Socio-materiality and modes of inquiry

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AGENDA AND BOOK OF ABSTRACTS

2018 Forum on Philosophy, Engineering and Technology

May 30 to June 1, 2018

Host: University of Maryland, College Park, Maryland, United States
Program in Science and Technology in Society, College Park Scholars
Venue: The Jeong H. Kim Engineering Building

https://philosophyengineering.com/

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AGENDA

Wednesday, May 30, 2018

10:00 am	**Pre-fPET mini-workshop: Reimagining the Future of Engineering** *Location:* **Zupnick Lecture Hall**	**Diane Michelfelder** **Neelke Doorn** **(see website for RSVP details)**
1:00 pm	**Registration Open** *Location:* **Kim Building Rotunda**	
2:00 pm	**OPENING SESSION** *Location:* **Zupnick Lecture Hall**	
	Framing Remarks	**Zachary Pirtle and Guru Madhavan** *Conference Co-Chairs*
	Welcome from the Host	**Darryll J. Pines**, *Dean, A. James Clark School of Engineering University of Maryland, College Park*
2:15 pm	KEYNOTE **Engineering Design Principles in Culture and in the Architecture of Nature** *Location:* **Zupnick Lecture Hall**	**William Wimsatt**, University of Minnesota
3:15 pm	**Break**	
3:30 pm	**CONCURRENT SESSIONS I**	
	TRACK A: Philosophy of Engineering *Location:* **Kay Board Room I** *Moderated by:*	**I-A1: Mark Bourgeois**, An exploration of applying self-determination theory as general technology design criteria **I-A2: Elihu Gerson and Alok Srivastava** Reconciliation in multi-disciplinary engineering projects: The role of scaffolds and brackets **I-A3: Ira Monarch, Muriel Mambrini-Doudet, Anne-Francoise Schmid and Eswaran Subrahmanian** Generic scaffolding for a non-standard engineering design ethic

TRACK B: Ethics I *Location:* **Kay Board Room II** *Moderated by:*	**I-B1: Ken Archer** Grounding AI Ethics in Bayesian AI **I-B2: Pieter Vermaas** Engineering Ethics for Normative Design **I-B3: Ximeng Chen** How to integrate public participation in engineering —a study with the morphological approach
TRACK C: Case Studies *Location:* **Pepco Room** *Moderated by:*	**I-C1: Rick Shang** Competition and the Creation of Neuroimaging: The History of Positron Emission Tomography 1976-1985 **I-C2: Zahra Meghani** The regulation of a genetically engineered mosquito as a pesticide: A case study **I-C3: Shawn Kimmel** Building trust in AI system design and operation: A Perspective from Automated Driving System
TRACK D: Ethics for New Technologies *Location:* **Zupnick Lecture Hall** *Moderated by:*	**I-D1: Richard Wilson, Michael Nestor and Richard Wilson** CRISPR and Anticipatory Biomedical Ethics **I-D2: Steven Umbrello** Intuiting Safe Design: Strengthening Design-for-Values Frameworks **I-D3: Ed Birrane and UMBC students** Briefing on Ethics Research

5:00 pm **Adjournment**

7:00 pm **Networking and Happy Hour**
(Dinner on your own)

Thursday, May 31, 2018

Breakfast on your own

9:00 am **CONCURRENT SESSIONS II**

TRACK A: Philosophy of Engineering
Location: **Kay Board Room I**
Moderated by:

II-A1: Brian Hanley
What Caused The Bhopal Disaster? Causal Selection in Safety Engineering
II-A2: Stanley Kranc
When is the Past Reality?
II-A3: Albrecht Fritzsche
Revisiting Hegel's traces: shifts of determinacy in the course of the digital transformation

TRACK B: Ethics II: Citizen Engagement
Location: **Kay Board Room II**
Moderated by:

II-B1: Mahmud Farooque, Jason Lloyd, David Tomblin and Kimberly Quach
Flipping the Model: Using Citizen Concerns to Frame Public Deliberations on Science, Technology, and Engineering Questions
II-B2: David Tomblin, Jen Schneider and Mahmud Farooque
Expertise and Participatory Technology Assessment: Going Beyond Laboratory Studies to Understand the Expert/Lay Divide
II-B3: Siddhartha Roy and Marc Edwards
Ethics in Citizen Science: Lessons from the Flint MI Water Crisis

TRACK C: Reconsidering Engineering
Location: **Pepco Room**
Moderated by:

II-C1: Thomas Siller, Gearold Johnson and Russell Korte
Why engineers must be more than problem solvers.
II-C2: Terry Bristol
The Middle Way Evolution of Engineering Design
II-C3: Wade Robison
Integrating ethics into the Grand Challenges

TRACK D: Education and Other Perspectives
Location: **Zupnick Lecture Hall**
Moderated by:

II-D1: Hengli Zhang and Qin Zhu
Teaching Engineering Ethics in the Chinese Context: Understanding Instructor Perceptions of Engineering Ethics Education at Chinese Engineering Universities
II-D2: Andrés Santa-María
The place of Philosophy in Engineering degree programs
II-D3: Bono Shih
Engineering Ethics without Engineers? How Western Philosophy Might Learn from Engineering Ethics in Taiwan

