Cognitive Overload and Wellbeing in the Fourth Industrial Revolution

Megan Blakely

Elsamari Botha

Ashley Cheeseman

"The chief and primary cause of this development and very rapid increase of nervousness is modern civilization, which is distinguished from the ancient by these five characteristics: steam-power, the periodical press, the telegraph, the sciences, and the mental activity of women." (Beard, 1868, p. vi)

Neurasthenia (nervous exhaustion)

So much has changed since these words were written, and yet so little. As humans, are we destined to resist change to the point of neuroticism, or is it reasonable to be overwhelmed?

Cognitive shifts in industrial revolutions one, two and three

The First Industrial Revolution, spanning from approximately 1760 to 1840, represented a seismic shift in the organisation of work, society, and human experience. It originated in Britain and rapidly spread across Western Europe and North America, transforming economies that were once dominated by agriculture and handcraft into industrial, mechanised systems of mass production.

At the heart of this transformation were a series of technological innovations. The invention of machines like the spinning jenny, the water frame, and the power loom radically accelerated textile production, while James Watt's improvements to the steam engine enabled more efficient manufacturing and transport. This era also saw a major expansion in iron production and coal mining, providing the raw materials and energy sources necessary to fuel factories and railways. The factory system, characterised by centralised production and division of labour, replaced the slower, more autonomous cottage industries of the past.

These technological shifts had profound social consequences. Millions of people moved from rural areas into rapidly growing urban centres in search of work. Cities became crowded and often unsanitary, and the traditional rhythms of agrarian life gave way to the rigid schedules of industrial labour. Workers, including women and children, endured long hours in often dangerous conditions for low wages. The rise of the industrial working class prompted the early stirrings of labour movements, as well as increased awareness of social inequality and class divisions.

Economically, the revolution marked a decisive move toward capitalism and wage labour. Wealth increasingly concentrated in the hands of industrialists, while the working class became more dependent on employment for survival. The resulting consumer markets helped to accelerate production and consumption cycles, setting the stage for the global economic systems that dominate today.

Culturally and cognitively, the revolution introduced new forms of discipline, structure, and time consciousness. Historian E. P. Thompson argued that industrial capitalism imposed a new temporal order based on clock time, displacing the more flexible, task-based time orientation of agrarian societies. Workers had to learn to measure their day not by the completion of a task but by the demands of a schedule, a change that likely affected internal temporal schemas, attentional control, and self-regulation.

From a cognitive psychology perspective, the structure of factory labour demanded a narrowing of attention and a suppression of creative or divergent thinking. Workers repeated the same task for hours on end, leading to what Harry Braverman later termed deskilling; a loss of autonomy, judgment, and embodied craftsmanship in favour of repetitive, mechanised labour(Braverman, 1974). This may have reduced the need for higher-order executive functions like problem-solving, adaptability, and motor coordination, while increasing cognitive fatigue due to monotony and external pressure.

Moreover, the shift from village-based communities to urban anonymity likely influenced social cognition and identity formation. As Emile Durkheim observed, the fragmentation of traditional social bonds could lead to anomie, or a sense of normlessness, contributing to psychological distress and alienation(Durkheim, 1951). The relational, embedded sense of self tied to land and kinship was replaced by the roles and expectations of industrial society, a transition that had lasting effects on how individuals perceived themselves and others.

The First Industrial Revolution revolutionised minds introducing new demands on attention, discipline, and cognition, restructured social life, and laid the foundation for a new kind of human, one increasingly shaped by external systems of control, technological mediation, and the logic of production.

The Second Industrial Revolution (1870–1914) marked a profound transformation driven by advances in steel production, electricity, chemical engineering, and mass manufacturing. Innovations such as the internal combustion engine, telegraph, and assembly line (notably Ford's model in 1913) redefined industrial productivity and global connectivity. This era catalysed the rise of corporate capitalism, urban expansion, and consumer culture, while also entrenching new forms of labour standardisation and managerial control. For individuals, the shift from artisanal to mechanised, time-regulated factory work meant increased alienation and task monotony.

