What is “Deep Tech” and why should corporate innovators care?

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> As the limits of the digital economy to solve some of our pressing problems have been acknowledged, companies—large and small—are beginning to examine the promise of deep tech ventures. But what exactly are deep tech ventures, how do they differ from digital ventures, and how can they help companies navigate their current challenges and opportunities?

In today's business environment, incumbent companies must navigate a landscape of challenges: labor shortages emerging from the war for talent, market pressures driving continuous innovation and market expansion, geopolitical tensions straining supply chains and the manufacturing base. These come on top of the urgent need to address societal challenges such as adopting sustainable practices[1]. Mastering these challenges demands clear strategic planning but also a recognition of the importance of innovation rooted in breakthrough science and engineering.

The notion that challenges and crises can act as catalysts for innovation is not new[2]. What is new is the promising reservoir of innovations that companies may tap into—deep tech innovations developed into potentially viable solutions to key challenges by so-called deep tech startup ventures. The term "deep tech" has recently emerged to characterize a specific category of solutions rooted in atoms rather than bits—in the physical world not simply the digital one. These technological areas encompass new materials, synthetic biology, fusion energy, or quantum computing. If innovation is considered as the match between problems (customer needs or opportunities) and solutions (technologies, business models, etc.), then deep tech represents that part of the solution space grounded in breakthrough science and engineering.

While research-heavy companies like Novo Nordisk or IBM have long been engaged in such technologies, discussions surrounding deep tech have garnered more widespread

[1] Segal, E. (2023, December 3). The 9 biggest risks and threats that companies will face in 2024. Retrieved April 1, 2024, from https://www.forbes.com/sites/edwardsegal/2023/12/03/the-8-biggest-risks-and-threats-that-companies-will-face-in-2024/?sh=3c5c34f35f4e
[2] Johnson, E. & Murray, F. (2020). What a Crisis Teaches us about Innovation. *MIT Sloan Management Review*. https://sloanreview.mit.edu/article/what-a-crisis-teaches-us-about-innovation/; Nidumolu, R., Prahalad, C. K., & Rangaswami, M. R. (2009). Why sustainability is now the key driver of innovation. *Harvard Business Review, 87*(9), 56-64

attention in recent years[3]. As important, deep tech ventures have emerged as a special type of startup venture dedicated to taking ideas from the lab bench to scaled global impact while recognizing the added time, capital, and risk required for the venture journey compared to their digital counterparts. In their rise to prominence, these ventures have thus become an essential element of conversations around talent, risk capital, and wider startup support.

In our discussions with executives, however, we find a lack of clarity about what exactly defines deep tech and as important, what are deep tech ventures[4]. Various conceptualizations have been circulating with confusion about whether and how these ventures differ from digital ventures that have long been understood as part of any effective digital transformation[5]. And yet, if companies want to effectively leverage deep tech—for example, by setting up a dedicated deep tech strategy or a deep tech corporate venture unit[6]—it is crucial to comprehend the essence of these ventures, as they operate under fundamentally distinct paradigms compared to their digital counterparts. Without such understanding, innovation managers will find themselves in murky waters, risking the comparison of apples to oranges, and consequently, being unable to engage in constructive dialogue, make informed market assessments, or take targeted actions.

To support corporate leaders, we offer two correctives. First, we conceptualize the deep tech venture, thereby also touching upon what distinguishes it from digital ventures. Second, we provide three reasons why corporate innovators should focus their attention on deep tech ventures, considering the current challenges of the global business environment.

1 Understanding a Deep Tech Venture

From our day-to-day interactions with deep tech ventures in the United States and across Europe, we have identified three core attributes that we believe are fundamental characteristics that transcend the boundaries of specific technology areas or industries. Below, we describe these attributes, illustrate them with real-world examples, and draw comparisons with digital ventures.

[3] De la Tour, A., M. Portincaso, N. Goeldel, U. Chaudhry, C. Tallec and A. Gourévitch (2021). *Deep Tech: The great wave of innovation*. BCG/Hello Tomorrow.
[4] We have taught and discussed about deep tech ventures with corporate leaders in MIT Sloan's Executive MBA program, MIT's global Regional Entrepreneurship Acceleration Program, and MIT Sloan Executive Education, especially our corporate innovation courses.
[5] Lamarre, E., Smaje, K., & Zemmel, R. (2023). *Rewired: the McKinsey guide to outcompeting in the age of digital and AI*. John Wiley & Sons; Bendig, D., Schulz, C., Theis, L., & Raff, S. (2023). Digital orientation and environmental performance in times of technological change. *Technological Forecasting and Social Change*, *188*, 122272.
[6] Candelon, F., Patel, V., Männig, M., & Paschkewitz, J. (2023). The Incumbent's Deep Tech Strategy Playbook. *MIT Sloan Management Review, 64*(3), 1-9; Siota, J., & Prats, M. J. (2022). The Three Internal Barriers to Deep-Tech Corporate Venturing. *MIT Sloan Management Review, 63*(2), 1-3.