10:30 am **Break**

11:00 am	**CONCURRENT SESSIONS III**	
	TRACK A: Engineering Narratives *Location:* **Kay Board Room I** *Moderated by:*	**III-A1: Dominic Berry** Narrative knowing and engineering: a case from the intersection of biology and engineering **III-A2: Travis Babikoff and Devlin Montfort** Epistemic Practices in Engineering **III-A3: Tara Gonzalez** Technology Readiness Levels: a common language or a common pain?
	TRACK B: Ethics III: Values in Design *Location:* **Kay Board Room II** *Moderated by:*	**III-B1: Rider Foley, Elise Barrella, Heather Kirkvold and Rodney Wilkins** Exploring knowledge, values, rationale and how they influence engineering and technology: The case of the Atlantic Coast Pipeline **III-B2: Taylor Stone** Towards a Darker Future? Designing Values into the Next Generation of Streetlights **III-B3: Zhenging Zhang** Robots as Others Expectations Moral Agents:From Human to Interactive Relationships
	TRACK C: Aerospace and Epistemology *Location:* **Pepco Room** *Moderated by:*	**III-C1: Matthew Shindell** Testing Technologies for Space: The Case of the Kepler Technology Demonstrator **III-C2: Edison R. Silva, Domício Proença Jr. and Roberto Bartholo** On the philosophy of planning in asset-intensive maintenance campaigns **III-C3: Stephen B. Johnson** Philosophical Observations and Applications in Systems and Aerospace Engineering
	TRACK D: On Transformations *Location:* **Zupnick Lecture Hall** *Moderated by:*	**III-D1: Mamadou Seck, Miguel Angel Toro Jarrin** Understanding Practical Problems in the Technological Age **III-D2: Fernando Nascimento** Software and Metaphors: the hermeneutical dimensions of Software Development **III-D3: Sascha Julian Oks and Albrecht Fritzsche** More than new technical devices: a semiotic look at the digital transformation of industry
12:30 pm	**Lunch (provided)** *Location:* **Kim Building Rotunda**	
2:00 pm	KEYNOTE **Challenges in Engineering Life Support Systems for Interplanetary Travel** *Location:* **Zupnick Lecture Hall**	**Robyn Gatens**, NASA
3:00 pm	**Break**	

3:30 pm	**CONCURRENT SESSIONS IV**	
	TRACK A: Philosophy of Engineering *Location:* **Kay Board Room I** *Moderated by:*	**IV-A1: Maarten Franssen** Philosophy of engineering and philosophy of technology: separation or integration? **IV-A2: Christopher French** Constructing Carnap as Conceptual Engineer in the World of Data Science **IV-A3: Michael Poznic, Claudia Eckert, Rafaela Hillerbrand and Martin Stacey** Jet Engines, Design Teams and the Imagination: Designing as Playing Games of Make-Believe
	TRACK B: Ethics IV *Location:* **Kay Board Room II** *Moderated by:*	**IV-B1: David E. Goldberg** Revisiting Schön's Reflection-in-Action in Transforming the Practice of Engineering Education **IV-B2: Darshan Karwat** Self-reflection for Activist Engineering **IV-B3: Kathleen Vogel** Bringing the National Security Agency into the Classroom: Ethical Reflections on Academia-Intelligence Agency Partnerships **IV-B4: Brian Dewhurst** Engineering at what cost, to what purpose? The U.S. federal budget process as a site for responsible innovation and engineering ethics work
	TRACK C: Language and Art *Location:* **Pepco Room** *Moderated by:*	**IV-C1: Rick Evans** "Can Saying Make It So?" J. L. Austin and the Philosophical Foundations for the Modern Construction of the Role of Communication in Engineering Practice. **IV-C2: Anne Meixner** A Thousand and One Engineering Stories **IV-C3: Misha Rabinovich and Caitlin Foley** The Alchemy of Maintenance Art
	TRACK D: Emerging Technologies *Location:* **Zupnick Lecture Hall** *Moderated by:*	**IV-D1: Marion Boulicault** Measuring Emerging Technologies: The Case of Brain-Computer Interfaces and the Illiteracy Metric **IV-D2: Janella Baxter** Is CRISPR-Cas Really Revolutionary? **IV-D3: David Morrow** Solar Geoengineering: A Case Study in Slippery Slope Arguments Against Emerging Technologies
5:00 pm	**Adjournment**	
7:00 pm	**Conference Dinner Reception and Keynote** (with cash bar) *Location:* **The Hotel at the University of Maryland**	Talk and Discussion: **Malka Older**, author of the novels *Infomocracy* and *Null States*

Friday, June 1, 2018

Breakfast on your own

9:00 am **CONCURRENT SESSIONS V**

TRACK A: Intersubjectivity
Location: **Kay Board Room I**
Moderated by:

V-A1: Ayush Gupta, Chandra Turpen, Andrew Elby and Thomas Phillip
The dynamics of perspective-taking in discussions on socio-technical issues
V-A2: Rider Foley and Araba Dennis
From deontological to interpretative: Self-reflection and recognition of others
V-A3: Dylan Wittkower
Applying Interpersonal Mental Models of Privacy to the Internet of Things

TRACK B: Ethics V
Location: **Kay Board Room II**
Moderated by:

V-B1: Carl Mitcham
Is an Engineered Life Worth Living for Humans?
V-B2: Joshua Earle
Morphological Freedom: Potential and Normativity in Transhumanism
V-B3: Damien Williams
Constructing Situated and Social Knowledge: Ethical, Sociological, and Phenomenological Factors in Technological Design

TRACK C: Trust and Privacy I
Location: **Pepco Room**
Moderated by:

V-C1: Daniel Susser
Online Manpulation: Is Transparency the Cure?
V-C2: Yan Teng and Guowei Jiang
From interpersonal trust to trust in technology itself: blockchain as a responsible design material
V-C3: Yvette Pearson and Jason Borenstein
Robots' Potential to Enhance Caregiving Virtues and Practices

TRACK D: Materiality
Location: **Zupnick Lecture Hall**
Moderated by:

V-D1: Manjari Chakrabarty
Prehistoric stone artifacts and epistemic complexity
V-D2: Erik Nelson
Humans, Trees, and Ethics
V-D3: Anders Buch
Socio-materiality and modes of inquiry

10:30 am **Break**

11:00 am **CONCURRENT SESSIONS VI**

TRACK A: Linear Models in Engineering
Location: **Kay Board Room I**
Moderated by:

VI-A1: Marci Baranski
The Green Revolution and Enduring Technology-Driven Approaches to Agricultural Development and Climate Adaptation
VI-A2: Zachary Pirtle
Epistemology driving policy?: Project Hindsight and the role of empirical studies in informing debates on the linear model of innovation
VI-A3: Paul Ceruzzi
Moore's law and Technological Determinism, Revisited

