# Integrating Theological Aspects to Engineering Education

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***Abstract*—Engineering brings functionality in the modern world across sectors from healthcare to education. The engineering method for problem solving consists of identifying, defining and structuring a problem and then creatively and systematically solving it. In the process, underlying the surface level thinking, the engineering mindset balances tensions between (1) exactness and ambiguity; (2) the familiar and the unfamiliar; (3) concretizing and abstracting problems; and (4) position within prevailing hierarchies. As a pivotal period of an engineer's professional growth, engineering education influences a student's position within these dimensions. Future engineers are expected to design solutions to increasingly wicked problems that can have ethical, moral and existential aspects. As a solution, several engineering curricula include courses in ethics. While such a course can be useful, it often fails to broaden the core set of the engineering students' epistemic beliefs. Furthermore, there are several ill-defined problems that ethics does not have tools to address. To bring balance to the engineer's epistemic toolkit, whilst still focused on achieving technical skills, we propose to integrate aspects of theology, i.e. the scholarship of existential questions and the ultimate, into engineering education. In this work we present both a theoretical foundation and conceptualization for our proposal which we supplement with findings from an empirical seminar discussion with engineering students and faculty.**

***Index Terms*—theology, digitheology, engineering education, wicked problems, engineering mindset, ethics**

## I. Introduction

In the contemporary world, questions of theological, or existential, origin are posing novel challenges to engineering education. While engineers have always been designing solutions to all aspects of life, including sacred spaces whose architectural design allows their dwellers to better experience the existential, we observe an emerging demand for support in fears related to wicked problems, such as climate change or virus outbreaks, or conflicts involving diverse and competing beliefs and ideologies. Moreover, the fragmentation of the world into isolated spheres of science vs. religion, elite vs. grassroots, and alike, is creating tensions, globally. Engineering students themselves encounter existential questions in their personal lives, and engineers, as professionals, are increasingly expected to derive answers which take into account the existential nature of the questions.

Thus, while the classic engineering approach to solving closed or well-defined problems was useful in the industrial era, the contemporary ages of information and imagination have brought in, already in the 1980s, ill-structured problems and other vast, obfuscated and non-orderly challenges that require novel competences from engineers [1]. Udwadia argued that some engineers possess or develop a mindset, discussed as the narrow engineering mindset, where engineers are only capable of operating inside a closed sphere that is oblivious to what is going on in the world around it, which guides the engineer's thinking also outside working environments [1]. Certain engineering students might gravitate towards engineering training because they already possess this kind of a mindset, and the formal education might then reinforce their thinking patterns further [2]. After graduation engineers move to work in jobs with other engineers, moving from a bubble to the next and spending a majority of their lives working with the same set of epistemic rules [2].

Some scholars have gone as far as to claim that engineer training might breed terrorists, arguing that the over-representation of engineers among Islamist extremists can be attributed to engineering education [3]. This argument is supported by analysis of the narrow engineering mindset among European engineering students, which shared the following similarities with right-wing extremists: (1) *"A need for cognitive closure, or a preference for order and distaste for ambiguity"*, (2) *"An acceptance of prevailing hierarchies"* and (3) *"The experience of high levels of disgust when confronted with the unfamiliar"* [4]. Furthermore, engineers casually create abstractions of problems - even sometimes resulting in dehumanizing individuals by seeing them simply via numbers [5].

As a solution to the challenge of epistemic reduction in the engineering mindset, Udwadia suggested that new and different world views should be introduced into the training of future generations of engineers [1]. Supplementing this idea, Floorman proposed including cross-disciplinary values in engineering education to support the birth of a wider world view [6]. More recently, these ideas were echoed by Frezza, who argues that any responsible engineering education should include teaching of values and principles, and not only pure engineering [2]. For *re-humanizing* engineering education, McPhail recommends encouraging attachment, commitment and emotion towards other people [5], concretized for example in Stanford's design school's focus on empathy as the guiding

step of any design, including engineering [7].

These aspects are to some extent taken into account in schemes like the CDIO (Conceive Design Implement Operate) model of engineering education that emphasizes real-life demands as a context and inspiration for engineering education [8]–[10]. What we propose goes however further. Real-life includes existential challenges to which systematic approaches such as the engineering process does not work. These types of problems are, for example, questions regarding how to live, what to take into account when living and working with other people or whom to love and why to live. We propose that theology can offer tools that are useful for addressing the above mentioned issues, and consequently, bring balance to the engineers' systematic approach to problem solving.

