



Disruptive Technologies and the Incumbent's Dilemma in Navigating the Digital and AI Era

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Abstract

The phenomenon of disruptive innovation, first articulated by Bower and Christensen, remains one of the most consistent patterns in business: the failure of leading companies to stay at the top of their industries when technologies or markets change. This paper revisits the foundational concepts of disruptive technology, updating the theoretical framework to account for the modern digital economy, platform ecosystems, and the advent of generative artificial intelligence (AI). Through a comparative case analysis of Uber, Airbnb, Netflix, NVIDIA and OpenAI, the paper illustrates how the innovator's dilemma has evolved and intensified in the 21st century. The argument distinguishes Christensen-style disruptive innovation from adjacent mechanisms such as platform disruption, architectural innovation and regulatory disruption. It shows that while the core mechanisms of disruption remain intact, modern disruption often unfolds faster and through ecosystem-level mechanisms, data advantages, network effects and regulatory arbitrage. The paper therefore contributes a strategic synthesis linking disruption theory with dynamic capabilities and organisational ambidexterity.

Subject Areas

Business Analysis, Business Management

Keywords

Disruptive Innovation, Platform Economics, Artificial Intelligence, Dynamic Capabilities, Strategic Management, Incumbent Failure, Network Effects, Generative AI

1. Introduction

One of the most consistent patterns in business history is the failure of leading

companies to maintain their market dominance when confronted with technological or market shifts [1]. The examples are numerous and span multiple decades and industries. Goodyear and Firestone entered the radial-tyre market late. Xerox allowed Canon to create the small-copier market. Bucyrus-Erie allowed Caterpillar and Deere to take over the mechanical excavator market. Sears gave way to Walmart. In the computing industry, IBM dominated mainframes but missed the emergence of minicomputers by several years, while Digital Equipment Corporation (DEC) dominated the minicomputer market but missed the personal computer revolution almost entirely [2]. Apple Computer established the standard for user-friendly computing but lagged five years behind the leaders in bringing its portable computer to market [1].

Why do well-managed, highly successful companies fail to make the technological investments that future customers will demand? Undoubtedly, bureaucracy, arrogance, tired executive blood, poor planning, and short-term investment horizons have all played a role in specific cases. However, as Bower and Christensen [1] originally posited, a more fundamental reason lies at the heart of this paradox: leading companies succumb to one of the most popular and valuable management dogmas—they stay too close to their existing customers. Although most managers like to think they are in control, customers wield extraordinary power in directing a company's investments. Before managers decide to launch a technology, develop a product, build a plant, or establish new distribution channels, they must look to their customers first: Do their customers want it? How big will the market be? Will the investment be profitable? The more astutely managers ask and answer these questions, the more completely their investments will be aligned with the needs of their customers—and the more blind they will be to the technologies that will eventually displace them.

This paper builds upon the foundational theory of disruptive innovation, updating it for the contemporary business landscape. The digital revolution, the rise of platform economics, and the explosive growth of artificial intelligence have fundamentally altered the speed and scale of disruption [3]. The paper uses a qualitative comparative case-study approach. Netflix, Uber, Airbnb, NVIDIA, and OpenAI were selected because each represents a high-salience instance in which a new entrant or a strategically repositioned firm challenged established incumbents through a distinctive mechanism: low-end or new-market disruption, platform-mediated disruption, architectural innovation, ecosystem control, or strategic AI substitution. Each case was analysed through four common dimensions: the incumbent's dominant value proposition, the entrant's initially unattractive performance dimension, the mechanism by which the entrant improved or scaled, and the incumbent's resource-allocation or organisational response. The paper proceeds as follows: Section 2 reviews the theoretical foundations of disruptive innovation; Section 3 examines the evolution from product-based to platform-based disruption; Section 4 analyses the AI revolution as the current frontier of disruption; Section 5 presents a comparative summary table; Section 6 outlines

strategic imperatives for incumbents; and Section 7 concludes.

2. The Theoretical Foundations of Disruption

2.1. Sustaining versus Disruptive Technologies

To understand why great firms fail, one must first distinguish between sustaining and disruptive technologies [4]. Sustaining technologies tend to maintain a rate of improvement; they give customers something more or better in the attributes they already value [1]. For example, thin-film components in disk drives, which replaced conventional ferrite heads and oxide disks between 1982 and 1990, enabled information to be recorded more densely on disks—a classic sustaining innovation that gave existing customers more of what they already valued. Established companies consistently lead their industries in developing and adopting sustaining innovations because their resource-allocation processes are designed to evaluate and fund projects that promise higher margins from known customers [5].

Conversely, disruptive technologies introduce a very different set of attributes from those mainstream customers have historically valued [6]. Often, they perform worse along one or two dimensions that are particularly important to those customers. Consequently, mainstream customers are initially unwilling to use a disruptive product in applications they know and understand [7]. Disruptive technologies tend to be used and valued only in new markets or applications; in fact, they generally make the emergence of new markets possible [8]. Sony's early transistor radios, for instance, sacrificed sound fidelity but created a market for portable radios by offering a new and different package of attributes—small size, light weight, and portability. The pattern in the hard-disk-drive industry, the central case study in Bower and Christensen's original article [1], is instructive. Between 1976 and 1992, disk-drive performance improved at a stunning rate: the physical size of a 100-megabyte system shrank from 5400 to 8 cubic inches, and the cost per megabyte fell from \$560 to \$5. Yet no single disk-drive manufacturer was able to dominate the industry for more than a few years. A series of companies entered the business and rose to prominence, only to be toppled by newcomers who pursued technologies that at first did not meet the needs of mainstream customers. The leaders stumbled at each point of disruptive technological change: when the diameter of disk drives shrank from 14 inches to 8 inches, then to 5.25 inches, and finally to 3.5 inches. Each of these new architectures initially offered the market substantially less storage capacity than the typical user in the established market required.

