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Affective Technology: Ethical Challenges to Engineering Education

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Affective Technology: Ethical Challenges to Engineering Education

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Abstract - Affective and derivative empathic technologies will become essential in the future of human-to-machine effectiveness. The discussion presents a brief review of the breadth and depth of how affect, valences, and emotions are measured and used. Reasoning mandates that the machine take-on this burden of understanding human perspective rather than humans forced to comprehend machine machinations. Potential applications will be found embedded in virtually every AI application. To maintain responsible and ethical use of this Affective Technology in the engineering educational system will need to incorporate an evolution due to the challenges presented by systems that use confidential and very private information and knowledge about the users of technology. In addition to the challenges, it also presents solutions this new breed of faculty must accept, adopt, and optimally develop to assure future ethical engineering practitioners.

Index Terms - Affective Computing, Affective Rights, human rights, ethics, privacy, empathy.

INTRODUCTION

Affective Technology comprising the numerous AI (Artificial Intelligence) technologies including ML (Machine Learning) which involve the simulation and stimulation of human affect and sentiment. [1] Though this technology may seem to be an interesting niche application of AI, it in fact poses to be the most significant challenge to the ethics of engineering education and practice. While at first blush seemingly hyperbole this paper will explore the dimensions and magnitude of this claim.

The discussion begins with a brief explanation and history of the technologies involved. This includes the methodology of this still nascent technology and the ambiguity of the inferences and decision-making results. While it does keep all the same potential of benefits and risks of other forms of AI, it carries the additional risk of always involving the collection and use of PPI (Personal Private Information). As such it has often been classified as a high-risk form of AI, even within recent standards concerning its application. [2] [3]

The issues raised in the disclosure of such voluminous amounts of PPI; the impact on privacy cannot be ignored or overestimated. The discussion explores the impact on privacy and the wellbeing of the people using this technology, whether it is a knowing or unwitting use. Since many applications are embedded in other AI applications, a knowing or meaningful consent can almost never be given in its use. This obscurity is revealed in how affective technologies collect and process this data. In fact, many if not most of the readers of this paper have already been subject to its use in everyday use of the internet, online social media, or in public surveillance use of affective technology mandated by work, school, or governmental and law enforcement applications.

To better understand the scope of this ubiquitous nature, the paper continues with brief overview of the methodologies and metrics of sentiment analysis. This technology presents ambiguity by the methods employed, since it is often the result of self-reporting by the data subject, or by inference. This is all without the availability of a ground truth to gauge its efficacy. However, and notwithstanding its limitations, it has great potential of benefits in certain applications, but with any very powerful tool, it must be used with proper caution and expertise to know the risks and limitations.

The paper then addresses the challenges presented in educating the next generations of engineers, technologists, and social scientists that will be trained to develop this burgeoning technology. Educators must become fully aware of the potential and limitations as part of the responsible role of guiding this next generation. In addition to the challenges, it also presents solutions that this new breed of faculty must accept, adopt, and optimally develop.

AFFECTIVE TECHNOLOGIES

Affective Technologies comprise a multitude of tools, skills, metrics that attempt to measure, simulate, and stimulate the affect and sentiment of living beings. This is most often related to human affect but can also be applied to non-human life forms. These technologies can range from passive data collection of interviews regarding emotions and feelings, or capturing gestures of the face, hands, eye movements, or body posture. Gait measurement can infer feelings of aggressiveness or fear with hesitations of movements, also including voluntary and involuntary micro gestures. The technology also includes various levels of invasive measurement of biometrics and even brain implants. [4]

The technology methodology can be organized with a classification which comprises:

- **Empathy Scores**, some tools, and platforms generate empathy scores by analyzing text or speech data. These scores reflect the degree of empathy expressed in the data.
- **Emotional Intelligence (EI) Metrics** which encompass self-awareness, self-regulation, motivation, empathy, and social skills, serve as valuable measures of empathy in data. These metrics can be evaluated through self-reports, behavioral observations, or physiological assessments.
- **Active Listening Metrics** is an essential element of empathy. Metrics such as response time, question-asking, and seeking clarification can help measure active listening in data. However, relying solely on such metrics as speech tempo and cadence without regard to cultural or individual considerations can provide misleading results.
- **Perspective-Taking Metrics** involve understanding and appreciating the viewpoints of others, including dimensions of Theory of Mind. Metrics, for instance how often a person acknowledges other perspectives or the variety of perspectives considered can gauge perspective-taking in data. This is quite challenging as it involves a more complete comprehension of not only the words used but the meaning of those words in a cultural context, which have fine granularity. Words can have nuanced meaning even within small geographics, to neighborhoods, and even down to family cultures.
- **Emotional Responsiveness Metrics** refer to how effectively an entity (human or machine) responds to others' emotions. The frequency of validating or acknowledging others' emotions is valuable for measuring emotional responsiveness in data. There is the challenge of differentiating between genuine versus feigned concern.
- **Facial Expression Analysis** analyzes facial expressions in images or videos to measure empathy. Certain expressions, like smiling or frowning, may indicate empathic responses, while involuntary micro-gestures can also provide useful insights into emotion and empathy. However, great care must be exercised as the nuances, and cultural variability can lead to errors in inferences. For example, the challenge of differentiating the meaning of a smile. It is difficult to determine whether a restrained smile is socially polite or feigning positive feelings. Consider the debate that the enigmatic Mona Lisa smile has generated over the centuries.
- **Gait and Posture Analysis**: analyzes stance, posture, and movement expressing a range of feelings such as anxiety, confidence, defiance, fear, hostility, or receptiveness. However, once again great care must be exercised as cultural variability can lead to errors in inferences. [5] [6] [7] [8]
- **Physiological Metrics** such as heart rate, skin conductivity, exhalation volume and gas composition, motor responses, and brain activity (e.g., electromagnetic, and hemodynamic signals) are useful for assessing emotion and empathy. Recent advancements in data collection tools now allow for contactless, remote, even surreptitious biometric measurements. Caution is also needed, for example polygraphs can be fooled by a trained individual or biometric measurements may be detecting an emotion that is not related to the immediate circumstance. This can be the result of fleeting thoughts caused by memories or external stimuli such as a scent evoking memory.