1) Grounded in cutting-edge technological inventions and research. Deep tech ventures are *first-of-a-kind*, meaning that they produce technical inventions based on cutting-edge research. As such, they are often technology-push although sometimes, problem-driven entrepreneurs will tap into the frontiers of scientific discovery to solve their challenges. Deep tech ventures excel in technological superiority, demonstrating unique technological capabilities (protected by patents and trade secrets), and often prioritize ongoing research and development. The Boston Consulting Group and French think tank Hello Tomorrow characterize inventions by deep tech ventures as "*solutions built around unique, protected, or hard-to-reproduce technological or scientific advantages*"[7]. Consider Vancouver-based Carbon Engineering, a company commercializing a closed-loop direct air capture (DAC) technology. This technology originated from original research conducted by Harvard University Professor David Keith[8]. This is in stark contrast with digital ventures, which create products or services by (re)combining already established digital technology platforms (e.g., cloud computing, proven web-design techniques, etc.) typically to satisfy a specific customer need (technology pull)[9].

2) Originating from scientific institutions. Deep tech ventures are typically deeply rooted in scientific knowledge and led by individuals who have built highly specialized expertise during academic careers, eventually leading to the founding of a startup venture centered around this knowledge. Given the complexity of these endeavors and the deep technical foundations required, these ventures are likely to emerge from higher education and research institutions, thus, transitioning "from lab to market". Take, for example, BioNTech, the venture now famous for its mRNA-based research, which spun off from the University of Mainz in Germany and was founded by Professor Ugur Sahin and Dr. Ozlem Tureci (both academics). Also, Auterion, which specializes in drone systems, has academic roots originating from ETH Zurich in Switzerland. Maintaining proximity to their origins' research institutions is essential for deep tech ventures, as it grants access to the human capital and infrastructure that support the early stages of technical development. As deep tech ventures progress through their lifecycle and seek to achieve commercial results, they may increasingly engage with a wider ecosystem of stakeholders, including governments and corporate partners, for funding and sources of demand such as customer contracts. Some prominent deep tech ecosystems are Kendall Square in Cambridge, USA, as well as the greater Zurich (CH), Munich (GER), and Tel Aviv (IL) areas. These areas

[7] De la Tour, A., P. Soussan, N. Harlé, R. Chevalier, and X. Duportet (2017). *From tech to deep tech: Fostering collaboration between corporates and startups*. BCG/Hello Tomorrow.
[8] Keith, D., Harvard University. (n.d.). *Direct Air Capture*. Retrieved April 1, 2024, from https://keith.seas.harvard.edu/direct-air-capture
[9] Huang, J., Henfridsson, O., & Liu, M. J. (2022). Extending digital ventures through templating. *Information Systems Research, 33*(1), 285-310; Lehmann, J., Recker, J., Yoo, Y., & Rosenkranz, C. (2022). Designing digital market offerings: how digital ventures navigate the tension between generative digital technology and the current environment. *MIS Quarterly, 46*(3).

boast technical universities and tech entrepreneurship centers that serve as vital pillars in the innovation economy, alongside large corporations, government entities, and venture capitalists[10].

3) Centered around physical assets. Deep tech companies are asset-heavy, meaning they are building, primarily, physical products that are tangible and typically centered around highly defensible intellectual property (IP)[11]. This distinguishes them from digital ventures, which frequently revolve around the creation of innovative software and service-based offerings. Consider Oregon-based Agility Robotics, a developer of bipedal walking robots, or Greater Boston-based Form Energy, which focuses on developing iron-air batteries for long-term, grid-scale energy storage. This integration of physical assets with intangible knowledge assets and know-how presents a unique challenge for scaling, necessitating substantial expertise not only in science and technology but also in engineering, the development of heavy industrialization processes, and the configuration of complex supply chains. Consequently, scaling deep tech ventures can be tricky, frequently entailing certification and regulation processes.

These characteristics of deep tech and of the deep tech ventures—that create, build, and scale deep tech solutions—lead to some essential features of the path from lab to global impact that ventures must navigate.