2.2. The Resource Allocation Problem

A company's revenue and cost structures play a critical role in how it evaluates proposed technological innovations [2]. Disruptive technologies typically look financially unattractive to established companies [9]. The potential revenues from discernible markets are small, and it is difficult to project long-term market size.

Furthermore, established companies have adopted higher-cost structures to support sustaining technologies than those required for disruptive technologies. As a result, managers typically see themselves as having two choices when deciding whether to pursue disruptive technologies: to go downmarket and accept the lower profit margins of the emerging markets that the disruptive technologies will initially serve, or to go upmarket with sustaining technologies and enter market segments whose profit margins are alluringly high [10]. Any rational resource-allocation process in companies serving established markets will choose to go upmarket rather than go downmarket.

The case of Seagate Technology illustrates this dynamic with particular clarity. Seagate was one of the most successful and aggressively managed companies in the history of the microelectronics industry, growing revenues to more than \$700 million by 1986. It had pioneered 5.25-inch hard disk drives and was the main supplier to IBM and IBM-compatible personal computer manufacturers. When the disruptive 3.5-inch drives emerged in the mid-1980s, Seagate's engineers were the second in the industry to develop working prototypes. However, Seagate's principal customers—IBM and other manufacturers of AT-class personal computers—showed no interest in the new drives. They wanted 40-MB and 60-MB drives, and Seagate's early 3.5-inch prototypes packed only 10 MB. In response, Seagate's marketing executives lowered their sales forecasts for the new disk drives. Senior managers, quite rationally, decided that the 3.5-inch drive would not provide the sales volume and profit margins Seagate needed. A former Seagate marketing executive recalled: "We needed a new model that could become the next ST412. At the time, the entire market for 3.5-inch drives was less than \$50 million. The 3.5-inch drive just didn't fit the bill—for sales or profits" [1]. While Seagate's attention was focused on the personal-computer market, former employees frustrated by the delays founded Conner Peripherals. Conner focused on selling 3.5-inch drives to companies in emerging markets for portable computers and small-footprint desktop products. By the end of 1987, 3.5-inch drives packed the capacity demanded in the mainstream personal-computer market. By then, it was too late for Seagate. In their 1994 fiscal years, the combined revenues of Conner and Quantum exceeded \$5 billion [1].

2.3. Performance Trajectories and the S-Curve

The concept of performance trajectories—the rate at which a product's performance has improved and is expected to improve over time—is central to understanding disruptive innovation [11]. Almost every industry has a critical performance trajectory. In mechanical excavators, the critical trajectory is the annual improvement in cubic yards of earth moved per minute. In photocopiers, an important performance trajectory is improvement in the number of copies per minute. In disk drives, one crucial measure is storage capacity, which increased by an average of 50% each year for a given drive size.

The key insight is that the trajectory of the disruptive technology relative to the

market is what is strategically significant—not the comparison of the disruptive technology with the established technology [12]. Many disruptive technologies never surpass older technologies in absolute terms. The reason the mainframe-computer market shrank was not that personal computers outperformed mainframes, but because personal computers networked with a file server met the computing and data-storage needs of many organisations effectively. Mainframe-computer makers were reeling not because the performance of personal-computing technology surpassed the performance of mainframe technology, but because it intersected with the performance demanded by the established market. **Figure 1** shows that disruptive technologies initially underperform in mainstream markets but improve faster than market demand, eventually displacing incumbent sustaining technologies. The red dot marks the point where the disruptive trajectory intersects low-end market demand—the moment disruption begins in earnest.

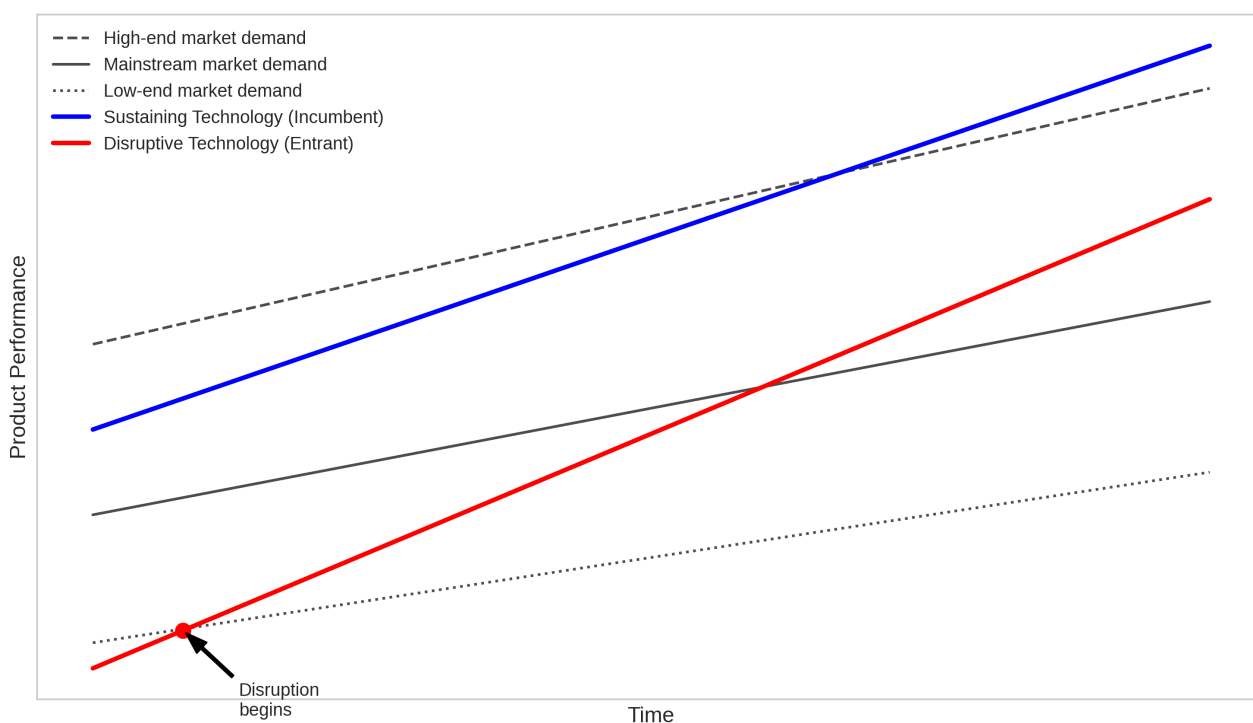


Figure 1. The disruptive innovation model.

