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Improving Prosthetic Arms through Better Testing

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For those of us who live with upper-limb loss, we wear prosthetic arms for specific reasons, if at all. Improving these devices requires adequate problem identification and, thus, testing. To do this effectively, we must define what, exactly, should be tested.

One of the reasons people with upper-limb amputations wear prostheses is for appearance, an attempt to blend in. But my experience with the current bionic options has been that they are expensive and fail to achieve a “natural” appearance. Try to attend a meeting wearing one of these, and just by pouring yourself a glass of water it becomes apparent that you are wearing a prosthesis—the hand is too loud and artificial looking, and the posture too stiff. To overcome these downsides, we need shamelessly unforgiving appearance tests to expose these deficiencies during the development of prosthetic hands.



Appearance aside, reliability/performance is the single-most relevant factor in prosthetic acceptance for many upper-limb prosthetic users. Shopping, ironing, handling containers, and preparing meals are examples of essential tasks the person will need to perform with the device. And given the somewhat reduced social acceptance that arm amputees seem to experience, attending parties or functions are of particular interest, and with those events comes the handling of delicate, breakable items, such as drinking glasses, or slippery objects, such as olives. The confidence that you will not drop or break anything outweighs any other aspect, even appearance. So even without wearing a prosthetic arm at all, I may perform with 100 percent reliability

and therefore be more accepted socially than when wearing a high-tech arm.

Prosthetic arms are also worn for functional tasks specific to work, home, garden, and recreation. These include manipulation of objects too heavy for single-handed work; repetitive activities, such as handling laundry; transfers or transports; or a combination of mechanical strains, such as weight and vibration; as well as handling tools, such as knives, pliers, or scissors. Every profession and job requires bimanual activities that may carry a risk of overuse, particularly when improperly balanced.

So how can researchers ensure that the prosthetic hands and arms they design actually meet these needs? To test appearance, have someone perform a typical daily task in front of a panel of observers, such as pulling out a wallet, handling the wallet and money, then buying a cinema ticket. Ask the observers to note when they can confidently identify on which arm the prosthesis is worn. Test to see how bimanual job-specific tasks are supported, test for these specifically. For reliability/performance and functional testing, ask the user to perform activities he or she might encounter in daily living, such as cutting hedges, moving furniture or boxes, or serving soup. Count the number of items dropped. More practical testing should lead to more practical solutions.

When prosthetic researchers want to know the direction their testing should take, I suggest they consider the specific reasons individuals with upper-limb amputations use prosthetic arms. I suggest that defining vocabulary, constructs, or tests, such as the Southampton Hand Assessment Procedure (SHAP), do not lead in the right direction to answer those questions. I suggest instead that more focus is needed on the particular tasks and scenarios that amputees encounter daily to determine which prosthetic devices will work. For more of my thoughts on the SHAP test, visit www.swisswuff.ch/tech/?p=3043

Wolf Schweitzer, MD, is a forensic pathologist and faculty member of the University of Zurich, Switzerland, Institute of Legal Medicine. He also has a right transradial amputation due to a tumor. He uses a body-powered prosthetic arm in his job, which allows him to handle weights of up to 100 kg, work under a wide range of environmental temperatures, and be exposed to various fluids required in his occupation. Schweitzer has also tested other types of prostheses, including a bionic hand that lost integrity in its cosmetic glove covering after washing a car. He maintains a blog, Technical Right Below Elbow Amputee Issues, www.swisswuff.ch/tech



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