An early yet contemporary pioneer of our agenda is the invitation of theologian Anne Foerst to bring in theological expertise to the MIT Media Lab, for designing a robot, anthropomorphic not only in stature but also in sin [11]. Expanding on her ideas and building off the extant literature, this work presents a theoretical foundation and basis for integrating aspects of theology into engineering education. To support our conceptual work we bring in findings from a 90 minute research seminar on the topic held with university engineering students and faculty. We conclude our work with an elaboration on the what theology can offer to engineering education with regards to (1) opening a new application area; (2) alleviating the potential engineering mindset issues described by Gambetta and Hertog [4] as well as McPhail [5]; and (3) giving tools to tackle ill-defined issues with existential dimensions.

## II. Background

In this section we go through prominent theories on how humans view existence and why, and what remedies theology can offer to arising issues.

### A. Theory of Existence- I-Thou

Martin Buber's book *I-Thou* [12] gives a philosophical framework that helps to understand the narrow engineering mindset. Buber argues that humans perceive reality through two types of relationships (1) I - It; and (2) I - Thou [12]. The I-It relationship refers to objectifying problems, with no limits to how much they can be criticized, opened up, simplified and formalized. It allows engineers to reduce complex systems to a form which they can understand completely. Despite the necessity of I-It for the engineering process, it should never be applied to human relationships [12]. Humans should be approached via I-Thou, that is, acknowledging them as persons and that they have similar level intelligence, and approaching them via conversation instead of simplifying and objectifying them to the I-It relationship. The modern CDIO approach seems to integrate the I-Thou personal relationship in engineering education, when working with real people in real-life situations [10]. However, the social identity theory suggests humans are prone to objectify groups of people, approaching perceived out-group members with prejudice [13] even if on an individual level they would conceptualize the relationship as I-Thou.

The Princeton University professor and philosopher Walter Kaufmann writes in the prologue for his 1970 translation of Buber's *I and Thou* the following: *"What is wanted is an oversimplification, a reduction of a multitude of possibilities to only two. But if the recommended path were utterly devoid of mystery, it would cease to fascinate men"* [12]. This fundamental aspect of simplifying choices into two, yet maintaining a level of mystery in both, is an inseparable part of the way humans perceive the world. This is echoed in religions and ideologies all around the world and has been doing so for the entire course of recorded history. Despite the oversimplification of our surroundings being natural, it does not mean it accurately depicts reality, nor is a healthy way of thinking. In fact, simplification eventually will lead to oversight and the dismissal of important aspects of life. The Nobel-prize winning physicist Richard Feynmann writes in his work *The character of physical law* about the difficulty of replacing Newton's laws for gravity: *"Newton's ideas about space and time agreed with experiment very well, but in order to get the correct motion of the orbit of Mercury, which was a tiny, tiny difference, the difference in the character of the theory needed was enormous. The reason is that Newton's laws were so simple and so perfect, and they produced definite results. In order to get something that would produce a slightly different result it had to be completely different. In stating a new law you cannot make imperfections on a perfect thing; you have to have another perfect thing. So the differences in philosophical ideas between Newton's and Einstein's theories of gravitation are enormous. [14]"*. His point further stresses the importance of avoiding reduction of frameworks into only a few well working ones, as slight improvements might require a complete overhaul of existing conceptualizations and even axioms.

Kaufmann reiterates Bubers most central thoughts: *"The only God worth keeping is a God that cannot be kept. The only God worth talking about is a God that cannot be talked about. God is no object of discourse, knowledge, or even experience. He cannot be spoken of, but he can be spoken to; he cannot be seen, but he can be listened to. The only possible relationship with God is to address him and to be addressed by him."* [12]. Here lies the key to what new theology can open up in the narrow engineering mindset. Instead of reducing all relationships, including that to other humans and God as *I-It*, theology challenges to view the world fundamentally through *I-Thou*, as a personal relationship. This can be a key to re-humanizing engineering education as it provides engineers with a completely new viewpoint on reality. This does not challenge the engineering method of problem solving, and engineers will still need to simplify and reduce reality, seeing it through *I-It* for effective and creative problem solving. However, theology provides balance to this process by guiding thought processes especially in the conceive and design phases of engineering as described by CDIO [9].

Contrasting Buber's worldview through I and Thou is, for

example, oriental or East Asian philosophy. Buber's dichotomy is not aligned with the approach of philosophies which do not separate between the object and the subject [15]. One example of such world view is to view people and objects alike through I-Thou, seeing something sacred or valuable in each object and person. This type of thought is present, for example, in Shintoism and the ideas are visible throughout Japanese culture. Questions regarding other types of approaches such as we-them and we-you also arise, as exemplified by Kaufmann in his prologue for Buber's seminal book [12]. These types of approaches are useful for explaining inter-human relationships and social phenomena [13].

