The Institute of Technological Sciences

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The Institute of Technological Sciences (ITS) was founded by Wuhan University (WHU) in 2017 and is independent of but directly affiliated with the university. Professor Sheng Liu, the dean of the School of Power and Mechanical Engineering, is the executive director. The institute focuses on pervasive problems that are hindering technological progress, as outlined by the documents *Chinese National Science and Technology Major Projects*, the *Special Project for the Internet of Things,* and the *Guideline for the Promotion of the Development of the National Integrated Circuit Industry*. These challenges are: (1) multiphysics, multiscale modeling and simulation, and large-scale scientific computing; (2) the experimental verification of models and simulations in varying temporal and spatial scales; and (3) sensors for onboard diagnostics in high-end smart equipment that require the development of new functional materials.

The mission of the ITS

The scientific research at the ITS is cross-disciplinary and based on the engineering disciplines of WHU. The institute's mission is to contribute to academics and industry in China by developing innovative and disruptive technologies and intellectual property, attracting a new pool of talent to introduce new ideas and techniques to the ITS engineering community, and helping companies to be technologically competitive (Figures 1 and 2). The institute's major areas of focus are advanced manufacturing, alternative energy sources, advanced materials, and aerospace engineering (Figure 3).

The ITS offers a unique scientific research platform that appeals to world-class scholars, researchers, and young talents who do not fit the profile of a traditional engineering major, yet are outstanding in their academic fields. The institute has attracted a group of experts, most of whom have doctoral degrees from internationally renowned universities such as Stanford and Tsinghua. Some are members of the Chinese Academy of Engineering, some are professors from the Ministry of Education's Changjiang Scholars program, and others are from the National Outstanding Young Scientists, 1,000 Talents, and 1,000 Young Talents programs. One expert is a National Natural Science Foundation of China (NFSC)/White House Presidential Faculty Fellow.

The ITS has a flexible policy for recruiting talent, educating undergraduate students, and developing its disciplines to cultivate graduate students with cross-disciplinary capabilities. One way the institute is establishing the university's reputation in engineering is through its "development zone" for emerging disciplines, which is advancing the frontiers of technology and engineering in critical scientific areas. The ITS has also established the "School of Hong Yi," a special class comprising students with the highest entrance examination scores in significant engineering fields, such as advanced manufacturing.

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FIGURE 1. The 2018 International Interdisciplinary Forum.

FIGURE 2. The 2018 Institute of Technological Sciences (ITS) Summer Camp

The development goals of the ITS

The ITS is continually improving its staffing, facilities, and reputation. Among its development goals for 2021 are to recruit 30–60 outstanding principal investigators; to achieve breakthroughs in fundamental research and applied sciences; to win national and international awards for the invention of new technologies; and to launch well-equipped research facilities and a scientific computing platform.

Discipline orientation

The ITS's principal research areas are described below, followed by their subspecialties. Each research area is cross-disciplinary and integrates some combination of chemistry, physics, mechanics, electronic information, automation, computer technology, and materials science.

1. Advanced manufacturing:

- **Electronic manufacturing**—the production of semiconductor-based electronics, flexible electronics, and femtosecond laser-based micro–nano devices, including microelectromechanical systems (MEMS), packaging materials, and processes;
- **Intelligent manufacturing**—the integrated design, production, and testing of smart equipment for the "Internet of Things";
- **Robotics**—especially the development of novel sensors and other critical technologies for service and industry;
- **3D printing**—especially the generation of high-precision printing equipment and new printable materials.

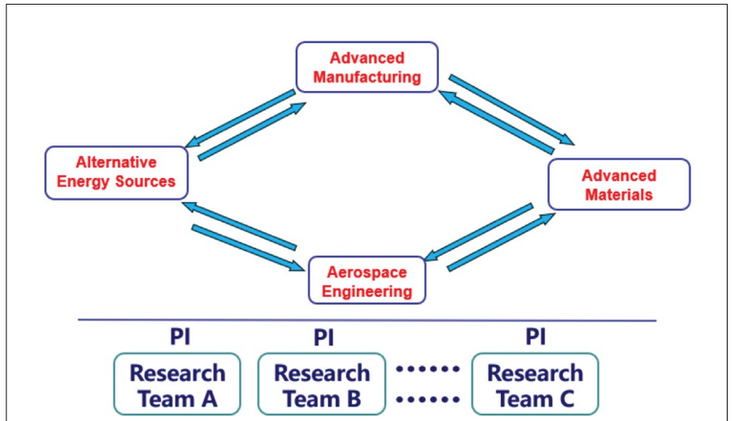

FIGURE 3. The main research areas targeted by the ITS. PI, principal investigator.

2. Alternative energy sources:

- **Shale gas**—especially the creation of a systematic shale gas geological policy system for China to provide independent shale gas–mining equipment and technologies for Chinese geological systems;
- **Renewable energies and advanced energy storage**—including the exploitation of ocean and environmental energy and the development of new technologies for high-density and low-cost energy storage and supercapacitors;
- **Power electronics**—the development of technologies ranging from bulk crystals to packaging systems, to reduce new-energy costs and improve the quality and efficiency of power conversion, especially in ultrahigh-voltage–based smart grids and electric vehicles.

3. Advanced materials:

- **Bioinspired materials**—the study of the optimum bionic design to create new multifunctional smart materials and systems;
- **Intelligent composite materials**—an applied-research area focusing on high-strength structural composite materials and smart composite materials and systems;
- **Nanomaterials**—their development, synthesis, and application, with real-time monitoring of low-dimensional materials and single-crystal thin films.

4. Aerospace engineering:

- **Laser-strengthened materials and laser processing**—the development of technologies for laser material surface-strengthening and femtosecond laser-based aerospace machining, such as turbine-blade cooling-hole processing;
- **Sensing in extreme environments**—the improvement of aero-engines through the measurement of pressure, temperature, vibration, and gas concentration using modalities such as surface-acoustic waves, piezoelectricity, ruggedized transducers, and lasers;
- **Reliability assessment in extreme environments**—the evaluation of materials under extreme conditions, such as ultra-high and -low temperatures and high irradiation, by physical-property testing, numerical modeling, and evaluating reliability virtually.

The School of Power and Mechanical Engineering

Intelligent ultrasound inspection technology and its application to industrial nondestructive testing

Xiaohong Li* and Jun Zhang*

The ultrasonic inspection of industrial components with complicated geometries and heterogeneous materials has been a significant challenge to the nondestructive testing (NDT) and monitoring of the health of major equipment. To address this gap, the School of Power and Mechanical Engineering has developed an innovative ultrasonic-testing system with intelligent procedure design, data acquisition, and analysis modules to maintain the security of new-generation industrial equipment.

The school established application-oriented acoustic models as the theoretical basis for a method to analyze the propagation

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FIGURE 1. Ultrasonic inspection equipment for control rod.

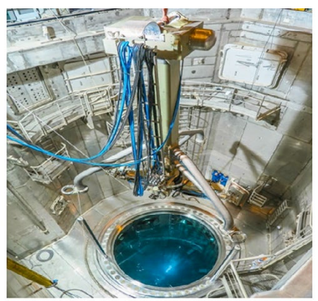

FIGURE 2. Ultrasonic inspection equipment for reactor pressure vessel.