Engineering 7 (2021) 1651–1652

Contents lists available at ScienceDirect

Engineering

journal homepage: www.elsevier.com/locate/eng

Editorial

Global Top Ten Engineering Achievements 2021

Junzhi Cui

Chinese Academy of Engineering, Beijing 100088, China

Engineering is a direct productive force for mankind to change the world. Throughout the ages, mankind has created countless amazing engineering achievements, promoting profound changes in the whole society and pushing human civilization to a new higher stage [1].

To motivate engineering progress and innovation and draw global attention to engineering science and technology, the journal *Engineering* organized and launched the selection of Global Top Ten Engineering Achievements in 2021. The chosen achievements are major engineering projects or significant engineering and technological breakthroughs with global influence that have been completed in the past five years and verified by practice. Moreover, they can represent the highest level of engineering science and technology in one or more fields and lead to future development.

On behalf of *Engineering*, Jianfeng Chen, the executive editor-in-chief of *Engineering* and secretary-general of the Chinese Academy of Engineering, presented the Global Top Ten Engineering Achievements 2021 on December 14, 2021.

1. AlphaGo and AlphaFold

In 2016, the AlphaGo computer program defeated a 9-dan professional in the board game Go for the first time. In 2018, the AlphaFold program produced highly accurate three-dimensional protein structures from protein sequences. Driven by massive data, advanced algorithms, immense computing power, and domain-specific knowledge, the traditional artificial intelligence is heading toward a new generation of artificial intelligence (AI). AI is enabling technology to empower our society [2,3].

2. The Development and Application of CRISPR/Cas9 Gene Editing

The two scientists who developed the clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR-associated protein 9 (Cas9) gene editing technology received the Nobel Prize in Chemistry in 2020. Working like genetic scissors, this technology allows extremely precise and efficient genome editing. The CRISPR/Cas9 gene editing technology has revolutionized molecular biology and holds profound potential for gene and tumor therapy, gene screening and detection, and the breeding and genetic modification of animals and plants [4].

3. Extreme Ultraviolet Lithography Systems

Extreme ultraviolet lithography systems use high-energy ultraviolet light with a wavelength of 13.5 nm to reduce the dimensions of process nodes during transistor manufacturing to 7, 5, or even 3 nm. In 2019, the Dutch company ASML announced its new-generation lithography system, which represents the most advanced fifth-generation lithography system. This system can extend the physical limits of Moore's Law [5].

4. Fifth-Generation (5G) Mobile Communication Technology

The first version of the 5G technical specifications was "frozen" in 2018, and was then commercially deployed in 2019. Owing to its advanced features, which include a high data rate, low delay, and massive connection density, 5G has the capability to support three typical applications, namely, enhanced mobile broadband, ultra-reliable low latency communication, and massive machine-type communication. 5G will realize the interconnectivity of humans, machines, and things, greatly accelerating the digital transformation of human society [6].

5. Five-Hundred-Meter Aperture Spherical Radio Telescope

The five-hundred-meter aperture spherical radio telescope, also known by the acronym FAST, became operational in 2020 as the world's largest and most sensitive filled-aperture radio telescope. FAST is located in a karst depression in Southwest China. Its spherical active reflector has a diameter of 500 m and is made of thousands of panels. FAST moves with high precision via a lightweight feed cabin that is driven by large-span flexible cables. FAST enables the expanded exploration of the universe [7].

6. Hybrid Rice

Heterotic rice hybrids with high yield, disease resistance, and good quality have been developed by using male sterile lines as a genetic tool. In 2020, the third generation of hybrid rice developed

https://doi.org/10.1016/j.eng.2021.11.001

by Chinese scientists set a new record, with an annual yield of 22 961.4 kg per hectare of double-cropped rice. The successful development and large-scale promotion of hybrid rice is a great breakthrough in crop science and technology, and provides an important foundation for global food security [8].

7. The InSight Mars Lander

In a geophysical mission on Mars by the United States, the InSight Mars lander successfully touched down on the surface of Mars late in 2018. InSight was the first lander dedicated to exploring the interior structure and processes of Mars. The cutting-edge instruments carried by InSight were designed to comprehensively delve into the structures of the Martian crust, mantle, and core, with the aim of uncovering the formation and evolution of Mars, as well as its current tectonic activity. The successful InSight mission opened up a new era of human investigation of terrestrial planets [9].

8. Public Health Epidemic Prevention and Control during the Fight against COVID-19

Active countermeasures continue to be enacted on a global scale to prevent the spread of the coronavirus disease 2019 (COVID-19) pandemic. Many countries, including China, New Zealand, and the Republic of Korea, are using science-based strategies to prevent and control COVID-19, including large-scale nucleic-acid-based testing, contact tracing using big data, and health code identification. These approaches enable the rapid detection, isolation, reporting, and treatment of cases, along with differentiated, graded, and targeted prevention and control. These countermeasures aid in the resumption of work and manufacturing by effectively controlling the large-scale spread of the virus causing COVID-19 [10].