The data collected is used to infer the subjects' state of mind, hedonic valence, and emotional states. The use of the term 'subject' signifies that the human may not fully comprehend the personal information being collected or shared. Even in the case of the interview, the human response may reveal or belie true feelings. Since it represents the psychological state, the subject may not be fully aware of their state of mind. Even in great literature down through the ages humans are accused of lying to themselves concerning intimate feelings or even business motives concerning finances.

As a result of nearly all the affective data is of a subjective nature, it is essential to realize that establishing ground truth is almost impossible. Is a smile really a smile displaying happiness or a feigning hidden feelings of jealousy or hate? Does a facial gesture indicate the feeling of the current circumstances being investigated or does it reflect a memory evoked by an uncontrolled transitory odor? While it may seem prudent to doubt the efficacy of affective technologies it also carries much promise for much the same reasons. Affective Technology can provide

a personally customized learning experience, tailored to the individual students' needs, capabilities, and difficulties.

I. The potential of affective technology

While most challenging to properly infer affect as an absolute, much can be provided by the careful application of the methods used. Comparative analysis can indicate changes in affect in response to various stimulus. Furthermore, if the application incorporates dynamic or learning components, the stimuli can be modified to affirm the detected response.

Without much imagination application to a product or service under evaluation for customer acceptance can be seen as very attractive to a marketing team. Gauging the potential of new products, the potential for performing arts such movies, music, or works of fiction, also industrial designs, restaurant décor, new food products, the list is nearly endless.

It has already been successful in the application to therapy of children on the autistic spectrum. Interfacing technology in some manner does not present the barriers that human-to-human contact has. Clearly a more serious application demands the need for unambiguous ethics, as does any use by the medical professions which carry very weighty dilemmas.

The use of affective technology in life issues is not limited to the health care domain. It is already finding applications in the legal system. Examples include application to the voir dire process of jury selection and use by courts to gauge attitudes of defendants. Consider the implications of a jurist using such aid to determine whether defendants take the proceedings seriously enough.

The reader may have experienced empathetic AI use in their personal transportation vehicles, detecting possible driver fatigue. Or with MLLM (Multimodal Large Lange Models) using their favorite chatbot, when the prompt creates an AI response infers the user's attitude or emotion that may or may not have been real or intended, in essence a chatbot hallucination.

II. Metrics of acquiring affect

There are currently many methods of measuring affect and emotion and are as numerous as the suggested number of emotions expressed and would take a volume to enumerate the competing methods. This would be beyond the scope of this discussion, but a brief description of sone popular scales is presented to illustrate affect-data collection.

PANAS (Positive and Negative Affect Schedule) is the most widely used and has many flavors of specific application, yet all measure mood or emotion with positive or negative connotations. The basic scale comprises ten positive measures (e.g., happy, relaxed) and ten negative affective states (e.g., angry, sad). The other versions are intended in special applications such as compensating for cultural differences. [9] [10]

MAACL (Multiple Affect Adjective Check List) is a self-reporting metric also for both positive and negative affect and is used in the diagnosis and treatment of mood disorders. [11] [12]

POMS (Profile of Mood States) ask subjects to rate adjectives from five-point: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigor-Activity, Fatigue-Inertia, and Confusion-Bewilderment in how well these adjectives match feelings for the previous period. The questionnaire consists of sixty-five specific named adjectives to be rated [13]

This interest in trying to obtain insight into the workings of the inner self and how these emotions are communicated is not a new endeavor. Studied and introduced by Charles Darwin indicates his recognition that the complex musculature of the face makes capable of a very nuanced expression of emotion. [14] Intricate emotion based in human facial communication was recognized and studied. Furthermore, he recognized that these expressions of emotion are displayed by other species, giving examples of our primate cousins, and our canine friends. [15] [16]

Since these two-hundred (200) years-old studies, this research has continued and current research in this field has provided refinement and revised interpretations of the emotions and meaning of semiotic communications. However, the insight of Darwin's foundation is unmistakable when comparing current research. [17] The essential point to take away is emotions, which guide an individual's pursuit of both privacy and connectedness has long been embedded in human comprehension. Nonetheless the physiological state of muscle tonicity can create an enormous volume of data that may or may not be relevant to a person's current affective state, even when it might be considered a simple situation. Figure 1 depicts some attributions that could be assigned to even momentary and fleeting facial expressions, including micro-gestures. These expressions can also be intentional voluntary somatic action or involuntary responses, i.e., sympathetic/parasympathetic, enteric.