1) Involving complex technology and commercialization risks. Deep tech ventures navigate a complex risk landscape, facing a range of commercialization and technology risks. Unlike digital ventures built on established technology platforms (e.g., platform or SaaS businesses), research-based deep tech ventures face the inherent risk that their technology inventions may not perform as anticipated. Even if they overcome this initial hurdle and the technology works as expected, they must then identify potential market demand, establish product-market fit, devise a sustainable business model, and ultimately effectively market their offerings i.e., they hold significant market risk. In this context, traditional build-measure-learn type startup methodologies (e.g., Lean Startup or Design Thinking), aimed at de-risking through minimum viable products (MVP) and customer feedback (e.g., conducting A/B tests on a specific software-service configuration to gather insights and refine), prove challenging to apply. This is because, in deep tech ventures, unlike digital ventures, the technologies involved are often too complex, costly, and resistant to rapid adaptation or prototyping. Add to this the risks of scale-up

[10] Budden, P. & Murray, F. (2022). Strategically Engaging with Innovation Ecosystems. *MIT Sloan Management Review*. https://sloanreview.mit.edu/article/strategically-engaging-with-innovation-ecosystems/; Frølund, L., Murray, F., & Riedel, M. (2018). Developing successful strategic partnerships with universities. *MIT Sloan Management Review, 59*(2), 71-79

[11] Palmer, M. (2022). 2022 will be the “year of deeptech” say investors. Retrieved April 1, 2024, from https://sifted.eu/articles/2022-deeptech-investors/

(i.e., production at scale with effective supply chains and unit economics) and regulation (in often uncertain regulatory contexts) and deep tech ventures must work along technical pathways in consultation with potential customers. This can be considered a minimum viable *pathway* to demonstrate product, scale, and regulatory success rather than a minimum viable *product*. In sum, the path to success for deep tech ventures requires resilience to navigate successfully without depleting resources before the ventures can fully realize their potential.

2) Demanding high capital investment. Given that deep tech ventures are research-intensive and asset-heavy and at the same time must navigate significant risks, they are characterized by substantial investment needs that must be sustained over a longer period to develop and scale effectively. For deep tech ventures, the average financing rounds in early stages (e.g., pre-seed or seed) are already significantly higher, typically up to $20 mn, compared to digital ventures. Capital requirements during later stages can range from $100 mn and more, depending on the technology, and may potentially reach up to $1 bn. Take Greater Boston-based Sublime Systems, a provider of decarbonized cement technology, which raised a Series A funding round of $40 mn in January 2023, or Austin-based Icon which secured a Series B funding round of $392 mn in February 2022. The convergence of risks, coupled with ambiguous unit economics and market volatility, makes it challenging for external parties to fully evaluate the future returns of such first-of-a-kind deep tech projects, leading to risks of under-investment, particularly at later funding stages.

3) Extended timelines. The timeline from lab to market for deep tech ventures is typically significantly longer than for other ventures. This is due to a few key factors: First, bringing innovative, complex technologies from the lab to a viable commercial product is a lengthy and challenging process. Second, deep tech startups face the daunting task of effectively commercializing their technologies. This involves identifying target markets, achieving product-market fit, developing sustainable business models, and successfully marketing their offerings. These tasks are typically more complex and time-consuming compared to digital ventures like SaaS or platform solutions. It is not uncommon for deep tech ventures to necessitate investors to wait 10 to 15 years or even longer before gaining traction in their target markets[12]. Carbon Engineering, founded in 2009, took six years to develop its first functioning prototype in 2015, and an additional seven years until 2022 to open the first large-scale commercial plant. Form

[12] Ramge, T., and Laguna de la Vera, Rafael (2024). Radical innovation needs old-school VC. *MIT Sloan Management Review*. Retrieved from https://sloanreview.mit.edu/article/radical-innovation-needs-old-school-vc/

Energy only now has a pilot facility after 5 years. Sublime Systems is at the threshold of building its pilot facility now that it has the capital in hand.

To summarize, we propose three attributes to characterize deep tech ventures that lead to three features of their scaling and growth: 1) Grounded in cutting-edge technological inventions and research; 2) originating from scientific institutions; 3) centered around hardware assets; leading to 1) involving complex technology and commercialization risks; 2) demanding high capital investment; and 3) extended timelines. These criteria not only define the space of deep tech ventures and their contrast to digital ventures but also shed initial light on respective paradigm shifts and likely challenges in managing them.

2 Reasons Corporate Innovators Should Care about Deep Tech Ventures

Building upon insights from our discussions with corporate leaders, we highlight three reasons why today's corporate innovators must care about deep tech ventures.

