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Balancing Technological Innovation and Human Values

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Abstract: Technological innovation and human values are frequently framed as competitors, with each advance in artificial intelligence, biotechnology, and data science treated as a concession extracted from privacy, dignity, or equity. This paper argues that the framing itself is the problem. Because technology is never value-neutral — design choices encode priorities about who is served, who is monitored, and who bears risk — the productive question is not whether to restrain innovation but how to steer it. The paper first examines why the balance is a design problem rather than a zero-sum trade-off, then traces the structural obstacle that makes balancing so difficult: the pacing problem and the Collingridge Dilemma, in which regulation arrives either too early to be informed or too late to be effective. It surveys four domains where the tension is most visible — algorithmic decision-making, privacy and surveillance, labour markets, and health and education — before assessing the frameworks built to resolve it: value sensitive design, responsible innovation, trustworthy AI, and digital humanism. It closes by arguing that principles alone are insufficient and that the balance must be institutionalised through adaptive regulation, participatory governance, and human oversight that preserves accountability in human hands..

Keywords: Artificial intelligence, education, academic integrity, personalized learning, equity

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1. Introduction

The relationship between technological capability and human welfare has never been a simple one. Emerging technologies "have significantly transformed human life, offered unprecedented benefits while simultaneously raised profound ethical concerns" (Bashi-ir, 2025), spanning privacy, data security, algorithmic bias, genetic engineering, and en-vironmental sustainability. The familiar response is to invoke balance — innovation on one side, values on the other — but this metaphor quietly assumes that the two are opposed quantities, and that every gain in capability must be purchased with a loss of principle.

That assumption is worth resisting, because the underlying frameworks do not treat values as external constraints on innovation but as constitutive of it. The premise of value sensitive design is that "design is never value free," and that identifying and ex-plicitly representing the values underlying a design produces better designs (Dignum, 2017). On this view, "values can help to align the design of technological products with societal concerns," promoting long-term sustainability and producing positive effects for affected stakeholders (Bednar & Spiekermann, 2023). Balance, then, is not the point of equilibrium between two adversaries; it is the ongoing work of making value com-mitments visible and deliberate in systems that would otherwise encode them by de-fault.

2. The Pacing Problem: Why Balance Is Structurally Hard

Even granting that balance is a design question rather than a trade-off, the timing of intervention remains genuinely difficult. Ahern describes how "the speed of innovation adds immeasurably to the regulatory challenge," producing a pacing problem in which "regulation [is] either too hot or too cold in temperature rather than about right" (Ahern, 2025). The dilemma is symmetrical: "regulating too early may stifle the innova-tion

lifecycle," while "delaying and regulating too late risks investments being strand-ed" (Ahern, 2025).

This is the core of the Collingridge Dilemma. At the earliest stages of a technology's development, "regulation is difficult due to a lack of information," whereas in later stages "the technology is so entrenched in our daily lives" that control becomes practi-cally and politically costly (Guihot et al., 2017). Abukari formalises the entrenchment logic: once "markets, infrastructures, and organizational routines have adapted around the technology, changing course does become costly and politically difficult," so that "regulatory response exhibits measurable lag relative to technology deployment" (Abukari, 2026). Yeung notes that this concern is often summarised as the pacing prob-lem, "which claims that law cannot keep pace with technology" (Yeung, 2023).

The empirical record in the user's own library bears this out beyond the digital sector. Analysis of big data investigation identifies the underlying pathology as an institution-al one in which "the pace of technological iteration far outpaces the rule of law's re-sponsive capacity" (Shen & Wang, 2026). Work on the governance of the low-altitude economy reaches a parallel conclusion: multidimensional risk "fundamen-tally stems from insufficient synergy among ethical values, policy guidance, and legal norms," prompting a proposed "trinity governance pathway integrating 'eth-ics-policy-law'" (Wang, 2026). The same source warns that developers, constrained by profit-seeking motives and by the complexity of disruptive technology, they cannot fully foresee the social risks their own technologies will produce (Wang, 2026).

The implication is that the balance cannot be struck once, at a single moment of regulation. It has to be maintained continuously, through institutions designed to learn faster than technologies entrench.

3. Where the Balance Is Tested

3.1 Algorithmic decision-making

Algorithmic systems concentrate the tension because they simultaneously promise enormous gains and distribute harms unevenly. Busuioc catalogues the pattern: a pro-prietary recidivism-prediction tool "was flagged by ProPublica as biased against black defendants"; natural language processing models "associate the word 'doctor' with 'fa-ther' and 'nurse' with 'mother'"; and facial recognition algorithms "have persistently been found to display much higher error rates for minorities" (Busuioc, 2020). The same source acknowledges that AI systems are "foreshadowed 'to supercharge the process of discovery'" while insisting on oversight of algorithmic decision-making (Busuioc, 2020).

