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## Theoretical Frameworks and Christian Engineering

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# Theoretical Frameworks and Christian Engineering

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by Douglas De Boer

## Abstract

From modernism to postmodernism to Critical Theory, our mostly pre-theoretical perspectives influence how we approach engineering. Lately these perspectives are being referred to in the literature as “frameworks.” How are these frameworks defined? Of course, there are no monarchical definitions for these frameworks. Nevertheless, this paper will attempt to describe categories of frameworks of the past and present. There are several categories of frameworks gaining new attention in various engineering contexts, especially Critical Theory frameworks and anti-deficit approaches to pedagogy.

One of the more recent developments is the notion that a framework ought to do more than help us understand a situation. A “Critical Theory” framework should also give direction as to how to change situations for the better. Goals in terms of improved retention in engineering studies and increased diversity within the student body are typical possibilities within a critical framework. Christian engineers ought to understand the basic contours of frameworks and how various eras of engineering literature and practice have foundations in these frameworks. This paper investigates these frameworks in contrast to other historical frameworks, including some recognized as Christian frameworks.

## Introduction: We Love Boundaries

Robert Pirsig, in his book *Zen and the Art of Motorcycle Maintenance*, colorfully describes a motorcycle road trip through Minnesota, the Dakotas, Montana, and all the way to the West Coast. Along the way he discusses the intricacies of the scenery they are passing and how to keep the motorcycles running smoothly. But are the motorcycles and the riders part of the scenery? Can you cut one from the other?

How do we talk about these things in engineering and in life in general? By paying attention to concepts such as cultural frameworks, worldviews, and norms, we can structure such conversations. It is in these lingual constructions and definitions that we find meaning (or aimlessness) and our conception of righteousness (or evil). In recent decades critical theory, deconstruction, reconstruction, anti-deficit thinking, and similar words and phrases have been making inroads in engineering journals. The point of this paper is to briefly review some ideas behind these new words and phrases. Further, the case is made that the concept of a critical theory has morphed through at least three phases, in which it has played significantly different roles, changing from a cultural framework to a worldview, and then to a norm-defining goodness.

And what is good Phadrus,  
and what is not good—

Need we ask anyone to tell us these things?  
(Front Matter in Pirsig's *Zen*)

It seems we do need a way to talk about what

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Dr. Douglas De Boer is Professor Emeritus of Engineering, Dordt University. Brian Swartz, President of the Christian Engineering Society (CEC), has given *Pro Rege* permission to reprint this recent CEC paper.

is good and bad in engineering design and in life. Pirsig describes “Phadrus’ knife” as an analytic tool to help us understand intertwined situations:

The application of this knife, the division of the world into parts and the building of this structure, is something everybody does. All the time we are aware of millions of things around us—these changing shapes, these burning hills, the sound of the engine, the feel of the throttle, each rock and weed and fence post and piece of debris beside the road—aware of these things but not really conscious of them unless there is something unusual or unless they reflect something we are predisposed to see. We could not possibly be conscious of these things and remember all of them because our mind would be so full of useless details we would be unable to think. From all this awareness we must select, and what we select and call consciousness is never the same as the awareness because the process of selection mutates it. We take a handful of sand from the endless landscape of awareness around us and call that handful of sand the world.<sup>1</sup>

It would be insane to try to keep track of every detail of every experience. (Pirsig suffered from schizophrenia.) Phadrus’ knife is sharp, even if the boundary is vague. Where does one cut? We hardly know where to cut, yet we all unavoidably apply the knife. The creative, the inventive, the profitable use of Phadrus’ knife requires a clever boundary along which to cut. The experience of scenery is not the same in an automobile compared to that from the seat of a motorcycle. Pirsig chose the motorcycle. The scenery is altered. The knife has done its work. Application of Phadrus’ knife is inevitable.

Engineering has a two-way relationship with history and culture. On the one hand, engineering accomplishments shape history. The development of the automobile, aviation, refrigeration, radio communication, etc., are all engineering accomplishments that have influenced history and culture. Engineering education has responded to follow the trends. On the other hand, historical events shape engineering and engineering education. World War II and the energy crisis of the 1970s are some examples of how world-wide events influence engineering. The passage in the USA of the Civil Rights Act of 1964, the rise of feminism,

and the Stonewall Riots of 1969 are also examples of historical events that have influenced engineering and engineering education in particular. More recent events such as the death of George Floyd can be assumed to have a similar effect of influencing the context of engineering education, thus indirectly influencing the priorities of engineering education itself.

