Online Journal of Art and Design
volume 13, issue 2, April 2025
DOI: https://doi.org/10.30935/ojad/2513033

Ethical Frameworks and the Dialectic of Human Autonomy and Artificial Intelligence in Industrial Product Design

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Abstract
This research investigates the interplay between artificial intelligence (AI) and human autonomy in the design and user interaction stages of industrial products. The study addresses the impact of AI on human autonomy in both product development and user experience, focusing on topics such as AI's role in product innovation, ethical frameworks, algorithmic influence, and the balance between AI efficiency and ethical responsibility. Through case studies of the Tesla Model 3 Highland, Nike Infinity Run React Flyknit 4, and Fitbit Sense, the analysis explores these themes within a theoretical framework.
The findings underscore the need for prioritizing AI ethics in industrial product design, advocating for systems that are user-centric, safe, and respect privacy. It is recommended that laws enforce full accountability for manufacturers regarding any potential harm caused by AI-driven products. Despite advances in AI, there remain ambiguity around industrial accountability; hence, stricter regulations are required to ensure responsibility. Given the data-centric nature of AI systems, issues of privacy and data confidentiality are paramount and should be managed with robust, transparent data protection measures to assure users of secure data handling.
Keywords: Design Ethics, Human Autonomy, Algorithms, Artificial Intelligence, industrial product design.

1. Introduction
The rapid advancement of AI technologies within the realm of industrial product development has, however, introduced a range of new ethical challenges and dilemmas. As AI systems become more prevalent in product design, concerns about accountability, fairness, and the potential for bias in algorithm-driven decisions are becoming increasingly prominent. Additionally, the growing reliance on automated systems raises critical questions about the diminishing role of designers, who are increasingly guided or even replaced by AI in decision-making processes. This research seeks to explore these ethical concerns by examining the frameworks necessary to regulate AI usage in product development, with particular attention to maintaining human autonomy while harnessing the technological advantages offered by AI.

The integration of AI into product design and development has notably reduced the extent of human involvement in these processes, sparking ethical debates regarding decision-making authority. Specifically, there is growing uncertainty regarding whether AI or human designers determine design decisions and product features. Key questions arise about the extent to which designers retain input and autonomy in shaping design characteristics and making critical decisions. Is there a balance between the influence of designers and AI in decision-making, and to what degree? Furthermore, can AI effectively design products that satisfy the broad spectrum of user needs, and does it adequately consider all human requirements during the product design process?

1.2 Research significance
The significance of this research lies in emphasizing the autonomy of industrial designers when utilizing advanced design software that incorporates artificial intelligence to generate ideas autonomously. It also addresses the importance of user autonomy in interacting with

smart products and their decision-making role in activating and controlling these products. This research explores these themes through the following key variables:

1. Highlighting the concept of human autonomy in relation to the independence of smart systems employed in both product design and operation.
2. Clarifying the relationship between the respective roles of human designers and artificial intelligence in collaborative decision-making processes.
3. Examining the ethical frameworks that govern AI technologies, ensuring the preservation of human autonomy during both the design and operational phases.

1.3 Research Objectives

The main objective of this research is to investigate the ethical issues and challenges concerning human autonomy that arise from the use of AI technologies in product development. The specific sub-objectives are as follows:

- Examine the role of AI in industrial product design and assess its influence on the design process.
- Analyze the ethical implications of algorithm-driven decision-making within design processes.
- Evaluate the impact of AI on human autonomy during various design stages, including its effects on manufacturing and product usage.

1.4 Research Limitations

- **Subject Limitation**: This study focuses on artificial intelligence, human autonomy, and ethical frameworks in design, examining the interplay among these variables.
- **Spatial Limitation**: The research is confined to three specific products: Tesla cars, Nike shoes, and Fitbit watches.
- **Temporal Limitation**: The analysis is restricted to products released in 2024.

1.5 Terms Definition

- **Design Ethics**: Refers to the principles of fairness, accountability, and transparency in the ethical implementation of AI systems. (McLennan et al., 2022).
- **Human Autonomy**: The individual's capacity for self-governance, wherein a person acts according to beliefs, values, motivations, and reasons that are inherently their own (Prunkl, 2023, p. 2).
- **Algorithms**: algorithms represent processes a set of instructions, commands, or rules. In architectural practice, as in many fields, decision-making often follows an "if-then-else" logic, governed by laws and regulations that shape which design options are available or excluded, based on specific data inputs (Terzidis, 2006).
- **Artificial Intelligence**: AI refers to systems capable of adapting and providing high-precision analyses of large external data sets. AI processes and interprets data, extracts knowledge, and applies it toward achieving specific objectives (Koricanac et al., 2021).

2. Literature review

2.1 The Role of Artificial Intelligence in Industrial Product Development

Artificial intelligence (AI), a field within computer science, focuses on developing intelligent machines that can perform tasks requiring human-like intelligence, such as perception, reasoning, and decision-making. AI can be applied in various ways, with three primary categories: rule-based systems, which make decisions using pre-defined rules; expert systems, which rely on domain-specific knowledge; and machine learning, where models improve performance through data over time (Håkansson & Hartung, 2020).

Product design and development are critical phases for organizations as they determine whether a product can succeed in the market efficiently and sustainably. With advances in information technology and rising living standards, there has been a growing shift toward product customization, with consumers now preferring tailored products that reflect their personal tastes (Ananto, Hsieh, & Mahendrawathi, 2021). This demand for customization increases product complexity and shortens product life cycles, making it essential for companies to respond swiftly, enhance design efficiency, and reduce time to market to maintain a competitive edge (Zuoxu, Jihong, & Lianyu, 2022).

Recent developments in AI have introduced new tools for product design, such as generative design and computer-aided design (CAD). Generative design, for instance, uses algorithms to generate multiple design options based on predefined criteria, allowing designers to explore a broader range of solutions in less time (Das & Varshney, 2022). Traditionally, customer satisfaction and requirements were assessed only at the end of the development phase or during post-launch revisions, leading to costly modifications and lost sales opportunities (Cantamessa et al., 2020). However, the concept of "flexible design" has emerged, bridging this gap by engaging customers early in the innovation process (Kratschmayr et al., 2015). This shift has been facilitated by digital transformation technologies that enable real-time data collection and interaction, allowing organizations to continuously adjust to customer needs and technological advancements in a collaborative design environment.

AI integration into design processes offers significant potential to transform problem-solving approaches and foster creativity. By utilizing AI-powered tools and algorithms, designers can gain deeper insights from data analysis, automate routine tasks, personalize user experiences, and generate innovative design recommendations (Bergström & Wärnestål, 2022; Chalyi, 2024). These AI capabilities not only streamline the design process but also enhance the effectiveness of solutions by aligning them more closely with user preferences (Verganti, Dell’Era, & Swan, 2021).

AI technology has grown in popularity for its ability to support decision-making in product design, enabling designers to implement fast and customized designs consistently. Given that customers now prefer personalized products, there has been a shift from traditional "production to stock" models to more flexible approaches like "configuration to order" or "assembly to order." In such customer-centric supply chains, accurate predictions of customer preferences are crucial, and AI plays a key role in making these predictions. AI can precisely forecast product designs that meet customer requirements, ensuring a seamless and profitable product manufacturing process (Koricanac et al., 2021).

However, with the increasing integration of AI in design practices, challenges and ethical considerations arise (Dwivedi et al., 2021; Saeidnia, 2023). Key issues include the balance between AI algorithms and human creativity, the ethical implications of AI-driven decision-making in design, and finding the right equilibrium between automation and human intervention. This literature explores the intersection of AI and design thinking, focusing on the opportunities, challenges, and best practices involved in using AI to enhance the design process and drive innovation. By emphasizing AI's transformative potential in design thinking, this research aims to inspire designers, innovators, and stakeholders to leverage AI for creative excellence and deliver user-centered solutions in the digital age.

