkage formation activities during new product development processes. *Small Business Economics*, *58*(1), 475-496. https://doi.org/10.1007/s11187-020-00426-9

Homfeldt, F., Rese, A., & Simon, F. (2019). Suppliers versus start-ups: Where do better innovation ideas come from? *Research Policy*, *48*(7), 1738-1757. https://doi.org/10.1016/j.respol.2019.04.002

How third-party information can enhance data analytics. (2019, April 22). Retrieved March 3 from https://hbr.org/sponsored/2019/04/how-third-party-information-can-enhance-data-analytics

Huberman, A. M., & Miles, M. B. (1994). Data management and analysis methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 428-444). Sage Publications.

Iakovets, A., Balog, M., & Židek, K. (2023). The use of mobile applications for sustainable development of SMEs in the context of Industry 4.0. *Applied Sciences*, *13*(1), 429. https://doi.org/10.3390/app13010429

Intel celebrates 40 years of digital revolution. (2011, November 15). Intel Corporation. Retrieved March 6 from https://newsroom.intel.com/news-releases/intel-celebrates-40-years-of-digital-revolution/

Intelligent engine management: Built-in intelligence. STIHL Corporation. Retrieved March 6 from https://www.stihl.com/intelligent-engine-management.aspx

Israel, P. (1998). *Edison: A life of invention*.

Kahn, K. B. (2022). Innovation is not entrepreneurship, nor vice versa. *The Journal of Product Innovation Management*, *39*(4), 467-473. https://doi.org/10.1111/jpim.12628

Katz, J. A. (2019, December 7). *Core publications in entrepreneurship and related fields: A guide to getting published*. Retrieved January 14 from https://sites.google.com/a/slu.edu/eweb/core-publications-in-entrepreneurship-and-related-fields

Khin, S., & Lim, T. H. (2018). Entrepreneurial opportunity recognition, exploitation and new venture success: moderating role of prior market and technology knowledge. *International Journal of Entrepreneurship*, *22*(4), 1-6. https://go.exlibris.link/S71GtD9G

Kuhn, T. S. (2012). *The structure of scientific revolutions*. University of Chicago Press.

Lahm Jr., R. J. (2021, April 14-16). Innovations large and small tied to COVID-19. Institute for Global Business Research International Conference, Online.

Lee, H., Smith, K. G., & Grimm, C. M. (2003). The effect of new product radicality and scope on the extent and speed of innovation diffusion. *Journal of Management*, *29*(5), 753. https://doi.org/10.1016/s0149-2063(03)00034-5

Mahto, R. V., Belousova, O., & Ahluwalia, S. (2020). Abundance – A new window on how disruptive innovation occurs. *Technological Forecasting & Social Change*, *155*, 119064. https://doi.org/10.1016/j.techfore.2017.09.008

Marion, T. J., Fixson, S. K., & Brown, G. (2020). Four skills tomorrow's innovation workforce will need. *MIT Sloan Management Review*, *61*(2), 1-7.

Marvel, M. R., Wolfe, M. T., & Kuratko, D. F. (2020). Escaping the knowledge corridor: How founder human capital and founder coachability impacts product innovation in new ventures. *Journal of Business Venturing*, *35*(6), 106060. https://doi.org/10.1016/j.jbusvent.2020.106060

Nazari, F., Taghavi, S. S., Valizadeh, E., Soleymani, M., Farahani, D. S., & Bagheri, R. (2022). An investigation on the impact of business intelligence over the performance of startup companies according to innovation and knowledge management as mediators. *Mathematical Problems in Engineering*, *2022*, 1-12. https://doi.org/10.1155/2022/3834696

Newmarker, C. (2017, July 11). *How to power handheld surgical devices*. Retrieved March 8 from https://www.medicaldesignandoutsourcing.com/power-handheld-surgical-devices/

O'Connor, G. C., & Ayers, A. D. (2005). Building a radical innovation competency. *Research-Technology Management*, *48*(1), 23-31. https://doi.org/10.1080/08956308.2005.11657292

O'Mahony, J., & Ma, S. (2018). *Connecting small businesses in the US*. Deloitte. Retrieved March 3 from https://www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-connected-small-businesses-Jan2018.pdf

