Students design workstations that accommodate groups and individual

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New school and office workspace designs created by a group of Penn State engineering students are intended to allow users to share space and materials while maintaining their own work areas—a dual purpose the researchers say has been neglected.

The research began in 2010 as a class project, according to Joseph M. Mahoney, former Penn State graduate student, now assistant professor of mechanical engineering, Penn State, Berks. "There's a lot of interest from an ergonomics perspective and workplace efficiency perspective of designing workstations for single users," Mahoney said. "But what we didn't see was, how do you quantitatively design something for multiple users to interact with each other and to have their own space?"

With this question in mind, Mahoney and his fellow students began by creating a virtual population of one million workstation users. They obtained population characteristics, such as age, body mass index and height from the National Health and Nutrition Examination Survey, and arm-length data from the US Army Anthropometric Survey. The surveys' data overlapped, but neither contained all the measurements the team needed so they matched the two populations using body mass index and height for each user, which both surveys contained.

The team's goal was to apply these characteristics in designing a workstation that would provide users their own area while also offering a shared workspace. To see whether users' space would overlap, they needed their population's "extended reach zones," or how far a person of

certain proportions could comfortably reach—for example, to hand a book to a colleague. To measure extended reach zones, the team turned to their 21 classmates, asking each to sit at a table and place a wooden block as far away as they comfortably could at different angles. The researchers statistically related these extended reach zones to each participant's body measurements so that the reach zones were applicable to the larger simulated population.

The team then looked at how these results affected workstation use. They ran five million random pairings from their virtual populations to see if "normal reach zones"—based on arm length—and extended reach zones—how far each person could comfortably reach—overlapped at tables of various shapes and proportions.

"We randomly select two people from this million-person population and we seat them at this table," said Mahoney.

If the pair's normal reach zones did not overlap but the extended reach zones did, then they had enough space to work individually but were also within reach of colleagues for the purpose of collaborating. Workstation designs that met these parameters were functional for the team's goal of accommodating the needs of both individuals and groups.

"We came up with a way of designing devices for multiple people to work together and also to be able to work independently, which had not been seen in previous work," said Mahoney.

Finally, the researchers used their results to find table shapes and sizes that would accommodate both groups and individuals from two virtual populations—one representing Penn State library users and the other, Penn State engineering students. They adjusted each population's sex ratio to the proportions found within the actual Penn State populations with an age range of 18 to 30 years old. There were substantially more

males than females in the engineering population and slightly more males than females in the general student population. The team tested square tables with users sitting either at the sides or at the corners, as well as triangular and circular workstations of varying sizes.

The researchers found that, for square and triangular workstations, there was a range of table side lengths that would allow users to overlap and share materials while maintaining a personal work space. Outside these size ranges, the percentage of pairs accommodated quickly decreased. Shorter table sides would force users to crowd together without personal workspace, and longer table dimensions would leave them too far apart to share materials. For circular tables, for which the researchers only tested the full university population, they identified three table diameters—about seven feet, eight-and-a-half feet and ten feet—that could most efficiently accommodate groups of three to six people.

The team continued to pursue the project after the class ended, with the encouragement of Matthew Parkinson, associate professor of engineering design and mechanical engineering. Ultimately they published their findings in the journal *Applied Ergonomics*.

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