Further complicating this analysis by an Empathetic AI (EAI) system is the question of contextuality: was the measured response a result of the stimulus known to the EAI system or was it the result of an undisclosed stimulus? Even under laboratory conditions this poses a difficulty, for example a test subject being given tactile and visual stimuli with response data collected, simultaneously the test subject receives an uncontrolled stimulus to the olfactory senses. The sense of smell is commonly known to be one of the most powerful stimuli of memory and past experiences. [18] So which stimuli was responsible for the data collected and the presumed new 'knowledge'?

Undoubtedly, it is infeasible now to create an EAI system which can be completely cognitively aware of all the stimuli and culture influencing the observed responses. This aspect of society norms and ethics mandates

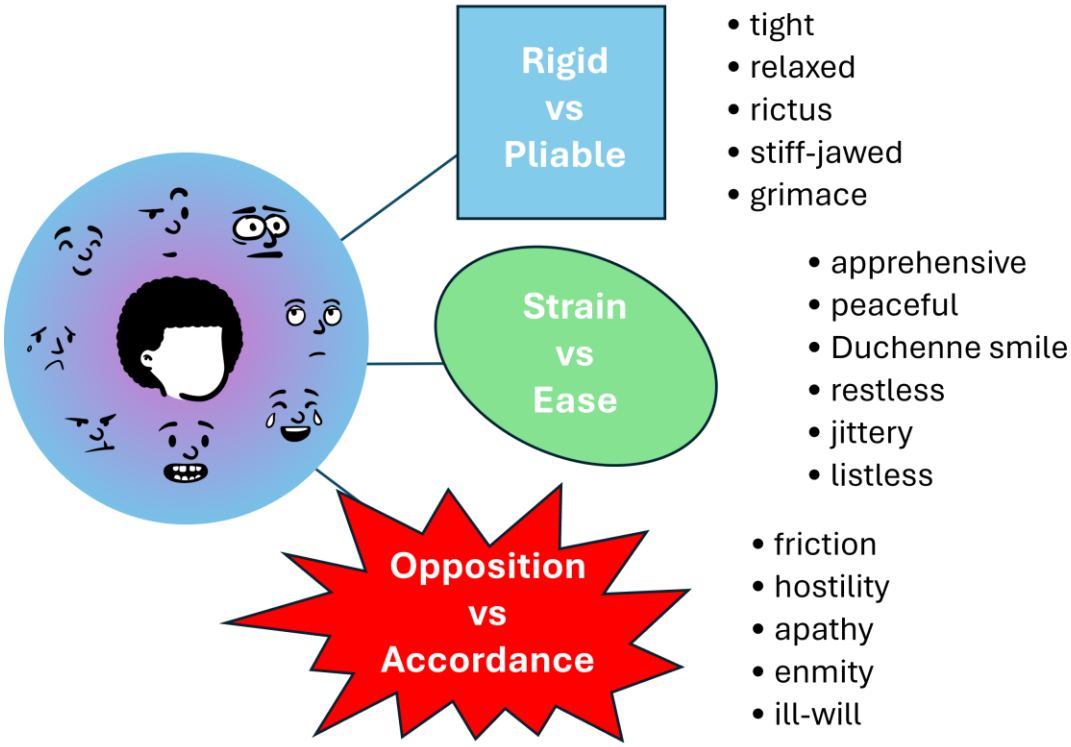

FIGURE 1: FACIAL MUSCLE TONICITY EXAMPLES AND POTENTIAL EMOTIONS COMBINING ANGER, SURPRISE, DISGUST, ENJOYMENT, FEAR, AND SADNESS.

responsible technology application and can be informative in the development of strong ethical standards.

Moreover, there is a less obvious means of data acquisition and that is the various indirect forms of metadata collection. It can become especially challenging to maintain privacy when induction and deduction make conclusions about metadata and data fusion. This fabricated data is assembled into new information creating new knowledge about a person, regardless of the actual accuracy and reliability of this knowledge. Unfortunately, it is presumed this new knowledge is valuable and even useful in creating a somewhat subjective 'ground truth' and marketed in widespread data markets.