The discussion above suggests some sort of boundary along which to slice with Phadrus’ knife, as if there is a practical way to talk about history and culture on one side of a boundary and engineering, including engineering education, on the other side. But of course, such an idea of a boundary is merely a simplifying academic abstraction to aid understanding of a complex and vague wholistic situation. Yet the idea of separating a situation into parts via a boundary helps us discuss the reality and imagine what might be achieved in the future. Some might go further and say that it is via these boundaries that we deconstruct our world and then reconstruct it in our own fashion. Even if it is impossible to define the best boundary along which to cut with Phadrus’ knife, it would be paralyzingly insane to refuse to use the knife. Creativity thrives in the imaginative establishment of boundaries upon the whole.

Having a view of the world leads us to contemplate boundaries.

### **Relation of worldviews, ideologies, frameworks, and norms to boundaries?**

Every person has a worldview. Not to have a worldview is to be unconscious. However, many people, if asked “What is your worldview?” would most likely be at a loss for words. In this sense, many people carry their worldview with them pretheoretically. A worldview is not something consciously chosen<sup>2</sup> as one might choose a wall color to enhance one’s living room decor. A worldview is just a view of our situation that we have somehow come to appreciate. Figure 1 is a visual attempt at showing how we see our world and react to it with pretheoretical gradations between this and that. It is an attempt to show how our worldview leads us in our thinking. It is an attempt to show how our worldview, with its boundaries, leads us to opportunities.



**Figure 1.** Our worldview presents us with boundaries where we find opportunities.<sup>3</sup>

*Worldviews* articulate, so far as is possible, what we believe about the cosmos, our existence, and the meaning (if any) of the cosmos and our lives. It is understood that any expression of a worldview is probably at least incomplete, and that people may occasionally act in ways contrary to what they express as their worldview. A worldview predisposes one, even without rational thought, to certain lifestyles and behaviors. By observing a person's responses to various events long enough, one will be able to surmise at least partially what a person's worldview is.

Christianity may be said to have an associated worldview: that we are created in the image of God, that history is "His Story" of redemption spanning from the garden to a new Jerusalem, and that the problem of pain is a consequence of original sin, etc. These are elements of a Christian worldview. In contrast, a Secular-Freudian worldview presupposes one to believe that the observable material world is all that exists, that there is no god, that religion is "the opiate of the masses," that the problem of pain is a childish wish that reality be something different from what it is, etc. These are examples of worldviews.<sup>4</sup>

An *ideology* is similar to a worldview, except that for the purposes of this paper, an ideology will be considered as having a more theoretical and consciously chosen basis than what is typical for a worldview. The difference between a worldview and an ideology is more in nuance and connotation than in substance. Whereas a worldview has more of the connotation of explaining our world, an

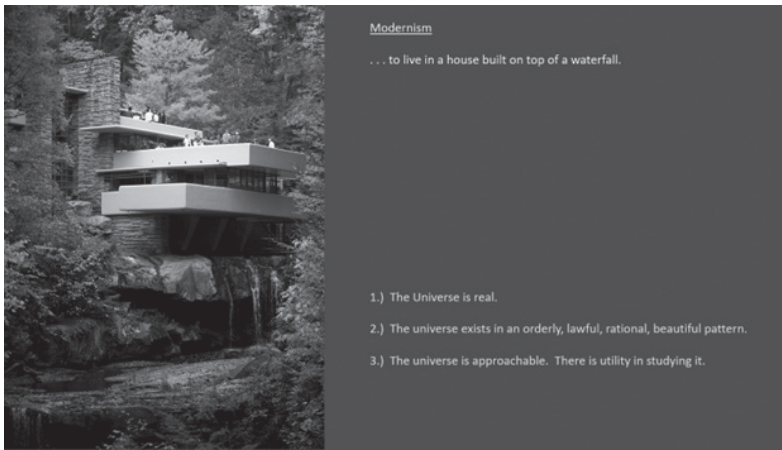
**ideology has more of a connotation of having a future goal to accomplish.** Whereas a worldview has the connotation of some ambiguity and the possibility of behaviors that are inconsistent with the worldview, **an ideology has more of a connotation of redefining currently held values and ideas,** thus inspiring more consistent behaviors. Whereas to the extent a worldview prescribes action, it does so by implication; an

ideology tends to directly prescribe means or instruments necessary to achieve its goal.<sup>5</sup> Examples of ideologies are egalitarianism, nationalism (or even Christian nationalism), Nazism, Fascism, and Progressivism. For the purposes of this paper, ideologies and worldviews will be considered analytically synonymous because distinguishing between them is a subjective judgment.