2.2 The Five Pillars of AI Systems

The AI ecosystem is comprised of five key pillars, each representing a critical element in the development, operation, and governance of AI systems (Ó Brolcháin et al., 2016):

1. **People**: The individuals who design, develop, and use AI systems, including engineers, developers, and end-users.
2. **Data**: The datasets used to train, validate, and operate AI systems, which form the foundation for decision-making and predictive modeling.
3. **Processes**: The methodologies, workflows, and practices that support the creation, testing, and deployment of AI systems.
4. **System**: The technical infrastructure, such as hardware and software, that facilitates the functioning and scalability of AI applications.
5. **Governance**: The regulatory frameworks and policies that guide, monitor, and regulate AI systems to ensure ethical standards, fairness, and accountability.

It is crucial to continuously test and monitor AI systems within their operational context to identify and rectify non-inclusive behaviors during development. Research indicates that neglecting diversity and inclusion in the creation, deployment, and usage of AI systems can lead to digital inequality, discrimination, and algorithmic oppression. Such issues undermine the reliability and fairness of AI systems, making them detrimental to users and society (Ó Brolcháin et al., 2016).

2.3 AI Ethics

In the literature surrounding AI ethics, numerous terms and concepts have emerged, focusing on principles essential to building and maintaining ethical AI systems. Drawing on Deloitte's Trustworthy AI™ framework, key characteristics such as transparency, fairness, robustness, privacy, safety, and accountability are central to the broader concept of "trustworthy AI" (Deloitte, n.d.).

2.3.1 Transparency and Explainability: This ethical principle highlights the need for clarity and openness in AI systems, which are crucial for fostering trust and ensuring accountability. Transparency involves disclosing the decision-making processes of AI systems, providing insight into how decisions are reached, and making these methods open to scrutiny and traceability.

2.3.2 Fairness and Impartiality: Fairness in AI systems ensures that individuals and groups are treated equitably and without bias. Intelligently designed AI systems can aid in overcoming human biases and making more impartial decisions, thus promoting inclusivity (Kazim & Koshiyama, 2020).

2.3.3 Robustness and Trustworthiness: Robust AI systems are designed to endure challenges and function reliably under various conditions, earning user trust while adhering to ethical standards. Reliability refers to a system's ability to consistently fulfill its intended purpose (Leslie, 2019).

2.3.4 Privacy: Privacy is fundamental to personal autonomy, freedom of expression, and societal norms. AI systems, particularly those in smart devices like connected homes and vehicles, often collect user data without adequate transparency regarding its handling. The principle of data minimization calls for only necessary data to be collected, with unnecessary information being deleted. AI technologies also raise concerns about the potential to identify and track individuals, even when anonymization techniques are used, leading to significant privacy challenges (Achara, Ács, & Castelluccia, 2015).

2.3.5 Accountability: Since algorithms and data they rely on are created by humans, accountability remains a critical ethical principle. This involves reporting, explaining, or justifying decisions influenced by algorithms, and addressing the potential social impacts and risks associated with AI use (Nicholas et al., n.d.).

2.3.6 Responsibility: Responsibility in AI ethics emphasizes that humans are accountable for decisions influenced by AI. Human judgment must be carefully considered, especially in areas that significantly impact individuals. In cases where AI causes harm while being used as intended and prove dependable, those involved in its development and use may not be held accountable (Christophe, Yoshua, & Sébastien, 2018).

2.3.7 Safety and Security: This principle aims to prevent harm to human well-being, covering psychological, social, and environmental dimensions. Safety risks in AI projects vary based on factors such as the algorithms used, data sources, and problem scope. Best practices involve incorporating safety considerations—accuracy, reliability, security, and robustness—into every stage of the AI project lifecycle, including thorough safety testing, validation, and ongoing system documentation (Leslie, 2019).

2.4 Algorithmic Influence in Product Design and Development

2.4.1 The "Black Box" Problem in Algorithmic Decision-Making

One of the most significant ethical challenges in the use of AI for product development is the "black box" problem, where the internal workings of algorithms are opaque, making it difficult to understand how final decisions are reached. This lack of transparency poses challenges for accountability, as developers may be unable to explain how or why a system made a specific decision (Pasquale, 2015). In the context of industrial product development, where safety, efficiency, and consumer welfare are crucial, reliance on AI systems that are not fully understood can lead to unintended consequences, such as design flaws or potential safety risks (Crawford, 2021).

2.4.2 Algorithmic Bias and Its Ethical Implications

Algorithmic bias is a key ethical concern in AI-driven product development. AI systems are trained on historical data that may contain ingrained biases, which can manifest biased design outcomes. This can result in unfair or discriminatory products that reflect social inequalities or biased assumptions about user needs. For instance, if AI models are trained on data primarily reflecting the preferences of male users, the resulting designs may overlook the needs of female consumers or other demographic groups, thus reinforcing discrimination in product design (Mehrabi et al., 2021). Biases embedded in algorithms can lead to the exclusion of certain user groups, further exacerbating societal inequities.

2.4.3 Consequences of Algorithmic Influence

The growing reliance on algorithms in product design and development carries a range of ethical, social, and environmental consequences. For example, if algorithms are designed to prioritize cost reduction, they may recommend the use of cheaper but environmentally unsustainable materials, thereby contributing to environmental degradation (Pan, 2021). Additionally, decisions focused solely on efficiency or profit maximization may disregard broader social factors, such as accessibility or inclusiveness, resulting in products that fail to meet the diverse needs of users (Dignum, 2019). This can lead to a lack of inclusivity in design, where certain demographic groups are not adequately considered.

2.4.4 Ethical Oversight of Algorithmic Design

To mitigate the risks posed by algorithmic influence in product development, establishing ethical oversight mechanisms is essential. Ethics committees, design review boards, and regulatory frameworks can ensure that AI systems are used responsibly and that their outcomes are aligned with ethical standards (Binns, 2018). Incorporating user-centered design principles can help ensure that algorithms account for the needs of all users, regardless of demographic background, thereby promoting fairness, inclusivity, and social responsibility in industrial product design.

2.5 Design Ethics in AI-Driven Product Development

Ethics by design emphasizes the need for AI developers and designers to carefully consider the purpose of the AI systems they are creating, as well as the potential ethical implications of their use (Dignum, 2019). This involves reflecting on the values and principles that guide the system’s design and purpose, aligning with similar efforts in software engineering to incorporate human values. By anticipating the consequences of neglecting certain ethical principles, this approach aims to address potential risks before they materialize (Ferrario et al., 2017).

Ethics by design extends to the behavior that AI systems should demonstrate during operation, ensuring that ethical principles such as harm minimization are integrated into their functionality. This includes imposing limits on the actions and decisions the system can take, which is particularly critical in autonomous systems that interact with humans or animals, or that provide recommendations impacting people’s lives.

Online Journal of Art and Design
volume 13, issue 2, April 2025
DOI: https://doi.org/10.30935/ojad/2513033

Design ethics also guides AI system developers through professional codes of conduct, ethical standards, and regulatory requirements. As the development of responsible AI is a complex and evolving task, organizations and governing bodies must create adaptive infrastructures capable of addressing these challenges (Dignum, 2019).

