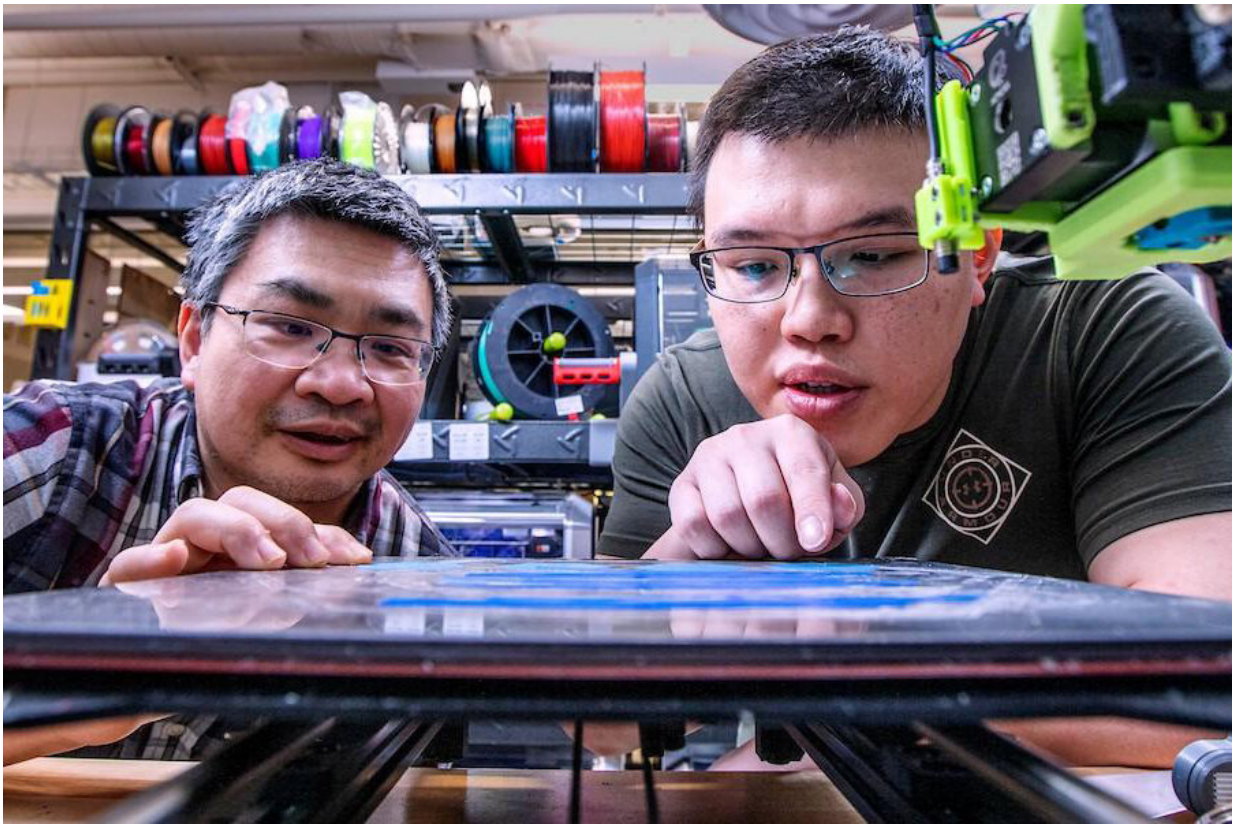
Researchers improve 3D printing quality by sharing data among machines

April 5 2022, by Trisha Radulovich



Hui Wang, left, associate professor of industrial engineering and An-Tsun Wei, a Ph.D. student, are the co-authors of a paper detailing how learning cloud data collected from interconnected 3D printers improves quality control and printing accuracy. Credit: M Wallheiser/FAMU-FSU Engineering