The cognitive shift from the First to the Second Industrial Revolution replaced flexible, hands-on problem-solving and community-based work with specialised, fragmented, and machine-focused skills. Attention narrowed to sustained monitoring of repetitive processes, memory moved from rich procedural recall to rote rules and schedules, and time perception was shaped by rigid, clock-driven rhythms. Problem-solving became constrained to troubleshooting within strict protocols, while social cognition adapted to hierarchical factory structures, fostering compliance and coordination with strangers over collaborative, trust-based workshop dynamics.

The Third Industrial Revolution, spanning from the late 1950s to the early 2000s, was characterised by the rise of digital technology, automation, and information systems, catalysed by advances in semiconductors, computing, and telecommunications. This era saw the widespread adoption of personal computers, the internet, and robotic automation, fundamentally altering how information was processed, work was organised, and knowledge was valued (Manuel Castells, 2009; Rifkin, 2011)The shift from industrial production to information-based economies required new cognitive capacities; abstract reasoning, digital literacy, and multitasking across virtual environments. Unlike earlier eras that emphasised routine procedural work, the digital age favoured fluid problem-solving, continuous learning, and adaptive attention (Autor et al., 2003).However, it also introduced cognitive challenges, including information overload, redistributed attentional control, and the externalisation of memory and calculation to digital systems(Beilock et al., 2002) . In essence, the Third Industrial Revolution marked a transition from physical to cognitive labour, reshaping the mental architecture of modern work and learning.

Cognitive shifts occurring due to the fourth AI revolution

The Fourth Industrial Revolution (4IR), a term popularised by (Klaus Schwab, 2016), is defined by the convergence of biological, digital, and physical systems, driven by technologies such as artificial intelligence (AI), machine learning, the Internet of things (IoT), robotics, and bioengineering. Unlike prior revolutions which mechanised or digitised specific domains, 4IR integrates intelligence into infrastructure, systems, and daily decision-making, creating a ubiquitous layer of computational agency. Human interaction with information is no longer limited to active retrieval; rather, AI anticipates, curates, and influences cognition in real-time (Klaus Schwab, 2016) This marks a profound epistemological shift, from knowledge production to knowledge orchestration, with humans increasingly in the role of adjudicators rather than generators of information.

The cognitive consequences of this transformation are multifaceted. Empirical studies suggest that reliance on generative AI tools can lead to reduced originality, externalised memory, and attenuated attention spans (Bai et al., 2023)Tasks once requiring deep processing are now offloaded to systems that automate reasoning, summarisation, and decision-making, potentially dulling the development of critical thinking, inductive reasoning, and epistemic vigilance (Singh et al., 2025).Simultaneously, there is an increasing demand for metacognitive regulation, the capacity to monitor, question, and refine one's own thought processes in the presence of powerful algorithmic feedback loops. Paradoxically, while AI expands our cognitive reach, it also fosters cognitive dependency, creating what some call "cognitive debt" an accumulation of underdeveloped mental faculties due to automation’s seductively efficient assistance (Kosmyna et al., 2025)

Looking forward, the cognitive shifts of the Fourth Industrial Revolution may be even more profound. As AI systems grow increasingly autonomous and embedded in decision environments, human cognition may undergo a reconfiguration akin to extended mind theory (Clark et al., 1998), where boundaries between human and machine cognition dissolve. Cognitive labour may increasingly shift towards judgment under uncertainty, ethical reasoning, and AI alignment, with human roles focused on ensuring the integrity and social responsibility of machine outputs.

In essence, the Fourth Industrial Revolution challenges not only what we do but how we think. It compels a reconceptualisation of cognitive agency, demanding a balance between augmentation and erosion, autonomy and dependency, and ultimately between being informed and being shaped by intelligent systems. Undoubtedly, contemplating the possibilities of the future evokes a profound sense of overwhelm, one that is arguably comparable to the cognitive disruptions experienced during previous industrial revolutions.