### B. Evolutionary Benefits of Theology and Religion

One of the evolutionary benefits of religion has been that of uniting people under the same moral obligations and cause [16]. This has made predicting the behavior of others less demanding, as according to social identity theory, the shared religion provides a framework in accordance to which everyone is expected to behave [13]. The benefit of being able to predict a fellow person's behavior does not limit to sharing religion, as culture, ideologies, common hobbies, family ties and other sorts of connections can support humans perceiving others as their in-group members [13]. On the other hand, people who do not share the same set of religious or ideological beliefs, or the same nationality, are perceived as out-group members or strangers, against which humans automatically form prejudices to protect themselves from uncertainty [17]. This mechanism serves to protect humans from information overload, which can have negative behavioral consequences [18]. On the other hand, in a multicultural globalized world we cannot afford to live in our tiny echo chambers.

Humans require education regarding their tendency to box people with prejudice, both positive and negative [19]. The unconscious or implicit bias can sometimes be hard to identify, as the causes can be anything from accents and ethnicity [20] to conflict in a fictional game world [21]. Thus, bias can occur even for educated individuals, such as those responsible for recruitment and interviews [20]. This has become a major challenge in the contemporary global world where multiculturalism is increasing. The cultural and ideological mix is being fuelled by increased immigration as well as the internet, personalized search results and polarizing social media [22]. As humans are thus increasingly being faced with difficult-to-predict behavior in the real world, they seek comfort in reading and listening to confirmatory thoughts online and not having their views challenged. This process makes humans eventually ill-equipped to deal with real world problems and might lead to cognitive dissonance [23]; this has been addressed in engineering education, for example, in the Concept and Design phases of the CDIO engineering education model [24].

For people who share a distaste for ambiguity, the process of polarization and avoidance of conflicting thoughts can be particularly damaging. Gambetta and Hertog demonstrate in their seminal book "Engineers of Jihad" [4] that engineers may exhibit narrow engineering thought patterns outside their work context, with serious consequences. Education has the opportunity and duty to interfere, and we propose that theology is a particularly effective medicine to the above described problem. Theology is a study of the prevailing religions, the shared ancestry of the humanity as expressed in various creation stories or myths, the set of dogmas, moral rules and mindsets which have stood the test of time. From the Jungian perspective theology gives perspective into the human collective subconscious [25]. Through religious archetypes morality, ethics, nature of good and evil, meaning of life and other important unclear and difficult questions can be explored. Returning to Buber's *I-Thou*, at the heart of theology is that instead of viewing existence via I-It relationship, it is founded on I-Thou, a personal relationship with God [12]. This core epistemic mindset wards from oversimplification of reducing and formalizing the reality into a narrow framework, and opens it for exploration.

### C. Ethics in Engineering

Several studies have proposed that ethics should be included in engineering education (e.g. [26]–[28]). One of the primary reasons is that engineers are involved in designing systems that end up serving real people. Lynch and Kline argue that informing engineers about previous system failures and engineering solutions that have cost human lives due to fallible engineering judgment, may improve the safety of solutions they create [29]. Ethics education can also be thought to prepare for life outside engineering problem solving.

Ethics and theology are both broad terms which encompass a vast amount of epistemic beliefs. Ethics can be observed from a theological perspective, for example, building on top of Judeo-Christian morality or the Golden Rule, but it can also be viewed from a secular perspective where ethical values are derived from the human biological reality or other sources. There is an ongoing debate on whether the morals of the Western civilization should be based on neural science and psychology [30] or religion and ideas tested by history [31], [32]. Both sides make convincing arguments, with the latter basing their claims on historical evidence and the fact that due to the evolution of ideas only those religious beliefs that resonate the strongest with actual biological reality of humans have survived [32]. The former then claim that despite the evolution of ideas, the current religious dogmas of world religions are not the final ultimate product of evolution and can be improved further with science [30]. Cautious Jungian psychologists have noted that the human subconscious and morality are not yet fully understood and via discarding some seemingly unnecessary religious values something that is in fact valuable might be lost [33].