2.6 Human Autonomy and AI in Industrial Product Development

AI technology has a profound impact on **human autonomy**, which can be either positive or negative. As AI becomes more deeply embedded in daily life, it is essential to examine its ethical implications. Calvo et al. (2020) state that digital technologies have become integral to many aspects of life, with AI systems influencing decision-making, recommendations, and even autonomous actions such as self-driving vehicles. These systems, by their nature, affect how humans think and act, posing significant implications for human autonomy. Protecting autonomy is increasingly recognized as a core ethical concern in AI development, as highlighted in guidelines like the European Commission's *Guidelines on Trustworthy AI* and the *Montreal Declaration on the Responsible Development of AI* (Montreal, 2017).

Human autonomy in AI contexts refers to individuals' ability to make independent decisions without external control or coercion (Coeckelbergh, 2020). As AI systems are increasingly used to guide or even make decisions in product development, the philosophical question arises: How much human control should be relinquished to AI systems? Although AI ethics includes various concerns beyond autonomy, autonomy is inherently linked to values such as privacy (Lanzing, 2016, 2019), transparency (Rubel, Clinton, & Pham, 2021), and human dignity (Riley & Bos, 2021). Protecting human autonomy remains essential, especially in contexts where AI could undermine self-determination and impose external control over decision-making processes.

2.7 Human Autonomy and System Autonomy

2.7.1 Human Autonomy

Human autonomy refers to an individual's capacity to act according to beliefs, values, and motivations that are authentically their own (Christman, 2018). Two key dimensions are central to autonomy:

1. **Authenticity**: The person's beliefs and values must genuinely reflect their "inner self" and not be unduly influenced by external forces Christman, 2009).
2. **Agency**: The individual must have the effective capacity to make meaningful decisions and control key aspects of their life (Mackenzie, 2014).

This model of autonomy comprises various dimensions, as identified by UNICEF (2021):

1. **Capabilities**: The potential for self-determination, including developed skills and capacities.
2. **Normative demands**: The duties of others (and the individual) to respect and support autonomy.
3. **Recognition**: The acknowledgment and respect of autonomy by others, contributing to relational autonomy.
4. **Self-esteem**: Positive self-regard, essential for exercising autonomy.
5. **Practice**: The actual realization of autonomy through decision-making and action.
6. **Resources**: The physical, economic, legal, cultural, and informational contexts that support or hinder autonomy, especially in digital or AI-driven environments.

2.7.2 System Autonomy

In AI research, system autonomy refers to systems operating independently of human control (Franklin & Graesser, 1996) (. From a technical perspective, autonomy in AI often involves systems that can learn, and act based on experience (Russell & Norvig, 1998). Unlike human autonomy, AI autonomy lacks the cognitive processes necessary for forming beliefs, values, or self-awareness. In AI, autonomy is purely instrumental—valuable only for the specific task the system is designed to achieve. AI autonomy, therefore, is task-focused and devoid of the moral and cognitive dimensions associated with human autonomy.

As AI systems continue to evolve and interact with humans in complex ways, understanding the distinctions between human and system autonomy becomes increasingly important for ensuring that AI systems serve human interests without undermining individual autonomy or freedom of choice.

2.8 The Interplay of Autonomy between User and System

A key question regarding AI systems is how system autonomy interacts with the agency dimension of human autonomy. When tasks are delegated to AI systems, there is concern that doing so might reduce human autonomy. It is crucial to examine how AI systems affect the freedoms and opportunities that societies value as fundamental. The issue is not whether an AI system is acting "autonomously" in a technical sense, but rather whether its actions constrain human freedoms. This distinction highlights that there is no inherent conflict between the autonomy of a system and human agency.

However, this is not to suggest that autonomous systems never pose risks to human autonomy. While there is no inherent conflict, autonomous AI can, in specific contexts, have negative impacts on human autonomy. For instance, automated decision-making in loan applications may significantly limit an individual's choices, affecting their life prospects. Similarly, recommendation algorithms on social media can manipulate users into spending more time on the platform than they might choose to if they critically assessed their actions. In both cases, the use of autonomous systems could undermine individual autonomy by influencing or restricting decision-making.

The agency dimension of autonomy becomes particularly relevant as AI systems are further developed and deployed. The concern is not that AI systems, by virtue of their autonomy, inherently harm human autonomy, but that the risks arise from the way these systems are implemented, the specific contexts in which they operate, and the unpredictability of certain AI behaviors. Therefore, the challenge to human autonomy does not stem from AI systems being autonomous, but rather from the potential misuse or unintended consequences of their deployment. The focus should be on understanding the broader ethical implications of how AI systems affect human agency and ensuring that these systems are used in ways that preserve and protect individual freedoms.

2.9 Balancing AI Efficiency and Ethical Responsibility

2.9.1 AI-Human Collaborative Product Design Models

One promising strategy for balancing AI efficiency with ethical responsibility is to adopt AI-human collaborative product design models. These models treat AI as a tool that enhances, rather than replaces, human creativity, enabling designers to leverage AI's capabilities while maintaining control over ethical decision-making (Ransbotham et al., 2020). By fostering a collaborative relationship between AI and human designers, industries can produce innovative and ethically responsible products that address both technological advances and societal needs.

2.9.2 Ensuring AI Ethics in Product Development

To ensure AI ethics in product development, companies must implement comprehensive internal policies that prioritize ethical considerations at every stage of the design process. For example, AI systems should be thoroughly tested for bias and fairness before deployment, with continuous reviews to ensure alignment with ethical standards (Dignum, 2019). In addition to technical measures, fostering a culture of transparency and accountability within organizations is essential. Designers should feel empowered to question and challenge AI-generated decisions, especially when these decisions may conflict with ethical guidelines.

Online Journal of Art and Design
volume 13, issue 2, April 2025
DOI: https://doi.org/10.30935/ojad/2513033

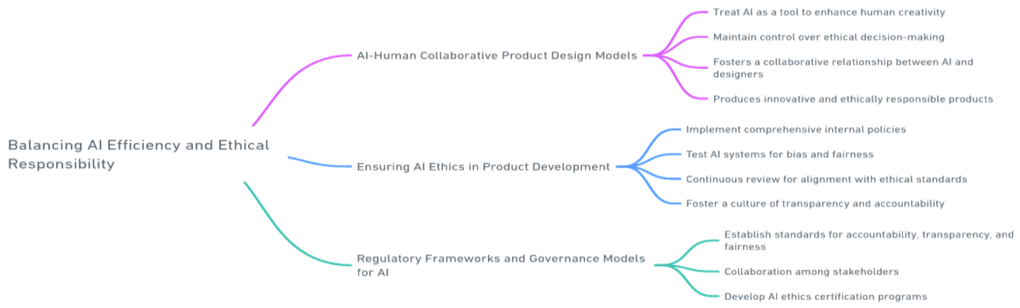

Diagram (1): Balancing Artificial Intelligence Efficiency and Ethical Responsibility in Industrial Product Design (Prepared by Researcher)

2.9.3 Regulatory Frameworks and Governance Models for AI

Effective regulatory frameworks are critical for governing the use of AI in industrial product development. Such frameworks should establish clear standards for accountability, transparency, and fairness in AI-driven design processes (Binns, 2018). Collaboration among stakeholders, including designers, developers, policymakers, and industry leaders—is necessary to create policies that support responsible AI usage while promoting innovation. Furthermore, AI ethics certification programs could be introduced to ensure that companies comply with ethical guidelines in the development and deployment of AI systems.

The following diagram (1) summarizes the approach to balancing AI efficiency with design creativity, highlighting the importance of collaborative efforts, ethical oversight, and regulatory governance.