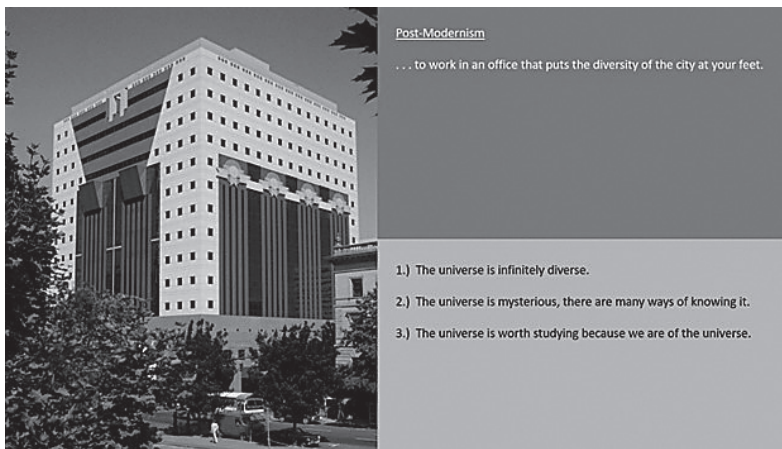
In some academic contexts, the admitted vagueness of what a worldview is—having pretheoretical components and the possibility of inconsistent behaviors—means that worldviews are considered unsuitable for academic study. In these contexts, researchers sometimes refer to concepts such as *existential meaning making*, which is probably not exactly synonymous with *worldview*.<sup>6</sup>

Ken Funk, Associate Professor Emeritus of Mechanical, Industrial, and Manufacturing Engineering at Oregon State University, offers a summary definition of a worldview: "**A worldview is the set of beliefs about fundamental aspects of Reality that ground and influence all one's perceiving, thinking, knowing, and doing.**"<sup>7</sup> Analogous to Phadrus' knife, a worldview suggests boundaries along which to work the knife for the purpose of finding opportunities. Figures 2, 3, and 4 try to get at this notion. (A picture is worth a thousand words.) The figures are not intended to be definitional, but rather to inspire thought about how deeply a worldview organizes our imaginations and how boundaries relate to worldviews. Hopefully, the reader agrees that the figures embody concepts that are consistent with the worldviews.

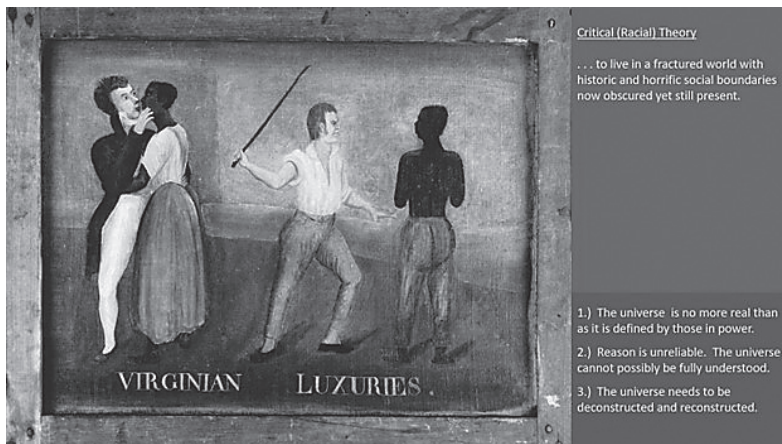




**Figure 2.** Modernism: A boundary between artificiality and nature.<sup>8</sup>



**Figure 3.** Postmodernism: A boundary between multifaceted knowledge and selfish naivety.<sup>9</sup>



**Figure 4.** Critical (Racial) Theory: A boundary between lawgiver and subject. The idea of a lawgiver may be broadened to a wordsmith or people who influence language, including dialects and slang.<sup>10</sup>

Further examples of world-views include Bourdieusianism, eastern mysticism, feminism, humanism, Marxism, moral therapeutic deism, nihilism, womanism, and more.

In the past decade, engineering educators have been becoming increasingly aware of the wide variety of world-views out of which various conclusions may be drawn about the strengths and weaknesses of engineering educational pedagogies and by which engineering programs may be evaluated. In order to evaluate their consistency with the institutional mission of the university and with Christianity, one must discover some ways to classify and understand worldviews. Ken Funk lists seven “elements of one’s worldview” that may be considered especially relevant to engineering education. He names them as follows: epistemology, metaphysics, cosmology, teleology, theology, anthropology, and axiology. This list constitutes a *cultural framework*.

A *framework* is another word that sometimes is used synonymously with *world-view* and/or *ideology*. From this author’s perspective, the word “framework” can refer to many different things in the engineering literature, sometimes even referring to a worldview. Even the Wikipedia (as of the writing of this article) unhelpfully defines a “cultural framework” as similar to a worldview.<sup>11</sup> The abstract to this article uses the








word *framework* in this synonymous way to be consistent with the style of recent engineering literature. But the reader is cautioned that in the body of this article, the word *worldview* will be used as defined above, and a *framework* is not considered synonymous with a worldview. To help underscore this difference, the word *framework*, when not referring to a *worldview* in this paper, will be prefaced with the word *cultural*, as in “cultural framework.”