From a Human Factors Psychology perspective, overwhelm refers to a state where a person experiences a high level of stress, emotional and or cognitive intensity, leading to a feeling of being unable to function effectively or manage a situation. Overwhelm is characterised by being "flooded" by thoughts, emotions, and physical sensations, often related to a specific problem or situation, making it difficult to think clearly, make decisions, and cope effectively(Spectrum Staff, 1983). Table 1 demonstrates some of the potential source of overwhelm.

Table 1

Changes in cognitive domain across the four revolutions.

Cognitive Domain	*First Revolution (1760–1840)*	*Second Revolution (1870–1914)*	*Third Revolution (1950s–2000s)*	*Fourth Revolution (2000s–present)*
Knowledge type	Procedural, tacit, experiential; based on craft and apprenticeship	Abstract, rule-based, codified; standardised technical knowledge	Technical, systems-based, specialised; formal education and structured training central	Hybrid human–machine, rapidly evolving, data-driven; continuous learning and adaptive expertise essential
Attention	Variable, task-driven, guided by physical processes	Sustained, monotonous, vigilance-focused for mechanised tasks	Split across multiple processes, screen-mediated; multitasking emerges	Hyper-fragmented, digitally overloaded; constant switching between digital inputs and automation cues
Memory	Episodic, skill-based, embodied in action and storytelling	Semantic, externalised via manuals, blueprints, documentation-driven	Reliant on external storage (paper, early computing); structured recall supported by tools	Outsourced to AI and digital systems; focus on retrieval pathways (transactive memory) over retention
Temporal cognition	Task-paced, flexible, aligned with natural cycles of work and daylight	Clock-paced, regimented, factory schedules dominate	Fixed schedules with early flexibility for knowledge work and global coordination	Blurred boundaries, 24/7 connectivity, asynchronous work patterns create temporal dissonance and cognitive strain
Problem-solving	Embedded in action, intuitive, trial-and-error in small teams	Separated from action, hierarchical decision-making, constrained creativity	Analytical, structured, linear; reliant on tools and standardised processes	Complex, non-linear, systems thinking; adaptive decision-making with AI collaboration under uncertainty
Social cognition	Local, small-group, community-oriented craft networks	Collective, bureaucratic, coordinated across hierarchical systems	Organisational, team-based, face-to-face and hierarchical communication	Distributed, networked, virtual and cross-cultural; human–machine collaboration adds relational complexity

The Fourth Industrial Revolution is driving humanity into a state of cognitive overwhelm, echoing patterns seen in every past industrial revolution (G M Beard, 1881; Spectrum Staff, 1983)but at a scale, speed, and reach never before experienced. The relentless pace of technological change, coupled with the constant demands of an always-connected world, creates excessive workloads intensified by dual-task interference, where competing demands on attention reduce accuracy and efficiency(Alami et al., 2025; Blakely et al., 2023). Digital platforms amplify cognitive overload by flooding individuals with more information than can be processed, evaluated, or acted upon effectively, while rapid organisational shifts, algorithmic decision-making, and technology-induced job uncertainty introduce unpredictability and erode the sense of control. Emotionally intense experiences compound these effects, leading to lapses in focus, increased errors, and poorer decision-making, with chronic overwhelm ultimately threatening both mental and physical health. Table 2 critiques potential positive and negative effects of this demand.

Table 2

Potential positive and negative effects of AI on cognition.

Cognitive Aspect	***Positive Effects***	***Negative Effects***
Memory	Offloads routine and repetitive tasks; enhances access to vast information archives	Impairs deep learning, long-term recall, and schema formation; fosters over-reliance on external storage
Critical Thinking	Supports decision-making; augments analysis with large-scale data processing	Reduces independent reasoning and problem-solving ability; risk of cognitive laziness and skill atrophy
Creativity	Provides inspiration, novel ideas, and cross-domain connections	Reduced originality; dependency on AI-generated content; homogenisation of ideas
Attention & Engagement	Frees cognitive resources for higher-level tasks; enables focus through automation	Shortened attention spans; frequent distractions; mental disengagement due to over-automation
Learning & Knowledge Acquisition	Accelerates information gathering and skill development through digital tools	Surface-level understanding; shallow processing; reduced capacity for slow, reflective learning
Problem-Solving	Enhances complex, data-driven decision-making; offers alternative solutions	Over-trust in AI recommendations; diminished ability to troubleshoot without external support

