

The Engineering Philosophy and Culture within Mohist Thought

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Abstract

This paper explores the enlightenment value of Mohist thought for the paradigm innovation of modern engineering education and the construction of an engineering philosophy system. Research shows that the Mohist ethical view of "universal love and non-aggression" provides a value cornerstone of "benefiting the people and being practical" for engineering ethics; the "Three Standards Method" verification system and the methodology of "mastering craftsmanship and seeking principles" constitute the earliest systematic engineering philosophy framework. In particular, Mohist ethics, with its emphasis on proactive care for collective welfare and preventive non-harm, offers a distinct contrast to the individual rights and retrospective case-analysis focus prevalent in conventional Western approaches. In the field of engineering education, the Mohist talent standard of "cultivating virtue and mastering skills", the educational method of "proactive teaching", and the trinity practical model of "experiment-inheritance-innovation" offer oriental wisdom for addressing the imbalance between technical rationality and humanistic values. The creative transformation of Mohist thought in the digital age—particularly in algorithmic ethics, cybersecurity, and green computing—highlights its transcendent value as a philosophy of technology. By reinterpreting the engineering and technological wisdom in the Mozi text, this study provides important theoretical support for constructing an engineering ethics education system and engineering philosophy paradigm with Chinese characteristics.

Keywords: *Mohist thought; engineering education; engineering philosophy; engineering ethics; craftsmanship spirit*

1. Introduction

Amid profound challenges facing global engineering practice and technological ethics, the pre-Qin Mohist school—an academic community integrating philosophical systems and engineering practice in ancient China (c. 5th-3rd century BCE)—has attracted widespread

interdisciplinary attention. Emerging during the turbulent Warring States period, Mohism was founded by Mo Di (Mozi) as a pragmatic philosophical and social movement that rivaled Confucianism. It distinguished itself through its rigorous logical system, its defense of pacifism and social utility, and its unique integration of ethical theory with hands-on technological innovation. The renowned British scholar Joseph Needham evaluated Mohist scientific and technological achievements in *Science and Civilization in China*: "The Mohists, who fully trusted human reason, clearly laid the foundations for what could become the basic concepts of natural science in Asia." [1]

However, in the history of academia, Mohist engineering philosophy has long been overshadowed. Mainstream views in engineering philosophy hold that both Western and Eastern philosophies have historically neglected technology and engineering, treating them only as occasional objects of reflection. [2] Nevertheless, a re-examination of the Mozi text—especially the Mohist Canons (Jing Shang, Jing Xia, Jing Shuo Shang, Jing Shuo Xia, Da Qu, Xiao Qu)—reveals that its ideological depth and systematicness far exceed previous academic understanding, with a formed systematic engineering philosophy framework termed "Mohist Design Philosophy" by scholars such as Ji Yang. [3]

From an interdisciplinary perspective of engineering philosophy and education, this paper systematically elaborates on the enlightenment value of Mohist thought for constructing a Chinese-style engineering ethics education system and engineering philosophy paradigm. It analyzes core Mohist concepts such as "universal love", "non-aggression", and "frugality" as manifested in engineering and technological practices, while combining contemporary dilemmas in engineering education and ethical challenges of digital technology. Furthermore, this study deliberately contrasts Mohist ethical frameworks with dominant Western models (e.g., deontological duties and utilitarian risk-benefit analysis) to highlight its unique pedagogical potential in cultivating engineers with a proactive, community-oriented ethical consciousness.