Provisional application for patent. (2022, June 24). United States Patent and Trademark Office (USPTO). Retrieved March 8 from https://www.uspto.gov/patents/basics/types-patent-applications/provisional-application-patent#

Pultarova, T. (2017, June 6). *Self-replicating 3D printers could build moon bases, fight global warming*. Retrieved March 3 from https://www.space.com/37101-self-replicating-3d-printer-moon-bases.html

Raj, S. P., & Athaide, G. A. (2022). Innovation's domain: The need for a sharper yet broader focus. *The Journal of Product Innovation Management*, *39*(4), 485-488. https://doi.org/10.1111/jpim.12638

Schwandt, T. A. (1994). Constructivist, interpretivist approaches to human inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 118-137). Sage Publications.

Sehrawat, D., & Gill, N. S. (2019). Smart sensors: Analysis of different types of IoT sensors. 2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India.

Sperling, E. (2022, July 13). *What future processors will look like*. Retrieved March 5 from https://semiengineering.com/what-future-processors-will-look-like/

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications.

Strauss, A., & Corbin, J. (1994). Grounded theory methodology: An overview. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 273-285). Sage Publications.

Swarm communication. Retrieved March 5 from http://www.swarmrobot.org/Communication.html

Taylor, P. (2022, September 8). *Volume of data/information created, captured, copied, and consumed worldwide from 2010 to 2020, with forecasts from 2021 to 2025*. Retrieved March 5 from https://www.statista.com/statistics/871513/worldwide-data-created/

Thiel, P., & Masters, B. (2014). *Zero to one: Notes on startups, or how to build the future*. Crown Business.

Thomas Edison and Menlo Park. (2023). Thomas Edison Center at Menlo Park. Retrieved March 3 from https://www.menloparkmuseum.org/history

Van Kuiken, S. (2022, October 21). *Tech at the edge: Trends reshaping the future of IT and business*. Retrieved March 3 from https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/tech-at-the-edge-trends-reshaping-the-future-of-it-and-business

Veryzer, R. W. (1998). Discontinuous innovation and the new product development process. *The Journal of Product Innovation Management*, *15*(4), 304-321. https://doi.org/10.1016/S0737-6782(97)00105-7

Wang, G., Henfridsson, O., Nandhakumar, J., Yoo, Y., Case Western, U., University of, M., University of, W., & Queen's, U. (2022). Product meaning in digital product innovation. *MIS Quarterly*, *46*(2), 947-976. https://doi.org/10.25300/MISQ/2022/15252

Weiss, M. M., Baer, M., & Hoegl, M. (2022). The human side of innovation management: Bridging the divide between the fields of innovation management and organizational behavior. *The Journal of Product Innovation Management*, *39*(3), 283-291. https://doi.org/10.1111/jpim.12624

Yang, Y., Wang, H., Jiang, R., Guo, X., Cheng, J., & Chen, Y. (2022). A review of IoT-enabled mobile healthcare: technologies, challenges, and future trends. *IEEE Internet of Things Journal*, *9*(12), 9478-9502.