3. Methodology

- This research adopts a case study approach, focusing on the selection of three industrial products. These products were chosen based on their compatibility with artificial intelligence programs or AI-integrated design tools at the initial configuration stage. Additionally, the products were selected for their use of AI in their operation and interaction with users. The three selected products are:

No.	product	Company	Year of Production
1	Tesla Model 3 Highland	Tesla	2024
2	Nike Infinity Run React Flyknit 4	Nike	2024
3	Fitbit Sense 3	Google	2024

- **Determining Analytical Axes:** a number of scientific axes were established to analyze the products, derived from the research’s cognitive propositions. These axes are as follows:

T	Main axis	Sub-axis	Secondary axis
.1	impact of artificial intelligence in the design and operational process of the product	Black box	
		bias	
		Consequences	
		Censorship	
.2	Ethical Frameworks for Artificial Intelligence in Product Design and Operation	Transparency and interpretability	
		Justice and impartiality	
		Durability and reliability	
		Privacy	
		Accountability	
		Responsibility	
.3	Design ethics according to artificial intelligence considerations	Human autonomy	Capabilities
			Standard requirements
			Recognition and respect
			self esteem
			Practice
			Resources
		System independence	
		The reciprocal roles of autonomy between user and system	Balancing AI Efficiency and Ethical Responsibility
			Product design models in collaboration between AI and designer
			Ensuring AI Ethics in Product Development
			Regulatory Frameworks and Governance Models for AI

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- **Percentage Calculation Methodology**: The percentage equation (part × whole) / 100 was adopted to determine the extent to which the analysis axes are achieved in the design of the three case studies. The individual percentages for each axis were set at 33.3% for each product.

3.1 Case Study Analysis
3.1.1 Tesla Model 3 Highland

First: Description

No.	Feature	Description
.1	Range	.It reaches 604 km depending on the configuration, improved compared to previous models
.2	Battery Technology	Equipped with Tesla's latest battery technology for increased efficiency and charging speed
.3	Autopilot	Standard Autopilot with optional Full Self-Driving capabilities, including Autopilot .Navigation, Autopark, and Summon
.4	Performance	Acceleration from 0 to 96.5 km/h in 3.1 seconds (for the performance version), with the dual-motor all-wheel drive system
.5	Inside	Simple interior design with updated instrument panel and 39.11 cm touchscreen display
.6	Security Features	Advanced safety systems such as collision avoidance, emergency braking, and enhanced .driver monitoring
.7	sound system	Enhanced audio system with active noise cancellation for a quieter driving experience
.8	Contact	LTE ,Wi-Fi ,Bluetooth and premium connectivity options that include satellite maps , and real-time traffic updates
.9	Design	Updated design with sleeker front and rear bumpers, redesigned front grille, and improved aerodynamics
.10	charging	Compatible with Tesla's fast charging network, capable of charging up to 170 miles in 15 minutes
.11	Wheels	.18inch Aero wheels are standard, with 19- or 20-inch performance wheel options-
.12	Climate control	Tri-zone climate control withHEPA filtration to purify the cabin air

Second: Analysis

1. The Algorithmic Impact of Artificial Intelligence in the Design and Operational Process of the Product

1.1 Black Box: The computational algorithms used in Tesla vehicles function as a "black box," meaning that their internal decision-making processes are opaque and cannot be easily understood. These algorithms rely on the data they are fed, which serves as the ethical and practical foundation for the car's operations. This lack of transparency leaves users unaware of how the car interacts with various road conditions and what decisions it makes, thereby weakening user trust in the car and raising concerns among designers. The absence of transparency in how decisions are made, and the nature of these decisions creates uncertainty regarding the system's reliability.

1.2 Bias: The algorithmic frameworks that govern Tesla's operation are based on data input from specialists within specific environmental and contextual parameters. As a result, the algorithms perform according to the data they were trained on, which may introduce bias. This bias can emerge from the selective nature of the data used to train the system, reflecting the limitations or focus of the specialists' input.

1.3 Consequences: Given the lack of transparency in the decision-making process of Tesla's algorithmic model, and the potential bias present in its operational frameworks, the consequences of the car's autonomous actions can be significant. The system may fail to accurately account for environmental and contextual road variables, leading to misjudgments in how it interacts with various places, roads, and road conditions. These failures could result in severe consequences, particularly in situations where the car cannot adequately respond to unexpected variables.

1.4 Control: Control is a critical aspect of managing autonomous algorithms. The ability for designers and users to monitor the car's performance and its automatic behavior is essential for building trust in its autonomous functions. Effective control mechanisms allow for oversight of the car's actions, providing users and designers with confidence in the intelligent system's ability to perform autonomously while maintaining safety and reliability.

2. Ethical Frameworks for Artificial Intelligence in Product Design and Operation

2.1 Transparency and Interpretability: Tesla's autonomous driving system operates through independent algorithms that recognize road conditions and perform specific actions without user intervention. Transparency in this context refers to the system's ability to clearly display and explain how it autonomously makes decisions regarding performance and navigation. This transparency fosters trust between the user and the vehicle, contributing to a sense of security.

2.2 Fairness and Neutrality: The AI algorithms governing Tesla's performance must act impartially, treating all users and road variables equitably. The design of these algorithms should ensure fairness, making sure that all users, including pedestrians and other drivers, are treated neutrally and without bias.

2.3 Durability and Reliability: Given Tesla's reliance on autonomous driving, the AI algorithms need to be robust and dependable. These systems must demonstrate high levels of accuracy and immediate responsiveness, ensuring that the car performs its functions effectively, especially in dynamic road environments.

2.4 Privacy: Tesla's AI systems collect data through onboard sensors and cameras to analyze road variables and other vehicles. This data collection process involves user-specific information, raising concerns about privacy. The AI system should protect user privacy while collecting necessary data for vehicle performance. This protection ensures that users trust the system to manage their data securely.

2.5 Accountability: Accountability in Tesla's design involves identifying who is responsible in the event of an accident—whether it's the car, the driver, or the company. If an issue arises from the algorithms, it raises questions about the system's reliability and the company's responsibility, impacting user confidence.

2.6 Responsibility: Tesla holds the responsibility for ensuring the safety of both users and the environment. By relying on electric systems, Tesla promotes sustainability, taking into account both the user's and the ecosystem's well-being. This dual focus reinforces trust in the company and its products.

3. Design Ethics According to Artificial Intelligence Considerations

3.1 Human Autonomy: Tesla's autonomous driving system grants vehicle independence in navigating roads, but this autonomy must be balanced with the user's ability to intervene. Ensuring that users retain control in unexpected situations is essential for fostering trust and safety.

3.1.1 Capabilities: The AI in Tesla enhances the vehicle's capabilities, allowing it to autonomously manage road conditions and providing users with greater comfort and efficiency. This mutual control between AI and the user enhances the overall performance.

3.1.2 Standard Requirements: Tesla’s AI system adheres to international and local road safety standards, monitoring road conditions and ensuring compliance with speed limits and collision avoidance to protect the user and ensure safe driving.

3.1.3 Recognition and Respect: Tesla’s AI system recognizes user needs, offering tailored responses that ensure comfort and luxury while respecting personal boundaries and privacy. The system adapts to the individual user, maintaining confidentiality in handling data.

3.1.4 Self-Respect: Tesla’s AI should balance its autonomous functions with human control, ensuring that users retain a sense of self-respect and control over their vehicle, even as they rely on its autonomous capabilities.

3.1.5 Practice: The ease of interaction with Tesla’s AI system allows users to control driving features through the digital interface, ensuring smooth, user-friendly engagement with the vehicle’s features.

