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Editorial

Global Top Ten Engineering Achivements 2023

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Engineering benefits humanity, and technology creates the future. Linking scientific discoveries, technological inventions, and industrial innovation, engineering technology is an important driving force for economic and social development and a key support for addressing global risks and challenges. Today, in the early 21st century, a new round of technological revolution and industrial transformation is continuing to evolve, and engineering technology innovation has entered a dense and active cycle, especially in fields such as information technology, energy technology, biotechnology, advanced manufacturing, and space exploration. Groundbreaking achievements in engineering innovation are constantly emerging.

Engineering, the flagship journal of the Chinese Academy of Engineering, has taken on the mission of promoting the progress of, leading innovation in, and carrying forward the spirit of engineering science and technology. To display the major innovations that have been achieved in engineering science and technology, guide the attention of all sectors of the world to this field, and create an atmosphere of respect and admiration for engineering science and technology, *Engineering* and the Global Engineering Frontier Consulting Research Project Team of the Chinese Academy of Engineering have jointly organized and carried out the selection of the Global Top Ten Engineering Achievements annually since 2021 [1,2]. In the past two years, the selection of the Global Top Ten Engineering Achievements has attracted the enthusiastic participation of engineering and technology workers around the world, as well as widespread public attention.

The selection of the Global Top Ten Engineering Achievements 2023 was determined by the global collection of nominations, expert selection and recommendation, a public questionnaire, and deliberation by the Selection Committee. The shortlist for the Global Top Ten Engineering Achievements this year mainly comprises major achievements in engineering science and technology innovation that have been successfully and effectively implemented in the past five years (2018–2022) by engineering and technology workers individually or cooperatively from all over the world and that have global influence. These achievements take the forms of major engineering projects, key technical equipment, and key original innovations and breakthroughs in engineering science and technology.

The Global Top Ten Engineering Achievements 2023 have several characteristics: ① The achievements represent the most advanced technical level or major original breakthroughs in one or more fields of engineering science and technology and can lead the direction of future technological progress. The emergence of ChatGPT, for example, has aroused widespread concern around the world, making this product an epoch-making application of artificial intelligence (AI). ② Most of these achievements achieve the overall target through technology integration, system integration, and resource optimization, demonstrating remarkable innovation in system integration. For example, the world's first hydropower station with a single-unit capacity of one million kilowatts, Baihetan Hydropower Station in China, has complex geological conditions and a huge project scale, representing the highest level of hydropower technology development in the world today. ③ These achievements are generally associated with many related industries and have huge industrial and economic driving value (e.g., lithium-ion power batteries, unmanned aircraft, and robots); all have a wide range of application scenarios, show a trend of explosive growth in recent years, and have produced huge economic and social benefits.

On the occasion of the official release of the Global Top Ten Engineering Achievements 2023, we offer our warm congratulations to the scientists and engineers who have made significant contributions to the research and development, construction, and operation of the selected achievements! Your outstanding work has given rise to great projects and has promoted economic and social development and human progress. We greatly appreciate

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the support given to *Engineering* during the selection process from domestic and foreign experts, scholars, and engineers, and the colleagues from the selecting teams for each topic area; we also express our gratitude to the Selection Committee for the Global Top Ten Engineering Achievements of *Engineering*.

The Global Top Ten Engineering Achievements 2023 are presented below; the ranking is not in any particular order.

1. ChatGPT

ChatGPT is a chatbot product released by OpenAI on November 30, 2022. As a natural language generation neural network model based on an attentional learning mechanism, ChatGPT can realize text content synthesis, machine translation, automatic document abstracting, code generation, and other functions through a combination of self-supervised learning, supervised fine-tuning, and human-in-the-loop reinforcement learning. ChatGPT is one of the most successful products to date to empower AI through natural language interaction, providing a paradigm for the human achievement of general AI [3].

2. China's space station

In November 2022, the in-orbit assembly and construction of China's space station was completed after 11 launch missions. The main body of the space station is composed of three modules; with a total mass of 67.5 t in orbit and 122 m^3 of activity space for astronauts, the station can accommodate three-person long-term or six-person short-term residence. China's space station is equipped with four unique LT-100 high-power Hall thrusters to maintain orbit operation and adopts advanced regenerative life-support technology to realize the closed-loop utilization of resources. The completion and operation of China's space station will provide broader prospects and opportunities for human exploration and development of space [4,5].

3. The exascale supercomputer

On May 30, 2022, the supercomputer system Frontier, collaboratively built by Oak Ridge National Laboratory (ORNL) and Advanced Micro Devices (AMD), Inc., was named the world's fastest computer by the International Supercomputing Organization, at 1.1×10^{18} floating-point operations per second. As the first computer in the world that can exceed an exascale-per-second performance, Frontier opens up a new era of E-class computing and will provide more powerful computing tools for solving the world's toughest scientific challenges, such as accurate climate modeling, nuclear fusion simulation, and new material and drug development [6].