	TRACK B: Ethics VI *Location:* **Kay Board Room II** *Moderated by:*	**VI-B1: Daniel McLaughlin** Judgement, Engineering and Engineering Judgement **VI-B2: Tonatiuh Rodriguez-Nikl** Technology, Uncertainty, and the Good Life: Rediscovering Lessons from Ancient Philosophy **VI-B3: Eddie Conlon** How many kinds of Engineering Ethics?
	TRACK C: Trust and Privacy II *Location:* **Pepco Room** *Moderated by:*	**VI-C1: Jason Borenstein and Joseph Herkert** Ethics and Chatbots: Beyond Privacy and Rogue AI **VI-C2: Jo Ann Oravec** Interdisciplinary Analysis of Engineering and Business Initiatives Involving Personal Privacy and Information Control: Implications for Consumer Participation **VI-C3: Malka Older interviewed by Elise Barrella** Infomocracy and the societal implications of social networks and information sharing
12:30 pm	**Lunch (provided)** *Location:* **Kim Building Rotunda**	
2:00 pm	KEYNOTE **Why Engineers and Philosophers Should Learn to Love a Good Technological Fix** *Location:* **Zupnick Lecture Hall**	**Daniel Sarewitz**, Arizona State University
3:00 pm	**CLOSING SESSION** **Synthesis and Reflections** *Location:* **Zupnick Lecture Hall** *Moderated by:* **Zachary Pirtle and Guru Madhavan**	
3:30 pm	**Adjournment**	

SESSION I

Mark L Bourgeois, University of Notre Dame

An Exploration of Applying Self-Determination Theory as General Technology Design Criteria

Engineers are increasingly aware of the social and ethical stakes of their designs; or, at least, increasingly aware that they have them. Academic and popular media coverage of issues such as the psychological impact of social media consumption and the economic and social impacts of impending widespread automation such as driverless cars have presumably disabused many engineers of the notion that their technology is in all ways an unalloyed good.

But if so, this recognition only highlights another, equally serious gap: the lack of any framework or principles with which to grapple with these impacts, or to encode them as articulable criteria that can factor into complex design decisions. Philosophers, historians and sociologists have had much to say about the complex and nuanced social ramifications of technology. But few if any of these efforts have been oriented towards handing design engineers a tool kit to aid their practice and improve these impacts.

While any such simplified heuristic would undoubtedly be inadequate to fully capturing a technology's full import in society, it could be a significant improvement on not having any relevant actionable social and ethical guidance whatsoever. It may also allow engineers to begin conceiving of such issues as relevant, indeed, vital design parameters – rather than as mere ineffables or unaccountable personal judgments.

One potentially promising candidate for constructing such a tool kit comes from psychology rather than philosophy or STS. Psychologists Ed Deci and Richard Ryan's Self-Determination Theory of motivation posits that human beings require the full exercise of three primary capacities in order to flourish: Autonomy, Competence, and Relation. Autonomy refers to the need to feel that one is the originator or author of one's own actions and choices, rather than being externally controlled by others or by binding rules. Competence is the need to develop and exercise a complex skill, and overcome challenges in its exercise. Relation refers to our need to develop significant and meaningful relationships with other people, and to feel known and respected within them. Significantly, decades of international empirical research have backed up these conclusions.

As a succinct, empirically-based and relatively tractable picture of human flourishing, these principles could potentially be conscripted to begin roughly analyzing the social and ethical impacts of a design schema.

Even a cursory examination of current designs of, for example, social media or automation with reference to these principles reveals significant issues – from automation that encourages both passive overreliance and deskilling to the thin connections of social media substituting for real relation. Such a toolkit would clearly not be a panacea, and like any design criteria it would have to contend with pressing financial incentives and limitations. But the development and implementation of such guidelines could help make these tradeoffs more visible to those who must make them on our behalf, and could conceivably help them to make ethically better tradeoffs.

Deci, Edward L. and Flaste, Richard. Why We Do what We Do: Understanding Self-motivation. Penguin books, New York, NY. 1995

Reconciliation in multi-disciplinary engineering projects: the role of scaffolds and brackets

Elihu M. Gerson and Alok Srivastava

Engineering projects bring together many different specialties and other stakeholders. Participants from different worlds typically differ in their conventional practices. They characterize the world somewhat differently, frame problems in different ways, deploy different models, use different techniques to work with data, and respond differently to the concerns of different audiences. Moreover, these differences are embedded in larger institutional contexts, which impose restrictions on what can be attempted as well as limits on who can participate, and on what terms (cf, e.g., Johnson 2017). As a result, when multiple worlds participate in a single project, they often don't complement one another effectively. The resulting local and particular issues must be reconciled if the project is to continue. Agreement on every point is not necessary, nor is a general theoretical solution (Griesemer 2006); participants need only do what's needed to let the project continue. Reconciliation in particular projects means that participants face trade-offs posed by the need to accommodate others. Understanding the reconciliation process in a general way requires developing means for analyzing these trade-offs that are not limited to any particular context. In this paper, we illustrate our approach with descriptions of two recent bioengineering programs aimed at building general platforms for synthetic biology projects: a minimal bacterial genome (Hutchison et al. 2016), and a synthetic yeast genome (Richardson et al. 2017).

As projects develop and participants interact, they employ some combination of tactics in order to reconcile their positions within a larger institutional context that scaffolds the project. Scaffolds act as taken-for-granted contexts that provide many resources and restrictions to a project; for example, standards for electrical current. Although specialization and standardization is the traditional engineering strategy of reconciliation, articulating activities must also be coordinated through mechanisms of co-adaptation and translation (brackets; Gerson 2008) that enable effective, efficient and equitable joint efforts among multiple specialties. In practice, this means that participants negotiate and revise their own approaches as they come to understand one another's limits, requirements, and capacities. Thus each participant learns to anticipate others, and adjust accordingly. Moreover, the reconciliation tactics and arrangements used in a project are themselves progressively improved over time, so that joint efforts become (other things equal) better integrated and more reliable.

To the extent that a reconciliation tactic is effective in a particular project, it can be used and modified in similar projects, and thus gain a degree of generality. These more general arrangements can become the basis of the common pool of techniques, models, and concepts that form the basis of new or reformed specialties and technologies. For example, bacterial plasmids have evolved into an extensive toolbox of shuttle vectors to transfer modified genes between organisms.

