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Constructing the Quality Story

by Michael Bolton

What we know about a product's quality isn't inherent in the product; our knowledge is constructed by us. In today's world, we often construct knowledge by means of experiments that we call "tests"; yet, at one point in history, the experimental approach was both new and controversial. That controversy is outlined in a book, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* by Steven Shapin and Simon Schaffer.

The story begins in 1659, when Robert Boyle and his colleague Robert Hooke finished building a version of the most sophisticated and complex scientific instrument of its time, the air pump. While trying to learn about air, Boyle realized something that we now regard as commonplace: If you want to understand how a system is affected by something, get rid of that thing. In 1660, at roughly the same time as the Royal Society was established, Boyle published the results of several experiments in which he removed the air from the "receiver"—a chamber in the air pump—and observed the effects on animals and objects that he had placed inside. More significantly, his writings discussed how a community could arrive at a *matter of fact*—something upon which everyone could agree without dispute. Boyle proposed three main points. First, the advance of scientific knowledge would depend upon instruments that would simultaneously extend human observation and remove human subjectivity. Second, experiments should be performed in front of groups of people who could observe the proceedings and the experimenter, and bear witness to accounts of what had happened. Third, a style of recording and writing should be adopted so that anyone else (with sufficient skill and funding, presumably) could reproduce the experiment.

Thomas Hobbes, a prestigious natural and political philosopher of the day, had serious objections to the ex-



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perimental approach. He didn't object to experiments per se, but at the same time, he didn't believe that they presented conclusive evidence of anything. For one thing, air pumps were very unreliable. Although Hooke and Boyle spent years trying to improve theirs, it leaked persistently. Hobbes also dismissed the idea that an experiment proved anything definitively—other than the fact that the air pump didn't work well. That was easy to demonstrate because of the leaks and the fact that different experimenters obtained different results. Hobbes also believed that the air pump couldn't work to produce universal knowledge. Even in the event that the air pump did work here and now, how do you *know* that it will work somewhere else later? You can't, unless or until you actually try it, said Hobbes, so the "knowledge" that you create isn't forever and always. Experimental knowledge is always provisional.

Hobbes also pointed out that the air pump experiments and the theories that they were intended to prove had a kind of circularity to them. The air pump had its effects because Boyle's theories were true, and Boyle's theories were true because the air pump proved them. Hobbes may not have been the first philosopher to notice this loop in science (which, at the time, wasn't yet called science), but he was vocal about it, and he certainly

wasn't the last to raise the problem.

Hobbes's principal issue was that people would not agree on the evidence of experiments if their interests were at odds. His own objection alone was proof of that. Hobbes believed that true knowledge should be based upon axioms and reasoned analysis that is derived from them—the foundation of his philosophy was geometry. He had alternative and (at the time) plausible theories to explain Boyle's observations. Hobbes had a stake in maintaining his beliefs and wasn't going to give them up based on the seventeenth-century equivalent of a product demo.

It didn't help Hobbes's argument that his attacks were exceptionally nasty and personal. Boyle had widespread support from his colleagues in the Royal Society, and both Hobbes and his point of view were marginalized. The experimental approach, though imperfect, proved sufficiently useful to help generate new explanations for the way the world works, and the objections of Hobbes and several other critics were largely forgotten by history. Yet, Hobbes should be credited for sharpening the scientific method. Boyle and his colleagues were compelled to acknowledge and deal with Hobbes's criticisms, which led to refinement of the equipment on the one hand, and more explicit and more guarded truth claims about experiments on the other.

All of this occurred 350 years ago. What can we learn from it? A surprising amount, I think.

When we're testing, we're constructing knowledge. That knowledge takes the form of two parallel stories. There's a story about the product—what it is, what it does, how it does it, how it works, and how it might fail. The second story—the testing story—is about how we arrived at the product story. The testing story has a structure based on what we decided to test, the oracles that we used, the extent to which we covered our models of the product, and the techniques we applied. Building that structure is the process of test design. The testing story also has a narrative in which we describe how we configured, operated, observed, and evaluated the product; that's the process of test execution. Testing is a process of composing, editing, narrating, and justifying those stories. Our tests, our product demos at the end of a development cycle, and our careful accounts of the most interesting tests—whether delivered in conversation or in writing—can be traced right back to the staging of experiments, witnessing, testimony, and reporting that were part of Boyle's protocol.

Boyle's insight of removing something to understand its effects remains an important testing technique. Want to find interesting bugs? Learn about strengths and weaknesses of the system by depriving it of something it needs. Delete or rename a file, and observe how the system handles the situation. (In *How to Break Software Security*, Herbert Thompson and James Whittaker describe finding an important security bug in Microsoft Internet Explorer using this exact technique.) Want to find out about initial state problems? Clean out the database (remember to make a backup copy first) and see how the system deals with empty tables. Unplug the network cable, remove a registry key, or shut down a process on which the program depends.

Hobbes's criticism of the experimental apparatus reverberates in today's testing tools. Many of the popular tools on the market are like the air pump—expensive, complicated, finicky, sometimes erratic, and in need of continuous

maintenance. It still seems a good idea to remain highly skeptical of tools that are simultaneously expensive and unreliable.

Our knowledge of our products can be both extended and limited by our models and by our test tools. We need to beware of the risk of believing that the product works because our tools show it works, and believing that our tools work because they show the product works.

Social issues—how we relate to one another, how we build credibility, and how we manage trust—are at the center of testing. We can demonstrate something about a product with a test, but a test result on its own doesn't determine the quality of the product. If testers and programmers can't agree on the meaning or the significance of a test result, there's no need to argue. Go to a higher power to end the disagreement—someone who has the authority to make quality-related decisions about the product. Hobbes's political philosophy, expressed in *Leviathan*, was that a strong, central authority was crucial to maintaining civil peace. The ideal is clearly for teams to work by consensus, but when disagreements arise, it's important for testers and programmers alike to recognize that our clients are ultimately the ones in charge.

Finally, just as there are controversies in science, there are controversies in testing. Our ideas about testing are continuously being refined and shaped by our experiments, experiences, and observations. If we're to be excellent testers, we should continue to question and critique widely accepted beliefs as Hobbes did, and we should respond to those critiques as Boyle did. {end}

What do you know about history that you could connect with testing today?

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