For sociologists, a *cultural framework* is a **system of comparisons to help one understand the differences between two or more entities** or any methodological arrangement of analysis. The entities to be compared could be worldviews. A cultural framework may also be used along with the norms of a worldview, or several worldviews, to help analyze the goodness of a single entity (an event, an object, practically anything that can be described) with respect to the worldview(s) chosen. The concept of Phadrus’ knife and boundaries, as already discussed, is an example of a simple cultural framework. One could create a tabular system of comparisons, listing various worldviews and for each a boundary along which the worldview creates a separation. Here a boundary is considered an *aspect* of a worldview. More complicated cultural frameworks will draw attention to more than one aspect of each worldview.

A possible application of a cultural framework is to help one understand people from other cultures. Seminal work to develop a cultural framework that can be applied in international business situations was performed by Geert Hofstede a few decades ago.<sup>12</sup> Other cultural frameworks exist. Examples include the following: The Lewis model, Trompenaars Seven Dimensions of Culture, Schwartz Culture Model, and the Five Factor Model.<sup>13</sup>

In the book *Understanding the Times: A Survey of Competing Worldviews*, by Jeff Meyers and David

Noebel, six worldviews—titled “Secularism,” “Marxism,” “Postmodernism,” “New Spirituality,” “Islam,” and “Christianity”—are introduced. Then a cultural framework of ten aspects of worldviews is introduced. The aspects are titled “theology,” “philosophy,” “ethics,” “biology,” “psychology,” “sociology,” “law,” “politics,” “economics” and “history.”

	 SECULARISM	 MARXISM	 POSTMODERNISM	 NEW SPIRITUALITY	 ISLAM	 CHRISTIANITY
THEOLOGY	 Atheism	Atheism	Theological Suspicion	Pantheism	Monotheism	Trinitarian Monotheism
PHILOSOPHY	Materialism & Naturalism	Dialectical Materialism	Anti-Realism	Spiritual Monism	Dualism	Dualism
ETHICS	Moral Relativism or Utilitarianism	Proletariat Morality	Cultural Relativism	Karma	Divine Command Theory	Agape
BIOLOGY	Neo-Darwinism	Punctuated Equilibrium	Anti-Essentialism	Spiritual Evolution	Special Creation	Special Creation
PSYCHOLOGY	Mind/Body Monism (Self-Actualization)	Mind/Body Monism (Classical Conditioning)	Decentered Self	Mind/Body Monism (Buddhist Form)	Mind/Body Dualism (Taoistic)	Mind/Body Dualism (Hindu)
SOCIOLOGY	Personal Autonomy	Proletariat Society	Social Constructionism	Collective Consciousness	Ummah	Sphere Sovereignty
LAW	Legal Positivism	Proletariat Law	Critical Legal Studies	Self-Law	Shariah Law	Natural Law
POLITICS	Progressivism	Statism	Political Positivism or Liberalism	Autarchy	Islamic Theocracy	Subsidiarity
ECONOMICS	Economic Interventionism	Socialism	Economic Interventionism	Universal Enlightened Production	Shariah Economics	Biblical Stewardship
HISTORY	Social Progress	Historical Materialism	Historical Revisionism	Evolutionary Godhood	Pan-Islam	Redemptive Narrative

**Figure 5.** An example of a cultural framework in action. This is the cultural framework of Meyers and Noebel. Worldviews are listed across the top. Aspects of the framework are listed down the left side. At each row-column intersection a word or phrase offers some normative method of analysis of the worldview with respect to the aspect. Meyers and Noebel’s book fleshes out the details of the analyses.

Figure 5 on this page appears in the front-matter of their book as an aid to understanding the table of contents of that book.<sup>14</sup> The book proceeds by analyzing the worldviews through the proposed cultural framework of aspects (the discussion follows down each column of Figure 5). Then the book circles back and repeats the analysis, but this time discussing the aspects in light of each worldview (going across the rows). It is a good illustration of how any cultural framework sets up some type of methodological set of comparisons. (The details of each word in Figure 5 are not important to the theme of this paper. The methodological nature of this cultural framework as representative of any cultural framework is the point.)

Note in passing that the aspects of Meyers and

Noebel's framework correspond generally to academic disciplines. This seems to be a common occurrence in many cultural frameworks. It suggests the relevance of general education courses (or core courses, etc.) to an engineering curriculum. General education courses are not merely required to round out the student's education or to enhance diversity. These courses help us answer Pirsig's question, "What is good?" even in engineering. These courses are an essential part of developing good judgment for use within the engineering discipline itself.