Ira Monarch, Muriel Mambrini-Doudet, Anne-Francoise Schmid and Eswaran Subrahmanian

Generic Scaffolding for a Non-Standard Engineering Design Ethic

Our view is not to see engineering from the point of view of philosophy, nor is it to see philosophy from the point of view of engineering. We are offering neither a philosophy of engineering, nor a re-engineering of philosophy, nor a philosophy from an evolutionary point of view, nor do we see engineering as an applied science. Moreover, our focus is not on validation or justification. Rather, we are proposing that the relationships among philosophy, engineering, science and the arts need also to be seen from an interdisciplinary, concept genericity perspective, where philosophy, the disciplines or crafts are on equal footing, no one dominating or making decisions for any of the others, where the emphasis is on producing unstable integrative objects seen from the future or played within virtual environments or multiply configured in different philo/science/engineering theoretical fictions. This is not to say that the other perspectives do not have an important role or are insignificant, but rather that this interdisciplinary generic perspective sets in relief issues that are usually not considered, though are also important.

Our aim is to forge new relationships between philosophies, the sciences, the arts and engineering through a reconfiguration of design and philosophy into a unilateral duality of non-standard design/philosophy. From a non-standard design/philosophy orientation, both human subjects and objects are taken as indefinite and generic, capable of assuming determinations not countenanced in standard disciplines. This is not to say that standard disciplines and standard philosophy are ignored. Quite the contrary, they are hyper-retained but decomposed into flows of fragmentary materials that can be recomposed into non-disciplinarily flows of superposed counterpoint or inchoate harmony or melody. For example, conceptual fragments from quantum theory become entangled with those of philosophy (identity and superposition), a study of space-time, biology, information and computing, psychology, linguistics, and fiction. These compositions can split into unstable and uncertain integrative objects and also into equally unstable heretic collectives or perhaps even forgo splitting into a subject/object duality. In the process of conjugating relationships between philosophies, the sciences, engineering and the arts a generic epistemology emerges that is at once aesthetic and ethical.

Collective identity, generic decomposition and recomposition and architecting an interdisciplinary generic space to house and support collective and compositional processes, techniques and apparatuses are mutually formed and produced. This generic work needs scaffolding at the boundary between generic space inside and contexts outside to moderate and modulate the entrenched philosophic and disciplinary forces that seek to impose certain human and object identities. The scaffolding both protects the generic non-disciplinary space of non-standard design from the impositional effects of outside contexts and also enables materials from the outside to be used generically inside. For example, the individual as homo-economicus can be refashioned as homo-non-standard-economicus and value as a competitive advantage can be refashioned as value for generic humanity. Non-standard philo/design fictions are modes of resistance to the well-entrenched disciplinary and philosophic stories repeated as sound-bites in our mediatized world that also point toward a new non-standard design engineering ethic.

Grounding AI Ethics in Bayesian AI

Ken Archer
Chief Data Officer, Thunder
MA Philosophy, Catholic University of America

A central obstacle to adoption of AI ethics by practitioners is the grounding of AI ethics on a set of ethical rules exogenous to AI technology. Broader adoption of AI ethics would be expected with an aggressive agenda for AI technology from the inside that adequately addresses ethical concerns.

This paper argues that Bayesian machine learning, a rapidly developing approach to AI, provides this ethical direction for AI from the inside. Whereas classical machine learning, the workhorse of most AI applications, calculates the probability of data given a single model, Bayesian machine learning calculates the uncertainty of various models given a set of data. By combining human expertise, previous studies from related domains and data from the given domain, Bayesian machine learning is far more flexible than classical machine learning which defines human expertise, experience and uncertainty out of the problem domain.

Classical and Bayesian machine learning thus approach the world in fundamentally different ways. Classical machine learning is premised on all causal features of a domain being knowable to the senses, quantifiable and computationally tractable, while Bayesian machine learning is premised on the real world as infinitely complex. In turn, classical machine learning has an agenda that, in principle, leads to complete autonomy of AI applications, including robots.

The message of AI ethicists to practitioners should be that classical AI is not merely ungrounded from an ethical perspective, it is also limited in its potential on AI's own terms. Because the world is infinitely complex, the most powerful AI incorporates as much of this complexity as possible through Bayesian methods that require a symbiosis between man and machine.

Bayesian machine learning is reminiscent of Aristotelian deliberative reasoning which grounded ethics and technology for most of the history of technology. Prior to the 20th century, technology was not conceived as applied science, but as a craft distinct from the sciences. Technology advanced through trial and error, a process that integrated human judgment and science strikingly similar to Bayesian machine learning. The classical presentation of this process is found in Aristotle's Ethics, where techne and phronesis are two modes of deliberative reason (reasoning in the face of uncertainty) distinguished according to the activities with which they are concerned – production and action. Phronesis is what is most commonly associated with ethical reasoning, and Aristotle presents phronesis as a higher form of techne, different in degree but not in kind.

This was the basis for ethics and technology until the late 19th century, when technology was reconceived as applied science, and no room for uncertainty or human judgment was permitted for technical advance. This led to the current predicament of autonomy associated with AI, and the ethical concerns raised by this autonomy. A return to the classical basis of technology, which grounds an appeal to simply do better technology by accounting for uncertainty, can provide ethical grounding to modern technology. Bayesian machine learning provides this appeal, and should be central to ethics and AI.

Engineering Ethics for Normative Design

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a proposal for fPET 2018, track 2: *Ethics relating to engineering and technology*

In this contribution I argue that engineering ethics leads to the obligation to designers to be transparent to stakeholders about the values they aim to realise in normative design approaches such as value-sensitive design, design for values, social design and nudging.

This argument is motivated by two observations. The first is that the ethical obligations of designers working within social design (e.g., Marzano 2007) and nudging by the design of choice architecture (Thaler and Sunstein 2008) seem less articulated than the obligations of engineering design as captured by engineering ethics. Secondly the distinction between engineering design and these normative design approaches seem to be fading by the emergence of value-sensitive design (Friedman et al. 2006) and design for values (Van den Hoven et al. 2015). By this emergence engineering design cannot be understood anymore as merely the meeting of technical and function requirements in technical artefacts but becomes also the realisation of values of consumers and society in products, services and technologies. This fading of the distinction now given the opportunity to broaden engineering ethics to normative design approaches, and thus arrive at well-developed moral obligations to designers within value-sensitive design, design for values, social design and nudging.