3.1.6 Resources: Tesla’s smart resources, such as internet-based system updates and troubleshooting, enhance control and provide security, reinforcing ethical values of monitoring, safety, and user comfort.

3.2 System Autonomy: Tesla's autonomous driving system is highly autonomous, relying on inputs from sensors, cameras, and proximity detectors to navigate roads and respond to variables. However, in cases of accidents or unexpected road conditions, this autonomy requires immediate user control to maintain safety and reliability.

3.3 Reciprocal Roles of Autonomy Between the User and the System:
3.3.1 Balancing AI Efficiency and Ethical Responsibility: Tesla achieves a balance between manual and automatic control. The user can switch between autonomous and manual driving modes using the digital interface, ensuring a balance between AI-driven automation and user preferences.

3.3.2 Collaborative Product Design Between AI and Designers: Tesla's design incorporates data configured by a multidisciplinary team in collaboration with AI design tools. These tools help analyze driving data, update maps, and manage contextual variables, ensuring the system performs its functions effectively.

3.3.3 Ensuring AI Ethics in Product Development: Tesla's AI systems are designed with transparency and fairness, allowing users to control and understand the system. The algorithms respect user privacy and ensure the safety and comfort of the user while maintaining a balance between AI performance and human input.

3.3.4 Regulatory Frameworks and Governance for AI: Tesla complies with legal and regulatory standards for AI systems, ensuring user safety and privacy. Its AI systems adhere to international laws and guidelines, protecting users from potential risks and ensuring compliance with vehicle safety standards for road use.

3.1.2 Nike Infinity Run React Flyknit4

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First: Description

Feature	Description
Upper Material	Flyknit material for a lightweight breathable and flexible fit.
Cushioning	React foam midsole for soft responsive cushioning
Support	Wide base for stability and support during runs.
Heel Design	Padded collar and supportive heel to reduce pressure and enhance comfort.
Outsole	Durable rubber outsole for traction and durability on multiple surfaces.
Fit System	Flywire technology integrated with laces for a secure locked-in fit.
Flexibility	Designed for natural foot movement with strategic grooves for flexibility.
Weight	Lightweight build to reduce fatigue during long runs.
Usage	Suitable for both everyday running and high-mileage training.
Sustainability	Contains some recycled materials contributing to Nike's sustainability goals
Design	
Stage	**Description**
Definition	The user defines the features desires
Ideation	user choose acquired features.
Simulation	The AI simulates different design variations based on user input
Refinement	Based on feedback, users make iterative changes. AI assists with running optimization
Finalization	The final design is selected. AI generates desired output
Feedback	After the product is launched, AI can continue to track user feedback

Second: Analysis

1. The Algorithmic Impact of AI on the Design and Operational Process of the Product

1.1 Black Box: The algorithms employed in designing Nike shoes function as opaque systems, often referred to as a "black box," where the decision-making processes are not transparent. These algorithms rely on data inputs, which form the ethical and practical foundation for the shoe's design. As a result, users are unable to fully understand how AI generates design forms or integrates their preferences. Despite this opacity, the overall process provides a significant advantage by enabling personalization, allowing users to design shoes according to their individual needs and preferences. This customization enhances user satisfaction and acceptance of the product, as it reflects personal choices.

1.2 Bias: The algorithmic frameworks for Nike shoe design are based on data, templates, and forms provided by specialists in footwear or general design. Consequently, the AI operates according to the data it has been trained on, which can introduce biases. These biases may stem from the specific shapes, images, and templates used in the system. Additionally, the AI's design suggestions may be influenced by patterns frequently selected by other users, leading to a bias in the forms and compositions that the system presents. This repetition could limit the diversity of design options and perpetuate certain stylistic norms.

1.3 Consequences: Due to the lack of transparency in the decision-making process and the potential biases in the design frameworks, the final shoe design produced by the AI system may lack originality. Repetitions in design templates and the combination of features may result in a product that is not entirely unique, which contradicts the primary objective of providing a personalized, distinct product. The consequence of relying on algorithmic design in this context is the potential for reduced diversity and creativity in the final output, especially when the system repeatedly offers similar design choices based on past user preferences.

1.4 Control: Nike's design platform provides users with the ability to interact with the AI system by selecting templates, patterns, and features to create customized shoes. However, the control afforded to users is limited to choosing from pre-existing options provided by the algorithm. The system allows real-time modifications, but it essentially

DOI: https://doi.org/10.30935/ojad/2513033

presents a curated set of design choices, materials, and patterns. Therefore, the process requires careful oversight to avoid over-reliance on repeated patterns or biased design suggestions. While this system offers a degree of customization, it does not represent true artificial intelligence, as it primarily operates by offering predetermined selections rather than dynamically generating entirely new designs.

2. Ethical Frameworks of Artificial Intelligence in Product Design and Operation

2.1 Transparency and Explainability: Nike's design platform uses an algorithmic system that provides users with a range of design patterns and options for customizing their shoes. Transparency is demonstrated by the system's ability to clearly show how the user's selections—such as colors, materials, and patterns—are combined to create the final design. With each change, the system updates and visually displays the evolving product, ensuring the user can see how their choices impact the design in real time. However, this system is not fully autonomous AI; instead, it offers predefined design options, which limits its interpretability as a true AI system but makes the design process more accessible and clearer to the user.

2.2 Fairness and Neutrality: The platform provides users with a limited set of design options based on a predefined set of materials, colors, and patterns. While this allows users to personalize their shoes to some extent, the system lacks the range and flexibility needed for complete fairness and neutrality in customization. A broader variety of choices would enhance the system's ability to cater to a wider range of preferences, ensuring that it remains neutral and offers equal opportunities for all users to create truly unique designs, regardless of individual style or preference.

2.3 Robustness and Reliability: The AI system on Nike's platform offers robustness by reliably presenting users with functional and visually consistent design options. However, this reliability is limited to the predefined color schemes and material patterns available on the platform. The system does not allow for fundamental changes to the shoe's structure, which limits its capacity to adapt or innovate beyond these basic parameters. As such, while the platform performs consistently within its set framework, it lacks dynamic flexibility typically associated with more advanced AI systems.

2.4 Privacy: Nike's design system ensures privacy by allowing users to personalize their designs without sharing sensitive personal information. Although the level of customization is relatively simple focused on materials and colors, the system does offer users a private design experience where they can create products that reflect their preferences. This approach helps ensure consumer privacy, as users are not required to share detailed data beyond their design choices.

2.5 Accountability: Accountability within Nike's design platform is reflected in its ability to meet user expectations through customization. The platform tracks user preferences, updates design in real time and ensures that the final product closely matches the user's choices. Moreover, Nike takes responsibility for ensuring user satisfaction by studying customer feedback, analyzing user opinions, and continuously improving the design platform. This process ensures that the platform serves a diverse range of users, regardless of their cultural or social backgrounds.

2.6 Responsibility: Nike's platform demonstrates responsibility by guaranteeing that the product delivered to the user matches the design specifications they selected. In cases where discrepancies occur, such as the final product not aligning with the user's design, Nike commits to rectifying the issue, ensuring user satisfaction through compensation or redesign. This responsibility underscores the brand's commitment to quality control and customer satisfaction in AI-driven product design.

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DOI: https://doi.org/10.30935/ojad/2513033

3. Design Ethics According to AI Considerations

3.1 Human Autonomy:

Nike’s design platform offers limited human autonomy, allowing users to select certain design features like patterns, materials, and colors. However, users have no control over modifying the core structure of the shoe. The platform restricts customization to superficial elements, making it a constrained form of autonomy in product design.