Studies have shown that several engineering ethics courses fail in that they manage to create an image of an ideal hero engineer who is individualistic and whose capabilities of dealing with the world outside engineering are unimportant [26]. Ethics is represented to engineers in an unambiguous way, as rules or professional ethical guidelines, providing a fixed

framework and structure on how to behave, epistemically resembling the simplified narrow engineering worldview. This kind of education can feel familiar to engineering students, but can simultaneously disengage them from the ethical thought processes that are necessary for solving ill-defined morally or theologically unspecified problems. Ethics is learned as if it were the same as law, to which humans abide in fear of sanctions, whereas moral behavior is motivated by avoiding the feeling of guilt, a concept with theological connotations, and the wish to receive praise [34]. For more elaboration on the stages of moral development, see Kohlberg [35]. Thus, engineering ethics and engineer's ethics should both be taught to ensure the learning of capabilities to deal with complex moral dilemmas in the modern world [26].

### D. Digital Theology

We have shown that engineers benefit from encountering alternative epistemic beliefs, human-centered thinking (Buber's I-Thou [12]) and ethics in learning to solve ill-defined and wicked problems, but also to support thinking outside the engineering profession. Despite, theology being a solution to these challenges, the connection to theology as a discipline deserves more justification. Perhaps the primary reason to choose theology over ethics or religious studies is that it involves a personal relationship with God, I-Thou, instead of reducing religion and ethics to a controllable system of thought via I-it [12]. Thus, theology escapes the pitfall of previous engineering ethics courses where ethics is reduced and forced to fit the engineering mindset [26]. In addition, theology can provide an application area for engineers to innovate and design solutions. A recently emerging field where software engineering is applied to theological problems is called digital theology [36], and it is worth looking into not only as an application area, but also because it serves as an example of how engineering and theology might be integrated.

Digital theology is distinct from its neighboring field digital religion. Whereas digital religion covers the phenomena of religion in digital culture and their meaning, digital theology is focused on the digital aspects of the study of the nature of God, God's interaction with the world and the exploration of the mystery of faith [37]. Phillips et al. [37] propose four levels or waves of digital theology:

- The use of digital technology to communicate or teach theology;
- Theological research enabled by digitality;
- Intentional, sustained and reflexive theologically-resourced engagement with digital culture; and
- A prophetic re-appraisal of digitality in the light of theological ethics.

In the context of our research problem, the fourth wave seems the most relevant. It is an approach to digital ethics that cannot be reduced to an unambiguous framework, but understanding of which requires exploration and dialogue [37], a true engineering challenge in the era of digitalization.

### E. Summary of the Theoretical Foundation

We identified four theoretical perspectives that indicate, explicitly or implicitly, the potential of theology for enriching engineering education and widening the graduates' engineering mindsets. The perspectives are particularly critical when the engineer works on wicked problems with existential threads and with users or clients from diverse cultural and, usually hence, religious backgrounds, especially in the C (conceive) and D (design) stages of the problem solving process, as defined by the CDIO model of engineering education [9].

The four perspectives enhance engineering education as follows. (1) The I-Thou aspect offers a complementary basis for an engineer's encounter with the people that the engineering problem is relevant to [12] and wards against the simplification and reduction of reality by enforcing the tension of ambiguity. (2) Evolutionary and social psychology show the engineer's challenges in coping with the diversity of people as in the globalized world engineers are working on problems with people from multiple cultures, and also designing solutions to a wide variety of people. Theology reminds of all the humanity's common grounds and gives concepts, terms and approaches to a reasonable dialogue and encounter. (3) Ethics and morality are issues which many people approach from their religious and ideological bases. The argumentation is important for an engineer to comprehend, especially due to the ethical questions' increasing inference in engineering problems. (4) The emerging field of digital theology elaborates concepts, models and approaches where software engineers can work with theologians for designing digital services for challenges of theological relevance. In a way, they are the church and temple architects of the contemporary era of information and imagination.

Finally, it is important to stress that theology does not reduce to ethics, or vice versa, although they share common interests. Theology is a scholarship that focuses on human condition and dignity from the viewpoint of the Ultimate, and questions of existence and meaning. Theological reasoning and argumentation are globally ubiquitous for several of engineers' clients, also in the clients' decision making, and thus, the engineer needs to, if not follow them, be aware of and respect them.