In the argument I first take three elements from engineering ethics: engineering codes of conduct, the obligation to acquire informed consent with stakeholders, and the obligation to take responsibility. Second I apply these elements to the mentioned normative design approaches. Third I shown that each of these elements requires designers to be transparent to stakeholders about the values they aim to realise in products, services and technologies. I furthermore discuss two counterarguments. The first is that informing stakeholders about the values to be realised may hamper the effectiveness of normative design. The second counterargument is that engineering ethics does not apply to social design and nudging. I agree that adding transparency as an extra value requirement may make value-sensitive design, design for values, social design and nudging more challenging, yet not impossible. And I observe that even if one rejects engineering ethics as applicable to such normative design approaches, proponents still accept transparency as an obligation (e.g., Sunstein 2015).

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How to integrate public participation in engineering?
—a study with the morphological approach

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Abstract China is undergoing a fast process of economic and technological growth. This results in environmental concerns and social frictions.Therefore, there is a need for a broad approach in engineering, in which these issues are incorporated right from the start and in the whole process of design, planning, construction and operation.In its growth, China aims to increase its trade with the surrounding world, especially in the One Belt, One road project .China also aspires to be an example for other developing and developed countries, especially now under Trump. So it needs a socio-technical approach that 1. supports its development at home and 2. helps to develop other countries, for example the ones involved in the One Belt, One Road project. The "morphological method", as explained in this presentation, could give shape and contents to this required socio-technical approach. Lot of engineering projects having led to the unrest, dissatisfaction, discontents and demonstrations etc. In the west, the public participation in engineering practices has been successfully achieved , is that also good for China? what is public participation?(methods, problems, solutions), What is the stages for public participation in China?(forms, problems) . Actually, the problems in China not solved by more communication cases as in the west, because China has its unique socio-political context , so it requires new approaches. One candidate can be the morphology method. what is the morphology method ? How to apply it ? We take the Xiamen-Gulei PX as an example to explain how this method works and what we can learn from the example . And then it comes out the conclusions 1: The method is workable in China, although in theory, it can solves present problems 2: Morphological method needs refinement. Disorder is not good, we want order (normative judgement). Thus, we need the morphology method. It can be applied when dealing with problems in the engineering practice, especially in the process of embedding technology in society—such as how to communicate between different parties, how to build a balanced system, and how to achieve effective dialogue in the stages of decision-making and planning of engineering works with public engagement. This paper explains this by developing a framework for public participation from a morphological perspective, which might overcome the communication problems that usually emerge in the involvement of the public in engineering . The Xiamen / Gulei Port PX case will be used as a case.

Keywords Morphological method, Public participation, Xiamen-Gulei Port

Rick Shang, Washington University in St. Louis

Competition and the Creation of Neuroimaging: The History of Positron Emission Tomography 1976-1985

Competition is one of the fundamental elements of scientific development. But how does competition shape scientific development? Few philosophers attempt to give an answer. Lakatos, for example, endorses a "winner-takes-all" account, according to which, the winner is better than the loser according to all or most of the relevant evaluative criteria and replaces the loser (Lakatos 1970).

The history of neuroimaging defies such a "winner-takes-all" account. In 1974, researchers at Washington University in St. Louis created a prototype of a new medical imaging device called the Positron Emission Transaxial Tomograph (PETT) scanner. By 1977, fewer than 20 articles a year were published about research that used the most advanced PETT scanner. Many researchers wondered whether the marginal increase in precision or accuracy over competitors could justify the million-dollar price tag (Keyes et al. 1977). To promote the PETT scanner, researchers radically redesigned the scanner and focused on a virtue neglected by the medical imaging community: speed. In 1978, they made the PETT scanner the only device fast enough to image biological processes in the brain *in vivo* (Ter-Pogossian 1981). They further prepared new questions about cognitive functions, and came up with standardized methods and procedures to use the PETT scanner to answer those questions. In two years, the number of journal articles that included research using the PETT scanner took off – first hundreds and then thousands per year, creating a new field now known as neuroimaging.

While it is true that fierce competition sometimes leads one research program to blot another out, the creation of neuroimaging demonstrates that sometimes fierce competition can change the competitive landscape, modify or even create evaluative criteria, and sometimes completely rewrite the rules of the game. In the case of neuroimaging, competition created an entirely new field with its own rules and virtues.

The creation of neuroimaging further challenges the following philosophical positions. First, no universal or historically stable list of scientific virtues exists. Competition can create new virtues. Second, scientific and pragmatic virtues are deeply intertwined in the history and our evaluation of scientific development. Third, because the rules of the game change constantly, we can only assess local, but not general progress in scientific development.

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The regulation of a genetically engineered mosquito as a pesticide:

A case study

by

Zahra Meghani

Genetically engineered (GE) organisms meant for release in the 'wild' present a challenge for regulatory agencies functioning under the auspices of biotechnology regulatory policy frameworks that pre-date the development of such entities and which did not anticipate their 'creation'. This presentation will discusses some of the problems with regulatory agencies attempting to regulate GE organisms using a categorization schema that fails to recognize them as living entities. To that end, the efforts by US regulatory agencies to regulate a GE mosquito intended to suppress the population of its wildtype (presumably, resulting in a lower incidence of the transmission of the Zika virus and dengue to humans) will be used as a case study. The GE insect was initially classified as a new animal drug that fell under the regulatory jurisdiction of the Food and Drug Administration (FDA). In October 2017, the FDA ceded regulatory authority over the GE mosquito to the Environmental Protection Agency (EPA) on the grounds that the GE insect was a pesticide (US FDA 2017).