Within the engineering discipline we often use a *decision matrix* to help make design decisions. One might argue that sometimes a decision matrix amounts to an ad hoc cultural framework customized to a particular situation. In discussion of how the International System of Units (*Le Système International d'Unités*, SI) has been standardized, Robert Crease defines three "important properties" of a good measurement system. They are as follows: appropriateness to the task, accessibility, and assurance of a satisfactory result. He considers them in a decision matrix style. These are meaningful only within a cultural context. Ergo, Robert Crease's "important properties" are a cultural framework of specialized utility for application in the field of metrology.<sup>15</sup>

Monsma *et al*, in their book *Responsible Technology*, have proposed six "aspects" for evaluating engineering designs.<sup>16</sup> They are the "pistic," "ethical," "juridical," "aesthetic," "economic," and "cultural aspects." Here we have another philosophical or cultural framework that is broadly applicable to engineering work. The book goes on to propose "norms" for the aspects, one norm per aspect except for two norms proposed for the cultural aspect. These norms are proposed as being consistent with Christianity. For example, the ethical aspect (of an engineering design) should be normed by trustworthiness, the economic aspect should be normed by stewardship, the cultural aspect should be normed by cultural appropriateness and openness of communication. Here is another cultural framework for engineering designs. Presumably this book's cultural framework could also be applied to the design of an engineering major.

The Dutch philosopher Herman Dooyeweerd provides a description of fifteen modal aspects of reality, which would of course include engineer-

ing designs and engineering education in "all reality." Dooyeweerd ranks the aspects from "lower" to "higher" and introduces them in that order. He posits that the lower modal aspects are subject to God's laws but the higher modal aspects are subject to humanly devised "norms," the goal of which is to reflect God's natural law. He discusses norms that would be consistent with Christianity. In that sense, Dooyeweerd's philosophical work amounts to a "Christian philosophy." Dooyeweerd's modal aspects of all reality set up another cultural framework that has relevance to engineers. Dooyeweerd has developed his philosophy in a magnum opus multi-volume work in which his modal aspects are a central component.<sup>17</sup>

Dooyeweerd's fifteen modal aspects have been more succinctly described by L. Kalsbeek in his book *Contours of a Christian Philosophy*. Kalsbeek's names for Dooyeweerd's fifteen aspects, listed here in order from "lower" to "higher," are: arithmetic, "spatial," "kinematic," "physical," "biotic," "sensitive," "analytic," "historical," "lingual," "social," "economic," "aesthetic," "juridical," "ethical," "pistic." The sensitive aspect has to do with emotional reactions to situations and can be considered related to psychology. The analytic aspect can be considered related to mathematical logic—detailed cause-and-effect analysis. The pistic aspect has to do with our opinion of ourselves and our works with respect to the rest of the cosmos. Are we arrogant? Do we feel "in control" or not? Do we have a sense of responsibility, and if so, to whom is such responsibility owed?<sup>18</sup> Various other names are used for the fifteen modal aspects when other authors discuss this work. Here again is a cultural framework having applicability within engineering and engineering education, against which other worldviews may be compared.

Another accessible introduction to Dooyeweerd's work is Roy Clouser's book *The Myth of Religious Neutrality*. This book especially makes the case that theories can only be evaluated with respect to the aspects of a religiously held worldview and norms consistent with the worldview.<sup>19</sup>

Given a worldview, a cultural framework can be applied to evaluate something with respect to the worldview and the cultural framework. Take Robert Pirsig's motorcycle story as an example. Pirsig humorously recounts the story of how,

while far from a repair shop, he improvised in the field a repair for his friend's motorcycle by using a scrap of a found beer can as a shim to stabilize the slipping handlebars on his friend's motorcycle. Pirsig considered his repair beautiful work, but his friend considered it an ugly bodge. Perhaps Pirsig was using a secular-scientific worldview, whereas his friend was using a humanist worldview. Then, when considering the aesthetic aspect of a cultural framework to evaluate this repair, we find that two different conclusions arise because each worldview implies different norms (value judgements) for the

works" (plural) can help engineering education become more inclusive and "not simply superficially diverse."

The remainder of this paper is an attempt to compare these trends involving critical theory and antideficit strategies against the background of long-standing cultural frameworks, worldviews, and norms. Is Critical Theory a worldview, a cultural framework, a norm, or something entirely different? It is hard to say. Critical theory has changed over time. What it is now in the engineering literature is certainly not what has been in the past.