While using substantially the same techniques and methods to realize new designs for a product, e.g., computer, vehicle, material, even medicine, it can bring enormous benefit to both patients and humanity. However, when it is used to create new knowledge about a person in EAI systems it should be quite evident that it also creates enormous ethical challenges for the use of this technology. When non-Emotional AI is used for ordinary design and engineering functions the results can be evaluated and refined in a controlled laboratory setting. In application to humans and other sentient life forms in sentiment and emotion processing the result can be great good but it can also bring irrevocable and catastrophic harm.

For example, consider the difference in the case of AI re-routing cabling in electric vehicle design, results can be evaluated and verified before deployment. If the new method is not satisfactory it is improved or discarded as appropriate. However, in the case of EAI application to people, without meaningful consent and adequate safeguards would be tantamount to high-risk human experimentation such as eugenics which has long been considered to be wholly lacking in ethics. Thankfully, we are not repeating this sordid past with several efforts to benefit from EAI and avoid the risks.

Among these safeguards are carefully designed curricula, socio-technical standards development, and training programs for faculty and administration. Evidenced to this is the current offerings and work in progress of IEEE SA (Institute of Electrical and Electronics Engineers Standards Association) for standardized educational records, curricula, certification, and licensing. These efforts address the unique challenges of AI, Affective, Empathic, Metaverse and Augmented Reality Technologies, all already being deployed in schools and universities. Even live laboratory animal models benefit from extensive protocols ensuring mandated ethical protocol integrity and safeguards remain intact.

PRIVACY: HUMAN RIGHT AND FUNDAMENTAL NEED

In discussing privacy, it is essential to first establish it as both a human need and its recognition as a human right. In creating a more accessible understanding of human rights, they can be classified into three categories:

- **Life Rights**: those rights are essential to basic needs of maintaining life and its procreation.
- **Affective Rights**: the recognition that humans must have autonomy to be able to understand their existence, their beliefs, inner emotional states, and valences; and the right to determine when, with whom, the extent and if they share this.
- **Life Fulfillment Rights**: this is the basic set of rights to pursue happiness, life beyond mere survival, and to find a personal means to achieving life's purpose.

It should also be recognized that this classification of rights does not add or remove long standing recognition of rights, it provides a more intuitive comprehension of how respect for foundational rights is mandatory for life to survive and flourish, and they are inherent to the very state of existence, i.e., inalienable. It should also be recognized there are crossover aspects to these rights and the dimensions clarified by this classification must recognize this interdependence. [19]

I. Maslow's hierarchy of needs and wellbeing

The complexity of privacy can begin to be understood with a review of Maslow's Hierarchy of Needs. [20] It helps explain why humans need the hierarchy of a private inner life, and an external public life: [21]

1) Physiological basic biological needs.
2) Safety satisfying the need for security and avoiding the feelings of insecurity. This is sought by individuals in many ways and to vast degree of variability. [22] [23] [24]
3) Need of Love, Affection and Belongingness to overcome feelings of loneliness and alienation, both in giving and receiving of this nurturing. [25]
4) Need for Esteem involving both self-esteem and for the esteem displayed by others. [26] [27]
5) Need for Self-Actualization which is to be and do that by which the person finds an identity or destiny. [28]
6) Self-transcendence, not originally included by Maslow, is a human need for introspection and metaphysical exploration of self, others, and spirituality. [29]

These needs demonstrate that privacy requires both shared and non-shared elements of the human psyche and for attaining and maintaining individual wellbeing. [30] [31] Furthermore, it establishes that privacy is required.

II. Privacy versus Security

It is most important to clarify the difference between Privacy which is an inalienable Human Right, also a basic human need for survival and flourishing. On the other hand, security is infrastructure used to protect PPI that has been shared either legitimately or illegitimately. It is also needed at times to share PPI to survive and flourish and should be left to the individual to determine the circumstances of that sharing.

It would be informative to briefly examine how privacy can be shared or invaded. Regardless of whether disclosures are legitimate or illicitly obtained, accomplished with full knowledge and consent or with soft or hard coercion, or at times surreptitiously these revelations are mainly experienced in the following ways, the more common and egregious privacy invasion examples are given in parentheses:

- **Invasion of Solitude**, (peeping, eavesdropping, wiretapping, recording images w/o consent,)
- **Invasion of brain function**, (brain-computer implants, chemical, biological, electromagnetic, or mechanical means,)
- **Identity Appropriation**, (identity theft, use of images or endorsement w/o consent,)
- **Public Disclosure**, (disclosure of personal information, gossip,)
- **False Light**, (false personal information, defamation, libel, slander,)
- **Coercion to Disclosure**, (disclosure by either soft or hard coercion,)
- **Misuse of Disclosure License**, (disclosure beyond the consent given, data shell game, dark patterns,)
- **Induction/Deduction of Affective States**, (EAI, presumption of Theory of Mind and/or Society of Mind.) [32]

Each of these types of disclosures or invasions have potential for both great benefit and great harm with the application of EAI.