The mechanisms of harm are now well characterised. A hiring algorithm "used by Amazon systematically discriminated against female candidates," and algorithmic dis-crimination "can be caused by flawed or biased input data or by the mathematical ar-chitecture of the algorithm," so that "AI systems run in danger of reproducing or even exacerbating existing social inequalities with detrimental effects for minorities" (Kieslich et al., 2022). The ethical stakes are structural, not incidental: "bias in AI algo-rithms can perpetuate societal inequalities and discrimination," while accountability gaps raise concerns about responsible use and legal liability (Islam, 2024).

Redress therefore requires more than technical fixes. Cheong argues that "governing AI bias requires proactively engaging affected communities to understand their lived ex-periences," alongside rethinking non-discrimination frameworks for systemic and in-tersectional impacts (Cheong, 2024). In high-stakes domains such as medicine, Mennel-la and colleagues propose a model of "collective responsibility" that holds all parties in development and deployment accountable, and insist that "mechanisms for compensa-tion must be put in place" so that those harmed by algorithm-based decisions have ac-cess to prompt and effective remedies (Mennella et al., 2024).

3.2 Privacy, surveillance, and human rights

In the digital sphere, rights that were once settled have been reopened. The digital age has "redefined the meaning, scope, and protection of human rights," generating "new vulnerabilities, particularly concerning privacy, surveillance, data security, and algo-rithmic biases" (Kumari, 2026). The resulting governance question is squarely a balanc-ing question: how "security needs and individual privacy combine," and where the boundary between legitimate governance and rights infringement should fall (Par-bhakar, 2025).

Regulatory instruments are the primary lever. Analysis of the GDPR emphasises its role in countering "excessive surveillance, unauthorized use of data, algorithmic discrimination, and infringement of personal freedoms," and calls for "a rights-based and balanced approach to data governance that supports technological advancement and economic growth while ensuring accountability, transparency, and personal freedoms" (Murali-nathan, 2025). The trajectory of international jurisprudence — from data-retention cas-es to the "right to be forgotten" — reflects a sustained effort "to balance innovation with dignity and autonomy" (Okonkwo, 2025).

3.3 Labour markets and inequality

The labour-market dimension shows how distributional outcomes depend on institutional choices rather than on technology alone. The literature is genuinely divided: some studies suggest automation "may lead to job displacement, particularly for work-ers in routine tasks," with consequences of "unemployment, wage stagnation, and an increase in income inequality," while others argue it creates new high-skilled opportu-nities and raises productivity (Zarifhonarvar, 2023).

What is more settled is that gains are unevenly shared. Acemoğlu and Restrepo derive formally that "automation increases inequality," and show the effect "becomes Worse when there is a severe skill mismatch," since displaced workers are squeezed into a narrow range of tasks and their wages fall sharply (Acemoğlu & Restrepo, 2018). Mer-ola reports that automation is "likely to affect mostly middle-class jobs," with displaced workers "compete[ing] downwards, rather than falling into unemployment," and cites evidence that while AI may reduce 90:10 wage inequality it "will not have an impact on the top 1% earners" (Merola, 2022). Aggregate accounts confirm that "the advantages of automation are not uniformly dispersed and frequently exacerbate already-existing economic disparities" (Sultana et al., 2024).

Crucially, the labour literature locates the remedy in policy rather than in restraint. Bessen's formulation — that automation "might not cause mass unemployment, but it may well require workers to make disruptive transitions" — frames the challenge as one of transition support (Merola, 2022). Kapoor's analysis concludes that mitigating adverse effects requires "education reform, lifelong learning, social safety nets, and progressive taxation" so that the fruits of the technological revolution are more fairly redistributed (Kapoor, 2025).

3.4 Health and education

In clinical settings, the value question becomes concrete: how much authority should an algorithmic recommendation carry? The dominant answer in the literature is that AI should augment rather than substitute for human judgement — "AI should not be regarded as a replacement for decision-makers, but as an augmentation," with the clinical expert's final decision remaining critical (Moreno-Sánchez et al., 2025). Abd-Alrazaq and colleagues operationalise this into three strategies: AI systems "should function strictly as decision support tools rather than autonomous decision-makers, ensuring that ultimate responsibility remains with clinicians"; training should emphasise both capabilities and limitations; and governance protocols should reserve complex or ethi-cally sensitive decisions for human judgement (Abd-Alrazaq et al., 2025).