Social Cognition	Expands collaborative networks globally; supports cross-cultural communication	Erodes face-to-face interaction skills; increased miscommunication in virtual, AI-mediated environments
Temporal Cognition	Optimises scheduling, planning, and time management through digital tools	Blurs work-life boundaries; constant availability increases cognitive fatigue and time pressure
Metacognition (Self-Awareness of Thinking)	Promotes reflection via feedback from intelligent systems	Risk of overconfidence in AI outputs; reduced introspection and self-generated evaluation skills

The Fourth Industrial Revolution is reshaping cognitive work in ways that frequently exceed human limits, creating an unprecedented risk of mental overload and compromised wellbeing. Human factors literature has long warned that when task demands outstrip cognitive resources, mental workload rises to unsustainable levels, resulting in degraded performance and heightened psychological strain (Wickens, 2008; Hart & Staveland, 1988). Current workplaces are promising an ease to cognitive burdens, but paradoxically leave humans to handle the ambiguous, unpredictable, and high-risk decisions that machines cannot resolve (Lee & See, 2004)This elevates attentional demands and increases mental effort, producing a mismatch between technological pace and cognitive capacity. Dual-task interference compounds the problem with workers expected to simultaneously monitor AI outputs, assess contextual relevance, and engage in human-to-human interactions, forcing rapid task-switching that introduces reaction time delays, higher error rates, and cognitive fatigue(Squire & Parasuraman, 2010). Over time, this cycle undermines productivity, and the psychological resources needed for sustained wellbeing. Table 3 shows the lessons learned and what we should potentially be focusing on in the future.

Table 3

The evolution of cognition type by revolution

Cognitive Domain	*First Revolution (1760–1840) – Lessons Learned*	*Second Revolution (1870–1914) – Lessons Learned*	*Third Revolution (1950s–2000s) – Lessons Learned*	*Fourth Revolution (2000s–present) – Emerging Lessons*
Knowledge type	Education systems evolved from oral tradition to basic literacy and numeracy to meet factory demands; apprenticeship gave way to standard schooling.	Widespread technical training and vocational education established to handle specialised, rule-based work.	Universities and corporate training programs scaled to prepare workers for information-driven roles.	We must design continuous, lifelong learning systems that blend human judgment with machine intelligence, avoiding over-reliance on AI to think for us.
Attention	People learned to work to the rhythm of machines and time clocks, creating early attention discipline under structured schedules.	Workers developed sustained vigilance and endurance for repetitive tasks but suffered fatigue, leading to labour laws and rest-break regulations.	We introduced task prioritisation and early ergonomics to manage screen-based multitasking.	We must reclaim focused thinking time, set cognitive boundaries, and design tech that filters rather than floods.
Memory	Storytelling and tacit skill-sharing were formalised into manuals and standard operating procedures to ensure	External documentation allowed scaling, but human memory was underused, creating	Digital storage allowed massive externalisation but required new retrieval strategies and information	We need deliberate "memory scaffolding" practices, training humans to retain critical

	knowledge transfer.	dependence on instructions.	management skills.	knowledge despite AI offloading cognitive load.
Temporal cognition	Workers shifted from natural cycles to fixed schedules; early adaptation came through structured routines and communal time discipline.	Laws on working hours, shift patterns, and rest periods protected health as clock-based work intensified.	Flexible scheduling and global time coordination practices developed to reduce fatigue.	We must reset human rhythms in a 24/7 connected world, embedding protected downtime and cognitive recovery periods.
Problem-solving	Trial-and-error learning evolved into systematic troubleshooting and engineering disciplines.	Scientific management and process improvement methods emerged to compensate for constrained creativity.	Analytical frameworks, decision-support tools, and structured problem-solving training scaled knowledge work.	We must train adaptive thinking under uncertainty, ensuring humans can challenge AI outputs and innovate beyond machine logic.
Social cognition	Communities adapted from village-based to factory-based social structures, creating unions and mutual aid networks.	Bureaucracies and hierarchies were developed for coordination but caused alienation, leading to early organisational psychology practices.	Team-based management, leadership development, and corporate culture were introduced to humanise large organisations.	We must rebuild trust and connection in distributed, AI-mediated workplaces, fostering collaboration between humans and machines without eroding human empathy.