APPLICATION OF AFFECTIVE TECHNOLOGY

Case studies are important to the science of empathy and the potency and risk-benefit balance of Affective and Emotional AI. The following two case studies illustrate the benefits and risks that must be managed in the use of such potent technology. Our minds' inner emotional life, in the creation of a morality using complex neurochemistry and illuminated by pioneer P.J. Zak is the physical underpinning and link to affective technologies. [33] Conversely there is ambiguity in predictable responses to the stimulation of this biochemistry. [34] Affective technology leverages this by influencing the release of those biochemical controls, with the potential to either positive or negative emotional responses. Certainly, such a powerful tool with non-determinate effects needs the highest level of care and caution in its application, with

indiscriminate and non-vital use, to be strictly controlled globally and in the most dubious applications, banned.

I. EAI Childhood Autism

The parents, family, and friends of those who have children on the Autism spectrum are always hopeful and look for effective ways to allow those children effective means to communicate and relate with their world and share their very private and remote inner lives. Much of the pain is not knowing if the children know they are loved, and if that love is comprehended and reciprocated. There are several autism researchers, and specialists working to that end using EAI. Many of those go beyond simple data collection but also attempt to provide feedback to the child in efforts to augment a view of their environment allowing for improvements to their interactions and relationships with those loved ones. [35] [36]

These efforts are not just laudable in goals but are in part fulfilling the promise of EAI in what might be, with responsible, cautious, and sagacious use of this technology. It is these applications that also contribute to the complexity of privacy. In these cases, invasions of privacy are warranted, with full knowing consent and even welcomed. These cases are the most challenging, involving several ethical concerns.

The children subject to these interventions cannot provide informed consent, so this consent must be by proxy, usually by their parents. When EAI efficacy is found to be a satisfactory risk-reward balance the experiment is regarded as appropriate. What of the applications that do not show improvements or exhibit harm and retrogression of the child patient? Does society just regard this loss as collateral loss, and the cost of the potential good? What forms of ongoing assistance are to be provided to mitigate that harm realized, and who is to provide that ongoing support and costs? These are tough questions to ask and even more difficult to answer.

II. EAI in Determining Intent and Predicting Behavior

While EAI is considered high-risk technology, and especially so when applied to more commonplace, and ill-advised situations such as job applicant evaluation, social companion screening, and games and toys. These may be examples of such applications that should be considered unacceptably high-risk applications, there are others that introducing a global ban would be a reasonable ethical and moral response. That is in the arena of legal applications and the adjudication of those a priory of any criminal behavior.

EAI is already being evaluated for the jury selection "voir dire" process, monitoring jury member emotions during and after jury selection, eliminating and favoring those predicted to being able to be manipulated, with data collection of reactions and suggesting modification to case presented. While experts in human behavior have long been employed to assist in this process it is more skill of art rather than science or even pseudoscience. But to have cameras and biometric instrumentation catching every nuanced state of jury members brings a quantum leap in risk. [37]

Another tending to the bizarre application is EAI used in the sentencing phase of a criminal trial. This is where those nuanced behaviors and micro gestures are informing on the severity of the sentence meted out. Therefore, a defendant more capable of controlling their reactions, i.e., the poker face versus someone more expressive in their emoting receives differential sentencing. This inequity introduces an inherent bias generating institutionalized criminalization of thought!

Let us take this another step into this dystopian world where individuals are adjudicated guilty without benefit of trial. Such EAI applications are in fact being employed and evaluated during the pre-custodial interview process. In an analogous non-consensual perpetual and persistent grotesque form of polygraph. This would be especially egregious with application to children, differing cultures, and populations at risk. [38] In these instances, the harm done would likely be irreversible and not comprehended by those harmed. A persons' individual needs must be considered. [39] [40]

Facial reactions, [41] respiration, [42] [43] blood flow, gestures, micro-gestures, speech, utterances, [44] and non-contacting biometrics [45] are analyzed with interpretations of guilt, guile, and mendacity making determinations without trial or the ability to impeach this damning EAI expert 'witness'. [46] The risk of defeating this entire concept of justice, with the underpinnings predating English Common Law by nearly two millennia and found in Roman jurisprudence, should not be underestimated. [47]

Undeniably, as EAI efficacy improves becoming more established, its authority will become ever more difficult to challenge its determinations and predictions. Eliminating the possibility that all people, including those with evil thoughts, are assured fair treatment and due diligence. They would be prevented from exercising or even acknowledging possession of freewill and control over their behaviors and remain within the law and social norms. When the EAI agents go astray or even worse when the humans behind its deployment are compromised, will today's student and tomorrow's practitioner be able to declare that the emperor has no clothes?

Prediction and punishment, a priory of any wrongdoing is a chilling effect of indiscriminate use and application of EAI technologies. This aspect of entrusting control of such EAI applications brings to light another issue in the abrogation of Human Rights, especially that of Privacy in the tension between those who control EAI and those to which it is applied, becoming either beneficiaries or victims.

III. Embedded EAI

In the previous discussion, the use cases depicted special purpose applications of EAI. However, this is not the only way this technology is used. In fact, the use of EAI will and is becoming ubiquitous and embedded in nearly all AI applications. These embedded uses will allow a more natural interface for humans, where the applications will simulate natural conversations and interactions. It is even used to stimulate responses to guide, nudge, or subtly coerce, and even forcefully manipulate the human.