Deep tech ventures can contribute to creating a competitive edge because they facilitate radical leaps in innovation. In today's dynamic markets, competitive advantage may not always come from incremental innovation or digital solutions. Engaging deep tech ventures cultivates a robust pipeline of products and technologies that potentially provide a step change in capabilities or costs for customers. For Boeing, the acquisition of Greater Boston founded Aurora Flight Sciences provided the company with a range of new capabilities in autonomy, urban air mobility, and experimental air systems. Likewise, Saab acquired the UK-based BlueBear to access autonomous swarm technology. Beyond defense and aerospace, corporate leaders in sectors facing significant competition, but with wellsprings of capital and patience so essential to deep tech, will seek opportunities for competitive advantage, especially at the scientific horizon far from familiar disciplines and areas of in-house expertise.

Deep tech ventures can drive operational efficiency and productivity for corporations facing increasing labor shortages and rising costs[13]. In this context, novel scientific and engineering breakthroughs can help maintain competitiveness, particularly in manufacturing companies. For example, deep tech ventures are making significant advances in robotics and automation. While traditional manufacturing primarily uses robots for repetitive tasks, these

[13] Levenson, A (2022). Getting Ahead of Rising Labor Costs. *MIT Sloan Management Review*. Retrieved from https://sloanreview.mit.edu/article/getting-ahead-of-rising-labor-costs/

technologies enable modern robots to perform more complex, adaptable, and intelligent operations that would otherwise only be performed by humans. Think about, for example, the Palo Alto-based company Aksha Imaging, which emerged from the MIT Media Lab and has developed deep imaging systems for robots in manufacturing contexts with higher resolution for feature detection, tracking, and pose estimation[14]. This technology enables robots to perform highly complex, non-repetitive tasks in manufacturing and logistics contexts with highest precision. For companies across a range of industrial and manufacturing processes, engaging with deep tech ventures has the potential to transform costs and ensure that customers can be served effectively.

Deep tech ventures may help to drive sustainability goals and support corporate aims to significantly enhance ecological performance. By harnessing deep tech, companies can optimize operations, increase energy efficiency, and minimize their environmental impact. Consider, Cambridge-based company Mantel which devised a carbon capture process tailored for energy-intensive industries like cement, steel, or power generation. This process involves directing industrial greenhouse gas emissions through molten salts, effectively capturing carbon dioxide emitted at high temperatures. Similarly, Vancouver-based Svante pioneered a solid adsorbent-based carbon capture technology for post-combustion industrial and power plant flue gas streams. Now collaborating with BASF, they are advancing industrial-scale production of this innovative adsorption technology[15]. The same is also true of Occidental Petroleum's recent acquisition of Carbon Engineering[16]. This move not only enhanced Occidental's DAC business unit and secured a solid pipeline of future projects to drive DAC deployment but also accelerated their commitment to addressing environmental concerns.

3 Corporate Innovators as Bold Partners

Deep tech ventures are led by entrepreneurial teams who introduce innovative technological solutions based on breakthrough science and engineering. However, it is often established corporations who face the challenges and seek the opportunities that these ventures solve. Today we see a growing need to bring these two sides together: entrepreneurial founders of deep tech ventures with the corporate innovators who will serve as partners providing the much-

[14] Calechman, S. (2022, February 18). Using deep imaging for higher resolution. MIT News. Retrieved April 1, 2024, from https://news.mit.edu/2022/using-deep-imaging-higher-resolution-0218
[15] Svante Inc. (2024, March 7). Svante secures commercial supply of MOF advanced sorbent materials with BASF for carbon capture market. Retrieved April 1, 2024, from https://www.svanteinc.com/press-releases/svante-secures-commercial-supply-of-mof-advanced-sorbent-materials-with-basf-for-carbon-capture-market/
[16] Occidental. (2023, August 15). Occidental enters into agreement to acquire direct air capture technology innovator Carbon Engineering. Retrieved April 1, 2024, from https://www.oxy.com/news/news-releases/occidental-enters-into-agreement-to-acquire-direct-air-capture-technology-innovator-carbon-engineering/

needed expertise in managing complex risk, the balance sheets that can provide significant capital for global scale, and the timelines that provide the patience but also urgency. Investors in the early stages of deep tech ventures are likely to welcome these bold corporate partners because they often provide an opportunity for liquidity.

To seize this moment, it is essential for corporate innovators to first cultivate a more fundamental understanding of deep tech ventures and distinguish them and the solutions they generate from other kinds of innovation efforts. Thus, before developing a deep tech strategy, a certain level of “deep tech savviness” is needed. Armed with this understanding, they should boldly approach these ventures to leverage technological solutions to their most pressing challenges.