2. The Technological Philosophy System of Mohist Thought

2.1 Engineering Ontology: The Creation Wisdom of "Achieving Results Through Causes"

A core contribution of the Mohist thought system is the construction of the world's earliest engineering philosophy framework. The Mozi Jing Shang opens with the proposition: "Gu (cause) is that which, when obtained, results in the completion [of a thing]." Defining "cause" as the sufficient condition for the formation of things, this proposition addresses the fundamental issue of analyzing the causes of material properties. Transcending the limitation of Aristotle's *Metaphysics*, which confined research objects to natural things, this proposition incorporates the generative mechanism of artificial objects into philosophical reflection: "A minor cause (xiao gu) is that which, when present, does not necessarily produce the effect, but when absent, necessarily fails to produce it. It is like a part, such as a point in a line. A major cause (da gu) is that which, when present, necessarily produces the effect, and when absent, necessarily fails to produce it. It is like the conditions required for seeing to occur" (Jing Shuo Shang). This causal analysis framework regards engineering activities as a dialectical unity of deconstruction ("when absent, necessarily fails") and construction ("when present, necessarily succeeds"), forming a systematic engineering methodology known as the "cause-effect achievement method". By controlling variables to verify the relationship between element functions (minor causes) and overall system efficiency (major causes), it aligns closely with modern engineering design methods such as Fault Tree Analysis (FTA) and reliability engineering.[4]

2.2 Systematic Thinking and Design Epistemology

The Mohist Canons further propose: "Ti (part) is that which is divided from jian (whole)" (Jing Shang), illustrating the relationship between the whole (jian) and parts (ti) through examples like "one of two" or "a point in a foot-long line", establishing the world's earliest view of systems engineering. This thought is particularly evident in engineering practice: the city defense system demonstrated by Mozi during "Persuading Chu to Abandon the Attack on Song" integrated subsystems such as reconnaissance (earth listeners), weaponry (continuous crossbows), and transportation (wooden kites), embodying modular design thinking. Through

the pinhole imaging experiment, the Mohists constructed a light propagation model that studied the light source, aperture, and imaging surface as an interactive system of elements nearly two thousand years earlier than similar European research.[5]

In terms of epistemology, the Mohists proposed: "Qie (imminent) refers to stating what is to be" (Jing Shang), defining design as "the conception of the form of things to come": "That which is imminent from the perspective of the future is called qie; that which has passed is called yi; that which is occurring is also called qie." This definition is essentially consistent with the modern definition of design in Herbert Simon's *The Sciences of the Artificial*: "Design is the process of conceiving courses of action aimed at changing existing situations into preferred ones." [6] The Mohists emphasized the feasibility of design: "That which requires effort to complete must be accomplished through effort", demanding that design schemes be verified through engineering practice—reflecting the unity of theoretical conception and practical verification.

2.3 Engineering Axiology: The Ethical Core of "Benefiting the People and Being Practical"

The core value criterion of Mohist engineering philosophy is embodied in "Gong (merit) is benefiting the people" (Jing Shang) and the systematic evaluation principle of "being unable to do something does not constitute harm": "That which benefits people is called qiao (skilled); that which harms people is called zhuo (clumsy)" (Mozi Lu Wen), clearly stating that technological value lies in people's well-being. "Eliminating unnecessary expenses is the way of sage-kings" (Mozi Jie Yong), advocating resource optimization through lean design. "Preparedness is the weight of a state; food is its treasure; soldiers are its claws; cities are for self-defense" (Mozi Qi Huan), emphasizing the security value of defensive engineering.[7] This value system unifies instrumental rationality and value rationality, affirming the importance of "mastering craftsmanship (qiao chuan)" while emphasizing the innovative value of "seeking principles (qiu gu)", forming a two-way interactive framework of "technological application-ethical reflection".