4. Baihetan Hydropower Station

On December 20, 2022, all units of Baihetan Hydropower Station, which is located in the lower main stream of the Jinsha River in China, went into operation to generate electricity. For the first time in the world, low-heat cement concrete was used to pour an entire 300 m super-high concrete double-curved arch dam for a power station. Containing 16 water turbine generating units, each with a capacity of one-million-kilowatt scale, Baihetan Hydropower Station leads the hydropower industry into a new era of the single-unit production of million-kilowatts scale. Together, the Baihetan Hydropower Station, the Three Gorges Project, the Gezhouba Project, Wudongde Hydropower Station, Xiluodu Hydropower Station, and Xiangjiaba Hydropower Station constitute the world's largest clean energy corridor, spanning 1800 km on the Yangtze River in China [7].

5. The Double Asteroid Redirection Test (DART)

On September 27, 2022, the US National Aeronautics and Space Administration (NASA) used the DART spacecraft, which has a total mass of 610 kg, to impact a smaller asteroid in a group of near-Earth double asteroid systems at a relative speed of 6.6 $km \cdot s^{-1}$ in space, 11 million kilometer away from the Earth, thereby shortening the orbital period of the small asteroid by 32 min. This was the first test mission to protect the Earth from the threat of asteroid impact; it successfully demonstrated the ability of humans to purposefully alter the orbital motion of celestial bodies [8].

6. The RTS,S/AS01 malaria vaccine

On October 6, 2021, the World Health Organization recommended widespread use of the RTS,S/AS01 malaria vaccine among children in some areas where the risk of malaria transmission is high. Developed by GSK plc (UK) and PATH Malaria Vaccine Initiative (MVI), RTS,S/AS01 is the first malaria vaccine to be approved for use worldwide. The vaccine innovatively fuses the C-terminal sequence of the *Plasmodium falciparum* circumsporozoite protein (CSP) with the surface antigen of the hepatitis B virus and is assembled into a subunit vaccine with a virus-like particle structure, greatly improving the immunogenicity. The RTS,S/AS01 malaria vaccine represents an important milestone in the fight against malaria [9].

7. The Harmony operating system (OS)

With a microkernel and scenario-oriented design, Huawei Technologies Co., Ltd., released a completely new distributed OS, Harmony OS, on August 9, 2019. Harmony OS applies a distributed architecture for a terminal OS for the first time to achieve a seamless cross-terminal collaborative experience for users. It also adopts a completely new microkernel design to reshape the trusted security of terminal devices and realizes cross-terminal ecological sharing with one-time development (supported by a unified integrated development environment (IDE)) and multi-terminal deployment. Harmony OS provides a solution for the interconnection of people, devices, and environments, and represents technological innovation for the era of all-scene wisdom [10].

8. The Spot and Atlas robots

In recent years, each new robot released by Boston Dynamics has had a strong visual and cognitive impact. The upgraded four-legged robot Spot, with a 360° obstacle avoidance function, can walk, run, climb, and so on in different terrains and environments. The new generation of the Atlas bipedal humanoid robot, with 28 degrees of freedom, can naturally and consistently complete jumping, tumbling, handstands, dancing, parkour, and other movements. The robots developed by Boston Dynamics represent the advanced level of current robot research and development, with broad industrial application prospects [11].

9. The lithium-ion power battery

With a lithium-ion embedded compound as the positive electrode material and carbon as the negative electrode material, the lithium-ion power battery has the advantages of high energy density, a long life, a light weight, and environmental friendliness. In recent years, the core technology of lithium-ion power batteries

has been continuously upgraded, with the energy density of the battery system reaching 255 $W \cdot h \cdot kg^{-1}$, the cycle life exceeding 5000 times, the thermal diffusion time increasing to more than 24 h, and the safety performance improving greatly. As a new energy storage technology, lithium-ion power batteries have been widely used in electric vehicles, electric bicycles, electric light vehicle, power tool, aerospace, and other fields [12].

10. Unmanned aircraft

Unmanned aircraft are unmanned aerial vehicles that are remotely operated by humans or controlled by autonomous programs and can perform a variety of tasks. In recent years, with the continuous breakthroughs in dynamic technology, hovering technology, navigation technology, human–computer interaction, clustering technology, and AI, unmanned aircraft have become increasingly intelligent, miniaturized, clustering, and systematic. DJI, Parrot, 3D Robotics, and other companies are taking the lead in global drone technology and industrial progress in this field. As highly flexible vehicles, unmanned aircraft have demonstrated great potential applications in military and civil fields [13].

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