# Study finds that human subjects prefer when robots give the orders

August 22 2014, by Adam Conner-Simons

Giancarlo Sturla and Matthew Gombolay (front) collaborating with the PR2 robot on an assembly task. Credit: Jason Dorfman/CSAIL

If you've seen a sci-fi flick with autonomous robots in the last 40 years, you may be wary of giving robots any semblance of control.

But new research coming out of MIT's Computer Science and Artificial Intelligence Lab (CSAIL) suggests that letting robots have control over

human tasks in manufacturing is not just more efficient—it's actually preferred by workers.

While manufacturers have long recognized the benefits of automation in streamlining processes and freeing humans from tedious tasks, such as aisle-running, there's always a concern that workers may feel devalued or even replaceable.

"In our research we were seeking to find that sweet spot for ensuring that the human workforce is both satisfied and productive," says project lead Matthew Gombolay, a PhD student at CSAIL. "We discovered that the answer is to actually give machines more autonomy, if it helps people to work together more fluently with robot teammates."

Specifically, in the study, groups of two humans and one robot worked together in one of three conditions: manual (all tasks allocated by a human); fully autonomous (all tasks allocated by the robot); and semi-autonomous (one human allocates tasks to self, and a robot allocates tasks to other human).

The fully-autonomous condition proved to be not only the most effective for the task, but also the method preferred by human workers. The workers were more likely to say that the robots "better understood them" and "improved the efficiency of the team."

Gombolay emphasizes that giving robots control doesn't mean a team of cyborgs will be running the show. It means the tasks are delegated, scheduled, and coordinated via a human-generated algorithm.

"Instead of coming up with a plan by hand, it's about developing tools to help create plans automatically," he said.

The algorithm can also conduct on-the-fly replanning, instantly

developing an alternate "schedule" for a task if, say, a new part arrives or a machine malfunctions—a clear advantage over its human counterparts, who generally require time to call an audible.

The research—developed by Gombolay, MIT undergraduates Reymundo Gutierrez and Giancarlo Sturla, and assistant professor Julie Shah in the Interactive Robotics Group at CSAIL— is part of a long line of recent advances that allow robots to interact in less predictable environments, and to therefore collaborate directly with human workers in factory settings.

Gombolay says that, in the future, similar algorithms could be applied to human-human collaboration (like scheduling hospital resources), search-and-rescue drones, and even one-on-one, human-robot collaboration in which the robot could help someone with discrete building and construction tasks.

**More information:** The paper is available online: interactive.mit.edu/sites/defa … ombolay_RSS_2014.pdf

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