3. Mohist Wisdom in Engineering Ethics

3.1 The Foundation of Engineering Ethics: "Universal Love and Non-Aggression"

The Mohist thought of "universal love and non-aggression" provides a philosophical foundation for engineering ethics. This principle advocates for impartial care (jian ai) towards all people, without the gradations of familial priority found in Confucianism, and an active commitment to avoid harm (fei gong). This establishes a proactive, preventive ethical stance centered on collective welfare and security. The concept of impartial care in "universal love" translates into a responsibility to protect public safety, especially vulnerable groups, in engineering ethics. Regarding engineering responsibility, the Mohists proposed the normative principle of "Fa (standards) are followed by all" (Jing Shang), requiring technical standards to be publicly enforceable: "Intention, compass, and circle—all three together constitute a standard", meaning that a complete standard must include design intent, normative criteria, and implementation tools. This holistic view of standards, integrating purpose (yi), measurement (gui), and tool (ju), moves beyond mere compliance to embed ethical intent directly into technical specifications. This thought has evolved into the philosophy of "moralization of technology" in contemporary times, demanding that engineers embed safety redundancies in design.[8] For example, the "mechanically triggered trap" in Mohist defensive equipment included three interlocking safety mechanisms: (1) gravity-triggered device (intention); (2) directional limit slot (compass); (3) crossbow locking mechanism (circle). This multi-safety design has been inherited by modern elevator safety systems.

3.2 A Comparative Perspective: Mohist Ethics vs. Conventional Western Frameworks

To clarify the distinct pedagogical contribution of Mohist thought, it is instructive to contrast it with foundational pillars of Western engineering ethics. Conventional approaches often draw from deontological (duty-based) ethics, which emphasizes adherence to universal rules and professional duties such as the NSPE Code of Ethics, and while crucial for establishing baseline professional conduct, it can sometimes be applied in a legalistic, compliance-oriented manner focused on individual responsibility; utilitarian (consequentialist) ethics,

which judges actions based on the net balance of benefits over harms for the greatest number and is central to risk-benefit analysis and cost-benefit calculations in engineering projects, though it can struggle with protecting minority rights and may justify harm to a few if the aggregate benefit is large enough; and rights-based ethics, which focuses on protecting the fundamental rights of individuals such as safety, privacy, and autonomy, a concern strongly reflected in modern product liability and safety regulations. The Mohist framework offers a complementary and distinct orientation that addresses potential gaps in these models. First, it shifts from retrospective analysis to proactive care: while Western frameworks are often applied to analyze ethical dilemmas post hoc or during design review, Mohist "universal love" (jian ai) instills a proactive, affirmative duty to care for and benefit all people, especially the vulnerable, moving the ethical mindset from "avoiding violation" to "actively promoting welfare." Second, it moves from individual rights to collective flourishing, as Mohist ethics is fundamentally communitarian, with the core criterion "Gong (merit) is benefiting the people" prioritizing the welfare of the collective (li ren), which contrasts with and supplements the strong individualistic focus of rights-based ethics by training engineers to consider social cohesion and public good as primary design objectives. Third, it advocates a shift from calculated harm to absolute non-harm, where the principle of "non-aggression" (fei gong) presents a strong normative injunction against causing harm that can temper purely utilitarian calculations which might trade off harms to some for greater aggregate benefit, aligning with a precautionary principle in engineering design. Finally, it emphasizes integrating ethics into technical standard (Fa), as the Mohist conception of Fa as integrating intention, norm, and tool provides a model for teaching students to see ethical values not as external constraints but as intrinsic components of technical specifications and quality standards. This comparative analysis suggests that integrating Mohist ethics into pedagogy can cultivate engineers who naturally consider broad social welfare, adopt a preventive stance against harm, and view ethical values as inseparable from technical excellence, thereby complementing the analytical strengths of conventional Western approaches.