## III. Empirical Research Design

To bring an empirical viewpoint into our study, we wanted to involve stakeholders from software engineering and computer science in the discussion on how they would balance in tensions associated to the four dimensions of engineering: (1) exactness and ambiguity; (2) the familiar and the unfamiliar; (3) concretizing and abstracting problems; and (4) acceptance of and questioning prevailing hierarchies [4], [5]. To this end, a 90 minute seminar was organized in March 2020 at the University of Turku, Finland, involving both software engineering students and faculty members. The seminar began with the first author holding a presentation concerning the content of the theoretical section of the current paper. The seminar was then opened for a semi-structured discussion where each

of the four engineering mindset dimensions were tackled separately. Roughly 10 minutes were spent on each of the problems, during which participants' key ideas were recorded. Finally, all participants were presented four ill-defined real world scenarios to which they had to write down their ideas how to approach them. The scenarios were: (1) What should morality be based upon? (2) How should we deal with the coronavirus (COVID-19) pandemic? (3) Climate change; and (4) Would you comply with the existing ruling structures of the world i.e. engage or disengage with politics, participate in decision making or not and accept or challenge prevailing hierarchies? The scenarios were designed to address each of the four engineering mindset dimensions, with the purpose of figuring out whether the identified narrow engineering mindset problems [4] existed among the faculty members and students in the seminar, to what extent and how. The aim was to get engineering students' perspectives for the presented ideas to see what aspects of the theory resonated with them, and what aspects were possibly missed or overlooked in the theoretical research.

Altogether, 13 students and 3 faculty members participated in the seminar, wrote down their answers and gave a permission to use their answers for research. The replies were collected on paper and no names or credentials were asked in order to protect participants' anonymity. Participants (N=16) consisted of mainly graduate students, both male and female. The seminar took place on Friday 6th of March and was part of a monthly interaction design seminar series. Student participants received a mark for being present that counted towards their study credits from seminar participation. The seminar was carried out at a university where neither computer science nor software engineering degrees involves any mandatory courses on ethics or theology.

The discussion was analyzed by writing down points and ideas that were brought into the discussion. These notes were observed together with the participants' written responses. Open coding as guided by Strauss and Corbin [38] was done on the written responses. These codes were then gathered across all written assignments and notes and clustered together based on their themes. This allowed us to identify trends or anomalies within the replies. Following the Gioia method [39] these clusters formed our 2nd order themes. After obtaining the 2nd order themes, we reflected these in light of our theoretical conceptualization in order to connect the findings to the theory. We present our findings through these emerged aggregate themes and refer to both academic literature and seminar participant comments. Due to practical reasons and scheduling issues, the open coding [38] and thematic analysis [39] were carried out only by a single researcher. Furthermore, the sample was limited. Thus, the seminar discussion findings need to be considered as exemplar and supplementary rather than exhaustive.

## IV. Findings

This section presents key points from the seminar discussion analyzed by and related to literature and relevant theories presented in the theoretical section of this work. First, we look at how theology can expose to ambiguity through open discussion and students' replies to all the questions. Second, we look at how theology can give tools for encountering the unfamiliar through the case of the COVID-19 pandemic. Third, We observe how theology re-humanizes accounting and engineering through the question of climate change, where we asked students' to view the climate change problem through the perspective of people who are in most likely danger to suffer from it first. Fourth, we look at how theology can expose to thinking hierarchies in a new way through the questions concerning the ruling structures of the world. Fifth and finally, we take a look at the seminar participants' ideas on what morality and ethics should be based on, and what opportunities and needs that opens for integrating aspects of theology into engineering education.

### *A. Theology can Expose to Ambiguity*

The first discussed issue was the engineers' distaste for ambiguity identified by Gambetta and Hertog [4]. Surprisingly, none of the participants said to avoid ambiguity. This was evident in both the discussion as well as the written answers students returned at the end of the seminar regarding the four ill-defined real world problems. This would suggest that the narrow engineering mindset issues identified in previous studies (e.g. [4]) only concern people at the very end of a spectrum and not the majority of engineers. It is also noteworthy that the participants were university students and academics, and as such, perhaps not representative of engineers as a group of professionals despite studying and teaching engineering.

In Jewish and Christian philosophy ambiguity is ubiquitous. Rabbis, theologians and philosophers propose contradictory theories which are still both accepted to be true. While exegetics seeks to bring clarity and rigour to these mysteries, systematic theology creates dogmas, that is, religious axioms, to organise and structure the knowledge. Still, ambiguity remains. For example in Christianity, the idea that God is simultaneously three, the Father, the Son and the Holy Ghost is a central concept. Furthermore, theologians approach God via a personal conversation, I-Thou [12], or ontologically, instead of viewing God as an object of study. This makes reducing God to a framework impossible, but the personal relationship allows a method to deal with ambiguity via this exact conversational relationship.