## All the worldviews, cultural frameworks, and norms discussed so far may be considered the background from which modern trends are emerging.

aspects of the cultural framework. The secular-scientific worldview recognizes the combination of strength and the relative softness of the aluminum with respect to the steel of the motorcycle as a beautiful fit for the situation. The humanist worldview recognizes the low cost and the dirty-with-stale-beer origin of the shim as an unfitting smudge on the refined image of a BMW motorcycle.<sup>20</sup> This fun little story points out the necessary roles of cultural frameworks, worldviews, and norms.

### **A norm is a means of making a value judgment with respect to an aspect of a worldview (or any entity).**

All the worldviews, cultural frameworks, and norms discussed so far may be considered the background from which modern trends are emerging. A recent trend is the use of phrases such as "critical theory" or "critical framework" or "critical racial theory," etc., and the use of the phrase "anti-deficit" and similar phrases in connection with engineering and engineering education. One example of such a paper that caught this author's eye is a paper presented at the 2017 ASEE Annual Conference.<sup>21</sup> There are now many more such papers. The authors of that paper lament a half-century of poor progress toward increasing diversity in engineering education and propose that an accurate use of "critical theoretical frame-

### **Critical Theory—Origins**

Critical Theory draws on the work of Immanuel Kant and other philosophers of the era of the Enlightenment and Marxism. The word *critical* in the phrase *critical theory* is a deliberate reference to Kant's book *Critique of Pure Reason*. Stephen Eric Bonner (and others) place Critical Theory's origins in the Frankfurt School in Germany and in the era of the Weimar Republic (1920's and 1930's primarily). He describes "alienation and reification" as two themes originally associated with Critical Theory—reification in the sense of discovering or proposing abstract ideas and acting on them as if they are real entities. Using this Critical Theory, Auschwitz can be explained as an incarnation of the alienation and reification that Critical Theory was there to critique. How could rational Nazis devolve to such barbarism? If only they had paid attention to alienations between peoples and the de-humanizing possibilities of reifications—e.g. eugenics in this case. Then Critical Theory could have pointed the way to a better world.<sup>22</sup> The Soviet Gulag, McCarthyism, atomic warfare, and other historic systems could be similarly critiqued. In this formation of Critical Theory, it is functioning as a cultural framework. This strategy explains nothing of our situation in the cosmos in and of itself. It is a method of analysis. Any worldview can be evaluated (critiqued if you will), and any entity such as a law, a government, even probably a



pencil can be profitably critiqued in terms of alienation and reification.

### **Critical Theory—Second Era**

The work of Jürgen Habermas beginning in the late 1950s is recognized as giving rise to a second era in the development of Critical Theory. In this era the application of Critical Theory became more focused on the communicative and legal aspects of life. Habermas built on at least two influential new ideas. One is the concept of a *lifeworld* (German: *Lebenswelt*), which is a person's everyday experience, as expressed in actions, social relationships, and communications. Habermas proposed that capitalist companies seek to dominate our lifeworlds. Money and power are seen as keys to domination. A second idea that Habermas introduced to Critical Theory is the idea of the *colonization* of the public sphere. News and entertainment sources, being capitalist entities themselves, are prime factors in the domination of lifeworlds. In order to better understand colonization, Habermas proposes that there are two categories of communication—ideal speech and strategic speech. Ideal speech has a goal of communication. Strategic speech has a goal of manipulation. Habermas believes that for society to function well, everyone needs an equal chance to engage in ideal speech. In contrast, capitalized media companies seek to monopolize or seek an oligarchy over media to employ strategic speech in the service of colonizers.<sup>23</sup> Habermas' Critical Theory is no longer a cultural framework, but rather a worldview that attempts to explain our situation, our lifeworld, in the cosmos.

### **Critical (Something) Studies— Subgroups Springing from Critical Theory**

The Conference on Critical Legal Studies was founded in the 1970s by a group of legal scholars who had been formerly involved in the civil rights movement of the 1960s. These scholars noted that law does not usually yield a determinate and predictable answer to specific disputes. They drew on Critical Theory to explain this indeterminism: "They focused from the start on the ways that law contributed to illegitimate social hierarchies, producing domination of women by men, nonwhites by whites, and the poor by the wealthy. They claim that

apparently neutral language and institutions, operated through law, mask relationships of power and control. The emphasis on individualism within the law similarly hides patterns of power relationships while making it more difficult to summon up a sense of community and human interconnection."<sup>24</sup>

Within the second-era Critical Legal Studies movement, it was recognized that an ideology was at play, but without any internal criticism of its own methods. It was recognized that the works of the Conference on Critical Legal Studies was a departure from mainstream legal research: "While mainstream research implicitly legitimates legal process, the explicit goal of the Conference is to delegitimize legal process by documenting the incoherence of doctrine."<sup>25</sup> Here begins an inclusion of political action goals into the Critical Legal Studies movement. A worldview generally consistent with a Critical Theory (second era) is now assumed, and the Critical Legal Studies movement is introducing norms for law consistent with that worldview.

