Scilight

Sustainable Engineering Novit
https://www.sciltp.com/journals/sen

Opinion

Chen-Ning Yang: A Legacy of Sustainable Scientific Development and Global Cooperation †

Zhan Zhang

School of Chemistry and Materials, Yangzhou University, 225009 Yangzhou, China; zhanzhang@yzu.edu.cn

† In memoriam: Chen-Ning Yang (1922–2025), whose vision for a sustainable future continues to inspire.

How To Cite: Zhang, Z. Chen-Ning Yang: A Legacy of Sustainable Scientific Development and Global Cooperation. *Sustainable Engineering Novit* **2025**, *1*(1), 8. https://doi.org/10.53941/sen.2025.100008

Received: 12 November 2025
Revised: 4 December 2025
Accepted: 26 December 2025
Published: 31 December 2025

Abstract: Chen-Ning Yang (1922–2025), a Nobel laureate in physics and one of the most influential scientists of the 20th century, left an indelible mark not only on theoretical physics but also on the sustainable development of science, education, and cross-cultural collaboration. His contributions to "sustainable engineering" extend beyond conventional environmental definitions, encompassing the long-term strengthening of scientific infrastructure, the nurturing of talent, and the fostering of global partnerships that endure across generations. This article honors his legacy by exploring four key dimensions of his work: scientific foundations for sustainability, institutional building, talent cultivation, and science-driven economic strategies.

Keywords: sustainable scientific foundation; institutional building; talent cultivation; science-driven economic strategy

1. Scientific Contributions with Lasting Impact

Yang's groundbreaking work provided the theoretical underpinnings for advancements in physics [1,2], which later enabled technologies critical to sustainable development [3,4]. His research exemplifies how fundamental science can drive long-term innovation.

Yang-Mills Gauge Theory: Proposed with Robert Mills in 1954, this theory became a cornerstone of the Standard Model of particle physics, unifying the electromagnetic, weak, and strong nuclear forces. Its mathematical framework inspired developments in quantum field theory and condensed matter physics, indirectly supporting future energy technologies (e.g., nuclear fusion and particle accelerators). Moreover, this theory serves as a foundational pillar for a wide range of modern technologies, from core medical imaging modalities like MRI to the semiconductor fabrication processes that are integral to all modern electronics [5].

Parity Non-Conservation: In 1956, Yang and Tsung-Dao Lee theorized that weak nuclear forces violate parity symmetry, overturning a fundamental assumption in physics. This earned them the 1957 Nobel Prize and paved the way for experiments probing matter-antimatter asymmetry, relevant to understanding cosmic evolution and nuclear energy.

Yang-Baxter Equation: This work in quantum integrable systems influenced statistical mechanics and mathematics, providing tools to model complex many-body problems. Such models are now applied in material science and quantum computing-fields pivotal to sustainable engineering. For example, future applications of liquid-nitrogen-temperature superconductors (e.g., YBCO)—including lossless power grids, highly efficient maglev trains (reducing energy consumption by more than 90%), and medical superconducting magnets—are heavily dependent on the understanding derived from this equation, which is central to analyzing their superconducting mechanisms [5].

Yang often described these achievements as part of a broader "humanity's understanding of nature" [3,6], emphasizing that foundational science is the bedrock of future technologies [7].

2. Building Sustainable Scientific Institutions

Yang dedicated his later years to creating and strengthening research institutions in China [8–10], ensuring their longevity through strategic vision and advocacy. Though his early decision to take American citizenship for the sake of scientific breakthroughs was misunderstood by many, even by his father [11], it remains un undeniable face that dedicated his later years to serving his country through science across national borders.

Tsinghua University Institute for Advanced Study (1997–2025) [9]: As honorary director, Yang modeled the center after Princeton's Institute for Advanced Study, emphasizing autonomy, interdisciplinary collaboration, and long-term basic research. He personally donated $4 million as seed funding and advocated for policies to attract top global scholars, including Turing Award winner Andrew Chi-Chih Yao.