3.3 Practical Ethics: "Frugality and Valuing Worthiness"

Mohist engineering ethics emphasizes the unity of resource conservation and technological inclusiveness. The thought of "frugality" advocates "eliminating unnecessary expenses", opposing extravagance and emphasizing the rational use and efficient allocation of resources—essentially consistent with modern resource conservation concepts. In terms of technological governance, the Mohist thought of "valuing worthiness" (Mozi Shang Xian Shang) advocated breaking class solidification: "Officials are not permanently noble; the people are not permanently humble", emphasizing that engineering decisions should rely on professional judgment. In contemporary practice, this is reflected in an engineering decision-making mechanism where major projects undergo ethical review by independent expert committees; a talent training mechanism establishing a "revolving door" system to promote talent flow between industry, academia, and research; and an accountability mechanism based on the thought of "respecting ghosts" to establish an immutable engineering responsibility chain.[9]

3.4 The Engineering Verification System: The "Three Standards Method"

As an important epistemological tool in ancient Chinese philosophy, Mozi's "Three Standards Method" has a profound connection with modern engineering verification systems. "Ben zhi zhe (examining the root)" emphasizes "taking as the basis the deeds of ancient sage-kings" (Mozi Fei Ming Shang). This emphasis on historical experience is closely linked to the "historical data analysis method" in modern engineering verification, where engineers study the successes and failures of past engineering cases to inform current designs and avoid potential risks. "Yuan zhi zhe (investigating the source)" advocates "examining the actual perceptions of the people" (Mozi Fei Ming Shang), coinciding with modern engineering processes such as field surveys and experimental testing, which collect objective data and practical feedback to ensure the feasibility of engineering schemes. "Yong zhi zhe (applying the standard)" proposes "implementing it as laws and policies to observe its benefit to the state, the people, and the people" (Mozi Fei Ming Shang), aligning with modern social impact assessments and sustainability evaluations in engineering, which consider the comprehensive benefits of projects for society, the environment, and people's livelihood. Clearly, the

verification framework constructed by Mozi's "Three Standards Method" provides timeless wisdom and a theoretical prototype for modern engineering verification.[10]

4. Mohist Enlightenment for Engineering Education Models

4.1 Reshaping the Educational Concept: "Cultivating Virtue and Mastering Skills"

The Mohists proposed a three-dimensional competency framework for engineering talents: "cultivating virtue, being proficient in discourse, and mastering diverse skills" (Mozi Shang Xian), providing a model for modern engineering education, as shown in Table 1:

Table 1. Three-Dimensional Training Framework for Engineering Education

Mohist Dimension	Modern Transformation	Educational Practice
Cultivating Virtue (Hou De)	Engineering Ethics Literacy	Integrate "grand engineering perspective" ethics courses, emphasizing the responsibility to protect vulnerable groups based on "universal love".
Proficiency in Discourse (Bian Yan)	Systematic Communication Skills	Add verbal practice sessions such as technical communication and project defense to cultivate engineering decision-making abilities based on rational persuasion.
Mastering Diverse Skills (Bo Shu)	Interdisciplinary Technology Integration	Establish project-based learning to simulate the interdisciplinary collaboration (mechanics/optics/mechanical engineering) in Mohist city defense projects.

This educational policy of "cultivating virtue and mastering skills, integrating knowledge and action, and developing both morality and technical competence" is applicable to addressing the current separation of technical rationality and humanistic literacy in engineering education. In terms of teaching methods, the Mohists opposed the Confucian passive education model of "responding only when questioned" and advocated proactive education of "speaking even when not questioned" (Mozi Gong Meng). This "proactive teaching" model is

particularly crucial for engineering education, as it shoulders the mission of cultivating urgently needed engineering and technological talents for the country, enabling them to realize their life values through creating social wealth.[11] Indeed, the mission of engineering education aligns with Mozi's goal of cultivating "impartial scholars" who are "virtuous, articulate, and skilled" (Shang Xian).