2.4. Architectural Innovation and Dynamic Capabilities

Henderson and Clark [11] expanded on Christensen’s framework by introducing the concept of “architectural innovation”—innovations that change a product’s architecture without necessarily changing its components. Incumbents often fail not because they lack the component technologies, but because their organisational structures, communication channels, and information filters are optimised for the old architecture and are therefore ill-suited to recognise and respond to architectural change [12]. The theoretical response to this challenge is found in

the dynamic capabilities framework [13]. Dynamic capabilities refer to the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments. Teece [14] further elaborated that dynamic capabilities encompass sensing (identifying and assessing opportunities and threats), seizing (mobilising resources to address them), and transforming (continuing renewal). Firms that possess strong dynamic capabilities are better positioned to recognise disruptive threats and to respond before it is too late. The challenge, as the following sections demonstrate, is that the very success of an incumbent firm tends to erode its dynamic capabilities by creating organisational routines and resource allocation processes optimised for the existing business model [15].

3. The Evolution of Disruption: From Products to Platforms

While the original disruptive innovation theory focused heavily on physical products, the 21st century has seen the locus of disruption shift decisively to digital platforms and ecosystems [16]. The cases that follow should therefore not be read as identical examples of Christensen-style disruption. Netflix most closely follows the classic trajectory from an initially unattractive service attribute to mainstream displacement; Uber and Airbnb combine platform disruption with regulatory and asset-light business-model innovation; NVIDIA illustrates architectural innovation and ecosystem control; and OpenAI illustrates a strategic threat from generative AI whose market-displacement effects remain emergent rather than fully settled. This distinction matters because incumbents may fail for different reasons depending on whether the entrant is changing product performance, market architecture, regulatory boundaries or ecosystem control. The advent of the internet, smartphones, and cloud computing created the infrastructure for a new form of disruption that operates not only through product performance trajectories but also through network effects and the commoditisation of assets.

3.1. Platform Economics and Network Effects

Digital platforms disrupt traditional “pipeline” businesses by resetting entry barriers, changing value creation, and leveraging network effects [17]. In a traditional pipeline business, value is created through a linear sequence of activities: inputs are transformed into outputs, which are sold to customers. In a platform ecosystem, by contrast, value is created by facilitating interactions between external producers and consumers [18]. The platform itself does not produce the value; it enables others to do so. As the number of participants grows, the value of the platform increases exponentially—a phenomenon known as network effects, first formally analysed by Katz and Shapiro [19]. This creates a powerful winner-take-all dynamic: the platform with the most participants becomes the most valuable, attracting still more participants, further increasing its value. This dynamic is qualitatively different from the performance-trajectory model in the original Bower and Christensen [1] framework, and it has important implications for how incum-

bents are disrupted.

Traditional pipeline businesses compete on product performance, cost efficiency, and brand. Platform businesses compete on the size and quality of their network. An incumbent pipeline business, no matter how efficient, cannot easily replicate the network effects of a platform entrant without fundamentally transforming its business model—a transformation that, as the following case studies illustrate, is extraordinarily difficult for established firms to execute [16]. **Figure 2** summarises that platform businesses leveraging network effects experience exponential growth in value creation, eventually overtaking traditional pipeline businesses that rely on linear scale economies. The central dot marks the point at which platform value creation overtakes that of the incumbent pipeline model.