The GE mosquito in questions is a genetically modified Aedes aegypti mosquito, with a heritable synthetic genetic sequence that results in tetracycline dependency. That dependency causing trait, in effect, amounts to a lethality gene; the vast majority of such insects cannot survive outside of laboratories unless they have access to tetracycline (Oxitec 2002-18). The intent is to release sufficient numbers of male GE mosquitoes such that they will outcompete their male wild-type counterpart to mate with their female wild-type, resulting in offspring who will inherit the tetracycline dependency trait. It is expected that the larvae will not survive to adulthood because, presumably, adequate amount of tetracycline will not be present in the regions where the GE mosquitoes are released. As a result, the population of Aedes aegypti in the target area will decline, presumably, resulting in lower incidence of transmission of Zika and dengue in humans (infected female Aedes aegypti transmit those viruses to humans).

Given that the GE mosquito is a living animal, the decision to construe the GE insect for regulatory purposes as pesticide raises the following question: Will the GE mosquito be appropriately regulated?

To engage with that question, this presentation will do the following:

i. Consider the question what it means to regulate a living organism.
ii. Identify and evaluate the normative concerns shaping the decision to classify the GE Aedes aegypti mosquito as a pesticide for regulatory purposes.
iii. Examine the significance of the regulatory categorization of a living organism as a pesticide and consider alternative classification possibilities.

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Engineering Ethics without Engineers? How Western Philosophy Might Learn from Engineering Ethics in Taiwan

Author: Bono Po-Jen Shih

Keyword: Engineering ethics, engineering education, linguistic philosophy, Taiwan, gong cheng

Abstract:

This paper engages with a dominant thought more or less explicit in Western engineering ethics that "without engineers making decisions, there can be no engineering ethics." (Davis, 2007) The study seeks to contextualize contemporary engineering ethics and education in Taiwan and explains and defends the phenomenon when discussion of engineering ethics sometimes goes without engineers playing a key role or making decisions.

First and foremost among the issues is a linguistic philosophical perspective necessary to understand engineering in the Chinese language, or *gong cheng*, as a polysemous word including meanings of scheduled tasks, buildings, public works, and a credential-based profession responsible for designing, manufacturing and maintaining modern technologies. In this sense, engineering ethics is also ethics of technological activities and of technology. Responsibilities and commitments in engineering ethics not only applies to professional engineers, but can extend to all personnel involving in engineering work, sometimes without an engineer currently in charge of making decisions.

In learning engineering ethics, non-engineer participants and technology are not only the context professional engineers need to learn about when they are making ethical decisions. They are also the subjects engineering ethics directly address. The inclination to include critical players who are not engineers per se in engineering ethics is reinforced by the socioeconomic context of Taiwan as a highly populated technological society with a legacy of less strict regulations and the rapid growth during the "Taiwan Miracle."

Even though engineering ethics and education practice in Taiwan sometimes fail to delineate proper responsibilities of professional engineers, the eclectic approach to including non-engineers and technology as the scope of engineering ethics has several advantages to offer. In ethics theory and teaching, it helps bridge microethics and macroethics that are often separate in Western engineering ethics discussion. In practice,

it also transforms individual responsibilities into collective awareness and sustained support for ethical decisions and precaution principles in engineering that are so needed in a technological society like Taiwan.

CRISPR and Anticipatory Biomedical Ethics

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Key Words: Anticipatory Ethics, Biomedical Policy, CRISPR, Gene Editing, Gene Drive, Genetic Modification, Human Stem Cells

Abstract

Clustered regularly interspaced short palindromic repeats (CRISPR) genome editing has already reinvented the direction of genetic and stem cell research. CRISPR is already beginning to change the nature of how medical research and medicine is being practiced while also raising a variety of ethical issues. The nature of CRISPR gene editing technology is changing as rapidly as it can be developed. **Biomedical engineering** (**BME**) is the application of engineering principles and design concepts to medicine and biology for healthcare purposes (e.g. diagnostic or therapeutic). This field seeks to close the gap between engineering and medicine, combining the design and problem solving skills of engineering with medical biological sciences to advance health care treatment, including diagnosis, monitoring, therapy, and enhancement.From the perspective of medical research and the practice of medicine, CRISPR replaces earlier methods of gene editing and needs to be combined with (BME). For more complex diseases it allows scientists to simultaneously create multiple genetic changes to a single cell. Technologies for correcting multiple mutations in an *in vivo* system are already in development. On the surface, the advent and use of gene editing technologies is a powerful tool to reduce human suffering by eradicating complex disease that has a genetic etiology. Gene drives are CRISPR mediated alterations to genes that allow them to be passed on to subsequent populations at rates that approach 100% transmission. Therefore, from an anticipatory biomedical ethics perspective, it is

possible to conceive gene drive being used with CRISPR to permanently ameliorate aberrant genes from wild-type populations containing mutations.

However, there are also a number of possible side effects that could develop as the result of combining gene editing and gene drive technologies in an effort to eradicate complex diseases. In this paper, we critically analyze the hypothesis that the combination of CRISPR and gene drive will have a deleterious effect on human populations from an ethical perspective by developing an anticipatory ethical analysis of the implications for the use of CRISPR together with gene drive in humans.

Could CRISPR and gene drive technologies affect human populations? We believe that anticipatory ethics can be used to attempt to address the ethical issues raised by asking this question. Anticipatory ethics is concerned with examining potential ethical problems with emerging technology while this technology is still in the early stages of development. Ethical issues are identified at the research and development stage of technological progress and are explored as possibilities experienced by potential stakeholders. Both CRISPR and gene drives are technologies that are in the early phases of development and implementation and as such, they are ripe for an anticipatory ethical analysis and suggested courses of action for policy makers.

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Title: Intuiting Safe Design: Strengthening Design-for-Values Frameworks

Abstract:

This paper argues that although moral intuitions are insufficient for making judgments on new technological innovations, they maintain great utility for informing responsible innovation. The Value Sensitive Design (VSD) methodology is adopted as an illustrative example of how stakeholder values can be better distilled to inform responsible innovation. It is also argued that moral intuitions are necessary for determining stakeholder values required for the design of responsible technologies. This argument is supported by the claim that the moral intuitions of stakeholders allow designers to conceptualize stakeholder values and incorporate them into the early phases of design. It is concluded that design-for-values (DFV) frameworks like the VSD methodology can remain potent if developers adopt heuristic tools to diminish the influence of cognitive biases thus strengthening the reliability of moral intuitions.