Furthermore, since these applications will also be able to make use of dossier and data fusion techniques it will be possible to facilitate unfair advantage disparities. Consider a negotiation situation where one party has instant recall of everything that has been disclosed over a period of many years and has access to current situations that may be inferred or extracted from third party colleagues (affiliates, and data brokers) about the disadvantaged party. Additionally consider this party never experiences fatigue even over protracted negotiation sessions, never exhibiting any 'tells' and detecting every micro gesture, moment of distraction, or indication of fatigue. Undoubtedly even the most skilled negotiator could never be any match for such a situation.

IV. Disparity of power

The history of human abominations is replete with repetitive instances of those holding control of superior technology having harmed, subjugated, and even enslaved whole other populations. While there are many reasons, i.e., greed, bigotry, fear, ignorance, missionary zeal, limited resources all incentivize the conquest of other populations, it is often this Disparity of Power that enables that subjugation to be successful. When the driving force is at its base evil, it is plain to dismiss the resulting harm as the work of deranged minds, however, that would be dismissive as an anomaly ignoring it being symptomatic. This dynamic has been shown to be a predictable pattern of human behavior especially considering the seductive nature of power. [19]

More worrisome is the application of superior technology by those professing to do good and for the wellbeing of those impacted that may be the most tragic, and the most difficult to implement safeguards and harm mitigation criteria. Furthermore, these stories have repeated all through history even when the intent was to bring benefits and improved wellbeing to the 'uninformed' population, with both participating sides often ignorant of the true risks to the culture holding such societies together. Perhaps a dichotomy, EAI also has the potential to reverse this model by providing the holder of superior power with a means to understand rather than conquer, providing for the development of empathy. This new ethos must be instilled at the earliest stages of learning the potency of this EAI technology – in our engineering curriculum, but it will be a test of not only the technology but of human mores and ethics. [48]

V. A rose is a rose, but a smile is not always sweet

It must also be understood that even if technology captures every nuanced facial micro gesture, every posture, and every breath irregularity it may not indicate an accurate valence or emotional state. For example, studies have classified distinct smile types as little as just a few to as many as fifty (50) distinct variations displaying or disguising the valence it represents. So, without a consensus the question must be asked is that smile indicating true happiness, feigned happiness for a rival, is it a smile exhibiting genuine support, cynicism, or just politeness with a goal of social harmony.

Additionally, it is not just the facial gesture but the timing of that expression that is part of the meaning of a smile. There are also cultural differences of the appropriateness of public displays of emotions, and even individual idiosyncrasies. Given the complexity that something as familiar as a smile can introduce such ambiguity consider the added complexity of all the other ways emotions and empathy are displayed, or hidden, either intentionally or subconsciously. [49]

VI. Empathy

There are distinct levels of empathy, and there is no consensus in and among the professionals with an interest in the field. There are as few as two and as many as eight or more classified types of empathy offered as the defining categories. The most common description of three will suffice for the purposes of this discussion:

- **Cognitive**: Intellectual knowledge and perspective of another person's feelings and thinking.
- **Emotional** (Affective): The sensation or capacity to share with another physically and mentally.
- **Compassionate**: In addition to understanding and sharing feelings, experiencing a need to help.

Affective Empathy is at times considered separately, others would use differing terms, and yet others would make a list of as many as eight. Also, many consider Affective Empathy synonymous with Emotional Empathy, a subtlety that is not essential for this discussion. [50]

The lack of empathy, i.e., alexithymia, should also be considered and understood as inability to have or experience empathy, a cognitive deficiency to develop empathy. While this would often be exhibited as an indifference to another's circumstance, it is there being a void of possessing empathy. There would also be the condition of a real indifference to another person's feeling even if possessing Cognitive Empathy and an awareness that anticipated actions will cause harm and it has no weight in the decision process. In this case it should be realized any resulting harm would be knowingly created and with callous disregard. Finally, there could also be the situation of one possessing Cognitive Empathy but