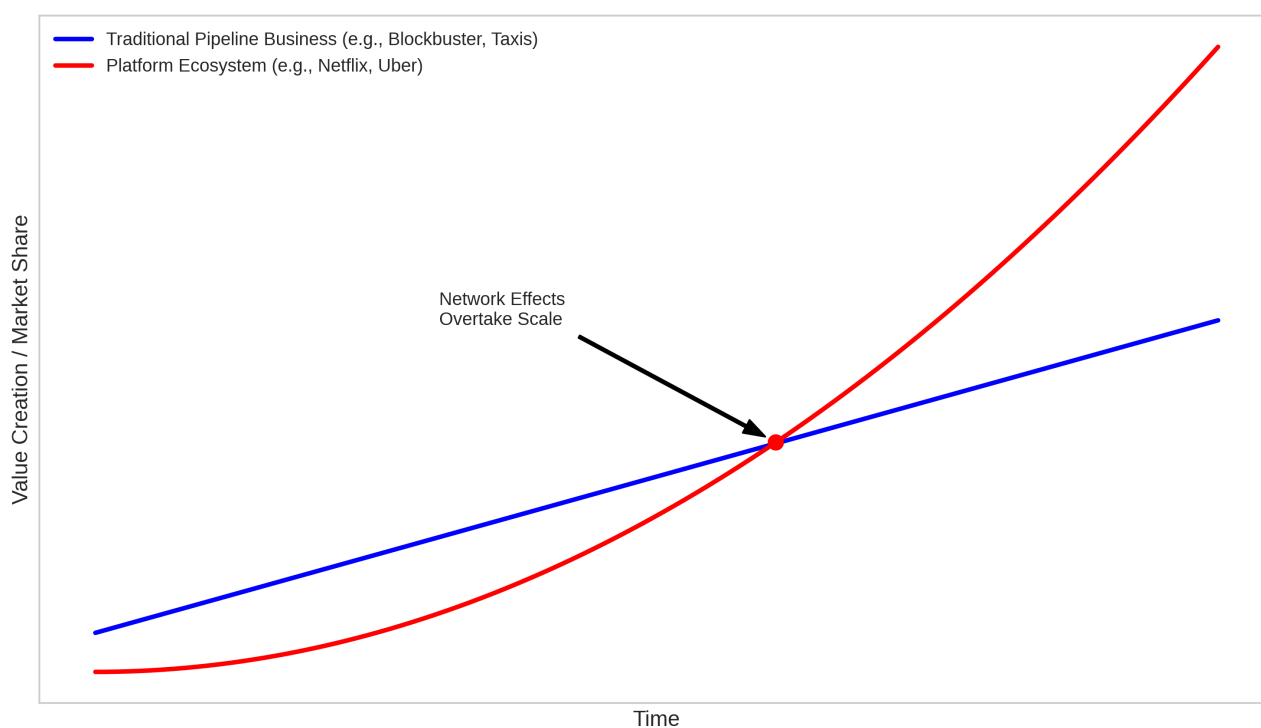


Figure 2. Platform disruption: the power of network effects.

3.2. Case Study: Netflix versus Blockbuster

The demise of Blockbuster at the hands of Netflix is the case in this paper that most closely approximates Christensen-style disruptive innovation. At its peak in 2004, Blockbuster operated more than 9000 stores worldwide and employed approximately 60,000 people. Its business model relied heavily on physical retail locations, late fees—which generated an estimated \$800 million annually—and the convenience of in-store browsing [20]. The focal customer-value dimension was immediacy: mainstream customers valued the ability to obtain a film instantly from a nearby store, while Netflix initially offered a slower but cheaper and more convenient alternative. Netflix entered the market in 1997 with a disruptive model: DVD-by-mail with no late fees, appealing initially to a niche market of

early DVD player adopters who were comfortable with the delay inherent in postal delivery. This was a classically disruptive entry: the service was inferior to Blockbuster on the dimension that mattered most to mainstream customers (immediate availability), but superior on dimensions that a small but growing segment valued (no late fees, a vast catalogue, and the convenience of home delivery). Blockbuster's mainstream customers—those who wanted to watch a film on a Friday evening—had no use for Netflix. Blockbuster's management rationally concluded that Netflix was not a serious threat.

As internet bandwidth improved through the mid-2000s, Netflix transitioned to streaming—an architectural innovation that fundamentally changed the nature of the service [21]. Streaming eliminated the physical constraints of the DVD-by-mail model and offered a new package of attributes: instant access to a vast library, personalised recommendations driven by algorithmic data analysis, and a seamless user experience across multiple devices. Blockbuster's physical-store-centric organisation, with its high fixed costs and entrenched retail infrastructure, could not effectively counter this transition. Blockbuster eventually launched its own online service, "Blockbuster Total Access" in 2004, and it briefly outpaced Netflix in subscriber growth in 2007. However, the company's board, concerned about the cannibalisation of its retail business, forced the resignation of the CEO who had championed the online strategy and reversed course—a decision that proved fatal [22]. Blockbuster filed for bankruptcy in 2010. Netflix, meanwhile, continued to invest in its platform. By 2013, it had launched its first original series, *House of Cards*, demonstrating that a streaming platform could also be a content producer. By the end of 2025, industry reports indicated that Netflix had more than 325 million global paid subscribers, while its 2025 Form 10-K noted that the company had discontinued routine membership reporting and emphasised revenue growth, engagement and advertising as complementary metrics [21]. The lesson is stark: Blockbuster's failure was not a lack of awareness of the threat, but an inability—structural, financial, and cultural—to allocate resources away from its highly profitable retail operations toward a lower-margin, uncertain streaming model [22].

3.3. Case Study: Uber and the Taxi Industry

Uber's disruption of the taxi industry is primarily an example of platform and regulatory disruption rather than a pure Christensen-style low-end entry [23]. The traditional taxi industry operated under a medallion system—a form of regulatory capture that restricted supply by requiring each driver to obtain a government-issued licence to operate commercially. In New York City, a taxi medallion sold for more than \$1 million at its peak in 2013, creating a formidable barrier to entry and generating substantial rents for medallion holders [24]. The focal performance dimension was regulatory certainty and standardisation: early ride-hailing was less institutionally settled than licensed taxi service, but it was often faster to summon, easier to pay for and more transparent to track. Uber, founded in 2009, introduced a disruptive platform that connected riders directly with private

drivers via a smartphone application. Initially, Uber operated in a legal grey area, positioning itself not as a taxi company but as a technology platform that facilitated peer-to-peer transportation. This framing allowed it to bypass taxi regulations in many jurisdictions, at least initially. The service initially sacrificed the regulatory certainty and standardised vehicles of traditional taxis for convenience, lower prices, and a seamless digital interface that included cashless payment, GPS tracking, and two-way ratings [25].

The platform's network effects rapidly scaled its operations. More drivers attracted more riders, which attracted more drivers, creating a virtuous cycle that was extraordinarily difficult for incumbent taxi companies to replicate [26]. Traditional taxi companies, burdened by the medallion system, high fixed costs, and fragmented ownership structures, were unable to compete with the algorithmic efficiency and capital-light structure of the ride-hailing giant [27]. Uber's 2025 Form 10-K reported that its technology was available in more than 70 countries and more than 15,000 cities, and that its network becomes smarter with every trip [24]. The taxi medallion market, meanwhile, had collapsed: New York City medallions that once sold for more than \$1 million traded at a fraction of that level after the rise of ride-hailing. The Uber case also illustrates a new dimension of disruption that was not present in the original Bower and Christensen [1] framework: regulatory disruption. Uber did not merely disrupt the taxi industry through superior technology; it disrupted the regulatory framework that protected the industry [28]. By moving faster than regulators could respond and by building a large user base that created political pressure for legalisation, Uber effectively changed the rules of the game [23]. This regulatory dimension of disruption is increasingly important in the digital economy, where platform businesses often operate across multiple jurisdictions and can exploit regulatory arbitrage [28] [29].

