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From *The 69th Meeting of The American Physical Society – Division of Fluid Dynamics*

Paddle or Rake to Improve Your Swimming Stroke?

Investigating Impact of Finger Position on Swimming Efficiency Favors Spread Fingers

EMBARGOED for release until 9 a.m. Eastern Time on November 21, 2016

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Washington, D. C., November 21, 2016—Note to elite swimmers: Are you looking for a competitive edge in the hydrodynamics of your front crawl?

Start by considering your stroke. If you are paddling, swimming with fingers pressed together like a blade, try spreading your fingers apart and rake the water for greater efficiency. The rake position of spread fingers increases the drag of the hand and reduces the slip velocity between the hand and the water. This diminishes the power dissipated for propulsion and as a result, increases your swimming efficiency.

That's the conclusion of new research from the Netherlands in which a team of fluid dynamicists built and printed a 3-D hand model using the public domain software *Make Human*, tested it in wind tunnel experiments and then combined those results with computer-based fluid dynamics simulations. While previous studies suggested spread fingers do, in fact, boost swimming efficiency, this is the most comprehensive evidence to support the concept. The team presents their findings Nov. 20-22 at the American Physical Society annual meeting, Division of Fluid Dynamics, held in Portland, Oregon.

The increase in efficiency from spread fingers is small, offering 2 to 5 percent increase in the drag coefficient related to the thrust that powers a swimmer. "However, when you are a top swimmer, this very small effect, only a few percent, can make the difference between a gold medal and no medal at all," said Ph.D. student Josje van Houwelingen, a swimmer herself, who does research at Eindhoven University of Technology as part of a team that also includes researchers from Delft University of Technology and the J.M. Burgers Centre for Fluid Dynamics in the Netherlands.

Spreading the fingers gives a small efficiency advantage by obstructing flow with the spaces created between spread fingers. This increase in drag also increases thrust. The higher the drag coefficient, the more efficient the pull.

Researchers measured force and torque under five different conditions of finger spread in which the thumb remained in a fixed position. Measurement began with the closed position of 0◦ -- all digits pressed together, similar to a paddle -- and fingers spread progressively wider through 5◦ intervals to a maximum of 20◦ degrees of spread (Figure 1).

They took measurements on various spread conditions in both the wind tunnel and through numeric modeling. Because air and water both behave as fluids, a wind tunnel seemed an ideal setting for a fine-grained force analysis of the hand swimming in water, using two force sensors fitted in tandem.

Results favored a spread finger position. Compared to a closed paddle hand position, even the smallest spread-finger hand position of 5◦ enhanced the drag coefficient by 2% in the numerical simulation, and by 5% in the wind tunnel experiment. Investigators also found the optimal finger spreading of 10◦ was the same in experimental and numerical simulations.

While the day-to-day practical effects may be small, given the few swimmers who swim well enough to benefit, the team sees a wider philosophical and aspirational benefit to this finding. "It may inspire other swimmers who are not Olympic-caliber to think about fluid dynamics, and contemplate the fluctuating forces which their hand and fingers experience while doing those boring laps."

The findings also set the stage for the next phase of research in which drag is analyzed under conditions of acceleration. Explains the team: "We will next put our hands in a big water tank and make realistic swimming movements using a robot, and again, combine this with numerical simulations."