4.2 The Trinity Practical System: "Experiment-Inheritance-Innovation"

The Mohist school established the earliest engineering practice education system in China and even the world, characterized by three core features. First, it developed an experimental methodology system by elevating craftsman experience to scientific theory: through the process of "mastering craftsmanship and seeking principles", they deconstructed skills such as "wheelwrights carving wheels" into teachable principles, with their optical experiments verifying the rectilinear propagation of light by controlling variables like pinhole shape, light source distance, and imaging medium, thereby establishing the earliest systematic experimental method in ancient times.[12] Second, it implemented an engineering inheritance mechanism, as Mozi advocated that "those who can debate should debate; those who can explain classics should explain classics; those who can engage in practical work should engage in practical work," whereby "debaters" specialized in logic and lobbying for political office, "classic explainers" inherited texts and disseminated theories, and "practical workers" focused on engineering and technology (Mozi Geng Zhu), a structure resembling the modern university's classified training model of "research-oriented-applied-comprehensive" talents that emphasizes organic collaboration. Third, it cultivated an innovation culture by opposing the Confucian conservative thought of "trusting and admiring the ancient", with Mozi proposing that "those who are good today should create, striving to increase goodness" (Mozi Geng Zhu), which encouraged innovative breakthroughs based on tradition, as seen when Mohist disciples invented kites (wooden kites) for military reconnaissance and improved continuous crossbows to enhance shooting accuracy, thereby embodying a virtuous cycle of "inheritance-innovation". Modern engineering education can draw on this model to construct a three-level training platform of "traditional craft workshops-modern engineering

laboratories-industrial innovation centers", realizing the creative transformation of traditional wisdom.

4.3 Modern Interpretation of Craftsmanship Spirit

The core of Mohist craftsmanship spirit lies in the unity of four dimensions: standards (yi), skill (qiao), benefit (li), and righteousness (yi). Adherence to standards (fa yi) establishes a sense of normativity where "all craftsmen work according to rules", while the pursuit of skill emphasizes "exquisiteness", achieving precise tolerance control in the design of crossbow triggers. The insistence on benefit entails "benefiting the people", as seen in inventing pulley hoisting systems to reduce the labor intensity of civilian workers, and the upholding of righteousness involves refusing to provide siege weapons for unjust wars.[13] This spirit remains worthy of inheritance and promotion in modern engineering education, for example, by integrating a "craftsmanship spirit" module into the Engineering Ethics course, including "benefiting the people and being practical" in graduation project evaluation indicators, and establishing a "Mohist Craftsmanship Award" to recognize engineers with both technological innovation and social responsibility.

5. Modern Transformation in the Digital Age

5.1 Mohist Solutions for Algorithmic Ethics

Facing the ethical challenges of artificial intelligence, Mohist thought demonstrates remarkable adaptability. In terms of data fairness mechanisms, the EU's Artificial Intelligence Act requires algorithms to mandatorily learn corpora of data from vulnerable groups, embodying the Mohist principle of "universal love". In terms of resource allocation ethics, computing power scheduling systems based on the principle of "the strong not oppressing the weak" prevent leading enterprises from monopolizing computing resources. In terms of accountability mechanisms, an immutable algorithmic decision chain is established with reference to the thought of "respecting ghosts" enabling accurate attribution of autonomous driving accidents.[14]

5.2 Cybersecurity and Green Computing

The Mohist thought of "non-aggression" emphasizes opposing aggressive wars and advocating peaceful coexistence, which aligns with the concept of resisting malicious attacks and maintaining peace and stability in cyberspace in the field of cybersecurity. In the virtual online world, malicious acts such as hacking and data theft are like aggressive wars in reality, undermining the harmony and security of the network ecosystem. Practicing the thought of "non-aggression" means constructing defensive systems, preventing cyberattacks, advocating self-discipline and restraint in online behavior, and jointly creating a safe environment free from "cyber warfare".

The Mohist thought of frugality advocates the rational use of resources and avoiding waste, which is highly consistent with the goal of green computing to efficiently utilize computing resources and reduce energy consumption. With the rapid development of information technology, problems such as high energy consumption in data centers and idle resources in electronic devices have become increasingly prominent. The thought of frugality reminds us to achieve precise allocation and efficient use of computing resources through optimizing algorithms, upgrading hardware, and innovating architectures, reducing energy consumption and electronic waste, and promoting the harmonious coexistence of digital technology development and environmental protection to advance the practice and popularization of green computing.