3.4. Case Study: Airbnb and the Hospitality Sector

Airbnb's disruption of the hospitality industry is best understood as a platform-mediated business-model disruption with a new-market-entry path [30]. Founded in 2008, Airbnb created a platform that enabled homeowners to rent out spare rooms or entire properties to travellers, effectively commoditising underutilised residential space. The service initially appealed to budget-conscious travellers who were willing to sacrifice the standardised amenities, predictable service levels and loyalty benefits of a hotel for lower prices, greater variety and a more authentic local experience [31].

Traditional hotel chains—Marriott, Hilton, InterContinental, and others—initially dismissed Airbnb as a niche service for backpackers and budget travellers. Their mainstream customers, business travellers and leisure tourists who valued consistency, loyalty programmes, professional service and brand assurance, had no immediate use for Airbnb. This was disruptive in the customer-value sense: inferior on the dimensions that mattered most to mainstream customers, but su-

perior on dimensions valued by an emerging segment. Hotel chains rationally concluded that Airbnb was not a serious threat to their core business. However, as Airbnb improved its platform—by introducing professional photography services for hosts, a comprehensive review system, and a “Superhost” programme to identify the most reliable hosts—it moved upmarket. By the mid-2010s, Airbnb was capturing not just budget travellers but corporate travellers and luxury vacationers [31]. The company launched “Airbnb for Work” in 2014, targeting business travellers directly. By 2019, Airbnb had over 7 million listings in more than 220 countries and regions—more rooms than the world’s largest hotel chains combined. Its initial public offering in December 2020, during the COVID-19 pandemic, valued the company at approximately \$47 billion.

The hotel industry’s response has been hampered by the same structural constraints that afflicted Blockbuster and the taxi industry: heavy capital investment in physical assets, high fixed costs, and business models predicated on asset ownership rather than asset orchestration [22]. Hotels cannot easily transform themselves into platforms without cannibalising their existing asset base. Some chains have attempted to respond by launching their own home-sharing programmes (Marriott launched “Homes and Villas by Marriott” in 2019), but these efforts have been modest in scale compared to Airbnb’s platform.

4. The AI Revolution: The Next Wave of Disruption

The current frontier of disruptive innovation is artificial intelligence, specifically generative AI and the underlying hardware infrastructure [3]. AI represents a general-purpose technology that, like electricity or the internet, has the potential to transform productivity and value creation across virtually every sector of the economy [32]. General-purpose technologies are particularly powerful disruptors because they do not merely disrupt individual industries; they disrupt the fundamental nature of economic activity itself [33].

4.1. Case Study: NVIDIA’s Architectural Dominance

NVIDIA’s rise to dominance in the AI sector is primarily a case of architectural innovation and ecosystem control rather than classic low-end disruption [33]. Originally founded in 1993 as a producer of Graphics Processing Units (GPUs) for the gaming market, NVIDIA recognised that the parallel processing architecture of GPUs was ideally suited for training deep neural networks—a task that requires performing vast numbers of matrix multiplications simultaneously [34]. The focal performance dimension was general-purpose CPU compatibility: GPU computing was initially unattractive to many mainstream enterprise customers because it was specialised, developer-intensive and oriented to gaming or research rather than conventional enterprise workloads [35]. This recognition led NVIDIA to make a series of strategic investments that would prove transformative. In 2006, the company launched CUDA (Compute Unified Device Architecture), a software platform that allowed developers to programme NVIDIA GPUs for general-pur-

pose computing tasks, including machine learning. This was a classic example of a sustaining innovation on a disruptive platform: CUDA made NVIDIA's GPUs progressively more useful for AI workloads, creating a virtuous cycle in which more developers adopted CUDA, attracting more investment in CUDA-compatible tools and libraries, which in turn made NVIDIA GPUs even more attractive [36].

Meanwhile, incumbent chipmakers—most notably Intel—focused on sustaining innovations in Central Processing Units (CPUs) for general computing. Intel's highly profitable CPU business, which generated margins of 60% or more, created exactly the kind of resource-allocation bias that Bower and Christensen [1] described. GPU-based computing for AI was initially a niche application, appealing only to academic researchers and a small number of technology companies. Intel's mainstream customers—enterprise software companies, PC manufacturers, and data centre operators—had no immediate use for GPU-based AI computing. Intel rationally concluded that the GPU market was not strategically significant. By the time the deep learning revolution of the early 2010s demonstrated the transformative potential of GPU-based AI, NVIDIA had established an insurmountable lead [6]. The CUDA ecosystem, with its vast library of optimised software tools and a large community of trained developers, created switching costs that made it extraordinarily difficult for competitors to displace NVIDIA, even with technically superior hardware. Intel's subsequent attempts to compete in the AI hardware market—through acquisitions (Altera, Mobileye, Habana Labs) and internal development (Intel Gaudi)—have achieved limited success against NVIDIA's entrenched ecosystem position [37] [38].

The financial consequences have been dramatic. NVIDIA reported fiscal 2025 revenue of \$130.5 billion, up 114% from the prior year, and full-year Data Center revenue of \$115.2 billion, up 142%, driven largely by AI workloads [39]. Its market capitalisation exceeded \$3 trillion during the AI investment surge, while Intel's relative market position weakened as investors re-priced the semiconductor sector around accelerated computing rather than conventional CPU leadership. These figures should be interpreted as evidence of architectural and ecosystem realignment rather than as proof that all competing chip architectures have been permanently displaced [40].