Wellbeing research shows that high cognitive load, fragmented attention, and low perceived control are strongly linked to stress, anxiety, and burnout(Calvo et al., 2020). Beyond pure cognition, current work environments introduce emotional and social strain. Algorithmic management and constant monitoring reduce autonomy, while AI-mediated interactions weaken human connection, a key component of wellbeing (Gillespie, 2025; Jörs & De Luca, 2024; Naswell, K.; Wong, J, Malinen, 2021; Smith, 2017). Emotional labour remains high, with healthcare, education, and customer-facing roles now demanding empathy for humans and vigilance for machines simultaneously, creating dual-task load (Hart & Staveland, 1988).Chronic exposure to these conditions reduces intrinsic motivation, disrupts flow states, and undermines eudaimonic wellbeing the sense of purpose and flourishing that sustains long-term performance (Jörs & De Luca, 2024).

Artificial intelligence should not be conceived as a static tool or one-off technological project. As recent global evidence indicates, trust in AI is fragile and public expectations for responsible governance are high, with over half of respondents wary about trusting AI systems and a clear majority calling for stronger regulation and continuous assurance mechanisms (Gillespie, 2025). These findings demonstrate that AI must be approached as a living system, dynamic, adaptive, and continually reshaping the social and organisational environments in which it operates.

Living systems require governance models that are equally adaptive. Traditional linear frameworks of change, such as Kotter's eight steps, and Lewin's (1947) unfreeze–change–refreeze model, are insufficient for AI contexts where model drift, regulatory shifts, and sociotechnical consequences emerge unpredictably. Smith (2017) offers a more appropriate paradigm through the concept of transformative praxis. Here, theory and practice are inseparable and enacted through ongoing cycles of action, critical reflection, and renewal. Such praxis aligns directly with the needs of AI governance, where oversight must be iterative rather than episodic, recalibrating as systems and contexts evolve.

Furthermore, the principle of tino rangatiratanga underscores the importance of maintaining agency and sovereignty in relation to AI. Rather than ceding control to external vendors or opaque systems, shifts should be made to embedding self-determination into governance processes, ensuring that decisions about adoption, oversight, and use remain grounded in collective human values and responsibilities. In this way, governance becomes a form of kaitiakitanga, stewardship that is cyclic, relational, and future-oriented.

Taken together, these perspectives suggest that managing the cognitive overwhelm of the Fourth Industrial Revolution requires a paradigm shift in governance. AI must be treated as a living being whose trajectory can only be stewarded through continuous, adaptive cycles of monitoring, reflection, and recalibration. Such an approach provides not only a safeguard against the risks of automation and dependency but also a pathway for embedding trust, responsibility, and resilience in an era defined by continuous change.

Perhaps we also need to recognise that we are living through the Fourth Industrial Revolution, and to take comfort in knowing that every previous revolution felt equally overwhelmed, just as G. M. Beard described in the 19th century. AI is undeniably complex, often beyond our ability to fully comprehend, but then again, most of us don't truly understand the intricacies of much of the technology that we use every day.

The question is whether this will become something we eventually look back on as another adaption, demonstrating human resilience, or whether it will be an unending wave of change, tilting towards either the utopian visions or dystopian warnings of science fiction. History suggests it's most likely to land somewhere in between, not catastrophic, not utopian, but messy, imperfect, and full of lessons learned. The key is to consciously apply past learnings, our frameworks for resilience, managing stress, navigating change, and protecting wellbeing, to ensure we bring the conversation back to people.

He aha te mea nui o te ao? He tangata, he tangata, he tangata.

