# Engineering Methodology Revisited

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**ABSTRACT**
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Please indicate clearly the type of contribution you are submitting: ___ hands-on, _X_ explore.

Though difficult to define and demarcate precisely, it is a fact that engineering science encompasses a multitude of other sciences or aspects thereof. In fact, engineering science is so varied and broad that it is difficult to imagine sciences that do not, in one way or another, bear impact on it. This observation should come as no surprise; after all, the engineer has always relied on all sorts of inputs for "making things work". It may also be of little surprise that the tendency of such interdisciplinarity seems to become more and more pronounced; after all, our societies become more and more complex thereby increasing the demand for complex engineering solutions (Christensen & Ernø-Kjølhede, 2006). A bit more surprising perhaps, and possibly also debateable, is the observation that interdisciplinarity also seeps into engineering science in an altogether different manner. Because of pressure from society at large, the engineer of today is no longer just a technology-creator; the role-model for an engineer today is an innovation-creator. This subtle shift instigates a radical change in the approach to engineering science and to the conception of what it means to be an engineer.

One can create technology without caring much for end-user needs and wants: technology remains technology even if no one is interested in using it. Creating innovation is a far more daunting task in as much as end-user needs and wants must be taken into account: innovation only becomes innovation when end-users adopt it (Frederiksen & Knudsen, 2017). Because this shift towards innovation-creator stems from pressure from society at large, it is literally everyone concerned with engineering that is affected by it. The innovation-creator is no longer the odd one out among engineers; he or she is the norm. Discovering end-user needs and wants is not a task that traditionally has befallen engineering science or the natural sciences for that matter; it pertains to sciences inherently situated within the Humanities. This new dimension to engineering science must generally be heeded by anyone who wants to excel in engineering, and this again implies that engineering training programs must pay due attention to it. In other words, engineers must be trained in the science methodology of the Humanities.

The paper and presentation begins with a discussion of the knowledge-categories pertaining to various scientific fields. I will end this discussion by contrasting knowledge within the natural sciences to knowledge within the Humanities emphasizing in particular the pertinence of the various sub-fields of engineering science. To do so I apply the following demarcation principle: all sciences based on laws of physics belong to the natural sciences whereas the rest are taken to be human constructs and to belong to the Humanities. Clearly a demarcation principle like this needs to be justified and I will adopt a scientific-realist position to do so (Musgrave, 1988).

I will then discuss how knowledge within the natural sciences is well-defined in the sense that the meaning of it is precisely given and invariably laid out by the specific theory to which it pertains. This has the consequence that knowledge can be shared essentially without risk of misunderstanding (provided, of course, that the persons involved in the knowledge-sharing actually understand the natural scientific theory at hand). In the Humanities, however, this is not the case. The human-construct aspect opens up for (mis)interpretation wherefore knowledge-sharing becomes a precarious activity where considerable time and effort must be spent to achieve shared understanding (even if the persons involved in the knowledge-sharing at the outset are familiar with the context).

Then I will go on to discuss the differences in the knowledge-generation methodologies of the natural sciences and the Humanities. This discussion will emphasize the impact of meaning, as discussed above, on the methodologies adhered to by the two knowledge-domains, respectively. Thus I discuss why the hypotetico-deductive method becomes the archetype of natural scientific methodology and contrast this to the Hermeneutical spiral, the methodological archetype of the Humanities.

Lastly I will discuss the impact of the differences in knowledge-generation methodology on the *knowledge-sharing* (or pedagogical) methodologies of the two knowledge-domains. I will end up arguing that much knowledge and many concepts within today's engineering science are best learned through experiential methods. This again implies that traditional engineering teaching methods are not fit for this purpose if the students are to acquire deep knowledge.

Throughout the presentation, I will use Newtonian mechanics and the concept of innovation as exemplars of the two knowledge-categories.

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