The educational stakes are subtler but analogous. Where a clinical decision support tool generates recommendations that oppose a learner's own reasoning, educators must de-termine "which recommendation to consider authoritative" — a question about epis-temic authority and trust calibration, not merely about accuracy (Heslin, 2026). In edu-cation more broadly, the recommendation is again for "hybrid solutions by balancing the process of human- and AI-driven decisions and mutual monitoring of these deci-sions" (Ninaus & Sailer, 2022). Implementation, however, is constrained by more than design: real-world deployments "reveal limitations—including algorithmic bias, infra-structural inequities, and stakeholder resistance," which no amount of technical re-finement will resolve on its own (Evangeline, 2025).

4. Frameworks for Aligning Innovation with Values

4.1 Value sensitive design

Value sensitive design is the most developed methodology for embedding values in tech-nical work. It is defined as "a theoretically grounded approach to the design of technology that accounts for human values in a principled and systematic manner throughout the design process" (Gerdes & Frandsen, 2023), and it operates through an "integrative and iterative tripartite methodology, consisting of conceptual, empirical, and technical inves-tigations" (Friedman et al., 2002). A twenty-year review describes VSD as "the most com-prehensive approach to account for human values in technology design" (Winkler & Spiekermann, 2018). Its practical value is demonstrated in cases where it has been used "to help balance privacy concerns with usability for end-users" — precisely the balancing act this paper is concerned with (Thornton et al., 2019).

Two features make VSD well suited to the problem. First, it situates "moral questions early on in the process of design, development of technologies, systems and research," when the Collingridge window is still open (Dignum, 2017). Second, it treats value con-flicts as design material rather than as obstacles, enabling developers "to give conflict-ing social values a place in smart design and to combine them is such a way as to reach a win-win situation" (Dignum, 2017).

4.2 Responsible innovation

Where VSD works at the level of the artefact, responsible innovation works at the level of the process and its governance. Stilgoe, Owen, and Macnaghten propose four di-mensions — "anticipation, reflexivity, inclusion and responsiveness" — as a framework for raising, discussing, and responding to societal questions about the direction of in-novation (Stilgoe et al., 2013). Anticipation "involves system thinking and recognizes complexities, uncertainties, and risks" and extends governance beyond product risk to questions of pur-pose and trajectory (Koirala et al., 2018). Inclusion moves "beyond en-gagement of stake-holders to the wider public" (Pina & Acur, 2024), and responsiveness requires the capacity to "adjust the course of research and innovation activities in re-sponse to new knowledge, new perspectives, emerging social norms" (Hansen et al., 2020). Together these dimen-sions convert balance from a static settlement into a con-tinuous, reflexive practice.

4.3 Trustworthy AI

At the level of AI specifically, the dominant framework specifies seven requirements: "ro-bustness and safety, human agency and oversight, transparency, privacy and data gov-ernance, diversity, non-discrimination, and fairness, accountability, and social and envi-ronmental well-being" (Ali et al., 2023). The European Union's High-Level Expert Group on AI gave this its canonical formulation, defining Trustworthy AI through three charac-teristics — "lawful, ethical, and robust" — and the same seven key re-quirements (Jusup et al., 2022). The principles have been widely ratified: from "the Montréal Declaration for a responsible development of AI" to UNESCO's recommenda-tions, frameworks "share

terminology, common grounds on human rights, and agree on the relevance of preserving human decisions and responsibilities" (Díaz-Rodríguez et al., 2023).

Explainability is the connective tissue. Zhang and Zhang propose "scenario-based algorithm transparency" with strict limits on what is disclosed, coordinated with national security, social security, and commercial secrets — a recognition that transparency itself must be balanced against competing goods (Zhang & Zhang, 2023). Longo and col-leagues place explainability "at the centre of the current debates on AI regulation, trustworthy AI, and auditability of AI systems," while cautioning that explanations are often "satisficing" rather than fully faithful (Longo et al., 2024).

4.4 Digital humanism

Digital humanism supplies the normative foundation that procedural frameworks leave implicit. Its principles include "the quest for human dignity and the ideal of a better society based on core values of the Enlightenment," and it operates simultane-ously as a technical, political, and philosophical endeavour (Prem, 2024). Hanna and Kazim ground this in a "broadly Kantian theory of human dignity," premised on the existence of "human real persons who inherently possess human dignity" and who alone are "deeply morally or non-morally responsible for whatever fate the digital fu-ture may bring" (Hanna & Kazim, 2021). From this follows a practical prohibition: "not to attribute responsibility to AI and not to let AI make ethical decisions" (Nida-Rümelin & Staudacher, 2023).