3.1.1 Capabilities: The AI system’s capabilities are highly restricted, allowing only minor adjustments to surface-level features such as colors and patterns. Users are unable to make significant changes to the shoe’s structural design, which limits the depth of customization available.

3.1.2 Standard Requirements: The platform adheres to a small set of standard requirements, offering customization based on predefined material and color patterns. The system allows users to adjust, but only within a narrow scope of available design features.

3.1.3 Recognition and Respect: The platform enhances user recognition by enabling them to personalize the aesthetic elements of the shoe, such as color and pattern, according to their preferences. This provides a level of respect for the user’s individuality and personal tastes.

3.1.4 Self-Respect: By allowing users to customize their shoe designs, Nike’s platform fosters a sense of self-respect in users, as they can express their individuality through design choices. This personalization meets the user's desire for uniqueness and personal expression.

3.1.5 Practice: The platform allows users to easily navigate between design options and visualize their choices in real-time, offering a fluid and interactive design practice. Users can instantly see the effects of their decisions, providing an engaging and straightforward experience.

3.1.6 Resources: The platform provides a limited set of resources focused on variations in patterns, colors, and materials. These resources, while useful for customization, are insufficient for broader or more complex changes to the shoe’s fundamental design.

3.2 System Autonomy: The platform’s AI system exhibits a high degree of system autonomy because it operates within a closed framework, offering only a predefined set of options related to patterns and colors. Users are restricted to these preset options, and the system’s autonomy limits external input beyond the scope of these choices. Thus, the system functions autonomously, but only within the parameters it was programmed to follow.

3.3 Mutual Roles of Autonomy Between the User and the System

3.3.1 Balancing AI Efficiency and Ethical Responsibility: The platform achieves a balance between AI efficiency and ethical responsibility by offering users a range of customizable features that update in real-time, providing efficient feedback. Ethical responsibility is maintained by ensuring a variety of design options that cater to different user preferences, promoting inclusivity and user satisfaction while avoiding bias.

3.3.2 Product Design Models Through Collaboration Between AI and Designers: The shoe design process is a collaboration between AI tools and the design team, where the team inputs data and design variables that the AI system uses to offer customization options to users. While the structural components are predefined by the designers, the AI enables users to interact with the design, making their own modifications within the available framework.

3.3.3 Ensuring AI Ethics in Product Development: Nike’s design platform promotes ethical AI use by allowing users to customize their shoes according to personal preferences within a defined set of design variables. Although limited to superficial features, the system’s real-time updates and interactive display ensure users can make informed choices, respecting their individual preferences and promoting an ethical design process.

3.3.4 Regulatory Frameworks and AI Governance Models: The platform operates within a set of predefined regulatory frameworks, which govern the design options available to users. The system ensures compliance with these frameworks by offering a real-time display of patterns and materials that align with established guidelines. While it offers inclusivity and aims to satisfy most users, the platform’s limitations in flexibility reflect the constraints of its governance model.

3.1.3 Fitbit Sense3

First: Description

Category	Details
Health Tracking	Continuous heart rate monitoring, SpO2 sensor, ECG app for heart rhythm irregularities, advanced sleep tracking, and skin temperature monitoring.
Stress Management	EDA sensor for real-time stress analysis, guided breathing exercises, and mindfulness sessions.
Exercise & Fitness	Built-in GPS, 20+ exercise modes, automatic workout detection, VO2 Max estimation, and activity tracking (steps, distance, calories).
Sleep Insights	Personalized sleep recommendations, sleep score, and detailed REM, deep, and light sleep tracking.
Battery Life	Up to 6 days of battery life, with fast charging (one day's charge in 12 minutes).
Smartwatch Features	Notifications for calls, texts, apps, Fitbit Pay, and customizable watch faces.
Connectivity	Bluetooth, Wi-Fi, and optional LTE model for phone-free connectivity.
Water Resistance	Water-resistant up to 50 meters, suitable for swimming and water sports.
Build	Lightweight aluminum case, soft silicone band, designed for comfort and long-term wear.
Display	1.58-inch AMOLED touchscreen, bright and vibrant, optimized for outdoor visibility.
Customization	Interchangeable bands with various colors and materials (leather, sport).
Navigation	Haptic feedback button and intuitive swipe/tap gestures for easy control.
Aesthetics	Minimalist design with slim bezels and curved display for seamless look.
Durability	Scratch-resistant Gorilla Glass display, durable materials for long-term use.
AI Assistant Integration	Google Assistant for voice commands, smart home control, setting reminders, and answering queries.
Personalized Health Insights	AI-driven insights from health data, providing customized recommendations for workouts, sleep, and stress management.
Smart Alarms	AI-powered alarms wake users at the optimal sleep stage to avoid grogginess.
Activity Recognition	AI automatically detects and categorizes exercises (e.g., running, cycling) using motion sensors.

Second: Analysis

The Algorithmic Impact of AI on the Design and Operation of Products

1.1 Black Box: The operational procedures that govern the functional performance and intelligent tracking features of Fitbit Sense 3 are opaque. The algorithms that process data collected from the device's sensors—such as heart rate, stress levels, and other biometric indicators—operate as a "black box." Users do not have insight into how the system analyzes this data or how it makes decisions based on the information gathered. This lack of transparency forces users to rely on the device's output without fully understanding how it monitors and interprets their physical health metrics, leading to a potential disconnect between the user and the system's inner workings.

1.2 Bias: The Fitbit Sense 3's intelligent system relies on algorithmic processes built on large datasets that follow pre-defined and standardized frameworks. However, these frameworks may inherently contain biases, particularly if the training data does not represent a sufficiently diverse population in terms of gender, age, race, or fitness level. For example, if the data reflects a particular demographic, health recommendations could be less accurate or inappropriate for users from underrepresented groups. Such biases may result in inequitable outcomes, where health advice is more suited to some users than others, potentially disadvantaging certain groups.

1.3 Consequences: The reliance on standardized data within Fitbit Sense 3's algorithms can have profound consequences for users who fall outside of the product's target demographic or have unique health conditions. If users depend on the device's recommendations—such as advice on physical activity, sleep patterns, or stress management—without consideration of their specific needs, the outcomes could be harmful. For instance, inaccurate suggestions about exercise intensity or recovery periods could lead to adverse health effects, especially for those with underlying conditions or non-standard fitness levels. Thus, the potential for misguided health advice raises concerns about the broader applicability and safety of the system's algorithmic outputs.

1.4 Control: Fitbit Sense 3 offers users limited control over its algorithmic functions. While the device provides users with health and activity insights, they are not able to directly interact with or adjust the underlying algorithms responsible for processing their data. This lack of control means that users must rely on the company to ensure the accuracy and privacy of their personal data, raising ethical concerns about data ownership and user autonomy. The absence of user control over how their data is processed and how decisions are made introduces privacy risks and questions about the level of trust that can be placed in the device's management of personal health information.

2. Ethical Frameworks of Artificial Intelligence in Product Design and Operation

2.1 Transparency and Explainability: The algorithms and AI systems integrated into Fitbit Sense 3 are often not fully transparent or easily understandable for the average user. This lack of clarity leaves users uninformed about how these systems make decisions or how their personal data is processed. As a result, concerns about transparency and trust arise, particularly regarding how user data is stored, processed, and whether it may be shared with third parties without explicit user consent. This lack of **explainability** can diminish user trust in the device's ethical use of personal information.

2.2 Fairness and Neutrality: Although the AI in Fitbit Sense 3 is designed to serve a wide range of users, its system may not be fully inclusive, particularly for users with specific health conditions or unique physical needs. For instance, individuals with certain diseases or disabilities may find that the device's recommendations—such as fitness or lifestyle advice—are not tailored to their specific circumstances. This could compromise the fairness and neutrality of the system, as it may not accurately represent the needs of all users, potentially leading to inappropriate or biased health suggestions.