Keywords:

design methodology; moral epistemology; design psychology; innovation; value sensitive design

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Briefing on Ethics Research Three papers by UMBC Engineering Ethics Students and Dr. Birrane

(a) *Self-Driving Cars or Self-Inflicted Scars*: Edward Birrane, Cameron Blomquist, Sarah Heiner, Caroline Kery, Rushmie Kulkarni and Samantha Turskey

Self-driving cars are no longer an idea of the future. Automotive manufacturers have endorsed the concept of driverless technologies as evidenced by their funding of research and development in this domain. Social acceptance of driverless automobiles is perceived as a natural extension of the acceptance of technology and automation in others aspects of daily living. As governments seek to understand the liability and regulation implications of allowing these vehicles on public roads, a common consideration is how to evaluate the overall public good. We claim this is a complex consideration and demonstrate this complexity with a narrative describing a consequence of driverless automobiles. Based on that narrative we formulate a moral problem statement representative of this technology in general and conduct a formal ethical analysis of that problem. From this analysis, we conclude that as a society-impacting technology, self-driving cars must be constrained by a set of ethical requirements. Finally, we propose a set of such requirements that should be considered prior to allowing the deployment of these vehicles in public spaces.

(b) *Ethical Requirements for Cryptocurrencies*: Edward Birrane, Hemang Bhatt, Travis Early, Hannah Kiesel, Sumanth Neerumalla, David Reichard and Haley Sprehe

Cryptocurrencies offer peer-to-peer monetary transactions through decentralized systems. They are becoming popular alternatives to traditional financial systems based on the perception that they are more secure, incur fewer transaction fees, enable global access, and require fewer dependencies on third parties – including government institutions. This paper addresses the ethical motivations driving the creation and maintenance of cryptocurrencies as a domain. We investigate the concept that the design, implementation, and adoption of a cryptocurrency is burdened by the morality of its developers and that this morality must be understood to make correct ethical decisions related to this technology. To support this analysis, we define "Hailstorm Coin" a hypothetical representation of a cryptocurrency system with features found in current and likely near-future cryptocurrencies. Using Hailstorm Coin, we conduct a formal ethical analysis of the decisions relating to its development and maintenance and provide an example narrative associated with the consequences of ignoring ethical requirements as part of technology design. We conclude that while safety, privacy, and transparency are motivating ideas for end users, they can only exist if levied as ethical requirements on the design, implementation, and maintenance of the cryptocurrency itself.

(c) *Genomic Vaccines: An Ethical Analysis*: Edward Birrane, Aditya Kaliappan, Jonathan Ventura, Mitchell Yum, Nadezhda Bzhilyanskaya and Ujjwal Rehani

Genomic vaccines represent a potentially beneficial example of how technological advancements enable and accelerate bioengineering. As these vaccines become viable defenses against a plethora of diseases, focus must shift from their technological development to their ethical application. This paper analyzes several anticipated benefits of genomic vaccines to understand whether they are unique to this technology, whether they are actually benefits, and whether their

disposition is based on an accurate concept of the technical limitations of these vaccines. We illustrate the potential for misunderstanding the benefits of this technology with a hypothetical narrative describing how severe consequences may occur if proper precautions are not taken during the life cycle of the vaccine. In the context of this narrative, we identify a motivating moral problem with genomic vaccines and perform a formal ethical analysis of potential actions to take when faced with this problem. Our analysis highlights ethical ideals, stakeholders and known unknowns and strategies to tackle the problem. Furthermore, an evaluation and reflection of the moral problem using intuition and the ethical theories of Utilitarianism, Kantianism, and Virtue ethics will be conducted. Finally, there will be a brief discussion of further explorations that can be conducted to tackle known unknowns, with a final position on the technological area presented based on the ethical analysis that was conducted.

SESSION II

Author: Brian J Hanley
Title: *What Caused The Bhopal Disaster? Causal Selection in Safety Engineering*

In most cases of cause-and-effect, many causal factors jointly bring about the effect. Nevertheless, we often single out subsets of important causes from all these factors. Take for instance the case of the Bhopal Disaster. Investigators found that a human error and component failure during routine maintenance caused the disaster. However, many systemic factors also led to the disaster. Poor operating conditions and safety culture, along with design deficiencies and financial pressures were among many systemic causes of the disaster. There is disagreement over which causes were more important.

These kinds of cases raise interesting philosophical questions. Why are some causes more important than others? How and why do we select important causes? When and why does selecting some causes rather than others matter? Questions like these define *the problem of causal selection*.

Following the allied conclusions of John Stuart Mill (1843) and David Lewis (1973), philosophers traditionally have taken a dismissive stance toward causal selection. They think singling out important causes is unprincipled and inexact, not the kind of precise reasoning found in science or philosophy. Recently, some philosophers of science have challenged this consensus (Waters 2007, Woodward 2010, Franklin-Hall 2015, Ross Forthcoming, Weber Forthcoming). Noting that scientists often do make principled causal selections, they argue understanding causal selection is key to understanding causal reasoning in scientific practice. Most of these philosophers investigate causal selection in the context of experimental and explanatory practices in life sciences. As a result, their analyses mainly reflect the methods and interests of biologists. My research aims to broaden this literature by examining causal selection in engineering practice.

Safety engineering is one area of engineering that faces problems of causal selection. Modeling accidents like Bhopal and using them to design safer systems requires identifying causes as well as important causes. Traditional *linear causal models* used in safety engineering emphasize the importance of *proximate causes*. Human errors, component failures, and energy-related events that are spatially and temporally close to the accident are the types of causes these models single out. However, engineers like Nancy Leveson (2012) have argued that emphasizing proximate causes is misleading, and linear models should be replaced. She argues that *systemic causes* like safety culture are the more important causes of accidents, and accident models emphasizing them should be used instead.

