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# Pure versus applied science

Progress in engineering technology is in considerable danger of being thwarted at this time when the social impact of the rapid advances made in the preceding half century is mandating the need for progress. The dangers, strangely enough, are being created by the very sectors that are attempting to accelerate the progress.

Some such social impacts, for example, are those of energy consumption and environmental effects—both engineering problems created by engineering technology and, as such, deserving of solution by expanded engineering technology. The current trend, however, is to retard progress in achieving the solutions until the solutions can be addressed from the standpoint of pure science. This trend, in part, appears to result from a lack of understanding of the difference between *pure science* and *applied science*.

These two phrases are defined by Webster in the following manner:

- Pure: restricted to the abstract or theoretical aspects, as *pure* physics; contrasted with *applied.*
- Applied: used in actual practice or to work out practical problems, as *applied* science; distinguished from *pure*, *abstract* or *theoretical*.

The fundamental sciences, such as physics and chemistry, can be approached as either *pure* or *applied* sciences. Engineering, however, is not a fundamental science: it is by definition an *applied science*. Engineering utilizes laws, physical relationships, and other exacting knowledge developed within the pure sciences as its cornerstones. It then builds upon these with corollaries, hypotheses, principles, observed laws, and observations of physical relationships to change the forms of nature to those desired by man. Each time such a change is accomplished, the original order of nature is affected. This, of course, is the cause of the depletion of the natural resources that are used to accomplish the changes and environmental transformations that are brought about.

As these effects compound to a magnitude implying retardation of continued advancements in technology or adverse influence upon society, the applied science must be expanded to address the newly recognized problems. The solutions cannot await the rigorous and cumbersome cornerstones of pure science. Compared to the pure science, applied science can respond most effectively and rapidly to generate solutions to problems and subsequently accomplish the needed change. The pure scientist *must* deal in exacting terms: the number of electrons in a molecule, for example, is an exacting statement. The applied scientist, on the other hand, can function quite comfortably with such phenomena as *order of magnitude* or *significant figures*. Had mankind historically awaited the assurances of perfect knowledge offered by the pure scientist, it would never have had the first bridge, controlled combustion, or the wheel.

As the history of applied technology has advanced, the inevitable refinement of the orders of magnitude and assimilation of hypotheses, observations, and the like, have created the exponential curve of progress. For some, this refinement of the orders of magnitude and the extensive bank of technical development appears to have created an element of confusion between exactness and purity. That our electronic data processing tools can provide the answers to complex engineering problems to "*n*" significant figures does not necessarily assure any more reliability in the order of magnitude than the understanding of physical phenomena or algorithms which define the problems.

Conversely, if the algorithms, when properly applied, provide an answer that successfully produces the information to enable the engineer to accomplish the desired "change in the form of nature," they need not be discarded until verified by the techniques of pure science. *This is the essence of engineering*!

This discussion relates to all fields of engineering, but a specific example of concern regarding building environmental systems technology relates to load calculations and calculations regarding anticipated energy and energy resource consumption.

## Determine energy resourse use

The salient ingredient of the building energy consumption calculation is the time-integrated space load, including the quantitative effects of the load resulting from the external environment. This load response is a very complex phenomenon involving weather anticipation, thermal transfer characteristics, thermal storage characteristics, etc. In the field of building energy calculations, lack of agreement (and progress) on the *pure* method of calculating this integrated load has significantly retarded progress toward the ultimate recognition of acceptable methods of addressing the problem—*determination of the energy resource consumption*! The integrated load, although the salient ingredient, is but one input. Other aspects of the problem, such as system analysis, component performance, occupancy schedules, and operating modes, can often have a much greater impact on the consumption than the integrated space load.

## Consider new approach

It is time for the engineering community to consider a new approach to our goals. We must accept the lack of purity, move on with what we have, and subsequently readdress the problem at a later time when (and if) purity has been achieved.