Lighter weights, lower costs in additive manufacturing

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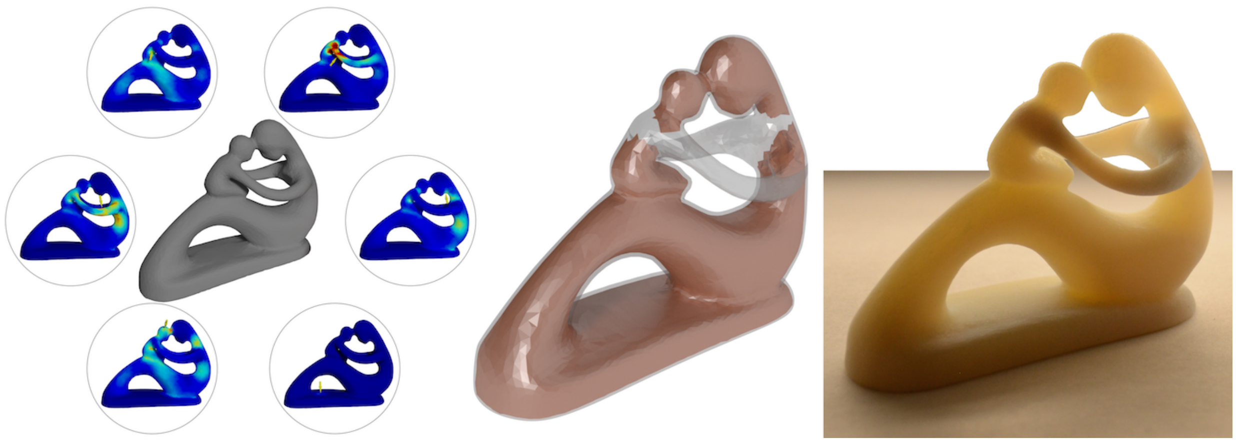

Critical instant analysis, a new process for improved structural optimization in additive manufacturing, unveils the possibility of designing products that are lighter in weight and cheaper to produce. Credit: Burak Kara and Erva Ulu, Department of Mechanical Engineering, Carnegie Mellon University

It's never long before the most advanced technology needs its own innovations. Additive manufacturing, the gold standard for innovative industry production, has reached that point. With its use steadily increasing, there arises the need to fine-tune this production method; to develop a process that makes additive manufacturing a responsible, cost-effective business decision. Mechanical Engineering professor Levent Burak Kara, his Ph.D. student Erva Ulu, and Robotics Institute assistant professor Jim McCann may have found that process.

In their paper "Lightweight Structure Design Under Force Location Uncertainty," presented at SIGGRAPH 2017 in Los Angeles, Kara and his colleagues detail their research on improved structural optimization in additive manufacturing, research that unveils the possibility of designing products that are lighter in weight and cheaper to produce.

Structural optimization refers to a product being as strong as possible while remaining as light as possible. Traditionally, structural optimization is achieved by analyzing external forces—literal pressures that stress the integrity of a design—that are known and fixed. However, because additive manufacturing creates products that can be stressed by a nearly infinite number of forces that are neither known nor fixed, a new way of integrity analysis is needed.

To address this, Kara and his team developed a process called critical instant analysis. Through digital mapping and simulation, they are able to determine the points on a design that are most vulnerable to critical force contact. With this information, each step in the optimization process accounts for the maximum amount of stress a design can handle before it fails. In turn, during manufacturing, material is distributed accordingly across the design, with more material being sent to areas that show the highest critical risk in order to protect against failure.

The resulting product is lighter than previous designs because it doesn't use extra material where it isn't needed. Less material means lower production costs. Not only have Kara and his team reduced weight and cost, but critical instant analysis designs have shown, through mechanical testing, to be more durable than designs of uniform thickness.

The development of a process that results in lighter weight products made at reduced costs could benefit industry in a big way. Says Kara, "The immediate application is to aerospace," where the importance of weight is obvious. "But automotive or even consumer products, where the product can be used in many different ways" could also benefit from critical instant analyses, he adds.

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More information: "Lightweight Structure Design Under Force Location Uncertainty," *ACM Transactions on Graphics*, Vol. 36, No. 4, Article 158. DOI: 10.1145/3072959.3073626 , dl.acm.org/citation.cfm?doid=3072959.3073626

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