4.2. Case Study: OpenAI and Generative AI

OpenAI's release of ChatGPT in November 2022 marked a strategically disruptive moment for the software and search industries, although the degree of realised market displacement remains contested and still unfolding [41]. The service attracted 100 million users within two months of launch, and it triggered a wave of investment and competitive response that reshaped expectations about search, productivity software and knowledge work. The primary mechanism is not yet full incumbent displacement, but strategic substitution: generative interfaces can shift user expectations from link retrieval toward answer synthesis [42]. Tradi-

tional search engines, most notably Google, operate on a highly profitable advertising model based on retrieving and ranking links to external web pages. Alphabet's 2025 annual reporting shows the continued centrality of Google Search and advertising revenues to the group, even as the company integrates AI features into search and cloud services [43]. Generative AI offers a fundamentally different attribute package: rather than presenting a list of links for the user to evaluate, it synthesises information from multiple sources and presents a direct, conversational answer [38]. For many query types, this is a superior user experience—particularly for complex, multi-step questions that require synthesising information from multiple sources—but the long-term effects on search advertising economics remain uncertain.

For Google, responding to OpenAI presents a strategic dilemma related to, but not identical with, the classic innovator's dilemma [1]. Deploying generative AI directly in search can alter the economics of search advertising: if users receive direct answers rather than lists of links, they may have less reason to click on advertisements. Generative AI responses also require materially higher compute resources than traditional retrieval-based search, although published estimates vary widely and depend on model size, caching, chip utilisation and inference architecture [37]. Google's resource-allocation processes are therefore shaped by both cannibalisation risk and infrastructure-cost risk.

OpenAI, unburdened by a search-advertising incumbent business model, was free to push generative AI into the market without the same direct concern for cannibalisation. Microsoft's role requires careful clarification: Microsoft is a legacy incumbent in enterprise software and cloud computing, but in the generative AI case it acts simultaneously as OpenAI's strategic partner, investor and distribution channel. Its multibillion-dollar partnership with OpenAI gave the entrant access to Azure infrastructure, enterprise relationships, and integration points in Bing and Microsoft 365, while allowing Microsoft to reposition parts of its incumbent portfolio as AI-enabled complements. Google has responded with Gemini and AI Overviews, but it has done so while balancing innovation against the economics of its existing advertising model. The outcome of this competitive dynamic remains uncertain; the evidence supports a strong strategic threat and a reconfiguration of competition, not a settled conclusion that Google has already been disrupted.

The broader implications of generative AI for disruption theory are significant. Eloundou, Manning, Mishkin and Rock estimate that large language models could affect approximately 80% of the US workforce, with at least 10% of their work tasks exposed to automation [42] [43]. Recent research also emphasises that competition in generative AI is shaped by platform ecosystems, data access, compute capacity, model deployment costs and complementor networks rather than by model quality alone [44] [45]. This suggests that generative AI is not merely a disruptive technology for the search and software industries, but a general-purpose technology with the potential to reshape knowledge work across many sec-

tors of the economy. The scale of this potential disruption far exceeds anything contemplated in the original Bower and Christensen framework.

4.3. The Incumbent's Dilemma in the AI Era

The AI era has introduced new dimensions to the incumbent's dilemma that deserve specific attention. First, the pace of disruption has accelerated dramatically. In the disk-drive industry, the transition from one disruptive architecture to the next took several years, giving incumbents at least some time to respond. In the AI era, the pace of innovation is measured in months rather than years. OpenAI released GPT-3 in 2020, GPT-4 in 2023, and GPT-4.5 and o3 in 2024 and 2025, each representing a substantial improvement in capability. Incumbents that fail to keep pace risk falling irreversibly behind.

Second, the AI era has introduced a new form of disruption that operates at the level of the production function rather than the product. Previous waves of disruption displaced specific products or services (e.g., film photography, video rental, taxi rides). Generative AI threatens to displace entire categories of knowledge work—legal research, medical diagnosis, software development, financial analysis—that have historically been the preserve of highly educated and well-paid professionals [33]. This creates disruption not just for incumbent firms, but for incumbent professions and educational institutions.

Third, the AI era has intensified the importance of data as a source of competitive advantage. Platform businesses such as Google, Amazon and Meta have accumulated vast repositories of user data that can be used to train and fine-tune AI models. This creates a new form of barrier to entry that was not present in earlier waves of disruption: the data moat. New entrants such as OpenAI have partially overcome this barrier through large-scale public-data training, synthetic data and strategic partnerships, but the data advantage of established platforms remains significant [45]. **Table 1** summarises the comparative innovations, initially unattractive value dimensions and incumbent dilemmas across the historical and modern case studies discussed in this paper.

5. Comparative Summary of Disruptive Innovations

Table 1 summarises a series of disruptive innovations across industries from 1960 to 2026, illustrating how established firms can be overtaken by entrants whose products initially appear inferior on traditional performance measures. In each case, the disruptive innovation began by serving overlooked, emerging, or low-margin markets with a different value proposition: smaller size, lower cost, convenience, accessibility, flexibility, or new forms of digital capability. These innovations were often unattractive to incumbents' core customers and therefore seemed strategically unimportant at first.

The table also highlights the recurring dilemma faced by incumbent firms. Because their existing businesses were profitable and their mainstream customers continued to demand improvements in established performance dimensions, in-

cumbents had strong incentives to prioritise sustaining innovation over investing aggressively in emerging alternatives. As a result, they often missed the opportunity to shape new markets before disruptors gained scale, improved performance, and moved into the mainstream. The examples show that disruption is rarely caused by technological weakness alone; it is frequently rooted in organisational incentives, customer commitments, margin structures, and fear of cannibalising existing revenue streams. Taken together, these cases demonstrate how disruptive innovation can reshape competitive advantage, displace once-dominant firms, and redefine the basis of competition across entire sectors.

Table 1. Summary of disruptive innovations and incumbent dilemmas, 1960-2026.

