https://doi.org/10.64142/jeai.1.3.28

Journal of Engineering and Artificial Intelligence

ISSN: 3117-3357

Research Article

JEAI-25-28

Technological Epochs and Generational Identity: Mapping Human Cohorts to Technological Shifts Amidst Biological Constancy

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Received date: August 19, 2025; **Accepted date:** August 27, 2025; **Published date:** September 19, 2025

Citation: Milelli R, Milelli P (2025) Technological Epochs and Generational Identity: Mapping Human Cohorts to Technological Shifts Amidst Biological Constancy. J Eng Artif Intell Vol.1 No.3: 28.

Abstract

This paper argues that generational cohorts from the Silent Generation to Generation Alpha are best understood through technological epochs rather than arbitrary chronological boundaries. Human biology has remained virtually unchanged over the last century, yet each generation has developed within distinct technological environments that shape cognition, behavior and cultural identity. By mapping generational boundaries to major inflection points in technological adoption, this study proposes a biologically grounded and empirically supported framework for understanding generational identity as a function of technological exposure. This model reframes generational theory by emphasizing environmental context over biological or sociological determinism, providing a predictive framework for interpreting the traits of future cohorts, including the anticipated "Generation Synthetica."

Keywords: AI-mediated environments; Cognitive development; Digital cognition; Generational identity; Technological adoption

Introduction

Generational categories such as Baby Boomers, Millennials and Gen Z are often invoked in sociological, political and economic discourse. Yet, the rationale for these boundaries is frequently inconsistent, relying on arbitrary chronological markers or anecdotal cultural trends. This paper proposes a more robust framework: Generational identity as a function of prevailing technological environments. Given that human biology has changed little over the past century, we posit that it is not biology but technological context that differentiates cohorts.

Methodology

To test this thesis, we identified the dominant technologies and media environments present during the formative years (ages 5–18) and their alignment with accepted generational cohorts. Cohorts are delineated not by fixed year spans but by inflection points in technological adoption and diffusion. Epoch boundaries were determined based on three converging criteria: (1) introduction of transformative technologies; (2) crossing of cultural and adoption thresholds (*e.g.*, approximately 25%+ uptake or widespread media/social impact) and (3) alignment with shifts in dominant cognitive tools or communication patterns. Each transition marks not just new tools, but a fundamental change in how human experience is mediated.

Following the definitions provided by the Pew Research Center, we pair each generation with its defining technological epoch using these criteria, allowing for a more precise correlation between technology exposure and the development of generational traits [1].

Biological constancy across generations

Human biology, particularly in terms of cognitive architecture, has remained consistent throughout the 20th and early 21st centuries. Lieberman's discussion of brain evolution makes the point that: "Since the late Pleistocene, the basic

https://doi.org/10.64142/jeai.1.3.28
Journal of Engineering and Artificial Intelligence
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organization and size of the human brain have remained essentially the same [2]. Most changes in human behavior since then are cultural, not biological". This constancy provides the baseline against which the influence of technological change can be measured.

Technology epochs and their generational misalignment

The central premise of this report is that technological epochs not arbitrary birth year brackets are the true markers of generational experience. Yet even a cursory comparison of commonly accepted generational cohorts and the onset of major technologies reveals a growing misalignment between the two. **Table 1** organizes modern history into technological epochs, each defined by innovations in digital technology that shaped everyday life, cultural norms and cognitive development for the cohort that grew up with it. While the approximate start dates indicate when these technologies entered widespread use, the dominant cohort refers to the generation whose formative years (roughly ages 5-18) were most influenced by these tools.

For example, the Silent Generation is typically defined as those born between 1925 and 1945, a span of 20 years. During that time, the dominant technologies included radio, early cinema and analog telephony transformative, but relatively stable over decades. Baby Boomers (1946-1964) saw the rise of television, suburbanization and mass consumer appliances. That era stretched nearly 19 years. But fast-forward to the digital age and the tempo quickens.

Table 1: Technology epoch.

