InFocus | Complicated + Complex = Wicked

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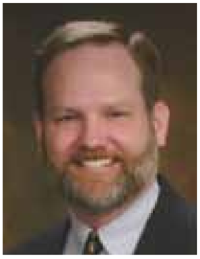

Human language is inherently ambiguous. Most words have multiple meanings, which are subject to change from time to time and from place to place. Even the correct pronunciation of the same arrangement of letters can vary, and the only way to tell which is correct is by taking the context into account. "Did you read my column last time?" "Yes, I read it."

Although spelled differently, the terms "complicated" and "complex" are often used as close synonyms in ordinary speaking and writing, so any distinction made between them is likely to be a highly technical one. Swedish authors Claes Andersson, Anton Törnberg, and Petter Törnberg attempt to thread this needle in a recent paper, "Societal Systems – Complex or Worse?" It appeared in the November 2014 issue of *Futures* (Vol. 63, pp. 145-157) and is available online at **www.insiteproject.org/wp-content/uploads/2013/05/RP_2013.pdf**.

Andersson et al. begin by acknowledging the close relationship between complicatedness and complexity. In fact, in order to differentiate them at all, we essentially have to define complexity as "what we intuitively think of as complexity, but minus complicatedness." One way to do this is advocated by Péter Érdi in his 2008 book, *Complexity Explained*: identify complicatedness as *structural* complexity, and complexity *per se* as *dynamical* complexity. Another is to associate complicatedness "with top-down organization, such as in engineering," and complexity "with bottom-up self-organization – like the behavior of a school of fish or a crowd."

Complicatedness is commonly addressed by means of various systems-based theories that account not only for the behavior of individual elements, but also the relations between them. Finite element analysis is an example familiar to structural engineers. The field of "complexity science" has emerged much more recently. While it is "highly multidisciplinary," involving the collaboration of a wide variety of specialists, Andersson et al. point out that "it is not as *methodologically* diversified," generally favoring formal and quantitative approaches, especially computer simulation grounded in non-linear dynamical systems theory. Its effectiveness is thus limited to "a specific *class of systems* that happens to be amenable to analysis using that particular toolbox."

Difficulties arise when the proper domains of systems-based theories and complexity science are not carefully observed. In particular, there is "no reason why systems could not be both complicated *and* complex at the same time." Andersson et al. refer to such systems as "wicked," a term adapted from management science, where it was coined in the late 1960s for "a class of problems that failed to fit into the molds of the formal systems theoretical models that were being applied across the board at the time with considerable confidence." As a result, wicked *problems* – such as "starvation, climate change, geopolitical conflicts, social disenfranchisement, and so on" – generally cannot be usefully defined apart from the proposal of a specific solution, which will often be only partial at best.

Wicked *systems* are similar, in that neither a systems-based theory nor complexity science is adequate for representing them – alone or even in combination. In particular, Andersson et al. assert that several researchers who have attempted to apply complexity science to wicked systems have been unsuccessful because they failed to recognize that wickedness is not just a different type or higher level of complexity, but has the additional dimension of complicatedness. What makes the interaction of these two properties so intractable is how they "fuse into something quite unlike either quality in isolation." In other words, wickedness is an *emergent* phenomenon: "the rules and entities are not only hard to uncover, *they change as a result of the dynamics itself*."

Andersson et al. suggest that this renders wicked systems resistant to "just about any conceivable formal theorizing." Utilizing Herbert Simon's terminology, they note that such formalization requires three key idealizations:

- "an *internal environment* where the dynamics that we study takes place";
- "an *external environment* that can be assumed to be static, or at least to be variable only in highly regular ways"; and
- "The boundary between the internal and external environment … referred to as *the interface*."

The resulting model "makes the world manageable" because "we declare our system as autonomous from external disturbance and we hide any complexity and complicatedness residing on lower levels." We are then able to "study this internal environment during … *the short run*: a time scale that (i) is long enough ... for important dynamics to have time to happen and (ii) short enough that our assumptions about the interfaces remain valid."

As Andersson et al. point out (citing Simon), "Engineered systems … are *designed* to fit into [the] above description … The parts of such a system can be improved independently, with respect to identifiable functions, as long as those functions in the system are retained … In fact, you can do *anything* to a component as long as you do not alter its interface." This is why engineered systems are often extremely complicated, but not necessarily highly complex, and therefore not wicked; they are intentionally devised and constructed that way.

The two principal examples of wicked systems are societies and ecosystems. Interestingly, these directly correspond to two high-profile concepts among engineers today: resilience and sustainability. We typically are in a position to address such considerations only one project at a time, since that is the limit of what we can *design* to fit into the above description. However, it is clear that their actual scope is vastly greater. Is it sufficient for engineers to continue playing such a small but important part in human attempts to preserve these wicked systems? Or is there a larger role that we can and should embrace?▪

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