The normative role of Critical Legal Studies is conscious on the part of those supporting this movement. Perhaps to their credit, some authors in this movement are brazen about it. One author writes in the introduction to his paper:

This essay sets out to assess the significance and import of the critical legal studies movement. It seeks to do this not by standing aside from the commitment of the movement but adopts and supports its partisanship. The approach adopted is one of committed support for the goals of the critical project; where I am critical I am motivated by a desire to further and advance what is not only a powerful challenge to orthodox scholarship but one whose greatest significance lies in its presentation of an identifiable alternative; an alternative which is not only within legal scholarship but which at the same time has much to say about the politics of law and, more broadly, about the shape and character of a future alternative society.<sup>26</sup>

Whereas Critical Theory in its original form functions mainly as a cultural framework, Critical theory in its second era functions more as a worldview (or an ideology). And here we see that a subgroup of critical theorists specific to legal studies has appeared, and in their critical legal studies they

are creating norms for use within a Critical Theory (second era) worldview.

In addition, Critical Race Theory, Critical Feminist Theory, and other such “Critical (something) Theories have sprung up. Parallel to the emergence of critical legal studies, these critical (something) theories function as norms consistent with a Critical Theory (second era) worldview.

### **Deconstruction and Reconstruction**

Deconstruction and reconstruction are words that are sometimes encountered now in engineering literature. These concepts draw on a form of Critical

laden language is held to be an indirect explanation of the world around us. Theory here is better thought of as interpretation of the world around us. Notice that the idea that a true theory has a correspondence to observable reality is explicitly rejected in the notion of reconstruction. In the language of reconstruction, a theory is true merely because in the eye of the beholder it is convincing, much in the way a magic trick is or is not convincing. Further, “reconstruction aims at uncovering universal competences in competent language users. What is to be uncovered is a pre-theoretical competence, a competence of which the actor is not reflexively conscious.”<sup>28</sup>

Within engineering literature, and especially within the literature of engineering education, it appears that the word *framework* may function as a synonym for a cultural framework, for a worldview, or for a norm or set of norms.

Theory. Deconstruction refers to the “critical” analysis of something in order to understand what is behind it, why it works, how it works, exactly what it does, etc. Deconstruction explains the reification of something. An explanation of how a magic trick works deconstructs the magic trick. A person given the explanation should no longer be able to think of the trick as invoking any magic. A basic idea behind deconstruction is that we have an inherent desire to understand, and we do this by reducing everything eventually to text. Deconstructing something, say a law (text), is thought to remove or reduce the thing’s power, especially powers to oppress peoples. The idea of deconstruction originates with the work of Jacques Derrida.<sup>27</sup> In a critical theoretical worldview, deconstruction is a good thing—a norm for reification.

But of course, one might deconstruct something not only to reduce its power, but also with the idea to eventually imbue it with different, better, power(s). Returning to the idea of a magic trick, we find that after a trick is explained, the trick can be repeated with some variation which again mystifies the audience—an entertaining gambit employed by many performers of magic. This is reconstruction, as advocated by Habermas, the person who launched the second era of Critical Theory. The role of language is central to the concept of reconstruction. Theory-

Reconstruction is telling a person how to perform a magic trick without delving into the theory of why it works. In a critical theoretical worldview, reconstruction is another norm of reification. It is how we exercise agency in our lifeworlds.

### **Deficit and Anti-Deficit thinking**

Another concept with origins in Critical Theory is the concept of *deficit thinking*. Any theory that holds a historically oppressed population (e.g. Black people, Jews, Native Americans, transsexuals, women, etc.) responsible for an inequity or injustice that they experience due to their class membership is said to be rooted in *deficit thinking*. The notion that perhaps Black people in the USA experience present-day hardships because of the legacy of slavery prior to the Civil War in the USA would be an example of deficit thinking. Black people must not be held responsible for the slavery that was practiced prior to the Civil War in the USA or for that legacy. In Critical Racial Theory, deficit thinking is held as perpetrating inequity. Deficit thinking is said to have a “blame the victim orientation.” It is considered a symptom of pervasive systemic oppression and reinforcing of “hegemonic systems.”<sup>29</sup>

Anti-deficit thinking is intended to recognize and avoid deficit thinking. The goal is to bypass def-

icit thinking entirely and replace it with asset-based thinking, also known as strengths-based thinking, wealth-based thinking, and similar phrases. One such strategy is Tara Yosso's Community Cultural Wealth Framework of six "cultural types of capital." (It is indeed a cultural framework here.) The six types of cultural capital are as follows: "aspirational," "linguistic," "familial," "social," "navigational," and "resistance." Anti-deficit thinking guided by Yosso's cultural framework consists of enabling educators to give primary attention to the cultural capital that the students bring with them.<sup>30,31</sup> Anti-deficit thinking is a set of norms consistent with the alienation aspect of a critical theoretical worldview.