5.3 Transformation of Engineering Organizational Forms

The Mohist thought of "shang tong (agreeing with the superior)" advocates social collaboration through a hierarchical consensus mechanism, sharing a profound underlying logic with decentralized organizational forms in the digital age. Based on the premise of "selecting the worthy and establishing leaders", "shang tong" constructs a path of value unification where "what the superior affirms, all must affirm; what the superior denies, all must deny", with its core lying in integrating scattered wills through virtuous authority to

form order for collective action.[15] Decentralized organizations, on the other hand, rely on technologies such as blockchain and smart contracts to dissolve traditional centralized authority, realizing equal collaboration among nodes through distributed ledgers and consensus algorithms. Although seemingly opposing, the two share the goals of "order construction" and "consensus achievement": the former maintains social consensus through hierarchical moral authority, while the latter replaces human authority with technical rules to achieve automatic trust and collaboration among nodes. The "universality" emphasized by "shang tong" intertexts with the "protocol-based" governance of decentralized networks, both striving to establish a stable collaboration framework among diverse subjects. This alignment reveals the convergent paths of traditional governance wisdom and modern technical rationality in pursuing group collaboration efficiency and order stability.

6. Conclusion

Mohist thought provides a philosophical foundation and practical wisdom for modern engineering education. At the level of engineering philosophy, its ontology of "achieving results through causes", systems view of "parts divided from the whole", design epistemology of "imminent reality", and axiology of "benefiting the people and being practical" together constitute the earliest complete engineering philosophy system in China and even the world. This system emphasizes the normative value of "standards" while affirming the innovative spirit of "mastering craftsmanship and seeking principles", offering oriental wisdom for addressing technological alienation. In the field of engineering education, the Mohists constructed a trinity educational paradigm of "cultivating virtue and mastering skills-proactive teaching-experimental innovation": their talent standard of "cultivating virtue and mastering skills" directly addresses the current imbalance between technical rationality and humanistic values in engineering education; the proactive educational concept of "speaking even when not questioned" provides methodological guidance for engineering education; and the technology inheritance model of "mastering craftsmanship and seeking principles" transcends the traditional master-apprentice system, establishing a complete cycle of theory-practice-innovation.

The creative transformation of Mohist thought in the digital age holds profound significance. From the "Three Standards Method" as an algorithmic verification framework to the "non-aggression" cybersecurity paradigm and the "frugality" green computing revolution, Mohist thought is participating in the construction of the underlying logic of digital civilization as a philosophy of technology. This transformation is not a simple appropriation of cultural symbols but a deep ideological resonance in dimensions such as technological ethics, organizational forms, and engineering methods.

Promoting the modern transformation of Mohist engineering thought requires constructing an implementation path of "two creations and three integrations": Specifically, this involves creative transformation through establishing a Mohist engineering case database and developing an interdisciplinary course on Mohist Wisdom in Engineering; innovative development by integrating "universal love" ethics into AI design guidelines and embedding the "Three Standards Method" into algorithmic review processes; educational integration by adding a Mohist humanistic course module in "new engineering" education; industry-academia-research integration through establishing "Mohist Craftsmanship Innovation Laboratories" to connect traditional crafts with modern engineering; and international integration by applying Mohist ecological wisdom in "Belt and Road" engineering projects.[16]

As Mozi stated: "That which benefits people is called skilled; that which harms people is called clumsy" (Mozi Lu Wen). In an era where technology profoundly reshapes human destiny, reinterpreting the essence of Mohist thought is not only about the paradigm innovation of engineering education but also bears the civilizational mission of constructing "technology for good". This ideological dialogue spanning 2,500 years will help Chinese engineering education embark on a distinctive development path integrating engineering and technological spirit with humanistic care, contributing oriental wisdom to global engineering education reform.

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