APPENDIX

Figure 1

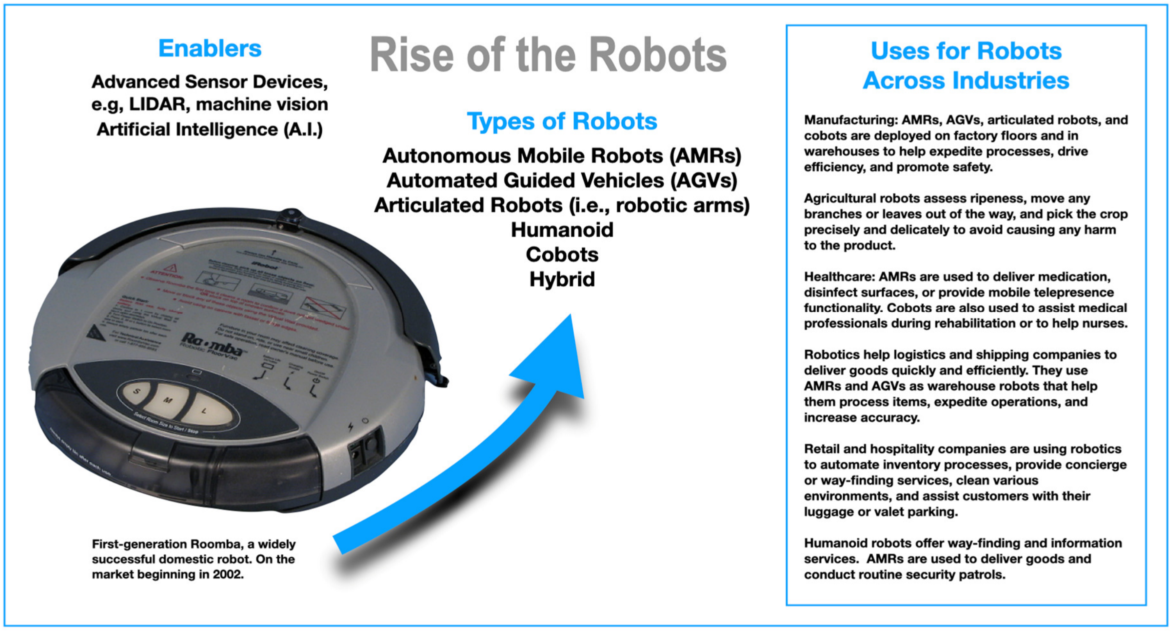


Image and description credit: Roomba robot vacuum cleaner. Smithsonian Institution: National Museum of American History, from https://americanhistory.si.edu/collections/search/object/nmah_1448432. Types of and uses across