### Frameworks in Engineering Literature

Within engineering literature, and especially within the literature of engineering education, it appears that the word *framework* may function as a synonym for a cultural framework, for a worldview, or for a norm or set of norms. Further, one or more of the three types of Critical Theory just discussed may (or may not) be at the heart of the "framework." Some examples will be illustrated next. Readers are advised that paying attention to how the word *framework* is being used may help them understand the author's intent and help them contextualize what is being read relative to other engineering literature. Furthermore, recognizing the norms implied by a "framework" may help the readers understand where the literature is consistent with Christianity and where it is not.

Use of the word "framework" appears frequently in engineering literature, as the following examples suggest. "The 'Fibonacci Sequence' of Critical Theoretical Frameworks: Breaking the Code of Engineering Education Research with Underrepresented Populations" is a document having the word "Framework" in the title.<sup>32</sup> This is the paper that was presented at the ASEE annual conference in 2017 and originally caught this author's eye. What is this "framework" stuff? This ASEE paper is a plea for engineering educators to use "critical theoretical frameworks" to analyze their engineering programs. In this paper an orderly sequence (hence the phrase "Fibonacci Sequence" in the title) of [critical] theoretical frameworks should be applied in any engineering program's assessment.

The "frameworks" specifically named are two: critical race theory and critical whiteness theory. This paper uses the word *framework* both to refer to Critical Theory (second era) as a worldview and to refer to critical (something) theory as norms. As for the consistency of this paper with Christianity, it is complicated. Understanding the way the "framework" presented is being used (cultural framework? worldview? norms?) will help the reader apply (or reject) various themes in this paper and others like it with respect to their institution's mission.

At present the ASEE is promoting a "Framework for P-12 Engineering Learning."<sup>33</sup> This 95-page document, with "Framework" in the title, carves "engineering learning" into three significant components: "engineering habits of mind," "engineering practices," and "engineering knowledge." It then proceeds to further categorize each of these three components and to carefully define each of the subcategories. This is a cultural framework designed specifically for comparing different engineering educational programs. The document goes on to define six "principles" to guide the application of the cultural framework. The six principles are (1) "Keep Equity at the Forefront"; (2) "Strive for Authenticity to Engineering"; (3) "Focus on Depth over Breadth"; (4) "Build Upon Children's Natural Problem-Solving Abilities"; (5) "Leverage Making as a Form of Active Learning"; and (6) "Connect with Student Interests, Culture, and Experiences." These principles are functioning as aspects of this cultural framework, with a norm for each aspect implied in the name and definition of each aspect; e.g. "Equity" is an aspect; "at the forefront" is the norm for Equity. The document does not overtly discuss a worldview. Probably a secular-humanist worldview or possibly a Critical Theory worldview is implied by these norms. Critical Theory or any of its variants are not overtly mentioned in this document.

A recent guest editorial in the *Journal of Engineering Education* has also recognized the various uses of the word *framework* in engineering. This editorial proposes classifying frameworks, first, according to intended application, and after that, according to whether they are theoretical (based on empirical research) or conceptual (descriptive or commonsensical) frameworks. Critical Theory is not explicitly mentioned, but clearly it would fall into a category

labeled “Theoretical Frameworks” in this conception of what engineering frameworks might be.<sup>34</sup>

## Conclusion

The traditional view of knowledge, learning, and creativity being driven by a process of abstraction has been reviewed in terms of cultural frameworks, worldviews and norms. Recent trends, especially since the 1960s, in the development of Critical Theory have increasingly influenced the literature in the field of engineering education. The trend is continuing. The way the words *framework* and *critical theory* have been used in the engineering literature may be confusing because these words do not have clear-cut definitions. Critical Theory has been presented as developing in three eras and functioning first as a cultural framework, then as a worldview, and finally as norms for use with a critical theoretical worldview. That the word framework may be referring to any of these and/or other concepts has been discussed. Also, words such as deconstruction, reconstruction, and anti-deficit have entered the lexicon of engineering literature. These words have more well-recognized definitions, which have been briefly discussed. Deconstruction, reconstruction, and anti-deficit thinking function as norms within a Critical Theory worldview.

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