The digital humanism programme converges with the design frameworks: it advocates "Human-Centered Design, inclusivity, transparency, and ethical universalism" as guidelines for AI that serves humanity rather than a technocentric paradigm (Sun et al., 2025). A synthesis of AI ethics research found that the field's central concern is precise-ly this alignment — a systematic review of 309 articles identified ethical concerns aris-ing both from AI design and from human–AI interaction, and underscored "the need to ensure that technological development aligns with human well-being" while uphold-ing "privacy, democracy, human dignity, and ethical values" (Cruz et al., 2025).

5. From Principles to Institutions

The proliferation of principles has not been matched by implementation. The con-sistent recommendation is "embedding principles such as transparency, fairness, and accountability into regulations governing AI to address algorithmic biases and ensure ethical use" — a step beyond voluntary commitment (Lescrauwaet et al., 2022). The trinity pathway proposed for the low-altitude economy is instructive as a general tem-plate: ethics must shift from "zero-risk" absolutism toward managing "tolerable risk" and "resilient governance," policy must move toward a service-oriented role, and law must pursue a dual track of "interpretation and legislation" — adapting existing rules while advancing forward-looking ones (Wang, 2026).

Participation is the second institutional pillar, though it is not self-executing. Responsi-ble innovation reinforces the idea that science and technology "should be aligned to so-cietal needs" through the four dimensions, but current practices are "often seen as in-adequate in achieving the stated goals," and the literature stresses the need "to recog-nize power dynamics, diversity of societal interests, the role of vested interests" (Ulnicane et al., 2020). The goal is a genuinely two-way alignment in which "AI should be aligned with human values and respect individual liberties in the digital age," sup-ported by ethically driven development, explainable and transparent systems, and in-terdisciplinary collaboration (Ayinla et al., 2024).

6. Critiques and Unresolved Tensions

Three objections qualify any optimistic account of balance.

First, the concept of responsibility is contested. Responsible innovation "seeks to align technological development with societal needs by integrating ethical considerations into design and implementation," yet "one of its main criticisms is defining what con-stitutes 'responsibility' in a rapidly evolving digital landscape," since the interests of developers, corporations, policymakers, and users "often diverge, making it difficult to establish a universally accepted framework" (Cruz et al., 2025).

Second, participation can be co-opted. Van Oudheusden argues that responsible inno-vation proponents "have little to nothing to say about the politics and power that play out in, and through, deliberative governance processes" — on whose terms participa-tion is established, and why (Oudheusden, 2014). Levidow's study of European partici-patory exercises on agricultural biotechnology found that although "some participants sought to open up technological decisions vis à vis alternative futures and normative choices, but such efforts were marginalised," so that "the exercises tended to biotech-nologise democracy" rather than democratise technology (Levidow, 2007).

Third, deliberation carries its own legitimacy puzzle. While "citizens should be in-volved in expert deliberations on science and technology issues," with the promise of more legitimate governance, there is a tension between deliberative democratic theory and the celebration of diversity and dissent, leaving the legitimacy of such arrange-ments justified on empirical rather than normative grounds (Lövbrand et al., 2010).

These critiques do not undermine the balancing project; they specify what a credible version of it must include. The recurring prescription is "interdisciplinary collaboration, ethical foresight, and regulatory adaptations" as the conditions for responsible devel-opment and deployment (Bashiir, 2025).

7. Conclusion

Balancing technological innovation and human values is not a matter of slowing one to protect the other. It is a matter of building the capacity — methodological, institutional, and normative — to keep the two in productive tension as technologies develop faster than the rules that govern them. The pacing problem is real: intervene too early and innovation is stifled by ignorance of its trajectory; intervene too late and the technology is entrenched beyond practical control. The response that emerges across the literature is not a single intervention but a layered one. At the level of the artefact, value sensitive design makes moral questions explicit while they are still answerable. At the level of the process, responsible innovation builds anticipation, reflexivity, inclusion, and re-sponsiveness into how research proceeds. At the level of the system, trustworthy AI requirements and legally embedded principles of transparency, fairness, and accounta-bility convert aspiration into obligation. And at the level of principle, digital humanism insists that responsibility remains with human persons and that AI not be permitted to make ethical decisions.

The empirical domains surveyed here — algorithmic decision-making, surveillance and privacy, labour markets, health, and education — all point to the same conclusion: outcomes are not dictated by the technology but shaped by the choices made around it. Automation increases inequality partly because of how transitions are governed; algo-rithmic systems discriminate partly because of how they are designed, audited, and contested; clinical AI augments rather than replaces expertise when governance says it must. The balance is therefore achievable, but only as an ongoing institutional practice rather than a settled compromise.

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