Bridging U.S.-China Scientific Exchange [9]: In 1971, amid diplomatic thaw, Yang became the first prominent scholar to visit China, initiating academic exchanges that later benefited fields from physics to environmental science. He established the Committee for Educational Exchange with China (1980), funding nearly 100 Chinese researchers for overseas training. These efforts laid groundwork for Sino-global collaborations on shared challenges like climate change.

Advocacy for Basic Research Infrastructure [10]: Yang consistently urged Chinese leaders to invest in large-scale projects. In the 1990s, he championed free-electron laser facilities, arguing they would enable breakthroughs in energy and material science. His persistence contributed to Shanghai's Soft X-Ray Free-Electron Laser, operational by 2017.

His approach-prioritizing "ecosystems over individual projects"-ensured institutions outlived their founders.

3. Cultivating Talent for Future Generations

Yang viewed talent development as the core of sustainability, stating, "I shall be a pine tree pointing the way for aspiring students" [9]. His methods included hands-on mentorship in Tsinghua, identifying and supporting brilliance and inspiring national confidence.

Hands-On Mentorship: At 82, he taught introductory physics at Tsinghua, emphasizing "steadfastness over cleverness, simplicity over flashiness (宁拙毋巧,宁朴毋华)". To uphold this 'clumsiness' was to embrace a spirit of science and reject empty ornament in favor of substance. His scientific attitude embodied reverence for truth and steadfast commitment to integrity. His lectures stressed critical thinking over rote learning, shaping a generation of innovators.

Identifying and Supporting Brilliance: He played a key role in recruiting leading scientists like physicist Shou-Cheng Zhang and cryptographer Xiaoyun Wang to Tsinghua. He also donated his Tsinghua salary to the fund (Foundation of Institute for Advanced Study, Tsinghua University) for young scholars [12,13].

Inspiring National Confidence: Yang believed his greatest contribution was "boosting Chinese self-confidence" [1,12]. In a 1995 interview with Radio Television Hong Kong, Yang remarked: "If Mr. Tseng were to ask me today what I consider the most important contribution of my life, I would say it is helping to change the mindset among Chinese people that they are somehow inferior to others. I believe my scientific achievements have helped boost Chinese confidence—and that, perhaps, is my life's most important contribution." [13] As a Chinese scientist, Yang has not only made groundbreaking contributions to the development of physical science, but also significantly bolstered Chinese national confidence. Being the first Chinese Nobel laureate in Physics, he not only established a distinct Chinese presence on the global scientific stage, but also reshaped the Western world's perception of China. By demonstrating global scientific excellence, he motivated countless students to pursue research addressing local and global sustainability.

4. Science-Economic Strategies for Sustainable Growth

Yang's insights into science-economy interactions helped shape China's transition toward knowledge-driven development [14].

Early Advocacy for Institutional Innovation: In the 1970s–1980s, he advised Chinese leaders to prioritize institutional reforms and market openness alongside technological adoption [10]. This aligned with later policies that spurred green technology sectors.

Balancing Basic and Applied Research: He consistently maintained that basic scientific research holds long-term strategic significance, yet its investment priorities must be aligned with the nation's developmental stage. Throughout the 1980s, he emphasized that China needed to prioritize applied research to address pressing issues like poverty alleviation, rather than indiscriminately pursuing energy-intensive fundamental disciplines such as high-energy physics [15]. In 2018, he criticized that short-term applied focus could undermine the sustainability of basic research, and advocated for enhanced investment in basic science. In the meantime, he proposed raising China's basic research funding from 5% to 15% of total R&D budgets [8,16], a shift crucial for long-term sustainability.

Cultural Resilience as a Foundation: In his 2004 speech "The Resilience of Chinese Culture", Yang argued that traditional "people-centric values" and the Communist Party's organizational strength were key to China's rise. This cultural endurance, he contended, underpins sustained scientific progress.