9. The Three Gorges Hydroelectric Power Station

The Three Gorges Project was completed in 2020 after more than two decades of construction. It is the world's largest hydraulic complex, with over 20 world-leading economic and technical indicators. The Three Gorges Project is a multi-purpose project with major functions that include flood control, electricity generation, navigation, and water supply. It brings huge socioeconomic and ecological benefits through energy conservation and emission reductions [11].

10. The Ultra-High-Voltage Transmission Project

Ultra-high-voltage transmission is the most efficient and economical mode of long-distance transmission, with advantages that include low transmission loss and the extensive utilization of transmission corridors. The first 1000 kV ultra-high-voltage alternating-current transmission project in China became operational in 2009. In 2019, the world's first ±1100 kV ultra-high-voltage direct-current transmission project began operating in China, along with the world's largest ultra-high-voltage transmission network. This technology has allowed China to achieve large-scale and cross-regional optimal allocation of energy [12].

The selection of Global Top Ten Engineering Achievements 2021 has attracted participation of engineers and technicians worldwide. The election procedures include global call for nominations, recommendations by domain experts, public questionnaire survey, and final determination by the Selection Committee.

This selection follows three principles of independence, objectivity, and scientificity, and the shortlisted Global Top Ten Engineering Achievements reflect three characteristics: First, they have made original breakthroughs in core science or technology or solved long-standing bottlenecks or difficulties, and they have remarkable competitiveness and reached world's leading level in terms of individual or multiple scientific and technical indicators. Second, they have distinctive advancements in technology integration, system integration, and engineering safety, precision, and sustainability, or they have made outstanding innovations in the allocation of resources and the organization and management of major projects. Third, they have achieved remarkable economic and social benefits in driving industrial development, promoted high-quality economic and social progress, and raised the level of human's understanding and transformation of the objective world.

Engineering plans to organize the selection of Global Top Ten Engineering Achievements annually and publish the list to the world.

In the end, I would like to extend my warmest congratulations to the scientists and engineers who have made significant contributions to the research and development, construction, and operation and maintenance of the top ten achievements. It is your remarkable dedication that created the greatest projects and promoted economic and social development. I sincerely thank the experts, scholars, scientists, and engineers from China and abroad for their support in the selection of the Global Top Ten Engineering Achievements, and thank the colleagues from the evaluation group and the Selection Committee.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.eng.2021.11.001.

References

[1] Xi J. Let engineering science and technology create a better future for humankind. Engineering 2015;1(1):1–3.
[2] Silver D, Huang A, Maddison CJ, Guez A, Sifre L, van den Driessche G, et al. Mastering the game of Go with deep neural networks and tree search. Nature 2016;529:484–9.
[3] Jumper J, Evans R, Pritzel A, Green T, Figurnov M, Ronneberger O, et al. Highly accurate protein structure prediction with AlphaFold. Nature 2021;596:583–9.
[4] Hille F, Richter H, Wong SP, Bratovič M, Ressel S, Charpentier E. The biology of CRISPER-Cas: backward and forward. Cell 2018;172(6):1239–59.
[5] Pirati A, Peeters R, Smith D, Lok S, van Noordenburg M, van Es P. EUV lithography performance for manufacturing: status and outlook. In: Proceedings of SPIE Advanced Lithography VII; 2016 Feb 21–25; San Jose, CA, USA. SPIE; 2016.
[6] Carlson EK. What will 5G brings? Engineering 2020;6(7):725–7.
[7] Gibney E. Gigantic Chinese telescope opens to astronomers worldwide. Nature 2019;574:16–7.
[8] He Q, Deng H, Sun P, Zhang W, Shu F, Xing J, et al. Hybrid rice. Engineering 2020;6(9):967–73.
[9] Knapmeyer-Endrun B, Panning MP, Bissig F, Joshi R, Khan A, Kim D, et al. Thickness and structure of the Martian crust from InSight seismic data. Science 2021;373(6553):438–43.
[10] Xu C, Dong Y, Yu X, Wang H, Tsamlag L, Zhang S, et al. Estimation of reproduction numbers of COVID-19 in typical countries and epidemic trends under different prevention and control scenarios. Front Med 2020;14(5):613–22.
[11] Three Gorges Dam: the world's largest hydroelectric plant [Internet]. Denver: US Geological Survey (USGS); [cited 2021 Sep 1]. Available from: https://www.usgs.gov/special-topic/water-science-school/science/three-gorges-dam-worlds-largest-hydroelectric-plant?qt-science_center_objects=0#qt-science_center_objects.
[12] Li Y. West–east power line reaches "milestone" [Internet]. Beijing: Chinanews; 2020 Oct 28 [cited 2021 Sep 1]. Available from: http://www.ecns.cn/business/2020-10-28/detail-ihacfvrp0929356.shtml.