Industry/ Sector	Incumbent (s)	Disruptor (s)	The Disruptive Innovation	Initially Unattractive Performance/Value Dimension	The Incumbent's Missed Opportunity/ Dilemma	Outcome
Disk Drives (1980s)	Seagate, CDC, Maxtor	Conner Peripherals, Quantum	Smaller form-factor drives (3.5-inch): initially lower capacity but rugged, lightweight, and suited to emerging portable markets	Lower storage capacity, but smaller size, ruggedness and portability.	Ignored small drives because mainstream PC and mainframe customers demanded higher capacity; margins on existing products were superior	Conner and Quantum revenues exceeded \$5bn by 1994; Seagate reduced to second-tier supplier in portable market
Mechanical Excavators (1960s-70s)	Bucyrus-Erie	Caterpillar, Deere	Hydraulic excavators: initially small and weak but simpler, cheaper, and suited to residential construction	Smaller bucket capacity, but lower cost and suitability for residential construction.	Mainstream contractors needed large-bucket machines; hydraulic excavators did not meet their performance requirements	Hydraulic excavators eventually dominated the market; Bucyrus-Erie lost its leading position
Photocopiers (1970s-80s)	Xerox	Canon	Small tabletop copiers: initially slow and low-volume but affordable and suited to small offices	Lower speed and volume, but affordability and decentralised office use.	Large photocopying centres (Xerox's core customers) had no use for small, slow tabletop copiers	Canon created the small-copier market; Xerox's market share declined significantly
Photography (1990s-2000s)	Kodak	Sony, Canon, Fujifilm	Digital photography: initially low resolution and expensive but no film or processing required	Lower image quality at first, but no film, instant review and digital storage.	Kodak invented the digital camera in 1975 but suppressed it to protect its highly profitable chemical film and processing business	Kodak filed for bankruptcy in 2012; digital photography now accounts for virtually all consumer photography

Continued

Video Rental (2000s-2010s)	Blockbuster	Netflix	DVD-by-mail (no late fees), then digital streaming: initially inconvenient but cheaper, with a larger catalogue	Delayed delivery and later bandwidth dependence, but no late fees, larger catalogue and convenience.	Relied on retail footprint and late fees (\$800m annually); failed to invest in streaming due to cannibalisation fears; reversed its online strategy in 2007	Blockbuster filed for bankruptcy in 2010; Netflix reached 300 m+ subscribers and \$400 bn+ market cap by 2026
Transportation (2010s)	Traditional Taxis	Uber, Lyft	Algorithmic ride-hailing platform: initially unregulated and inconsistent but cheaper, more convenient, and cashless	Less regulatory certainty and standardisation, but faster access, cashless payment and route transparency.	Relied on regulatory capture (medallion system); failed to adopt digital dispatch and dynamic pricing; unable to match Uber's capital-light model	NYC taxi medallion values collapsed from \$1 m+ to under \$100 k; Uber operates in 70+ countries with \$130 bn+ market cap
Hospitality (2010s)	Marriott, Hilton, IHG	Airbnb	Peer-to-peer accommodation platform: initially inconsistent but cheaper, more varied, and locally authentic	Less consistency and professional service, but lower prices, variety and local authenticity.	Dismissed home-sharing as unsafe and niche; burdened by heavy capital assets and fixed real estate; unable to transform into asset-light platform	Airbnb IPO valued at \$47 bn in 2020; over 7 m listings globally, more than the world's largest hotel chains combined
Semiconductors/ AI Hardware (2010s-20s)	Intel	NVIDIA	GPU parallel processing and CUDA ecosystem: initially niche (gaming/research) but ideally suited to deep learning	Specialised developer-intensive computing, but high parallel-processing performance for AI workloads.	Focused on highly profitable CPU sustaining innovations; dismissed GPU computing as a niche application; failed to build a competing ecosystem	NVIDIA market cap exceeded \$3 tn in 2025; Intel's market cap declined from \$250 bn to ~\$90 bn in the same period
Search/Software (2020s)	Google Search; incumbent software suites	OpenAI, supported strategically by Microsoft	Generative AI interfaces and foundation-model ecosystems: initially less reliable than search or specialised software, but capable of direct answer synthesis and task automation	Less reliable answer accuracy and uncertain monetisation, but conversational synthesis and workflow integration.	Search incumbents face advertising cannibalisation and compute-cost risk; Microsoft is both an incumbent and a partner using OpenAI to renew its own platform position	Strategic threat and ecosystem reconfiguration are evident; full market displacement remains uncertain.

6. Strategic Imperatives for Incumbents

How can established companies avoid the fate of Blockbuster, Kodak, or the traditional taxi industry? The research suggests several strategic imperatives that, taken together, constitute a framework for managing the threat of disruptive innovation.

6.1. Identify and Monitor Disruptive Technologies

The first step is to develop systematic processes for identifying and tracking potentially disruptive technologies, not just sustaining ones [1]. Most companies have well-conceived processes for identifying and tracking the progress of potentially sustaining technologies because these technologies are important to serving and protecting current customers. But few have systematic processes in place to identify and track potentially disruptive technologies. One approach is to examine internal disagreements over the development of new products or technologies. Marketing and financial managers, because of their managerial and financial incentives, will rarely support disruptive technology. On the other hand, technical personnel with outstanding track records will often persist in arguing that a new market for the technology will emerge—even in the face of opposition from key customers and marketing and financial staff. Disagreement between the two groups often signals a disruptive technology that top-level managers should explore [1].

A simple graph plotting product performance as defined in mainstream markets on the vertical axis and time on the horizontal axis can help managers identify both the right questions and the right people to ask. If the technology is disruptive, its initial performance will be far below what current customers demand. The key question is not whether the new technology can surpass the established technology, but whether its trajectory of improvement is steeper than the trajectory of market demand—because if it is, it will eventually intersect with mainstream market requirements [1].

6.2. Create Independent Organisations

To commercialise disruptive technologies, managers must protect them from the processes and incentives geared toward serving established customers [1]. This often requires creating completely independent organisations with their own cost structures, profit expectations, and customer relationships. The strategy of forming small teams into skunkworks projects to isolate them from the stifling demands of mainstream organisations is widely known but poorly understood. The key is not merely physical or organisational separation, but the creation of a genuinely independent business unit that is free to serve the emerging market on its own terms—with its own cost structure, its own sales force, and its own profit expectations calibrated to the scale of the emerging market rather than the scale of the incumbent's existing business.