5. Conclusions: A Vision Beyond His Time

Chen-Ning Yang's legacy in sustainable engineering is not defined by a single policy or invention but by a holistic philosophy integrating science, education, and cross-cultural dialogue. He demonstrated that sustainability requires:

1. Deep investment in basic science as a catalyst for future technologies.
2. Resilient institutions that nurture talent and collaboration.
3. Global bridges to address universal challenges.

His maxim—"Better to be steadfast than clever, better to be simple than flashy"—encapsulates the ethos needed for meaningful, lasting contributions. As the world grapples with climate change and resource scarcity, Yang's model of fusing scientific excellence with humanistic values remains a guiding light.

Funding

This research was funded by Jiangsu Shuangchuang Project (No. (2020) 30974) and Lvyangjinfeng Talent Program of Yangzhou (No. YZLYJF2020PHD110).

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

References

1. Accumulation of Character Materials: What Has Dr. Chen-Ning Yang Left Us? Available online: https://it.sohu.com/a/945805483_273163 (accessed on 20 October 2025).
2. A Profile of Dr. Chen-Ning Yang. Available online: https://www.xinhuanet.com/politics/20251018/5d7064c773a547909d0ae84cc1e48491/c.html (accessed on 18 October 2025).
3. Yang, C.-N. Beauty and physics. *Knowl. Is Power* **2001**, *8,* 18–19.
4. Cao, K.; Yuan, G.; Liu, M.; et al. Organoselenium catalyzed reaction: Sustainable chemistry from laboratory to industry. *Sustain. Eng. Novit* **2025**, *1*, 1.
5. The Contributions of Chen-Ning Yang: From Nobel-Winning Theory to Daily Life-His Work Powers MRI and Quantum Computers, Benefiting Us. Available online: https://baijiahao.baidu.com/s?id=1846751505243815792&wfr=spider&for=pc (accessed on 23 October 2025).
6. Yang, C.-N. Beauty in Science and Art: Similarities and Differences. Keynote Speech at Academic forum, National Art Museum of China, Beijing, China, 18 April 2015.
7. Full Transcript of Chen-Ning Yang's Lecture at the University of Chinese Academy of Sciences. Available online: https://blog.csdn.net/qingwufeiyang12346/article/details/97924604 (accessed on 31 July 2019).
8. Zou, W. Chen-Ning Yang's thought of science-economy and China's science and technology innovation. *J. Dialectics Nat.* **2021**, *43*, 108–113.
9. Mourning the Loss and Remembering Dr. Chen-Ning Yang. Available online: https://www.tsinghua.edu.cn/info/1173/121840.htm (accessed on 18 October 2025).
10. Qu, J. Chen-Ning Yang on "tenacity": The cause of China's rise. *Tech. Dig.* **2004**, *7*, 2.
11. Sutton, C. Chen-Ning Yang obituary: Intuitive physicist whose work was inspired by the beauty of symmetry. *Nature* **2025**, *647*, 32.
12. The Life of Professor Chen-Ning Yang. Available online: https://www.phys.tsinghua.edu.cn/info/1269/6566.htm (accessed on 18 October 2025).
13. Yang, Z.N. *1995 Interview with Radio Television Hong Kong*; Shuguang Ji (Dawn collection) (Rev. ed., 2018); SDX Joint Publishing Company: Beijing, China, 2018.

14. Beyond Money: The Path of Philanthropy of Scientist Chen-Ning Yang. Available online: https://baijiahao.baidu.com/s?id=1846461129824423523&wfr=spider&for=pc (accessed on 20 October 2025).
15. Huang, Q. The Debate between Tsung-Dao Lee and Chen-Ning Yang Regarding the Relationship between Basic and Applied Science Retains Its Enduring Relevance and Remains as Timely as Ever. Available online: https://news.ifeng.com/c/8bsL15mx5yx (accessed on 8 August 2024).
16. Why Was Chen-Ning Yang So Great? A Scientific Legacy That Lights the Path Forward. Available online: https://news.china.com/socialgd/10000169/20251024/48932433_all.html (accessed on 24 October 2025).