industries for robots developed from: How robotics technologies are shaping today's world. Intel Corporation, from https://www.intel.com/content/www/us/en/robotics/types-and-applications.html

Figure 2

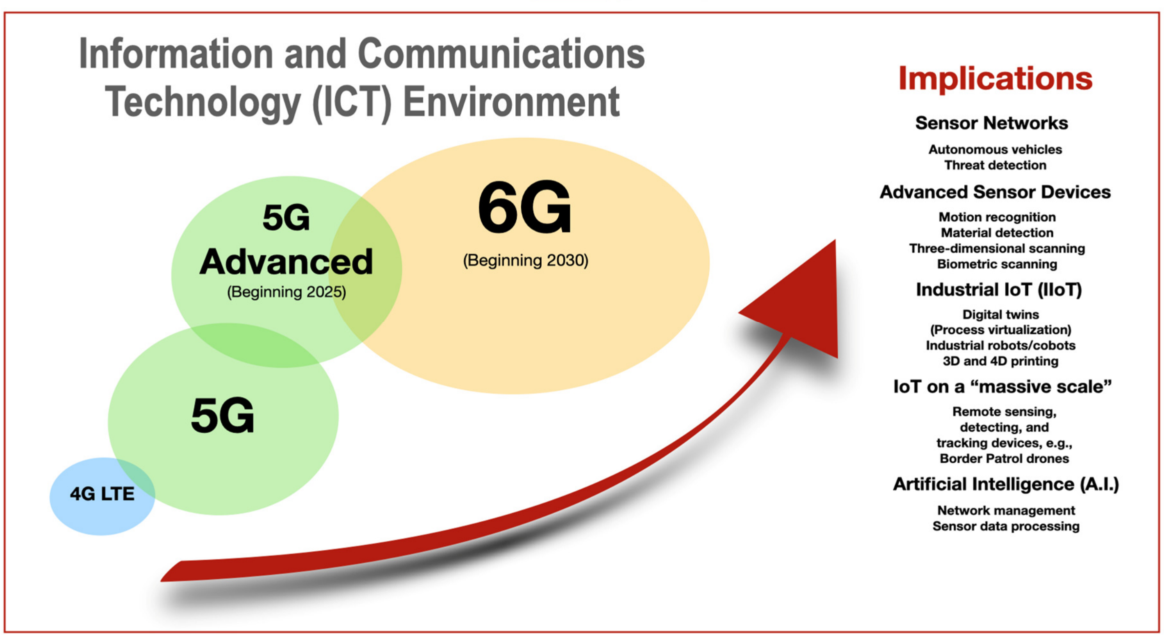
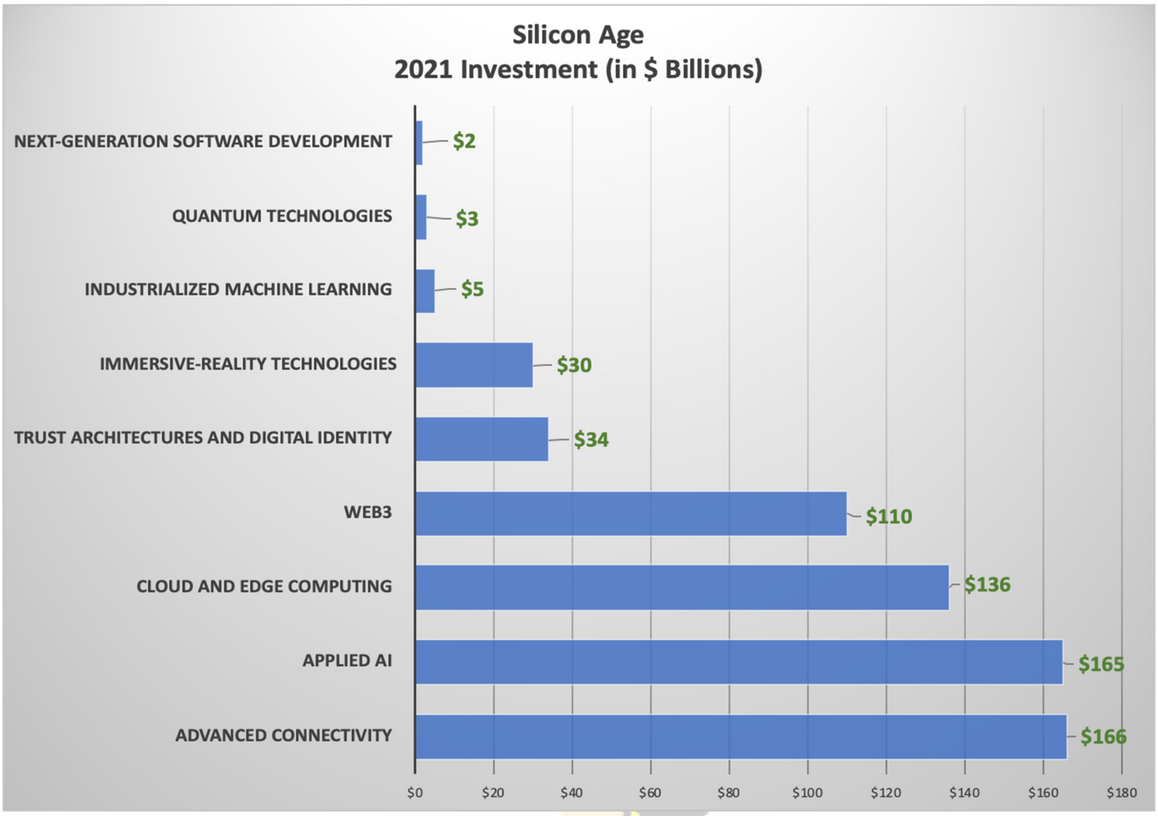