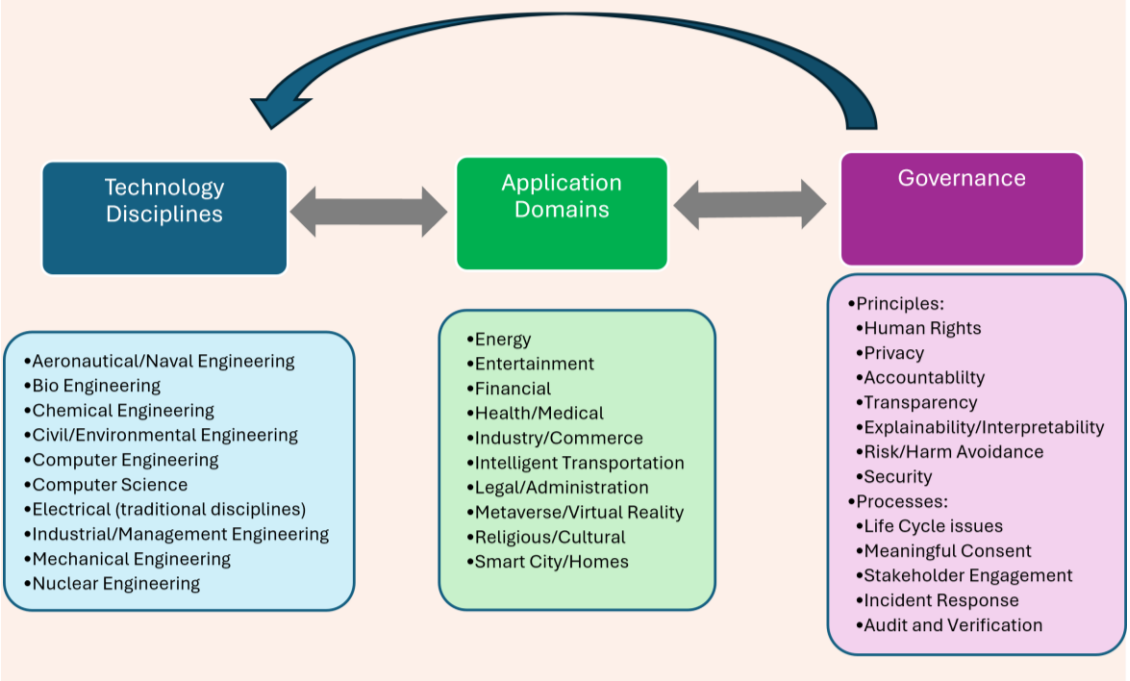

FIGURE 2 AI TECHNOLOGY GOVERNANCE DOMAINS

knowingly causing harm, but with an element of pleasure, this condition would be classified as schadenfreude (epicaricacy) and in the extreme, a mental illness. [34] [51]

In the current state-of-the-art, any of these types of empathic types and/or disorders could be emulated and simulated in an EAI system illuminating the purpose of the need to understand these conditions. The advent of EAI systems and embedded applications creates this same type of power imbalance that has historically been witnessed in human-to-human relationships, however with the added capability of automation, AI, and ML. As opposed to a human's abilities, an EAI system would never need sleep, it would have expansive memory however it would not possess human sagacity to limit its persistence; especially in risk laden applications intended to be benevolent.

ADDRESSING ETHICAL CHALLENGES

The discussion at this point has covered some very weighty issues. But the reader may ask how this concerns engineering education. But in fact, it is this community that educates, trains, explores the limits, and ultimately controls what this technology is, its capabilities, and what impact it has to the wellbeing and benefit for society, or its potential to harm that society.

It will be one of the most interdisciplinary applications of engineering to date. Consider the following non-exhaustive and alphabetic list of engineering disciplines:

- Aeronautical/Naval Engineering
- Bio Engineering
- Chemical Engineering
- Civil/Environmental Engineering
- Computer Engineering
- Computer Science
- Electrical (traditional disciplines)
- Industrial/Management Engineering
- Mechanical Engineering
- Nuclear Engineering

While it can be debated as to its arrangement or completeness and specialized missing domains, it is sufficient to illustrate the issues at hand. Each of these domains is already experiencing a revolution in the application of AI in the modern curriculum. In addition, it is now common to have cross-disciplinary curricula combining two or more of these such a Mechatronics, Bio-Electrical, or Bio-Materials programs.

Both educators and students are already debating and adjusting to the inclusion of AI/ML, MLLM, technologies and the rules that should apply to the students' learning process. Part of that discussion is contextual and dependent on the domain of application, such as these examples:

- Energy
- Entertainment
- Financial
- Health/Medical
- Industry/Commerce
- Intelligent Transportation
- Legal/Administration
- Metaverse/Virtual Reality
- Religious/Cultural
- Smart City/Homes/Building

Just as with the educational curricula these application domains can also be multi-disciplinary. Such as the use of Metaverse technologies for education or entertainment, multi-domain applications will combine financial data with legal, social, health, and entertainment data in Smart City applications. Universities have not yet understood or included the additional challenge that the nascent Affective Technologies will introduce to the learning and design of EAI.

The ethics and responsible use of technology in these domains must adopt governance principles and processes which include:

- Principles reflect the ethics and mores of the stakeholders impacted by the technology. It is expected to be different in their inclusion and hierarchy of importance. For example, a non-exhaustive list:
  - Human Rights
  - Privacy
  - Accountability
  - Transparency
  - Explainability/Interpretability
  - Risk/Harm Avoidance
  - Security
- Processes reflect the specific domains of application. Manufacturing versus Financial entities would be expected to have different processes, which could include these non-exhaustive examples:
  - Life Cycle issues
  - Meaningful Consent
  - Stakeholder Engagement
  - Incident Response
  - Audit and Verification

To comprehend how these factors can be taught and practiced with ethical and responsible application of technology, it should be realized that with each of these elements: technology development (engineering), the application domains, and governance must have an interactive relationship. This is illustrated in Figure 2, indicating that each phase, information, and knowledge must feed back and forth, to ensure the dynamic nature of AI applications represents current thinking, values, and performance goals.

