Mind the Gap:

Bridging the Chasm Between Technology and Value Creation

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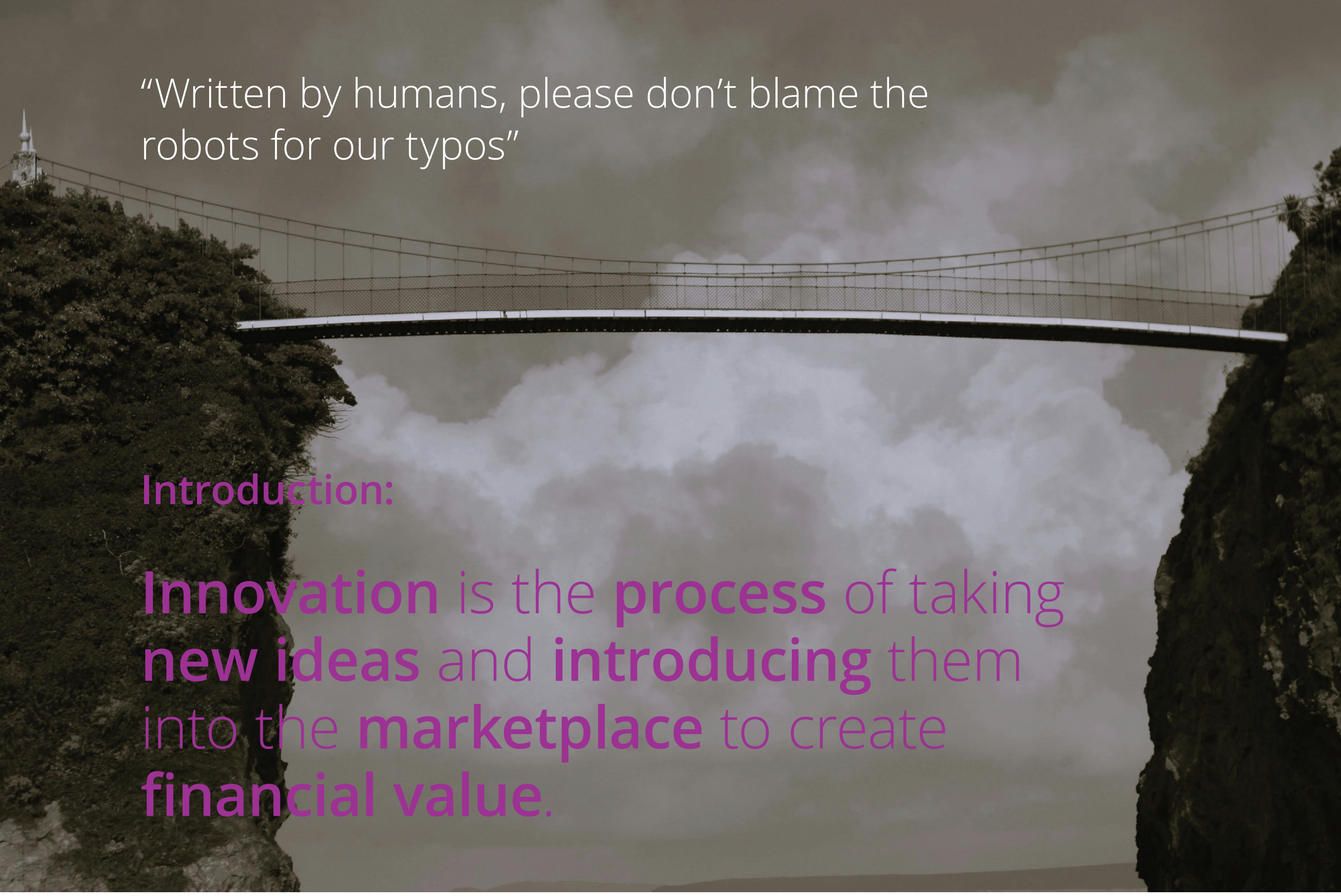

“Written by humans, please don’t blame the robots for our typos”

Introduction:

Innovation is the **process** of taking **new ideas** and **introducing** them into the **marketplace** to create **financial value**.

Many brilliant technical ideas are generated in university labs and corporate R&D centers, but only a small fraction of these brilliant ideas are innovative in the commercial sense – ie capable of solving a meaningful customer pain point or creating a new capability that the customers are willing to pay for. Furthermore, many brilliant ideas that should become a commercial success fail to gain traction in the marketplace.

In this paper, we will discuss the necessary conditions to consider when looking at *deep technology* opportunities. For the rest of this paper, we assume the strength of the founding team and senior leadership has been vetted and deemed qualified. When assessing the leadership team, we look for a demonstrated track record of entrepreneurship, ideally including at least one previous successful exit that demonstrated scaling. We also identify significant gaps in the leadership skill set and assess whether they can be readily addressed. Senior teams must demonstrate strong conviction in their approach while remaining coachable.