Technology Epoch	Approximate Start	Core Innovations	Dominant Cohort
Broadcast era	~1920s	Radio, early film, analog telephony	Silent generation 1928–1945
Televisual expansion	~1950s	Television, home appliances, long-distance telephone	Boomers 1946–1964
Personal computing era	~1975	PCs, video games, VCRs, cable TV	Gen X 1965–1980
Internet and mobile onset	~1990	Dial-up internet, email, basic cell phones	Millennials 1981–1996
Social and mobile web era	~2007	iPhone, social media, streaming	Gen Z 1997–2012
Algorithmic feeds and touch-based	~2013	Tablets, Facebook, voice assistants, smart homes	Gen Alpha 2013–2021

Millennials, a cohort lasting roughly 15 years (1981-1996), grew up during the internet and mobile phone revolutions. Gen Z, born between 1997 and 2012, entered childhood just as smartphones, social media and touchscreen interfaces began to dominate. Now, Gen Alpha, born from 2013 onward, is coming of age in an environment already shaped by AI assistants, algorithmic content feeds and immersive media. That boundary may last no more than a decade perhaps less.

This compression is not a fluke; it reflects the accelerating pace of technological change. What once took 20-30 years to define a generation now unfolds in 6-10. And unlike previous eras, the transitions are no longer linear. They are overlapping, possibly recursive and globally synchronized. This means that children born just a few years apart may have radically different cognitive toolkits, media literacies and attention habits not because of age, but because of the technologies embedded in their environment during early development. In that context, the conventional cohort labels (Boomer, Gen X and Gen Z) are increasingly anachronistic.

By focusing instead on technologically defined generations, we gain a more precise lens to understand how cognition, communication and identity formation evolve. The screen time data referenced later in this report is not an end in itself, but rather a proxy for this deeper transformation: The ways in which digital exposure shapes the wiring of the human mind.

- **Broadcast era (~1920s):** Characterized by the mass adoption of radio, early motion pictures and analog telephony, this period introduced shared, real-time information flows for the first time. The Silent Generation (born 1928-1945) matured in a world where entertainment and news were centralized, fostering a common cultural narrative and trust in institutional voices.
- **Television expansion (~1950s):** Postwar prosperity brought television into living rooms, expanded household appliance use and extended voice communication through affordable long-distance calls. Baby Boomers (1946-1964) grew up with this visual storytelling medium, which shaped both their consumer habits and political awareness.

https://doi.org/10.64142/jeai.1.3.28
Journal of Engineering and Artificial Intelligence
ISSN: 3117-3357
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- **Personal computing era (~1975):** Marked by the emergence of personal computers, home video game consoles and VCRs, this era offered individualized control over information and entertainment. Generation X (1965-1980) became the first to integrate digital tools into both leisure and work, bridging analog and digital worlds.
- **Internet and mobile onset (~1990):** The arrival of dial-up internet, email and early mobile phones created the first globally connected generation. Millennials (1981-1996) navigated adolescence and young adulthood amid rapid digital expansion, adapting quickly to new communication norms while still remembering pre-digital childhoods.
- **Social and mobile web era (~2007):** With the iPhone launch and the rise of social media and streaming services, Gen Z (1997-2012) experienced a fully mobile, interactive and algorithm-driven media landscape from childhood. This shaped their identity formation in a constant feedback loop of connectivity and content.
- **Algorithmic feeds and touch based (~2013):** Tablets, Facebook ("curation" feeds become the norm), cloud computing, voice assistants and integrated smart-home ecosystems defined Gen Alpha's formative environment.

Cognitive and cultural impacts of technology

Technology improves cognition by extending memory, outsourcing problem-solving and reshaping attention. Boomers adapted to print and analog media; Gen X witnessed the PC revolution; Millennials matured during the rise of the internet; and Gen Z emerged fully immersed in algorithmic feeds. Each cohort demonstrates distinct patterns of visual attention, language complexity and risk-related behavior, shaped by their dominant media environments. As an example, Greenfield explains: "Television, video games and the internet cultivate strengths in visual-spatial skills (such as iconic representation and spatial visualization), while exposure to violent media fosters desensitization and aggressive behavior an environmental skewing of cognitive profiles, not a change in brain biology" [3]. These shifts are not due to biological divergence but environmental input technology as context. The societal effects of each Technology Epochs on dominant cohorts continue to be researched and discussed and are beyond the scope of this paper.

