FROM PLATFORMS TO CONVERGENCE: TECHNOLOGICAL BREAKTHROUGHS ACROSS PAST, PRESENT, AND FUTURE

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Technological breakthroughs arise where prior ideas, enabling technologies, and social demand intersect. Looking across centuries reveals regularities that help separate hype from durable change: platform inventions trigger waves of downstream innovation (Perez, 2014), adoption tends to follow S-curves (Rogers, 2012), and standards convert prototypes into everyday utilities. This perspective connects the past to current trends and frames expectations about the future.

Past. The printing press made knowledge copyable; the steam engine and

factory system scaled mechanical work; germ theory and antibiotics turned healthcare from art into engineering; electric grids and the internal combustion engine synchronized energy, mobility, and urbanization. As these systems matured, institutions reorganized: literacy expanded, labor specialized, and life expectancy rose. These legacies shape how we evaluate breakthroughs today.

Present. Several general-purpose technologies are in mid-diffusion: artificial intelligence as a prediction and design engine (Brynjolfsson et al., 2025); gene editing and mRNA platforms as programmable biology; power electronics, batteries, and renewables as the backbone of electrified economies; reusable rocketry and miniaturized satellites lowering the cost of space; additive manufacturing and robotics customizing production. Taken together, they share a common thread of digitization in which bits increasingly steer atoms.

Future. Progress is likely to be organized by convergence: AI-native R&D that proposes experiments and materials, programmable therapeutics aligned to molecular profiles, abundant clean energy via grid-scale storage and possible fusion, human–machine interfaces, niche quantum sensing/links, and planetary computing for climate adaptation. Materialization depends on declining cost curves, the availability of complements (talent, capital, compute), and interoperable standards (Perez, 2014; Rogers, 2012).

The effects of breakthroughs and their governance are intertwined: in practice, breakthroughs first substitute for scarce inputs and later complement human capabilities, shifting task boundaries and firm design (Brynjolfsson & McAfee, 2025). Organizations often face short-term productivity lags while they rewire workflows, data pipelines, and skills. Consequently, leaders integrate technology with standards and resilient supply chains, while governance acts as a steering wheel: safety-by-design, audits, and risk-tied liability.

The most reliable signals and the near-term outlook can be inferred from learning curves, complement availability, interoperability, and real-world reliability; beware the demo effect. Together, these indicators help distinguish temporary excitement from progress that is reliable and scalable.

References:

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