It is also customary in theology that alternative, sometimes conflicting interpretations of the same texts exist. We see this in Biblical texts as well as other historical texts [40] and even archaeological interpretations [41]. While religious fundamentalism can serve the exact opposite, reducing religion into a strictly defined black and white picture of good vs. evil [4], theology as an analytical discipline breaks the illusion of such view being reality.

### *B. Theology Gives Tools for Encountering the Unfamiliar*

With a scenario regarding the timely COVID-19 pandemic (e.g. [42], [43]), we aimed to observe how engineering stu-

dents and faculty approach situations that contain a lot of unknown variables, where no pre-existing best approaches exist and where the consequences of inadequate actions and wrong decisions can cost lives. The majority of the responses seemed to reflect the importance of data collection followed by information-based decision making. Solutions were presented for how to collect global health data and disseminate knowledge, as well as how to avoid disinformation and fake news from spreading.

Surprisingly, ideological, political and religious decision making were addressed in only two replies. While this does not prove that the engineering students would be unable to make such decisions, it shows that perhaps they are more comfortable at approaching problems from the engineering standpoint. In the case of COVID-19, the data-driven approach to problem solving is unarguably an intelligent one. However, in addition to using science to solve COVID-19 related issues and predicting how the disease is going to advance, political decision making such as balancing between the economy and lives are needed. These kinds of decisions can be assisted with data, but are ultimately also influenced by ideological and religious beliefs. Acknowledging the existence of such beliefs is crucial for transparency in decision making.

Theology provides engineering with a novel application area; a matter critical and constructive to the development of engineering as a field. Designing solutions for theological challenges can invoke personal exploration of the meaning of life or thought processes regarding how to live, and support both spiritual and practical interpretation of the world. Furthermore, theology can offer complementary perspectives for problems that are not solvable only by engineering, from highly individual to those of global character.

### C. Theology Re-humanizes Engineering

One of the identified issues of the narrow engineering mindset is that as a consequence of abstracting humans as numbers in problem solving, engineers, accountants and decision makers eventually forget and lose sight of the fact that the numbers in their data represent real people [5]. We asked students how they would tackle climate change and take into account the people suffering from it the most. Based on the responses students' seemed conscious about the suffering and potential damage that climate change and overpopulation are causing. Surprisingly, the majority of the answers this time did not focus on technological innovations and engineering solutions, but rather on political measures such as population control and CO2 emission quotas. This is in stark contrast to their answers regarding the COVID-19 pandemic. One cause for these findings might also be the societal discussion that has been going on regarding climate change, and the fact that it has focused on political issues rather than how technology can help the situation.

The participants seemed emotional about climate change which might have been guided by how the problem was presented to them. While no strictly theological approaches emerged among the participants, the responses bare no connections to the extreme ends of the four problematic dimensions of the engineering mindset either.

Bringing in the theological perspective on this issue, the Bible, for example, is a human-centered book that deals with complex ethical and moral questions and introduces philosophy to deal with those questions. The archetypal stories as well as the moral teachings remind of the importance of taking care of fellow human beings and the disadvantaged. While we assumed based on Gambetta and Hertog [4] that some of the engineers might lack an emotional approach to climate change, this was not true in our case. It might be that the climate change debate has recently focused too much on emotion, and while the emotional responses and moral outrage can be justified [44], [45], they are not on their own solutions to the problems. The climate change problem could substantially benefit from engineers using their creative talents and systematic approach in devising innovations that help to deal with the climate change. The solutions might be aimed at either reducing CO2 emissions and decelerating the process or aiding in coping with the consequences.

### D. Theology Introduces Alternative Hierarchical Structures

In order to look at the dimension Gambetta and Hertog describe as "acceptance of prevailing hierarchies" [4], we asked participants quite frankly whether they were likely to challenge the existing ruling structures of the world either verbally or by other means. Among all the questions this was the one where the responses fully aligned with the narrow engineering mindset. Only four responded they would criticize prevailing hierarchies if there was reason to, however most stated they were happy with how things were without further elaboration. The results might be understood from the perspective that the participants were living in Finland, a country with high social security, high freedom of press and a high standards of living.

Independent of one's personal belief, theology provokes thoughts and encourages to conceptualize reality and position individual ideas within the surrounding world. This anchoring process is iterative in nature and brings fresh perspectives against the "engineer bubble". This might also help recognize possible issues in the prevailing hierarchies such as economical inequality, racial or gender biases, sub-optimal solutions and generally how things could be done better. However, these positive things are not unique consequences of theology.

