

DESIGNING BETTER DESIGNS

By creating algorithms that account for physical uncertainties and human nature, Wei Chen increases the efficiency and effectiveness of engineering complex systems.



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WEI CHEN Wilson-Cook Professor in Engineering Design and Professor, Mechanical Engineering

Humans have been designing mechanical solutions for their problems since ancient times, but the study of the design process itself—engineering design—came into its own as a research discipline only in the 1980s.

Wei Chen, Northwestern Engineering's Wilson-Cook Professor of Engineering Design and professor of mechanical engineering, has stood at the forefront since the field's early days with her groundbreaking work focused on uncertainty.

This year, Chen received one of the highest honors in engineering—election to the National Academy of Engineering—for her "contributions to design under uncertainty in products and systems, and leadership in the engineering design community."

Chen, who serves as director of the Integrated Design Automation Lab and the Predictive Science and Engineering Design Cluster, is admired as a passionate educator, a respected editor of leading academic journals, and a tireless supporter of the University and the engineering community at large. She holds two patents, has written or edited more than 280 publications, and is one of the most cited researchers in engineering design.

"Professor Chen is a model of excellence in everything she does," says Kevin Lynch, chair and professor of mechanical engineering. "She is a truly devoted leader who commits countless hours to her research and students."

Modeling uncertainty

Chen's work uses modern computing power to assess sources of uncertainty and incorporate them into engineers' decisions, especially in the design of complex systems like aircraft and automobiles.

Designing a car, for example, encompasses many sources of uncertainty. The variables involved in assessing safety during a crash include the materials a car is made of, its speed on impact, and the angle at which it is struck. "We model and quantify those uncertainties," says Chen, "to help designers make rational, optimal, and robust design decisions."

Without such algorithms, she says, a design engineer might make heuristic-based decisions that could deliver less-than-optimal solutions. For example, such decisions might result in a car that's heavier than required to ensure safety and could waste materials, money, time, and effort.

Manufacturing giants, including Boeing and Ford, use software programs, such as Isight and Altair HyperWorks™, that employ her methods. "It's satisfying to know that people aren't just reading my papers, but also using my work," says Chen.

The human factor

Her contributions to new research topics have influenced how the broader community understands design. This includes recognizing the role of humans throughout the design process—the engineer who designs a product, the corporate executive who markets it, and the consumer who ultimately uses it.

Crucial to her success are her collaborations with researchers from an extraordinarily wide array of fields, including decision theory, social network modeling, statistical inference, computer science, transportation, mechanics, manufacturing, and materials. Citing more than two dozen coauthors from Northwestern, she credits the University's interdisciplinary programs for inspiring her students to become catalysts for several fruitful projects.

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Giving back

Chen has a long record of service on editorial boards and professional societies, currently contributing as editor-in-chief of *ASME Journal of Mechanical Design*, president of the International Society of Structural and Multidisciplinary Design, and review editor of *Structural and Multidisciplinary Optimization* and *Design Science*. And she has an equally stellar track record as an educator.

For five years, she served as director of graduate studies in the Department of Mechanical Engineering. At the end of her tenure, she received the first-ever, University-wide Ver Steeg Award, which recognized her success in the demanding work of recruiting, onboarding, and mentoring diverse, top-rate graduate students. Lynch notes, "We're lucky to have her."

Though Chen stepped down two years ago, her example still influences recruitment efforts, Lynch adds. In fact, more than half of the department's newly matriculated graduate students are female, nearly double the percentage of female students pursuing a doctorate of engineering nationwide.

In all endeavors, Chen moves beyond uncertainty. As she puts it, "You have to go beyond your traditional domain to break new ground."

CATHERINE GARA