Carr argues that the Internet is reshaping human cognition by encouraging rapid skimming, multitasking and shallow information processing at the expense of sustained concentration and deep reading [4]. Drawing on neuroscience and media studies, he shows how digital environments rewire attention and memory patterns, subtly altering how individuals think and learn. His work supports the view that technological environments, rather than biological change, drive observable generational differences in cognitive style.

Technology exposure, not birth year, drives generational differences

Across education, work, healthcare and infrastructure, differences between age groups are commonly framed using labels like Boomer, Gen X or Gen Z. But these labels based on broad birth year ranges often fail to reflect the more meaningful dividing line: The technologies each group encountered during their formative years.

This paper argues that the habits, preferences and skills of each generation are shaped not by biology or age alone, but by the specific technologies present during early development.

In education, the contrast is particularly visible. Boomers were taught using chalkboards and paper textbooks. Gen Z, by contrast, encountered iPads, interactive whiteboards and personalized learning apps from an early age. Tools such as Carnegie Learning's MATHia and Google's Socratic respond to student input in real time, adjusting the way problems are presented. According to OECD findings, students who read primarily in print or balance print and digital reading scored significantly higher (by ~70 PISA points) than peers who read mostly or exclusively on digital devices, even after controlling for socioeconomic profile [5].This supports findings by Christakis et al., who show that early exposure to screen-based media may change attention patterns, leading younger generations to favor quick, frequent input over extended concentration [6].

In the workplace, the divide is also apparent. Boomers and Gen X generally prefer structured workflows and face-to-face communication, while younger generations are comfortable using tools like Slack, Notion and Microsoft Teams to coordinate across time zones and devices. These tools are not just new ways to communicate they change how teams track tasks, share knowledge and make decisions. As Greenfield explains, digital environments tend to reward multitasking and quick transitions between topics, rather than extended focus [3]. As she notes, "television, video games and the internet strengthen visual–spatial intelligence, which may come at the expense of deep processing skills, including reading, memory and critical thinking". For younger workers raised in that environment, switching contexts and managing many channels at once feels normal.

In healthcare, the shift is just as clear. Boomers tend to prefer in-person visits with doctors, while Millennials and Gen Z are far more likely to use telemedicine, health apps and

https://doi.org/10.64142/jeai.1.3.28
Journal of Engineering and Artificial Intelligence
ISSN: 3117-3357
Research Article

online symptom checkers. Gallagher et al., found that younger caregivers were significantly more likely their older counterparts to use wearable devices, health and wellness apps, telehealth and social media for health-related purposes when managing care [7]. These preferences reflect a growing comfort with making decisions through digital tools, rather than relying entirely on direct medical consultation.

In infrastructure and technical professions, the contrast continues. Gen X engineers were often trained on supervisory control systems that used analog inputs and basic digital monitoring. Newer professionals are entering fields where automation, predictive maintenance and real-time monitoring are standard. According to the OECD, younger workers tend to adopt new digital systems more quickly not because they are better trained, but because they've grown up surrounded by such tools [8]. Together, these contrasts reinforce the central argument of this paper: Generational identity is shaped not by biological change but by formative technological environments. The differences seen across education, workplace collaboration, healthcare and infrastructure are not isolated phenomena but expressions of the same underlying principle that cognitive styles and cultural practices emerge from the technologies each generation learns to treat as natural.

Taken together, these examples point to a consistent conclusion: Generational differences in learning, communication, healthcare use and technical work stem less from age itself and more from the technologies present during early development. Labels like "Millennial" or "Gen Z" may offer convenience, but they often miss the deeper reality that behaviors and expectations are shaped by the tools people grew up with, not just when they were born.

Screen time as a proxy for digital immersion

Screen time provides a practical if imperfect indicator of how deeply each generation is immersed in digital environments. Defined here as the average daily hours spent with smartphones, tablets, computers or televisions, it captures the cumulative exposure to mediated interaction rather than the precise quality of that engagement. While screen time cannot fully account for qualitative aspects of engagement (such as multitasking or content type), it remains a practical proxy for the depth of mediated exposure. Data across sources are inconsistent due to differing definitions (TV *vs.* immersive devices, self-report *vs.* logs). This paper harmonizes them only to illustrate the trend, not to assert precise absolute values.