References

Alami, J., El Iskandarani, M., & Riggs, S. L. (2025). The Effect of Workload and Task Priority on Multitasking Performance and Reliance on Level 1 Explainable AI (XAI) Use. *Human Factors*. https://doi.org/10.1177/00187208251323478

Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change, and empirical exploration. *The quarterly journal of economics* https://academic.oup.com/qje/article/118/4/1279/1925105

Bai, L., Liu, X., & Su, J. (2023). ChatGPT: The cognitive effects on learning and memory. *Brain-X*, *1*(3). https://doi.org/10.1002/brx2.30

Beilock, S. L., Carr, T. H., MacMahon, C., & Starkes, J. L. (2002). When paying attention becomes counterproductive: Impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied*, *8*(1), 6–16. https://doi.org/10.1037//1076-898X.8.1.6

Blakely, M. J., Smith, S. L., Russell, P. N., & Helton, W. S. (2023). Dual-task effects between tone counting and mathematical calculations. *Applied Ergonomics*, *111*, 104052. https://doi.org/https://doi.org/10.1016/j.apergo.2023.104052

Braverman, H. (1974). *Labor and monopoly capital: The degradation of work in the twentieth century.* Monthly Review Press.

Calvo, R. A., Peters, D., Vold, K., & Ryan, R. M. (2020). Supporting Human Autonomy in AI Systems: A Framework for Ethical Enquiry. In *Philosophical Studies Series* (Vol. 140, pp. 31–54). Springer Nature. https://doi.org/10.1007/978-3-030-50585-1_2

Clark, A. ©, Chalmers, D., & Clark, A. (1998). *The extended mind* (Vol. 1).

Durkheim, É. (1951). *Suicide: A study in sociology*. Free Press.

G M Beard. (1881). *American Nervousness*. G P Putnums Son.

Gillespie, S. , W. T. , M. A. , & H. G. (2025). *Trust, attitudes and use of artificial intelligence A global study 2025*. https://doi.org/10.26188/28822919

Hart, S. G., & Staveland, L. E. (1988). *Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research* (pp. 139–183). https://doi.org/10.1016/S0166-4115(08)62386-9

Jörs, J. M., & De Luca, E. W. (2024). *Through Eudaimonia's Lenses: EudAImonic Well-Being Variables As Guiding Principles For AI Design*. https://www.researchgate.net/publication/380938771

Klaus Schwab. (2016). *The Fourth Industrial Revolution*. World Economic Forum .

Kosmyna, N., Hauptmann, E., Yuan, Y. T., Situ, J., Liao, X.-H., Beresnitzky, A. V., Braunstein, I., & Maes, P. (2025.). *Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task*.

Lee, J. D., & See, K. A. (2004). Trust in automation: Designing for appropriate reliance. *Human Factors*, *46*(1), 50–80. https://doi.org/10.1518/hfes.46.1.50_30392

Manuel Castells. (2009). *The Rise of the Network Society : The Information Age - Economy, Society and Culture*. John Wiley & Sons, Incorporated.

Naswell, K.; Wong, J, Malinen, S. (2021). *The Sage handbook of organizational wellbeing*.

Rifkin, J. (2011). *The third industrial revolution : how lateral power is transformimg energy, the economy, and the world*. New York : Palgrave Macmillan.

Singh, A., Taneja, K., Guan, Z., & Ghosh, A. (2025). *Protecting Human Cognition in the Age of AI*. http://arxiv.org/abs/2502.12447

Smith, G. H. (2017). *6 Kaupapa Māori Theory: Indigenous Transforming of Education*. http://ebookcentral.proquest.com','_blank'

Squire, P. N., & Parasuraman, R. (2010). Effects of automation and task load on task switching during human supervision of multiple semi-autonomous robots in a dynamic environment. *Ergonomics*, *53*(8), 951–961. https://doi.org/10.1080/00140139.2010.489969

Spectrum Staff. (1983). Too much, too soon: information overload. *IEEE Spectrum*, *20, (9)*, 47–55.