### E. Do we share the same morality and ethical beliefs?

In the qualitative analysis one highly interesting topic emerged based on the first ill-defined question, *"What should our morality be based upon?"* The answer to this fundamental yet conceptually challenging question can be used to predict behavior in the long run, as it is part of the human core belief system. To our great surprise, out of 16 respondents altogether 13 different foundations for morality emerged in the open coding analysis [38]. This discovery deserved a closer attention, as it highlights one additional problem engineering education and even more broadly the entire world may face. Together with globalization and the internet it seems humans

are also increasingly choosing their own personal belief systems which may or may not be compatible with others. As these belief systems are often implicit and non-conceptualized, it can be challenging to trace thoughts back to them. This may contribute to the polarization of society which we observe daily in social media as well as real world encounters.

The 13 different reasons given as the basis for morality were: (1) science (broadly); (2) holy scriptures; (3) philosophy (broadly); (4) education (unclear); (5) personal world view; (6) action that causes cumulatively the most happiness among humans (utilitarianism); (7) law and regulations; (8) ethics; (9) historically proven well working values; (10) shared feeling-based acceptance of others and their behavior; (11) the government sets the limits on what is right and wrong; (12) empathy; and (13) social consensus -determined at a group level, not by individuals. Obviously these are not all exclusive in that multiple of them can co-exist. Still, the vast number of varying responses suggests large individual differences at this fundamental level.

Some respondents had time to justify and explain their answers while others simply mentioned a few key principles and left it at that. Over half of respondents mentioned multiple of the 13 reasons, for example, participant A stated: *"Morality should be based upon a combination of science, philosophy and religious scriptures. It should not be based upon a single principle"*. Following the clustering of open codes by Gioia et al., [39], this could have been a 2nd order theme or a category of its own, if not for several others mentioning parts of the response, science and morality for example, individually. A few participants compared different approaches, for example, participant F wrote: *"While Descartes questioned everything and wanted to improve everything, Giambattista Vico thought morality should be based upon historical evidence and values that have stood the test of time"*. Participant G mentioned utilitarianism to be according to him the most objective and clear basis for morality. Only a single participant mentioned moral behavior to be heavily dependent on our biological beings and a large majority seemed to view morality as a malleable construct which can change from culture to culture and over time.

While diversity is certainly desirable in most cases, diversity in morality might become problematic when people need to understand each other. Theology may be able to mitigate these issues by providing conceptual models and basis for morality and educating towards awareness and respect of the existence of diverse moral axioms.

## V. Discussion

### A. Key Findings

Our study consisted of two parts: (1) theoretical foundation; and (2) empirical exploration. In the theoretical part we had four perspectives through which we argued for integrating aspects of theology into engineering education: (i) Buber's I-Thou [12]; (ii) evolutionary and social psychology; (iii) ethics and morality; and (iv) digital theology. Consequently, we came up with four+ one dimensions which were brought to the seminar for further discussion. The four first dimensions were identified through prior literature whereas the fifth was obtained in the empirical exploration. These were simultaneously our key findings from the background. Thus, integrating aspects of theology into engineering education has the following potential benefits:

- Theology exposes to ambiguity.
- Theology gives tools for encountering the unfamiliar.
- Theology re-humanizes accounting and engineering.
- Theology introduces alternative hierarchical structures.
- Theology helps generate common moral ground.

While the research seminar participants in the second part of our work were deemed not to be representative of engineers as professionals, their thoughts and ideas gave further details and ideas for future work. Most interestingly, we found out the following:

- The moral landscape in Western countries seems to be shattered, with almost everyone having their own way to determine morals and how to live a proper life.
- Engineering students might, contrary to what we expected based on the work by Gambetta and Hertog [4], actually lack the narrow engineering mindset, however, this needs to be verified in future work. The lack of the narrow engineering mindset was evident, for example, from the climate change discussion where participants seemed to have emotionally loaded responses and no proposed engineering approaches to solving the problem.

With these findings, our study has several implications for future work and research concerning engineering education.

### B. How Theology can be Integrated into Existing Engineering Curricula

An important aspect to discuss with regards to our findings is how courses in theology or hybrid courses between engineering and theology would fit into existing curricula such as the computing curricula [46] or CDIO-based curricula [9]. As existing engineering curricula are often rigid, adding new content to them can be challenging. Accordingly, we believe that adding theological elements to existing courses would be easier to implement rather than adding completely new courses to existing curricula. Theology could be present in the types of exercises and examples given during engineering courses. As examples of the natural alliance between engineering and theology, real world application areas, for example, church architecture and religious sculptures could be discussed and used as examples. Theological aspects could be mentioned during classes to broaden and expand the students' thinking to enable them to situate what they are learning into the wide context that is life.

