An Ontological Approach towards the Next Generation Engineer

What it means to *become* and *be* an engineer

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***Abstract*— This paper proposes society specific research and reform in the field of engineering education and subsequently professional engineering. This is done by building on the ontological aspects of engineering, and then providing evidence to show how engineering and engineering education do not directly transcend over societies. The specific cases presented here are in the context of India, however the underlying theme can be applied to other societies as well. This reading attempts at making three broad claims: (1) it is *different to become* an engineer in India, it is *different to be* an engineer in India, and (3) reforms in curriculum and professional practice can help elevate the case of the Indian engineer, and thus contribute to greater progress in the field. By doing so, the author subsequently makes a case for future research to aid society-specific (in this case India specific) reforms in curriculum and professional practice.**

Keywords—engineering education research; ontology; self-actualization; curriculum research; professional development

I. INTRODUCTION

Ideas around the ontological part of being a professional [1, 2] have broadened to a growing interest in the becoming and being of engineers as well. How certain engineering habits of mind are inculcated amongst students, and how professional engineers identify with themselves are common questions that come up in the engineering education and professional development circles [3, 4]. With the term ontology having significant philosophical routes, for the purpose of this paper and for the reader to better understand my vision I borrow Dall'Alba's lens for looking at ontology as the "theory of being", and "where the focus is becoming; not simply knowing as an end in itself." Hence, how engineers identify with themselves and how these identities are built are now considered important factors for not just individualistic well-being, but for the progress of the engineering community and the society at large.

Another idea that has been surfacing in the community is that of "humanistic engineering" [5, 6]. Hynes & Swenson describe the "construct for the humanistic side of engineering that centers on the people involved in engineering". Fisher & Mahajan also make a compelling case for humanistic engineering by presenting the present day expectations from engineers as, "engineers are being asked to make decisions that not only require technical expertise but also a keen understanding of broad, socio-humanistic contexts and considerations". This highlights two aspects of humanistic engineering, the first being the engineer as a human her/himself, and the socio-humanistic contexts that engineers work in.

This human side of engineering and interest in the ontological part of being an engineer serve as encouragement for this work. I will present how *what it means to become and be and engineer* differs between individuals from broad cultural spaces or societies. As vast individual differences can be attributed to social contexts*, I will make a case for future research to aid society-specific reforms in curriculum and professional practice.* Though this claim can be extended to all societies, for this paper I will provide specifics from engineering and engineering education in India.

By the end of this paper, I aim to make three claims: (1) *it is different to become an engineer in India, (2) it is different to be an engineer in India, and (3) reforms in curriculum and professional practice can help elevate the case of the Indian engineer, and thus contribute to greater progress in the field.*

Before you read further I find it important to point out that by the means of this paper I will not make claims on how becoming and being an engineer in India is different, but just that it is different. To make comments on these characters, further research is required, and that research is what I'm encouraging.

In the next section, I will shed more light on the importance of ontology, its role in a profession, and subsequently the sense of being an engineer. Thereafter I'll provide a brief overview of the widely accepted theory of motivation proposed by Maslow [7] in order to use it as a tool for further discussions around individual differences and needs. In the last section, I will present evidence to prove my claim regarding the differences in *becoming* and *being* an engineer in different societies. I will conclude by restating my proposition of society specific research and reform in light of the discussions.

II. Ontology

A. Ontology and its importance

Ontology, or the theory of being has been closely related to the term "self-actualization" which in easy terms can be understood as "becoming what you are capable of becoming" [8]. Where ontology is the theory of being, self-actualization is this being itself.

The term "self-actualization" was originally introduced by the theorist Kurt Goldstein. He said that any organism's master motive and only real motive as "the tendency to actualize itself as fully as possible is the basic drive... the drive of self-actualization" [9]. Another noted psychologist, Abraham Maslow [7] while proposing the hierarchy of needs model, which I will discuss more in the next section, presented self-actualization as the highest attainable psychological state for an individual. Hence this phenomena of self-actualization has been worded by philosophers and motivation theorists in several ways, but I will try and unpack it in light of these theories and prevailing conditions of my concerns for this paper. It can be looked at as a state for an individual when she/he understands and continuously acts in accordance with her/his sense of being.