2.3 Robustness and Reliability: The AI system in Fitbit Sense 3 is regarded as robust and dependable, but its performance is directly linked to the quality and accuracy of the data it collects. The system's reliability also depends on how well this data is processed to generate appropriate advice for users. Additionally, there are concerns about data ownership and security—specifically, whether the user's data remains private or whether it might be accessed by the company for other purposes. Ensuring data privacy and preventing unauthorized access are critical to maintaining the system's reliability from an ethical standpoint.

2.4 Privacy: The Fitbit Sense 3 collects extremely sensitive data, including metrics such as heart rate, physical activity, location, stress levels, and blood oxygen saturation. Despite assurances from the company regarding data privacy and the non-sharing of personal data, doubts persist about how effectively user privacy is protected. Questions remain about the potential for data leakage, exploitation, or use by third parties for purposes outside of what the user has consented to, which poses significant concerns regarding data security and privacy.

2.5 Accountability: **Accountability** for any errors or issues that arise from Fitbit Sense 3 lies with the company, particularly if the device provides inaccurate or harmful recommendations. For instance, if users receive incorrect fitness advice that negatively impacts their health, the company bears the responsibility for addressing these mistakes. Google, Fitbit's parent company, has emphasized its role in ensuring that user interaction with the product is safe and that any concerns related to the accuracy of the recommendations are promptly addressed.

2.6 Responsibility: The company is responsible for ensuring that Fitbit Sense 3 delivers accurate fitness, health, and lifestyle recommendations to users. In cases where the AI system provides inaccurate or misleading guidance, the company is obligated to take responsibility for any negative consequences or harm that results. This responsibility extends to correcting the system's errors and compensating affected users, thus ensuring that the product meets the expected standards of performance and ethical accountability.

3. Design Ethics in the Context of Artificial Intelligence

3.1 Human Autonomy: Human autonomy in Fitbit Sense 3 is limited. While users can select certain product options and preferences, their control over the data collected by the devices such as health metrics and physiological processes—is minimal unless they choose to disable data collection functions entirely. This creates a tension between preserving user autonomy and the device's core functionality, which relies on continuous data collection for health monitoring.

3.1.1 Capabilities: The Fitbit Sense 3 is equipped with several AI-driven features that monitor various physiological processes such as heart rate, stress levels, and blood oxygen saturation. These capabilities offer substantial performance benefits by helping users monitor and improve their overall health. Additionally, the device provides personalized suggestions, such as ways to enhance sleep quality or manage stress, to improve lifestyle habits and well-being.

3.1.2 Standard Requirements: The AI system in Fitbit Sense 3 is built on a set of standard performance criteria derived from the data it collects through its sensors. These algorithmic standards allow the device to interpret the user's health conditions and offer corresponding suggestions. However, users do not have the ability to modify these metrics, which are predefined by the system. Despite this limitation, the performance standards are beneficial, helping users gain insights into their health and suggesting lifestyle improvements.

3.1.3 Recognition and Respect: The design of Fitbit Sense 3 respects users' needs by providing tailored health advice based on the monitoring of their physiological functions. This recognition of the user's health and lifestyle requirements is embedded in the device's ability to offer personalized suggestions that aim to enhance the user's quality of life.

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DOI: https://doi.org/10.30935/ojad/2513033

3.1.4 Self-Respect: By offering users continuous monitoring of key health metrics and personalized recommendations, Fitbit Sense 3 fosters self-respect. The ability to track one's health and make informed lifestyle choices boosts users' self-confidence, contributing to an overall improvement in their well-being.

3.1.5 Practice: The Fitbit Sense 3's AI algorithm encourages users to modify unhealthy **habits** by offering suggestions on how to improve their daily routines. This, in turn, leads to better health outcomes. However, there is a risk that biases in the algorithm or generalizations could result in inaccurate advice, potentially leading users to adopt habits that could harm their health.

3.1.6 Resources: Fitbit Sense 3 provides valuable informational and technical resources through its AI-driven health monitoring features. These resources allow users to make informed decisions about their health and adopt healthier lifestyle practices based on data-driven insights.

3.2 System Autonomy: The algorithmic system in Fitbit Sense 3 operates with a high degree of autonomy. It processes user data, such as heart rate and activity levels, independently of user intervention and generates health recommendations based on this data. The system functions without direct user control, focusing solely on analyzing data to offer insights and advice based on predefined objectives.

3.3 Mutual Roles of Autonomy Between User and System

3.3.1 Balancing AI Efficiency and Ethical Responsibility: The Fitbit Sense 3 achieves a balance between AI efficiency and ethical responsibility by processing data quickly and accurately to deliver health recommendations. The device must also adhere to ethical standards, particularly in terms of respecting user privacy and ensuring data security. However, there are lingering concerns about whether users can fully trust how their data is handled and whether it remains private after collection.

3.3.2 Product Design Models Through Collaboration Between AI and Designers: The technical and performance features of the Fitbit Sense 3 are the result of collaboration between industrial designers, software developers, and AI experts. This multidisciplinary approach ensures that the product meets the user's expectations for efficiency, usability, and performance, while also maintaining the ethical standards necessary for AI-driven health devices.

3.3.3 Ensuring AI Ethics in Product Development: Fitbit Sense 3's development emphasizes the importance of ethical standards in AI, focusing on privacy, inclusivity, and user benefit. The device's design ensures that the health recommendations provided are not only accurate but also accessible to a diverse range of users. Ethical considerations are central to the product's functionality, particularly in safeguarding user privacy and ensuring that the data is used to improve user well-being without exploitation.

3.3.4 Regulatory Frameworks and AI Governance Models: Fitbit Sense 3 operates under strict regulatory frameworks that govern how user data is collected, stored, and processed. These frameworks ensure compliance with privacy laws and protect user autonomy, preventing unauthorized access or misuse of personal health data. However, despite these regulations, many users remain uncertain about how their data is managed, highlighting ongoing concerns about transparency in AI governance.

4. Results and Discussion

- **Transparency**: Transparency achieved in 33.3% of the cases, particularly in the Nike shoe customization platform, where users could see and understand the algorithmic decisions involved in design choices. However, the Tesla and Fitbit systems were opaquer, offering no clear insight into how decisions were made by their algorithms, resulting in a 66.6% lack of transparency.