Researchers at the FAMU-FSU College of Engineering are improving

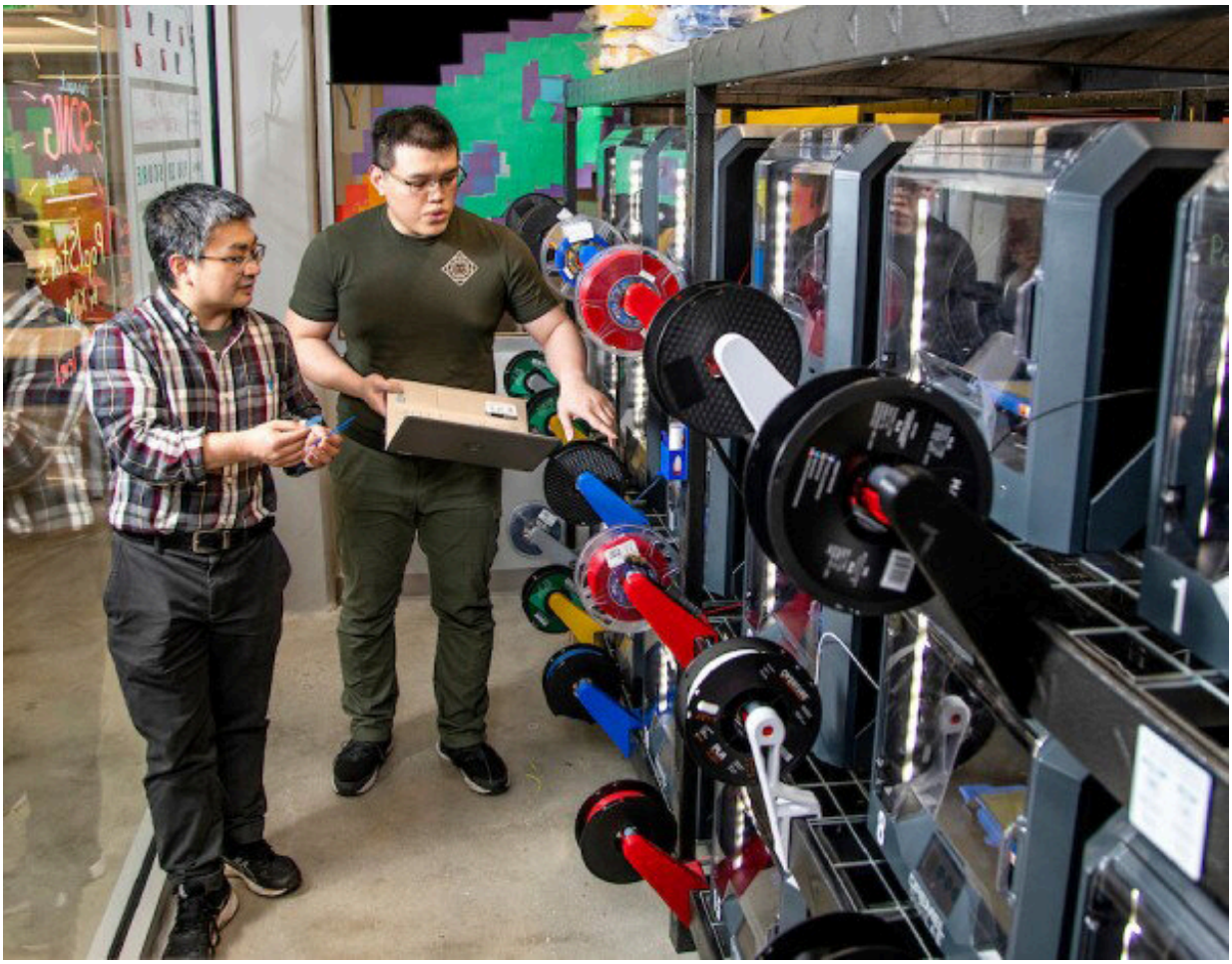
3D printing technology by teaching machines to learn from each other.

In a new study published in the *IEEE Transactions on Automation Science and Engineering*, researchers showed how data from one printer can be used by other machines to improve efficiency and quality.

"Cloud manufacturing, along with the Internet of Things (IoT), is a newly emerging technology," said paper co-author Hui Wang, associate professor at the FAMU-FSU College of Engineering. "The technology demonstrates that data generated from multiple production machines can be shared with each in a timely manner, and manufacturing can be enclosed as online services for meeting diverse market demands."

According to the on-demand manufacturing platform Hubs 2021 3D Printing Trends Report, the global 3D printing market grew by 21 percent in 2020, despite the effects of a worldwide pandemic. This growing industry is accelerating to print everything from metal to biological materials. The race is on to optimize these processes for competitive advantage.

Wang and his colleagues are working to develop new learning algorithms and ways to control the printing process. Tiny differences in the movement of a printer's nozzle can cause variations in processing and flaws in the finished structure. Their technique uses data shared among machines to reduce printing defects.



Wang and Wei used interconnected 3D printers to prove that transfer learning is a way to achieve “group intelligence” by which multiple learners collaborate to outperform a single learner. The technology can be applied to a variety of products using different materials. Credit: M Wallheiser/FAMU-FSU Engineering

The researchers connected different printers on a cloud platform, and then had the machines share data about accurate processing, which decreased the time needed to prepare and calibrate them.

The researchers also developed a mathematical model to better

understand the printing process, said An-Tsun Wei, a doctoral student in the college's Department of Industrial and Mechanical Engineering and a paper co-author.

"We can estimate geometric print quality and the related defects that might occur with the model," she said. "The information can be used to calculate adjustments needed in the input printing parameters to compensate for those errors."

Traditional machine learning requires a lot of experimental data, which may be difficult to collect. Printers used in manufacturing must be quickly adjusted to cope with new tasks. Transfer learning technology allows different printing processes to share experiences, which speeds up that process. The research demonstrates the feasibility of using historically shared data from interconnected 3D printers to reduce testing time and improve the finished product.

"With reduced testing, we can improve quality control faster and thereby quickly recalibrate the printing processes for meeting diverse market demands," Wang said. "This is particularly suitable for mass production of personalized products, a manufacturing paradigm envisioned in the future."

Wang calls this transfer learning a way to achieve "group intelligence" by which multiple learning agents (learners) collaborate to outperform a single learner. The technology can be applied to a variety of products using different materials.

More information: Jie Ren et al, Improved Modeling of Kinematics-Induced Geometric Variations in Extrusion-Based Additive Manufacturing Through Between-Printer Transfer Learning, *IEEE Transactions on Automation Science and Engineering* (2021). DOI: 10.1109/TASE.2021.3063389

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