To place these thoughts in the perspective of education and professionalism, I put forward how Plato explained the function of education as means for an individual to attain actualization to his capacity and hence be useful to the state [10]. To tie these thoughts down in the context of this text, education/training should strive towards an individual understanding her/his sense of being (we may call this self-actualization if it is comfortable to do so), and how the individual lives through life subsequently is governed by how the individual senses her/his being.

B. Ontology in a Profession: Being a Professional

Professionals are human, and so operate as humans on the inside and outside. The sense of being for a professional on the inside helps her/him make sense of who she/he is professionally. Dall'Alba [1] writes profoundly about the ontological part of being a professional, saying "not only do human beings have a range of possible ways to be, but also our being is an issue for us". By extending this to the paradigm of how professionals feel on the inside and how their being is an issue for them, I make my claim of how this helps them make sense of who they as people and in turn professionals. All professions have identities and habits attributed to them, which can be understood as sense of being. I'll talk more about these for the particular case of engineers in the next subsection.

C. The sense of being an Engineer

Because a sense of being is a human feeling and is different to different individuals, it can mean different things to different engineers too. The two qualities pertaining to an engineer's sense of being that I will talk more about here are identity and habits of mind. How an engineer identifies himself can be a function of her/his education or performance. All engineers do not hold degrees to practice engineering, but at the same time all people who hold a degree in engineering don't always practice engineering. Though even with the vast differences between individuals, there are certain habits and ways of being that have been identified as "engineering habits of mind" [3, 4]. These habits of mind are not only found as common qualities among engineers, but have also made way to some countries' standardizations of how to train and identify engineer [11]. Hence, how engineers identify themselves and the habits that they possess are important factors in their sense of being.

III. Self-Actualization via Maslow's Hierarchy of Needs

For the readers to better understand all statements made in relation to self-actualization, I present here one of the most acclaimed theories pertaining to human motivation and psychology. Figure 1 is Finkelstein's [12] artistic representation of Maslow's hierarchy of needs theory which was first proposed in 1943 [7]. Though the figure in many ways is self-explanatory and still the mere vastness of this theory cannot successfully be explained in words here, but I'll provide a brief overview. According to Maslow the needs of an Individual range from the most fundamental internal physiological needs like food, water sleep (homeostasis), to the pinnacle at self-actualization. An individual looks for fulfillment of higher lever needs once the lower level needs are met.

Maslow claimed that this theory embodies many highly acclaimed theories around the same subject. To quote from Maslow's paper, "this theory is, I think, in the functionalist tradition of James and Dewey, and is fused with the holism of Wertheimer [13], Goldstein [14], and Gestalt Psychology, and with the dynamicism of Freud [15] and Adler [9]. This fusion or synthesis may arbitrarily be called a 'general-dynamic' theory" [7].

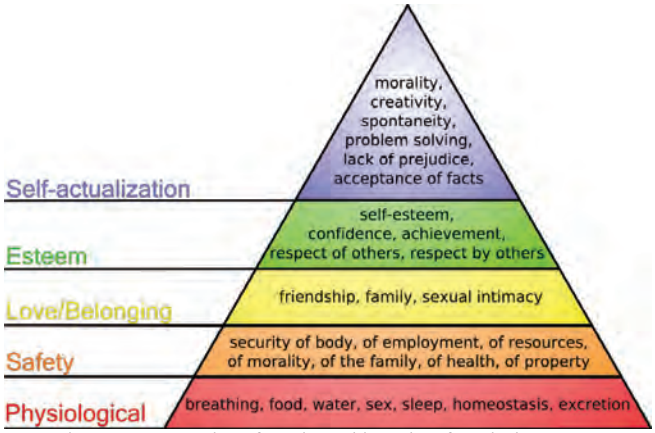

Fig. 1: Representation of Maslow's hierarchy of needs theory [12]

I will use this theory as a benchmark to compare levels of motivation and the path to self-actualization which in an ideal world are inherent to education and being a professional.