Control Data Corporation's experience with the 5.25-inch disk drive illustrates

this principle. When the 5.25-inch generation arrived, CDC assigned a small group of engineers and marketers in Oklahoma City, far from the mainstream organisation's customers, the task of developing and commercialising a competitive 5.25-inch product. "We needed to launch it in an environment in which everybody got excited about a \$50,000 order," one executive recalled. "In Minneapolis, you needed a \$1 million order to turn anyone's head" [1]. CDC's Oklahoma City operation secured a profitable 20% of the high-performance 5.25-inch market, a far better outcome than the company had achieved in the 8-inch generation, when it had tried to manage the new technology within its mainstream organisation.

6.3. Embrace Organisational Ambidexterity

O'Reilly and Tushman [15] argue that the most effective response to disruptive innovation is organisational ambidexterity, the ability to simultaneously exploit existing competencies (exploitation) while exploring new opportunities (exploration). Ambidextrous organisations maintain separate units for exploitation and exploration, with different cultures, processes, and incentive systems, but with strong integration at the senior leadership level to ensure that the two activities are strategically aligned. The challenge of ambidexterity is fundamentally a leadership challenge. Senior executives must be willing to invest in and protect exploratory units, even when they are small and unprofitable, and even when the resources they consume could be deployed more profitably in the existing business. This requires a long-term orientation and a willingness to accept short-term financial pain in exchange for long-term strategic positioning—qualities that are in short supply in publicly listed companies subject to quarterly earnings pressure [46].

6.4. Monitor the Periphery and Engage with Ecosystems

Executives must personally monitor intelligence on the progress of pioneering companies by regularly engaging with technologists, academics, venture capitalists, and other non-traditional sources of information [1]. They cannot rely on the company's traditional channels for gauging markets because those channels were not designed for that purpose. Lead customers—the most important accounts where new ideas are actually tested—are reliable when assessing the potential of sustaining technologies, but unreliable when assessing the potential of disruptive technologies. They are the wrong people to ask. In the platform era, this imperative extends to ecosystem monitoring. Incumbents must track not just direct competitors but the entire ecosystem of complementors, suppliers, and adjacent market participants that could enable or accelerate disruption [6]. NVIDIA's dominance in AI hardware was not merely a product of its GPU technology; it was a product of the CUDA ecosystem, the vast network of developers, tools, libraries, and frameworks that made NVIDIA GPUs the default choice for AI workloads. An incumbent that monitors only direct product competition will miss the eco-

system dynamics that are often the true source of disruptive advantage. This broader intelligence-gathering mandate points to a set of strategic imperatives for incumbents facing disruptive change. Rather than treating disruption as a narrow competitive threat, executives must build organisational routines that surface weak signals early, interpret them through ecosystem-level analysis, and translate them into concrete strategic action. **Figure 3** summarises these imperatives by showing how incumbent firms must move beyond conventional market monitoring toward a more expansive approach that integrates external intelligence, ecosystem awareness, and proactive adaptation.



Figure 3. Strategic imperatives for incumbents.

6.5. Limitations of the Framework

A limitation of the disruption framework is that it can become imprecise when applied too broadly to every form of technological change. Platform markets, regulated markets, and AI ecosystems often involve mechanisms that are adjacent to but not identical to classic low-end or new-market disruption. Regulation may protect or delay incumbents; multi-sided platforms may scale through cross-side network effects rather than product performance trajectories; and ecosystem lock-in may make displacement slower or more partial than early adoption metrics imply. The framework is therefore most useful when paired with complementary lenses such as architectural innovation, dynamic capabilities, platform strategy and competition policy.

7. Conclusions

The fundamental principles of disruptive innovation outlined by Bower and Christensen [1] remain highly relevant today, more than three decades after their original articulation. The pattern of incumbent failure in the face of disruptive change—rational management practices that prioritise current, highly profitable customers over emerging, uncertain markets—has been replicated with remarkable consistency across industries and decades. From disk drives to digital photography, from video rental to ride-hailing, from hospitality to AI hardware, the same structural dynamics have played out: an entrant introduces a technology that is initially inferior on the dimensions that matter most to mainstream customers, but superior on dimensions valued by an emerging segment; the incumbent rationally ignores the threat; the entrant improves its technology along a steeper

trajectory than market demand; and by the time the incumbent recognises the threat, it is too late. However, the nature of disruption has evolved in important ways since 1995. In the digital era, disruption is increasingly driven by platform economics and network effects rather than product performance trajectories. Platform businesses do not merely offer a better product; they create a new architecture of value creation that incumbent pipeline businesses cannot easily replicate without cannibalising their existing operations. The speed of disruption has also accelerated dramatically: Blockbuster took a decade to fail; the taxi medallion market collapsed within five years of Uber's launch; ChatGPT attracted 100 million users in two months. Incumbents have less time to respond than ever before.

The AI revolution represents the most profound wave of disruption since the internet itself. Generative AI threatens not just individual industries but the fundamental nature of knowledge work, creating disruption at a scale and speed that the original Bower and Christensen [1] framework did not anticipate. The cases of NVIDIA and OpenAI illustrate both the opportunities and the risks: NVIDIA succeeded by recognising the architectural shift required for AI computing and building an ecosystem around it; Intel failed by staying too close to its existing customers and its existing technology trajectory. OpenAI succeeded by being unburdened by an incumbent business model; Google has struggled to respond because its most profitable business model is threatened by the very technology it helped to create. To survive in the 21st century, companies must cultivate dynamic capabilities, build ambidextrous organisations, and be willing to cannibalise their own successes before a disruptor does it for them. The wave of disruptive innovation is always coming. The question is not whether it will arrive, but whether the incumbent will be ready to catch it.

Conflicts of Interest

The author declares no conflicts of interest.

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