Artifacts and Functions

By Jon A. Schmidt, P.E., SECB

In my last column ("Engineers Are from Aristotle," July 2010), I discussed Aristotle's thesis that there are four causes (or explanations) of any physical object: material, formal, efficient, and final. Note that the fundamental difference between a natural thing and an artifact is that the latter requires human intervention to determine its formal, efficient, and final causes. The design, construction, and purpose of an artifact must be imparted to it externally; they are not intrinsic to the item itself.

Focusing on this distinction, philosophers in the Netherlands initiated a project over the last decade or so to investigate what they call the *dual nature* of technical artifacts. Rather than retaining Aristotle's four causes, they characterized artifacts in terms of two types of descriptions: physical/structural and functional/intentional. The physical description includes tangible properties such as geometrical arrangement, chemical composition, mass, color, and shape. The functional description addresses the artifact's purpose, how it is supposed to be used, and the criteria and specifications that govern its design.

There is obviously a relationship between these two descriptions – in fact, they constrain each other – but you cannot derive one from the other. Knowing what an artifact *looks like* does not necessarily mean that you know what it is *for*. Likewise, having a task in mind does not necessarily mean that you know how to fashion an artifact that will effectively and efficiently do the job. This is where engineers come in – we translate the intentional requirements for a particular artifact into the corresponding structural requirements. In this sense, an artifact is a creation of both mind and matter.

This presents a bit of a challenge for modern philosophy; in fact, it is one aspect of the so-called "mind-body" problem that dates all the way back to Descartes. How is it possible for an abstract idea in the mind of a designer to become a concrete artifact that embodies that very idea? If there is nothing inherent in the physical structure of an artifact that determines its proper use, how can we say that it has one at all?

The notion of *function* is central here, and – much to the frustration of philosophers who have tried to work with them – engineers have a tendency to invoke this term in a variety of ways, typically showing little concern about the resulting ambiguities. Pieter Vermaas, a researcher in the Philosophy Department at Delft University of Technology, gave a presentation about this at the 2010 Forum on Philosophy, Engineering & Technology, noting that he is aware of at least eighteen different accounts of "function" in the engineering literature. He proposed five key concepts that cover the full spectrum from human intentions to their physical realization:

1) Goals – what I want to accomplish
2) Actions – what I will do in order to achieve my goals
3) Functions – what role an artifact will have in my actions
4) Behavior – what the artifact will do in order to carry out its functions
5) Structure – how the artifact must be configured in order to produce its behavior

Besides the third step here, engineers also often refer to goals or behavior as "functions."

One outcome of the Dutch dual nature project was a more (philosophically) precise theory of functions developed by Vermaas and his colleague, Wybo Houkes. They call it the ICE-theory because it combines ideas from previous accounts of functions that have been classified as intentionalist, causal role, and evolutionist. According to the ICE-theory, we ascribe a certain function to an artifact when we have reason to believe that the artifact has the capacity to perform that function if it is employed for an appropriate purpose in the manner intended by its designers as communicated to its users.

Most engineers will initially find a definition like this to be needlessly convoluted. An artifact's function is simply what it *does*, right? The challenge is that an engineer has to anticipate *all* of the functions that a particular system or component could have, and preferably *assign* those functions to it deliberately, instead of being caught by surprise when it does something unexpected. Failure generally occurs when an artifact attempts to perform a function that is beyond its capability, regardless of whether its designers or users ever intended it to do so.

Because of this, I believe that there is great value in seeking some philosophical clarity – not only for the language that we use to describe engineering, but also for the very practice of engineering itself, which is why I write about it so much in this space. Engaging in thoughtful reflection on exactly what it is that we do on a daily basis can help us to understand it more explicitly and, ultimately, go about it more carefully and successfully.▪

Your Turn

What functions do we routinely design structural elements to perform? What potential functions of structural elements are easily overlooked? How can we be more deliberate about assigning functions to structural elements? Please submit your responses and see what others have had to say by clicking on the "Your Turn" button at **www.STRUCTUREmag.org**.

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