The following sources provide representative estimates: Demand Sage reports screen time from the Silent Generation through Gen Z, with averages ranging from 2.7 hours daily for the Silent Generation to 7.3 hours for Gen Z [9]. Magnet ABA cites Gen Z at approximately 9 hours per day, with Boomers closer to 3.5 hours [10]. Mastermind Behavior estimates Gen Z at nearly 9 hours daily, with Boomers as low as 2.2 hours [11].

Although estimates differ widely across surveys, the directional pattern is consistent: Silent Generation averaged around 2.7 hours; Boomers ranged from 2.2 to 3.5 hours; Gen X ranged from 2.8 to 6.0 hours; Millennials ranged from 3.4 to 6.7 hours; and Gen Z ranged from 6.7 to 9.0 hours. The exact figures matter less than the trajectory. Each successive cohort allocates more of its waking life to screen-based activity, reinforcing the argument that technological epochs rather than chronological age form the true boundaries of generational identity.

Screen time's cognitive and educational effects are mixed. On the positive side, it can enhance multitasking, visual-spatial skills, learning and social connectivity. Excessive use, however, may impair attention, memory, academic performance and face-to-face interactions and can disrupt sleep. Thus, while screen time signals digital immersion, its impact depends on content, context and duration.

Figure 1 illustrates this escalation. The purpose of the visualization is not to resolve discrepancies among surveys but to highlight the unmistakable trend: With each generation, screen exposure rises sharply.

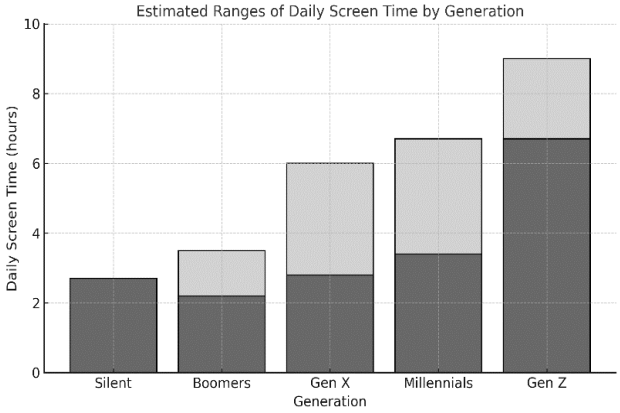

Figure 1: Average daily screen time by generation (range estimates). Bars represent lower and upper estimates derived from multiple sources, showing consistent escalation in screen exposure across cohorts.

Gen Alpha, now entering formative years, extends this trajectory, though comprehensive data are still incomplete. Early surveys already show young children averaging multiple hours per day on mobile devices, while industry monitoring points to tablets and streaming as dominant features of

https://doi.org/10.64142/jeai.1.3.28
Journal of Engineering and Artificial Intelligence
ISSN: 3117-3357
Research Article

childhood media diets. Most compelling, Pew reports that daily smartphone access among U.S. teens rose by more than twenty percentage points between 2015 and 2022 [12]. Extrapolated forward, this makes it reasonable to expect Gen Alpha to exceed Gen Z in daily screen exposure not as a fixed figure, but as a demonstrable trend of deeper digital immersion.

Digital (electronics/software) as dominant epochal technologies

One might ask whether other major technologies-such as advances in transportation, medicine or energy-have had comparable impact across generations. The answer is no. None rival the scale or speed of the digital transformation driven by electronics and software.

- Digital directly shapes cognitive development, influencing attention, memory and decision making.
- It alters identity formation through personalized environments and social media.
- It scales globally within years, reaching billions- far faster than any other previous innovation.
- Digital permeates every sphere of life: Education, work, politics, entertainment and beyond.

In short, while other technological revolutions have reshaped infrastructure and opportunity, only digital technology has redefined how we think, communicate and form generational identity. Its reach, speed and neurological influence make it the most accurate basis for defining modern generational categories.