To further illustrate this framework, consider the deployment of a personal intelligent vehicle. It will involve many of the engineering disciplines, just as it has for the past century. It will require at the minimum the efforts of mechanical, electrical, materials, and chemical design efforts. However, the modern intelligent vehicle whether fossil fueled or electric will require additional expertise to create a safe, reliable, and efficient vehicle. It will require the acquisition of vast data to optimize the operation.

For example, it may need instrumentation to detect which seats are occupied and if passenger restraints are properly used. Are those passenger adults or children, will air bags need to be enabled or disabled. The weight information might also be used to optimize the transmission for fuel efficiency. Before allowing the vehicle to be engaged it may require an assessment of the driver's alertness.

Once travel is initiated data collection will continue, are there obstructions in the path, is the vehicle within the lane, following too closely to the vehicle ahead, is the acceleration and braking often and abrupt, what volume of noise/conversation in the cabin, is the driver's gaze consistent with an alert driver, or distracted. In the case of distracted driving, very private conversations, either joyful or disharmonious, become just part of a data file. This is just a small sample of the kinds of data collected.

How will this data be used is yet another question. Will it be solely for the immediate vehicle operation, or will it be left personally identifiable or anonymized and uploaded to the manufacturer or third parties to analyze for product evaluation, will it be shared with marketing or insurance companies, will it be sold to data brokers? What, if any consent was obtained to collect and use this data is almost always left in an ambiguous state.

Now consider this is just one simple example of ethically challenged data collection. This is just one product of possibly hundreds of everyday applications that are and will be collecting very private and very personal data. How should we train the next generation of engineers, designers, market, and management professionals?

Concluding Discussion

The challenges created by the deployment of Affective/Empathic AI applications have been clearly demonstrated.

A first step to an Engineering Educational Curriculum must teach how to evaluate what technology advances are needed and will most likely provide advances to the wellbeing of society, but also to the individual members of that society. This can be contextual to the variable needs of communities. A solution that works for one may not be suitable or even harmful for another community.

This first step requires the skill of critical thinking to be advanced. Advances in technology are not always predictable; there can be no predetermined formula to decide which advances will be beneficial and which will be harmful. And the most difficult challenge is when advances come as a double edge sword with high-risk and high-benefit potential. Critical thinking prepares the engineer for the unknown.

Engineering education cannot mandate a universal set of principles; this must be performed by each engineer and every engineering student as a foundation of their personal and professional integrity. This process of adopting a foundational set of principles provides a touchstone that can guide the engineer into the unknown ethical dilemmas they will face. While the classic 'trolley problem' has

become a common trope, and even esoteric sophistry, every engineer will come face-to-face with genuine ethical dilemmas. Dilemmas that consume their thoughts and peace of mind. Principles adopted early in a career can become a comfort and pathway to deal with these challenges.

It has become a modern challenge to faculty teaching students to use AI ethically. It also requires faculty to develop new techniques that prevent the student from using AI in ways that circumvent the learning process. Simply relying on AI to provide answers is not learning in fact it may degrade the students' ability to learn. This applies to every discipline. However, the engineering curriculum is unique in that it also requires the teaching of ethics in the design of AI technology.

Teaching the design of this technology involves all the challenges that every other discipline but adds the burden of forming future practitioners to act ethically and design technology founded in ethical underpinnings. The very nature of the workings of AI technologies involves the collection and processing of vast amounts of data. Often this data is of a personal nature.

This paper discusses the added dimension of affective technology that involves the simulation and stimulation of affect, emotions, and valences. It demonstrated how this new development of AI will become pervasive and embedded in most every future application. Compared to other AI methods it also is very often considered high risk of harm to human rights, privacy, wellbeing, with complex and compounded undesired consequences.

If affective technologies were only capable of harm it would be straightforward to simply ban its use. However, there are applications that have great promise to promote wellbeing, more natural human-to-machine interfacing, and improved collaboration with machines. It is therefore imperative, as with any very potent tool, to develop new knowledge and expertise for the practice of safe design and application.

In summary, new engineering educational curriculums must be developed to prepare today's students and future practitioners for the development of AI and especially those applications incorporating affective technologies.

These new tenants of engineering education can be summarized by the following:

- Catalog and teach the basis of human and societal needs.
- Affirm the need for continuous critical thinking as basis to analyze framework of engineering advances.
- Essential to these goals is teaching students to establish their principles that will guide them throughout their career.
- Realization: Engineering Educational Curriculum involves three dimensions:
    - How to use AI with ethics
    - How to design ethical AI that reflects the mores of the society it serves,
    - Affective/Empathic AI creates additional demand due to its impact on human rights.
- Create a new curriculum that integrates this Engineering Philosophy and update the teaching of engineering ethics.

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