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Bill is a director of unlisted and listed technology companies internationally.**

With deep technology startups, we look for technical thought leadership (at the PhD level) that can identify and execute a pivot strategy if necessary.

It is also critical that teams understand their potential customers and have either development agreements in place, or substantive discussions with a broad set of prospective customers to gain a deep understanding of requirements, use cases and price sensitivity.

While there are no "sufficient" conditions that guarantee an investment's success, we provide rationale and examples to support requirements that go beyond the necessary conditions and should be considered when making deep technology investments.

Investing in Research & Development (Necessary Conditions)

Government and private companies invest in both basic science and applied research. There exist multiple frameworks to guide funding decisions, with one of the most widely used (at least within the US Government), being the Heilmeier Catechism (see text box below).

Named after an early DARPA[1] Director, the Heilmeier Catechism is deceptively difficult for a researcher to answer unless they have thought deeply about customer pain points and the competitive landscape.

When applied properly, this framework exposes weaknesses in proposals and allows for a more objective basis for prioritizing research investments.

Heilmeier Catechism

1. What are you trying to do? Articulate your objectives using absolutely no jargon.
2. How is it done today, and what are the limits of current practice?
3. What is new in your approach and why do you think it will be successful?
4. Who cares? If you are successful, what difference will it make?
5. What are the risks?
6. How much will it cost?
7. How long will it take?
8. What are the mid-term and final "exams" to check for success?

Source: www.darpa.mil/about/heilmeier-catechism

As a template it separates researchers who are enamored with their technology from those focused on solving an important commercial problem. From my personal experience applying this framework across multiple government agencies and private companies, a successful investment pitch typically requires multiple iterations to refine the potential core value proposition and the unique hypothesis that will drive success. If the competitive moat is weak (or nonexistent), additional research funding is often necessary to create a sustainable technical differentiation that can withstand competitive pressure.

[1] Defense Advanced Research Projects Agency (DARPA), www.darpa.mil

Crossing the "Valley of Death"

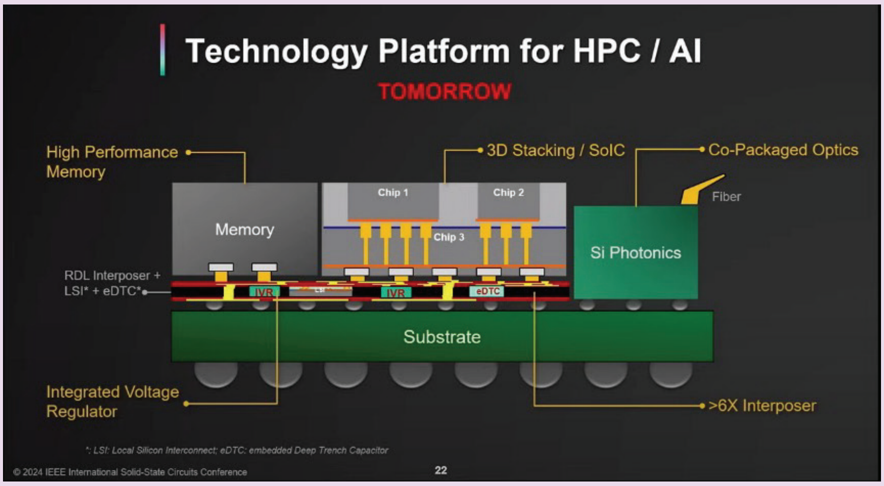
The Heilmeier Catechism is a highly effective framework to prioritize early-stage applied research funding, assessing customer willingness to pay and the potential ability of the company to capture fair share of the value that it creates.

The adoption of new technology may be stymied by supply chains, manufacturability, ease of customer adoption, unknown concept of operations, or a hostile or uncertain regulatory environment.

The gap between a brilliant technical idea and a viable commercial product is often referred to as the "Valley of Death" – the point at which the technologies fail due to an immature ecosystem to support the new technology deployment at scale. This valley typically reflects misalignment between technology readiness, market demand and supporting infrastructure.

Example: Silicon Photonics

Figure 1: TSMC 2.5D CPO for HPC



Source: https://tspasemiconductor.substack.com/p/tsmcs-silicon-photonics-architecture)

For decades, engineers claimed that silicon photonics was the "next big thing". Despite its promise, the technology never got traction due to gaps in foundry capabilities, large-scale testing & evaluation, and advanced packaging.

This dynamic is now changing. The almost insatiable demand for AI requires increasing data rates between graphical processing units (GPUs), boards, and servers. Traditional copper wires are limited in their bandwidth capacity, creating communication latency and inefficient use of CapEx. To address these high-value pain points, optical solutions are increasingly being developed for both scale-out and scale-up architectures.