IV. What it means to *become* and *be* and Engineer

As I stated in the introduction, I will not and in light of where research stands, cannot claim all that constitutes becoming and being an Indian engineer. However, after elucidating on the sense of being and psychological needs of an individual (and subsequently an engineer) in the previous sections, I now segue into pointing out how these differ in the context of engineering in India. For this purpose I'll touch upon two trends to show differences between societies: (1) motivation of students to pursue engineering in the light of employment, and (2) professional expectations.

A. Education: Becoming an engineer

Referring back to Figure 1, security of employment appears on the second level of Maslow's theory. Also many a times, especially in the Indian context, employment effects fulfillment of physiological needs of the first level as well. My claim to highlight the difference among societies is that even though the ideal purpose of engineering education (via an ontological approach) is discovering and sometimes embedding engineering in the sense of being of an individual, students over different societies enter institutions of learning at different levels of the pyramid. To quote certain figures to strengthen my claim: As in June 2011, the Association of German Engineers reported 76400 vacant engineering jobs [16]. In 2011, unemployment rate for engineers in the United States was 2% [17]. Whereas, in 2012, 200,000 engineers and 132,000 diploma holders were unemployed in India [18].

The sources can be debated upon, different sources might quote slightly different numbers, but we can't turn away from the large trend that is visible here. These telling numbers bring up a very obvious and necessary idea around how the motivation of students in India to pursue engineering are different, and so engineering education reforms need to be designed in a way to overcome these adverse effects on motivation. A naïve rebuttal to this example could be that these figures point towards India housing "enough" engineers, however with the country being nowhere near supremacy in the field [19], these dynamics definitely need to be thought of again and overhauled.

B. Profession: Being an engineer

Professional expectations also vary greatly over societies. This in many ways can be attributed to the inherent difference between societies. To give instances of two of India's engineering marvels: Chandrayaan 1 (worth $80 million) was hailed as the cheapest moon mission [20], and the Mars Orbiter Mission (worth $73 million) as the cheapest inter planetary mission to mars [21]. On the other side, NASA estimated $104 billion for a moon mission to return to the moon by 2018 [22].

I realize that the projects aren't the same, and that points towards how where the Indian engineer seldom claims making big technology that cost anything higher that the cheapest in the world, the American engineer can actually hope for if not always achieve such a project. In many ways this is a function of the country's economic standing, and that only helps me make my claim stronger about how different societies give their engineers different "facts" to show their "creativity" and "spontaneity" (keywords from the top level of figure 1). In no way does this take away from the skill and ingenuity of either, but it does push forth my claim of how it is different to be an Indian engineer, with a different set of constraints, resources, and social consciousness. To come back to the idea behind putting forth this trend, professional expectations vary between different societies, being oblivious to this and hoping for a smooth transcendence of engineering education over cultures might not prove very fruitful in the long run.

The above two trends are clear indicators of how it is different to become and be an engineer in different social contexts. Though at the same time, they are also healthy indicators of how if these characteristics are acknowledged within a society and reforms are created accordingly, it will lead to unprecedented progress on an Individual and National level.

I find this an important place to restate that even though this text is shaped more specifically for India, the underlying premise can be extended to most societies.

V. Concluding thoughts

This paper was an attempt at assimilating theories, facts and prevailing conditions to present a case for society specific research for engineering and engineering education in the context of India. For a brief backstory of this paper: I had put together programs and reforms that showed positive effects for societies, and intended on presenting how they would play in the Indian context. However as I delved deeper into this study, I realized that direct transcendence was not possible for most cases. This made me interested in the reasons behind this, and the difference in human beings (and broadly societies) came up as a very plausible explanation on the basis of prior work done and theories proposed. As I stated earlier, I wrote this paper with the intent of encouraging research and so it might not comply with the conventional style and structure of academic writings. I used active voice to ground my claims in valid evidence intentionally as it complied with the purpose of this paper. In conclusion, a case for future research to aid society-specific reforms in curriculum and professional practice was made in the domain of engineering and engineering education in India.

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