- **Bias**: Bias was present across all three case studies due to the lack of comprehensiveness in the foundational data and system designs, which led to biased decision-making in all systems. This resulted in a 100% bias rate, as none of the AI systems could fully account for the diversity of users' needs, backgrounds, or conditions.
- **Consequences**: The potential for profound consequences, such as poor decision-making due to lack of transparency and bias, was evident in all three cases. This could lead to undesirable or even dangerous outcomes, such as safety issues in Tesla's autonomous driving or incorrect health recommendations from Fitbit. The consequences applied at a rate of 100%.
- **Control**: Control over algorithmic systems was more present in Tesla and Nike platforms, where designers and users could manage variables like performance and customization, contributing to 66.6% user control. Fitbit, however, provided extremely limited user control, with oversight primarily in the hands of the manufacturer, resulting in 33.3% control.
- **Transparency and Explainability**: Tesla and Nike offered 66.6% transparency and explainability, providing users with insights into operational mechanisms and allowing some degree of user control. Fitbit, on the other hand, had limited transparency, failing to explain how its algorithms functioned or how it managed user data, contributing to 33.3%.
- **Fairness and Neutrality**: All three case studies demonstrated a lack of fairness and neutrality. The AI systems showed biases, particularly in their inability to account for diverse user groups, leading to non-inclusive results. This bias was present in both Nike and Fitbit, indicating that the AI systems in these designs lacked comprehensiveness and fairness, with a bias rate of 100%.
- **Robustness and Reliability**: The AI systems in Tesla, Fitbit, and Nike were robust and reliable, efficiently performing their intended functions. The systems demonstrated responsiveness, adjusting performance based on sensor input and data, providing good user experience.
- **Privacy**: Nike’s customization platform performed well in terms of user privacy, as it required limited personal data, contributing to 33.3% privacy protection. However, Tesla and Fitbit raised more privacy concerns due to the large amounts of personal data they collected, which raised potential risks of data misuse, leading to 66.6% concern about privacy.
- **Accountability**: All three case studies addressed accountability, with the companies responsible for these products—Tesla, Nike, and Google (Fitbit’s parent company)—stating that they would manage any AI-related errors. However, the extent of their institutional commitment to accountability remains debatable, though it was present across the case studies at 100%.
- **Responsibility**: Each company demonstrated responsibility in different ways. Tesla showed environmental responsibility by designing an eco-friendly electric vehicle, Nike ensured user satisfaction through product customization, and Google focused on providing accurate health advice. All companies demonstrated a 100% commitment to responsibility.
- **Human Autonomy**: Human autonomy was limited across the three designs. Tesla's self-driving feature allowed partial user control, but most of the car's functions were automated, leading to 33.3% autonomy. Nike provided users with the ability to customize shoe designs, contributing another 33.3%, though customization options were restricted. Fitbit offered minimal autonomy, as users had no control over the data collection process, also contributing 33.3%.
- **Capabilities**: Tesla and Fitbit demonstrated high capabilities in terms of AI input-output processes, enhancing user functionality and improving daily life at 66.6%. However, Nike’s customization platform, while functional, did not offer full AI capabilities, relying on preset templates, limiting its contribution to 33.3%.

- **Standard Requirements**: All three case studies adhered to specific standard requirements for AI input and output, ensuring that each system performed its assigned tasks with precision. This contributed to 100% compliance with AI standards.
- **Recognition and Respect**: The AI systems in all three products were designed to recognize and respect user needs, aligning with their preferences and improving their quality of life, achieving 100% in this regard.
- **Self-Respect**: The efficiency of the AI systems in all three case studies allowed users to feel empowered and confident in their choices, leading to a 100% enhancement of self-respect.
- **Practice**: The AI frameworks facilitated effective user interaction, offering efficient input-output performance that improved usability and overall user experience across the three case studies.
- **Resources**: Tesla and Fitbit provided substantial resources through their AI systems, allowing users to perform tasks with minimal effort, contributing to 66.6%. Nike offered limited resources, as users could not alter the core design, resulting in 33.3% resource availability.
- **System Autonomy**: The AI systems in all three case studies operated with high autonomy, functioning independently through predefined frameworks, achieving 100% autonomous performance without the need for human intervention.
- **Balancing AI Efficiency and Ethical Responsibility**: Both Tesla and Nike achieved a balance between AI efficiency and ethical responsibility, offering users control while maintaining system performance, contributing 66.6%. Fitbit lacked significant user control, which raised privacy concerns and contributed 33.3%.
- **AI-Designer Collaboration**: The case studies demonstrated that AI systems were designed based on collaboration between designers and AI algorithms, achieving 100% balance between autonomous system performance and manual user intervention.
- **Ethical Values**: The AI systems in all three case studies prioritized ethical values, focusing on user needs, privacy, and improving their quality of life, achieving 100% respect for ethical standards.
- **Regulatory Frameworks and AI Governance**: Each product adhered to regulatory frameworks and governance models, ensuring compliance with international standards and privacy laws. These frameworks safeguarded user privacy and respected their needs, achieving 100% compliance across the case studies.

5. Conclusion

Industrial products designed with AI inputs often suffer from a lack of transparency, making it difficult for users to understand how these systems operate. Improving transparency in future designs is crucial for building user trust, as it will allow users to make informed decisions and better comprehend the mechanisms behind intelligent systems. The primary challenge in designing AI-integrated products is achieving a balance between AI efficiency and user autonomy. When this balance is properly struck—where AI inputs are optimized but still allow for user intervention, the result is enhanced safety and trust in technology. Importantly, users retain a degree of control over the product's processes, which further bolsters confidence in AI-driven systems.

Many AI-based industrial products face bias due to data that does not adequately represent the diversity of users or the various contexts in which the products function. These biases can result in actions or recommendations that are irrelevant or inappropriate for certain user groups, potentially undermining the effectiveness and fairness of the AI system.

AI ethics must be a top priority for manufacturers. AI systems should be designed to serve, protect, and ensure user privacy, with legal frameworks holding manufacturers fully accountable for any harm or faults caused to users. While AI technology is advancing rapidly, the accountability of manufacturers remains unclear, necessitating stricter laws and policies to ensure that developers and manufacturers take full responsibility for their AI systems. Given that AI systems rely heavily on data collection about users, their environments, and their activities, privacy and data confidentiality are critical concerns. Manufacturers of smart products should prioritize these concerns by adopting strong data protection mechanisms that are transparent and reliable, reassuring users that their data is being managed with care and confidentiality.

AI-driven products tend to exhibit elevated levels of autonomy, prioritizing automated task execution through predefined algorithms. However, this can limit the user's ability to control or intervene in product processes, which can reduce their overall autonomy. The optimal approach is to create products that balance both system and user autonomy, allowing users to intervene when necessary or reconfigure the product's functionality to better suit their needs. AI-supported industrial products are characterized by robustness, reliability, and efficiency in performing tasks. However, AI systems and algorithms should be designed in a way that makes their processes understandable to users, while also ensuring safe and long-term usage.

As AI efficiency advances, there must be a clear commitment to ethical responsibility. Combining high performance with ethical standards will result in products that respect user rights and ensure user safety. Intelligent systems should account for diverse ethical values among users, enhancing their ability to meet personal needs while improving quality of life. This must be done without compromising ethics or sacrificing privacy.

Governance and regulatory frameworks are essential for ensuring that AI-supported products comply with international laws and standards. These frameworks need to be flexible enough to adapt to rapid technological advancements while continuing to protect user rights and ensure security.

6. Recommendations

1. **Integrate Ethical and Humanistic Education in Industrial Design**: It is essential to emphasize the teaching of ethical values and humanistic and social standards to industrial design specialists. This educational focus will enhance their understanding of the ethical implications of AI-driven products and ensure that these products are performance-based, user-centered, and aligned with broader human considerations. By fostering this knowledge, designers can contribute to achieving individual autonomy in collaboration with AI technologies, ensuring that products respect both technical functionality and human values.
2. **Enable User Control Over AI Systems**: Providing users with direct control over the outputs of AI systems in industrial product design is critical. This will reinforce user autonomy and build trust in AI-driven products by giving users greater control over the processes and outcomes. When users can interact with and influence AI outputs, they develop more confidence in the technology, ensuring that the system is transparent and adaptable to their personal needs.
3. **Develop Inclusive AI Algorithms**: There is a need to focus on creating more inclusive AI algorithms that accommodate the needs of diverse user groups. By developing systems that serve all types of users—regardless of age, gender, race, or physical abilities, the outputs of these algorithms will better reflect the varied desires and requirements of the user base. This approach will help reduce bias in decision-making and contribute to more equitable and relevant AI-driven products.

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