For engineering curricula with a modular structure, a study module such as "digital theology", "theological engineering" or "engineering and theology" could be created. Theological curricula could similarly be expanded with applications of engineering. Solutions of engineering such as computers are already in use in theology studies, but the education could

increasingly focus on how these solutions work. The COVID-19 pandemic brought forward a situation where people were isolated to their homes [42] and hence, unable to participate in regular church activities. This forced church employees to adopt an increased online presence, and in this situation, knowledge of digital tools or even programming and engineering could have been of great benefit. We expect that this situation will increase the demand of digital and engineering education for theology students.

### C. Future Work

This work opens up and argues for a completely new addition to engineering curricula: theology. While the proposal is bold, it can be justified. To this end, we showed altogether seven interesting perspectives. Our lab is currently planning on a 5 credit (ECTS) digital theology course aimed at computer science majors and engineers, based on which a MOOC on the subject might be created later. This course could be studied by both, engineers and theologians - this way theology students would get in touch and potentially benefit from the creative and systematic problem solving approach of the engineers. Through this course we will be able to get further empirical data on how such a course might impact the engineering students' thinking. Accordingly, we are planning on conducting a pre-and post study with the students. This will give insight into whether ethical or theological interventions on potentially narrow or reductive thinking patterns are needed. Empirical data is also needed on how engineering students experience courses in (digital) theology, since a proportion of students might reject such courses as being either overly religious or mundane.

With regards to the seven venues for future research, more focused studies are needed to supplement the exploratory findings of the current study. Digital theology as a discipline is still at its infancy [37]. All of the seven findings are quite abstract and thus difficult to measure and even difficult to conceptualize. Their importance is also not self-evident, which further complicates things, but does not mean the beneficial effects of theology for engineers would not be very real and necessary. In this study we focus on justifying the addition of theological aspects into engineering education and thus, the theological aspects received more attention than engineering. To support our findings a similar study could be conducted from the perspective of integrating aspects of engineering into theology education.

### D. Limitations

In this study we analysed how to open up engineering students' mindset so that they develop competences to solve ill-defined problems that have a built-in perspective of theological character. However, it is worth noting that an opposite argument can also be made. Previous studies have reported that a certain number of students leave software engineering programs specifically due to the lack of being exposed to or managing to adopt what we have called a narrow engineering mindset [47]. This finding suggests there are immense differences between engineering students, especially freshmen, and that omitting or reducing classical engineering education and replacing it with something else such as theology is counterproductive. Our findings echo this as in the qualitative analysis of seminar participants' problem solving the typical pitfalls of a narrow engineering mindset could not be seen. In fact, it might be that only later on in their careers some engineers face the problem of getting epistemically stuck into the reduced and simplified way of seeing reality.

With regards to practical limitations in the seminar (N=16) and subsequent analysis, the results should be viewed as preliminary. The reasons are the small number of participants, them being from a geographically and culturally limited area and having limited resources (mainly time) at their disposal for communicating their thoughts and ideas. Furthermore, while the seminar certainly had an academic atmosphere where scholars typically are not afraid to criticize and present even quite wild arguments, the majority of participants this time were students, meaning they might not have the courage to challenge ideas that more seasoned scholars do. The participants were mostly engineering students thus perhaps not yet representative of engineers as professionals. Finally, the qualitative analysis (open coding [38]) was only conducted by a single author, lacking inter-rater reliability which would have brought additional rigour to the process [39].

## VI. Conclusions

This study provided a theoretical justification for integrating theological aspects to engineering education. We have established that engineering education and training programs need to involve complementary epistemic approaches to the existing engineering curricula by integrating humanitarian values [2], which is evident from, for example, the CDIO [8], [10]. We argue that a simple superficial education on values is not enough for engineers to adapt new epistemic approaches. Instead, education that challenges and provides alternatives to the core epistemic beliefs of engineers [4] is needed. For example, with regards to a possible distaste of ambiguity, engineers should be encouraged to deal with problems where ambiguity or even conflict is omnipresent, as is the case in real-life problems with existential character. There are such contents in natural science, like the wave-particle duality [48] or the problem with combining quantum mechanics and general relativity [49]. Finally, the global village of modern times is in dire need of engineers who can tackle problems caused by the fractions and frictions of the multicultural society. Theological explorations prepare an engineer to identify their own prejudices and recognize the common origin in the seemingly unfamiliar, whether by a personal *I-Thou* relationship or a more ontologically grounded communion [12].

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