Figure 2's depiction and implications developed primarily from: 5G: The telecommunications horizon and homeland security. (2021, December), from https://www.dhs.gov/sites/default/files/2022-02/22_0224_st_5G_6G_Horizon%20Scanning%20Report_final_508.pdf

Figure 3

Silicon Age trends: Digital and IT technologies



Figures 3 and 4, along with Tables 1 and 2 that follow, developed from data presented in: Chui, M., Roberts, R., & Yee, L. (2022, August 24). *McKinsey technology trends outlook 2022*. McKinsey & Company, from https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-top-trends-in-tech

Figure 4

Engineering Tomorrow trends: Physical technologies e.g., energy, mobility

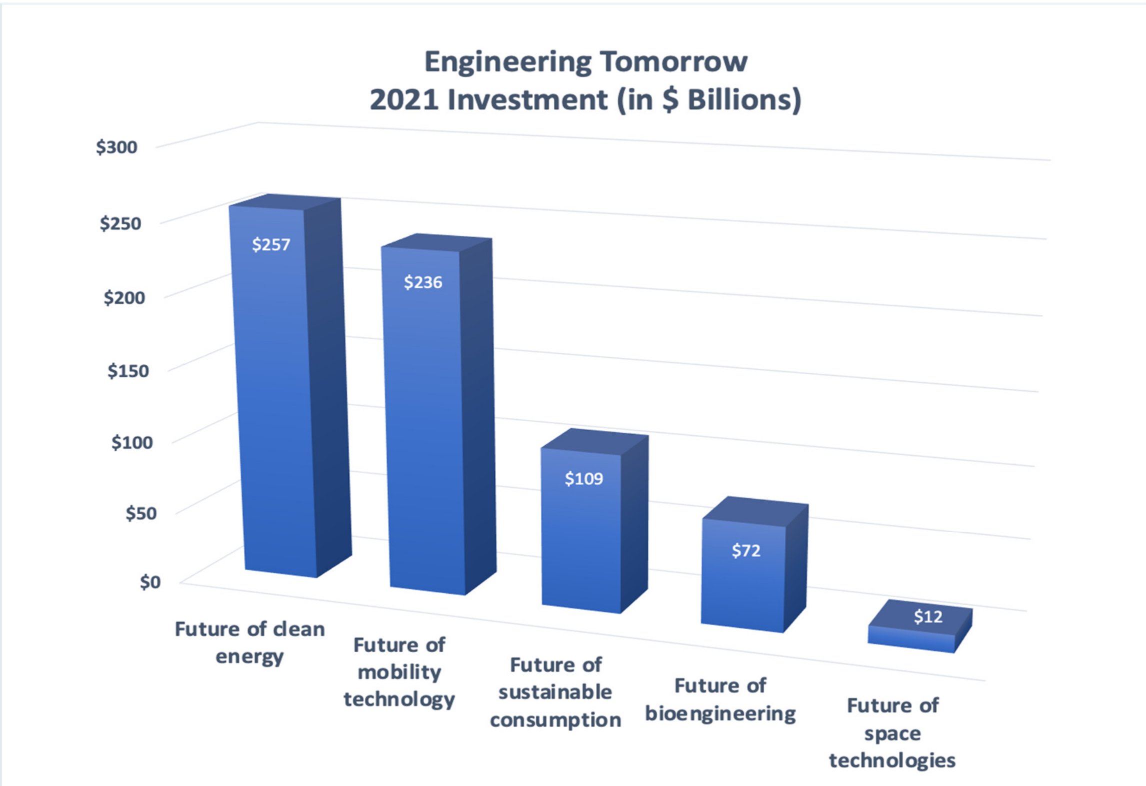


Table 1

Engineering Tomorrow definitions (quoted and edited for brevity from McKinsey & Company)	
Future of clean energy	Clean-energy solutions help drive toward net-zero greenhouse-gas emissions across the energy value chain, from power generation to power storage and distribution.
Future of mobility technology	Mobility technologies aim to improve the efficiency and sustainability of land and air transportation of people and goods.
Future of sustainable consumption	Technology to address environmental risks, including climate change.
Future of bioengineering	Converging biological and information technologies improve health and human performance, transform food value chains, and create innovative products and services.
Future of space technologies	Advances and cost reductions across satellites, launchers, and habitation technologies enable innovative space operations and services.

Table 2

Silicon Age definitions (quoted and edited for brevity from McKinsey & Company)	
Advanced connectivity	5G/6G cellular, wireless low-power networks, low-Earth-orbit satellites, and other technologies support a host of digital solutions across industries.
Applied AI	Models trained in machine learning (ML) used to solve classification, prediction, and control problems to automate activities, add or augment capabilities and offerings, and make better decisions.
Cloud and edge computing	Involves distributing computing workloads across remote data centers and local nodes to improve data sovereignty, autonomy, resource productivity, latency, and security.
Web3	Platforms and applications that enable shifts toward a future, decentralized internet with open standards and protocols while protecting digital-ownership rights, providing users with greater ownership of their data and catalyzing new business models.
Trust architectures and digital identity	Digital-trust technologies enable organizations to build, scale, and maintain the trust of stakeholders in the use of their data and digital-enabled products and services.
Immersive-reality technologies	Immersive-reality technologies use sensing and spatial computing to help users "see the world differently" through mixed or augmented reality or "see a different world" through virtual reality.
Industrialized machine learning (ML)	Uses software and hardware solutions to accelerate the development and deployment of ML and to support performance monitoring, stability, and ongoing improvement.
Quantum technologies	These could provide an exponential increase in computational performance for certain problems and transform networks by making them more secure.
Next-generation software development	Next-generation tools aid in the development of software applications, improving processes and software quality; tools include AI-enabled development and testing and low-code or no-code platforms.