Discussion

Despite the volume of generational research, most prevailing models rely on broad historical milestones or arbitrary birth-year cutoffs to define cohorts. These frameworks often overlook a central variable: The role of emerging technologies in shaping how people think, learn and communicate. While developmental psychology and media studies have long recognized that screen exposure and interactive media alter cognition and behavior, these findings remain largely disconnected from mainstream generational theory.

This disconnect has led to a misalignment. Generational categories like “Millennial” or “Gen Z” are treated as fixed, sociological constructs when in reality, the more meaningful dividing lines emerge from the technologies each cohort grew up with. A revised model is needed: One that defines generations not by historical events or decade markers, but by the dominant technological environment during their formative years.

This approach avoids the limitations of biological determinism and offers a more precise, evidence-based explanation for observed differences across age groups. It also better accounts for variation within cohorts recognizing, for example, that a child with early access to broadband and smartphones may differ significantly from a peer born in the same year but raised offline.

This paper addresses that gap. It proposes a classification system based on technological epochs, grounded in neuroscience, educational performance data and behavioral research. The model is both explanatory and predictive capable of identifying the roots of current generational behavior while anticipating the traits likely to emerge from ongoing shifts toward artificial intelligence, augmented reality and brain-computer interfaces.

Conclusion

Generations are not biologically fixed groups or simply the product of shared historical events. They are shaped by the specific technologies embedded in their environment during critical developmental years. As technological change accelerates, so too does the pace at which new generational traits emerge reshaping cognition, behavior and culture in the process.

This paper argues for realigning generational theory with technological reality. Instead of relying on decade-based categories or broad sociocultural milestones, future research should anchor generational definitions in the dominant technologies that shape how people learn, communicate and form identity. That includes mapping upcoming cohorts to technologies like artificial intelligence, virtual and augmented reality and brain-computer interfaces.

In Appendix A, the author offers a preliminary forecast of the post-Alpha generation, tentatively named Generation Synthetica a cohort expected to mature under increasingly synthetic, human-machine integrated environments.

Acknowledgements

This manuscript was conceptualized, directed and authored by Rosario Milelli, an independent scholar and retired aerospace engineer with expertise in systems thinking and sociotechnical analysis. The author takes full intellectual responsibility for the ideas, structure, interpretation and conclusions presented. Paul Milelli contributions included assisting in identifying inflection points and critical review.

https://doi.org/10.64142/jeai.1.3.28
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ISSN: 3117-3357
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Portions of the manuscript were prepared with the assistance of OpenAI's ChatGPT-4, used as research and drafting tool under the author's direct supervision. All output was critically reviewed, fact-checked and edited by the author to ensure academic integrity and originality.

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Appendix A: Post-Alpha Generational Forecasting

Based on the technological epoch model proposed in this manuscript, it is reasonable to anticipate the emergence of a new generational cohort following "Generation Alpha". This cohort, likely comprising individuals born between 2021 and next major technological revolution, will be shaped by a distinct set of technological influences that differ fundamentally from those that defined previous generations. It reflects the increasing fusion of human cognition, physical space, and technological mediation. This generation's identity will be forged within a hybrid reality defined by synthesis of AI-native interfaces, immersive mixed-reality environments, neuro-enhanced input systems, and biological augmentations. The convergence of "artificial" and "synthetic" in this context gives rise to a fitting designation: Generation Synthetica.

Defining technologies

- AI personal agents: Adaptive AI tutors, caregivers, and companions embedded in daily routines.
- Brain-Computer Interfaces (BCIs): Direct neural input for gaming, communication, and productivity.
- Mixed reality (AR/VR): Seamless integration of real and virtual environments for learning and social interaction.
- Autonomous systems: From driverless transport to AI decision-making in healthcare and legal triage.
- Synthetic biology: Wearables, gene therapies, and augmentations normalized in youth environments.

Children in Generation Synthetica will likely develop habits and expectations shaped by continuous interaction with intelligent systems and hybrid environments. As a result, they may show new patterns in learning, identity, and social behavior. Understanding this cohort will require updated approaches in education, child development, and health ones that reflect the deeper role of technology in everyday life.