At the same time, tier 1 foundries (e.g., TSMC[2, 3]) are developing silicon photonics processes within their foundry offerings (see Figure 1). To complete the full end-to-end manufacturing stack, companies focused on optical packaging (including CMOS co-packaging) and optical component testing now exist. We are finally at the junction where the customer demand and the manufacturing supply are aligned. As the silicon photonics ecosystem continues to mature, we anticipate attractive investment opportunities to arise.

[2] https://research.tsmc.com/page/on-chip-interconnect/21.html

[3] Kevin Zhang, TSMC SVP delivered remarks at 2024, **IEEE International Solid-State Circuits Conference**, https://www.isscc.org/isscc-plenary-videos

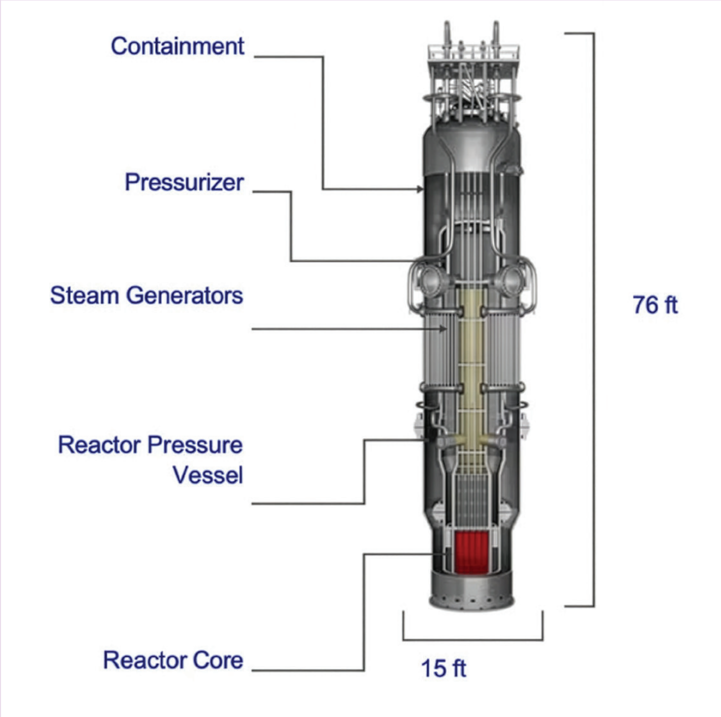
Example: Advanced Nuclear Reactors

Another example where customer demand is forcing changes to the technology and related ecosystem is nuclear power (fission – not fusion). Small modular nuclear reactors, recommissioning or extending the life of current reactors, and the prospect of space-based nuclear power are creating new investment opportunities. In this case, the core technology has not fundamentally changed (although safety and efficiency have improved). Rather, changes in fuel supply chains and regulatory environment have materially improved to make investments in nuclear fission practical.

Within the United States, the Department of Energy is now providing access to high-assay low-enriched uranium (HALEU)[4] needed for advanced reactors, and is collaborating with private companies (Oklo, Terrestrial Energy, TRISO-X, and Valar Atomics) to build advanced fuel fabrication facilities[5]. It has also leveraged the Defense Production Act (DPA)[6] to create a consortium addressing bottlenecks across the fuel cycle, from mining through fuel fabrication, substantially reducing supply chain risk.

Regulatory risk has also declined. The 2024 ADVANCE Act[7] expanded the Nuclear Regulatory Commission's (NRC) mandate to include licensing efficiently, not solely safety. The regulatory reform was reinforced by Presidential Executive Orders[8] which directs the NRC to streamline reviews for advanced designs, and mandate fixed timelines for licensing decisions (18 months for new reactors and 12 months for renewals). An example of a recently approved reactor design by the NRC (Figure 2 - May 28, 2025)[9] is NuScale Power's 77 MWe (250 MWth) small modular nuclear reactor.