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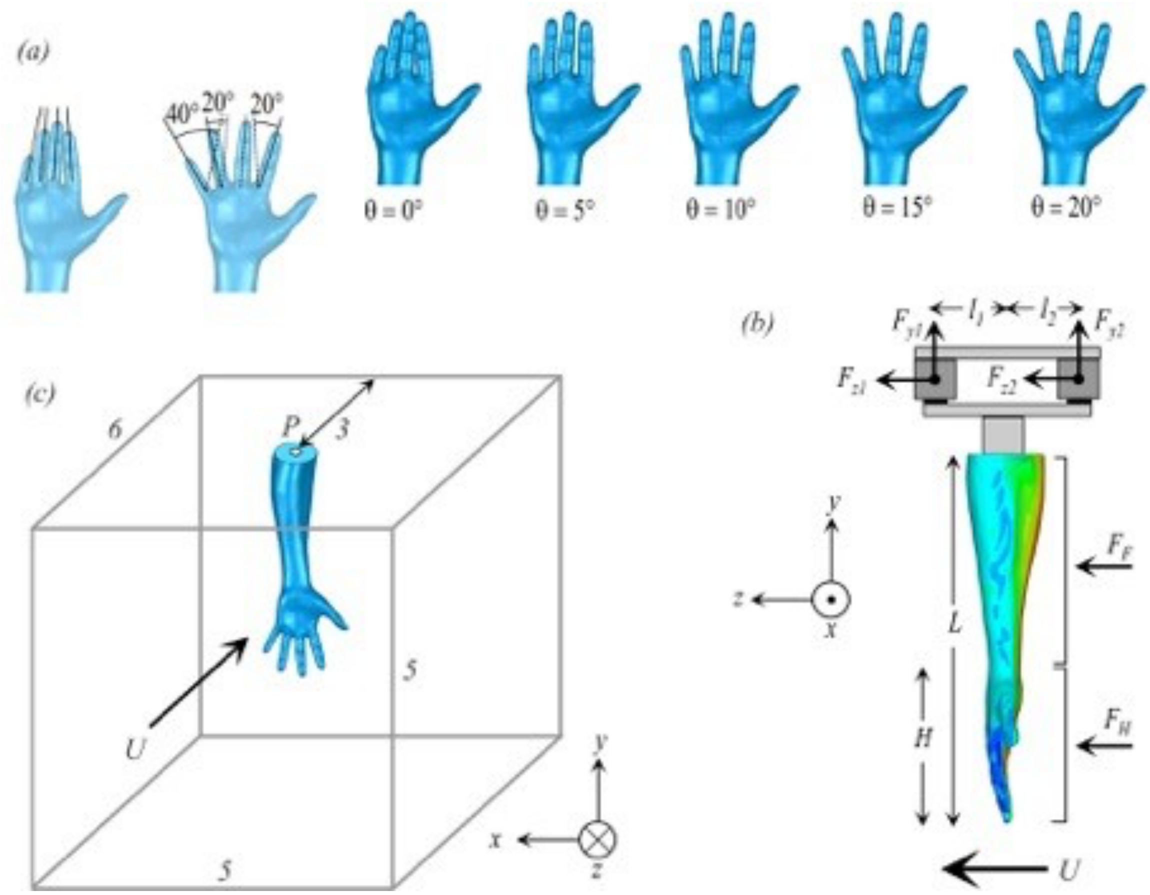

Figure 1. Top panel (a), left to right, shows the five hands and finger positions evaluated with finger spreads of 0, 5, 10, 15 and 20◦. The angle of each finger is defined as the angle relative to the 0◦ position. Middle right, panel (b), shows the schematic view of the wind tunnel experimental setup involving two force sensors in tandem configuration. Lower left, panel (c) shows the computational domain in which force moments are computed with respect to the point P.

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Abstract: L19.00008 : "More efficient swimming by spreading your fingers," by Wilem van de Water, Josje van Houwelingern, Dennis Wilemsenm Wim Paul Breugem, Jerry Westerweel, Rene Delfos and Ernst Jan Grift is at 6:01-6:14pm PST, November 21, 2016 in Room D136

For more information about the APS DFD 2016 meeting, visit: http://apsdfd2016pdx.org/

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PRESS REGISTRATION
We will grant free registration to credentialed journalists and professional freelance journalists. If you are a reporter and would like to attend, contact Julia Majors (jmajors@aip.org, 301-209-3103) who can also help with setting up interviews and obtaining images, sound clips, or background information.

LIVE MEDIA WEBCAST
A press briefing featuring a selection of newsworthy research will be webcast live from the conference on Monday, November 21st. The first briefing at 2:00pm (EST) is about the forensic analysis of blood spatter and how changing the position of your fingers can help you swim faster. The second one at 4:00pm (EST) is about cat's Velcro-like tongues and bubbles. More information can be found at the following link:
https://www.aps.org/units/dfd/pressroom/

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