Figure 2: NRC - NuScale Power's 77 Mwe9



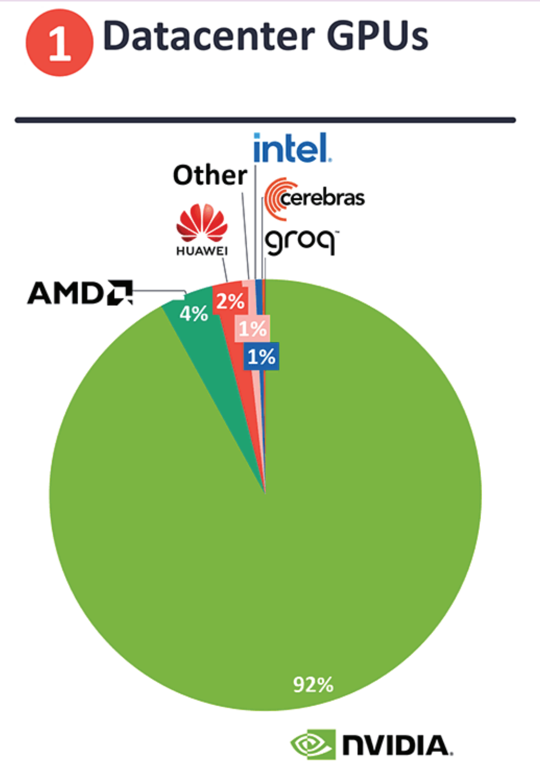
With these changes in the nuclear reactor ecosystem, the risks and costs for deployment and operations have been significantly reduced in the United States. Reduction of fuel supply risk and accelerating the efficient deployment of CapEx improves the estimated investment returns in advanced nuclear fission power deployment. Improving the reactor ecosystem will result in enhanced investment opportunities and returns.

4 https://www.world-nuclear-news.org/articles/doe-selects-first-recipients-of-haleu
5 https://www.energy.gov/articles/energy-department-selects-four-companies-advanced-nuclear-fuel-line-pilot-projects
6 https://www.energy.gov/ne/defense-production-act-consortium
7 https://www.nrc.gov/about-nrc/governing-laws/advance-act/about-advance-act
8 https://www.energy.gov/ne/articles/9-key-takeaways-president-trumps-executive-orders-nuclear-energy
9 https://www.powermag.com/nuscales-77-mwe-smr-clears-nrc-review-sets-stage-for-first-firm-order/

Example: NVIDIA and the Power of the Technical Moat

The final ecosystem example illustrates the importance of reducing customer adoption risk. In the late 2000s, Intel held 49.4% of the global GPU market share, while NVIDIA held 20.6% market share. At that time, GPUs were primarily used in game consoles, and product differentiation was limited.

Figure 3: 2025 GPUs Market Share[11]



During this period, it was recognized that GPUs could be used for general compute (beyond rendering graphics). This insight fundamentally changed the product roadmap, especially in 2009 when GPU applications for machine learning (dense matrix operations) was realized[10]. However, a major barrier to adoption was the need for programmers to learn new programming models distinct from CPUs. NVIDIA reduced this impediment by creating the CUDA (Compute Unified Device Architecture), a proprietary toolkit and application programming interface. CUDA made it easier for programmers to use GPUs, particularly for machine learning and artificial neural network problems.

NVIDIA further reduced customer adoption "friction" by developing proprietary connectivity solutions (InfiniBand) and interposers to high-bandwidth memory. The net results of lowering adoption risk for NVIDIA are shown in the above figure[11] which illustrates the 2025 market share for GPUs with NVIDIA at 92%, AMD with 4%, and Intel falling to less than 1%. NVIDIA's brilliant strategy was not just to make it easier for customers to use GPUs for broader applications, but to ensure they used NVIDIA's GPUs (creating a technical moat) due to an integrated proprietary design ecosystem (CUDA, InfiniBand, and interposers). This strategic decision to get the supporting ecosystem right created (to date) nearly $4 trillion of market capitalization for NVIDIA and substantially more in the broader AI marketplace.

[10] 2009, Rajat Raina, Anand Madhavan, and Andrew Ng; "*Large-scale Deep Unsupervised Learning using Graphics Processors*"; appeared in *Proceedings of the 26th International Conference on Machine Learning*, Montreal, Canada.

[11] https://iot-analytics.com/leading-generative-ai-companies

Conclusion

Advanced technologies offer the potential for disruptive investment opportunities. However, understanding the maturity of the innovation ecosystem required to support these technologies is critical to investment timing. The hype around a new technology almost always precedes the practical applicability and sustainable revenue generation (as illustrated by the Gartner Hype Cycle[12]).

To successfully cross the "Valley of Death," investors must look beyond the technical specifications and evaluate the supporting ecosystem. This includes addressing manufacturing risks (as seen in Silicon Photonics), supply chains and regulatory stability (essential for nuclear fission reactors), and overcoming customer adoption friction alongside defensible moats (as demonstrated by NVIDIA).

Ultimately, a successful investment requires not just the best technology but a supporting ecosystem to enable the solution to scale with minimal barriers to adoption.

At the HPQC fund, we seek early-stage technology developments with the potential to create market disruptions. While necessary, this alone is insufficient for our investment thesis. We also assess ecosystem maturity and the barriers to adoption. Often, this analysis leads us to pass on opportunities. In some cases, it leads us to invest in the broader infrastructure rather than the core technology itself, particularly where the winning architecture remains uncertain. When demand is clear, supply and adoption risks are low, and the ecosystem is aligned, we establish our highest conviction investments.

[12] Example: https://www.gartner.com/en/articles/hype-cycle-for-emerging-technologies

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