I propose that this methodological debate can be understood as a disagreement about causal selection. However, I argue that analyzing the debate and resolving the disagreement requires *a new approach to causal selection* not available in the extant philosophical literature. Existing accounts focus primarily on a narrow set of *explanatory* considerations. To analyze causal selection in engineering, a new approach must be developed that can analyze it in terms of a *diversity purposes* served by selecting different types of causes. Only by analyzing causal selection in terms of distinct purposes of explanation and prevention can the debate among safety engineers be clarified and potentially resolved.

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When is the Past Reality?

Stanley C. Kranc

Windows provide visual access to the world beyond physical walls that block our view. But what if the scene we see via the window is not the "right now" present; instead the view occurred five years ago? Or was a scene from somewhere else? These thoughts form the basis of Bob Shaw's much-anthologized short story, "Light of Other Days", where "slow glass" refers to a transparent solid that retards light transmission. Consumers purchase "scenedows"—panels previously exposed to various landscapes—to decorate their homes. But what does it mean to see the past? And where exactly *is* the space beheld? Does the scenedow provide access to perceptible reality or simply a new species of depictive image?

This paper suggests that Shaw's science fiction lies at the intersection of techno-science and the philosophy of perception. Slow glass is not such an bizarre idea; perhaps some substance like this might be developed in the future. The concept however, raises significant concerns regarding physics: would light passing through a thick panel be differentially retarded, depending on the original angle of incidence? If so, the resultant parallax effect would be inconsistent for the viewer. A related philosophical concern is the time-lag argument, sometimes offered against direct realism: the finite speed of light means that we never visually perceive anything as in the present. Since slow glass panels can also be relocated, the viewer's access to veridical egocentric spatial and temporal information is called into question.

In his nonfiction book, *How to Write Science Fiction,* Shaw discusses how he constructed the original story. He claims that, as author, he need not understand the physical principles underlying the science he proposes, and neither do his characters. He did however continue to explore the concept and eventually released *Other Days, Other Eyes,* a prequel-sequel volume centered on the life and work of the engineer/chemist who invented slow glass. Here, Shaw attempted to work around some of the physical complexities associated with this substance, while presenting several possible applications. In doing so, he introduced an ethical dimension to his speculative technological advances, exploring various consequences for individuals and corresponding societal repercussions. In particular, he examines potential criminal uses for slow glass contrasted with beneficial aspects of retained evidence. Most importantly, Shaw projects that slow glass could ultimately become a weapon of political oppression. Small particles of the glass dispersed by the government as a means of surveillance would result in the total and irreversible loss of personal privacy. Thus, the "story" of slow glass reads as a cautionary myth: a nascent technology beginning with a discovery/invention followed by a cycle of engineering development, resulting in unanticipated consequences, requiring engineering remedies, yielding more applications and subsequent complications. Along the way, the public comes to reject the technology and distrust the engineer who develops it. Taken together, Shaw's three works offer a unique opportunity to examine the relationship of speculative fiction has with the course of engineering development and the philosophy of technology, as influences on both author and reader.

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Albrecht Fritzsche, Friedrich-Alexander Universität Erlangen-Nürnberg

Revisiting Hegel's traces: shifts of determinacy in the course of the digital transformation

In the discussion about ubiquitous technology after the turn of the millennium, German philosopher Christoph Hubig raised concerns about the fact that the usage of technical devices would not produce any recognizable traces any more. This would put an end to the dialectic process described by Hegel in the reflection of means and ends. Multiple layers of technology which are nowadays involved in any instrumental action do not leave much to learn from the comparison of intended outcomes and actual outcomes of an action. Actors fail to understand how their mode of using a device for a certain purpose contributes to the effect of this usage. As a consequence, it becomes unclear how reason should be applied.

After another decade of progress with the digital transformation, such concerns can be discussed from a new perspective. Current approaches in the field of innovation management and systems engineering show how device usage does not only stop creating traces, but also how users themselves are made increasingly traceable at the same time. Decreasing determinacy on the side of the device goes along with increasing determinacy on the side of the user. In order to provide more customized and efficient services to their users, technical devices process more information about users, and the continuous accumulation of data necessary to provide this information has lately become one of the major drivers for technical development.

This development seems to confirm critical views of the progress of enlightenment as they were expressed earlier by Heidegger, Adorno, Horkheimer, Gehlen and others. In many respects, a direct line can be drawn from early modern political philosophy to current attempts of "user integration" in technology, which may explain why this development is perceived positively, fostering visions of participation and democracy. For the same reason, it is understandable that problems appear in particular when it comes to matters of privacy. The user as a participant in technical systems is a political actor; (s)he plays a public role, which requires consistency and reliability in the interaction with others. The private person remains in a sphere in which traces are preliminary and may change over time. The problem is the transition from the private person to the public role, and the effort to maintain the consistency that is necessary to fulfil this role, or, in other words, provide the ground for traces.

All this points towards the need for a research agenda in the philosophy of engineering and technology which focusses on the creation of determinacy in technological systems. Prior research has looked at the way how determinacy is created in engineering with respect to physical objects and formal-symbolic expressions. Today, the same mechanisms might have to be applied to the way how political actors are engineered in there public roles. Furthermore, it will be important to understand the ephemeral nature of these creations and their continuous re-negotiation in the course of technical design, like a dance in which music is constantly re-interpreted in new ways.

Flipping the Model

Using Citizen Concerns to Frame Public Deliberations on Science, Technology, and Engineering Questions

Mahmud Farooque (Arizona State University), Jason Lloyd (Arizona State University), David Tomblin (University of Maryland, College Park), and Kimberly Quach (Arizona State University)

Participatory technology assessment (pTA) methods engage citizens on critical science and technology issues through informed, structured deliberation (Sclove 2010). Intended to provide upstream support to scientific and technological decisions, conventional approaches to pTA, often formalized in grant or partnership agreements, require expert stakeholders to develop materials for citizens to use in their deliberations. This approach frames the discussion and the questions posed to citizens in such a way as to ensure that the deliberation outputs are useful to decision makers (Bellamy, et al. 2016).

What would be the effect of flipping this model? What if, rather than starting with a framework devised by experts, citizens are asked open-ended questions about their concerns regarding a particular technology, and deliberation materials are derived in significant part from analyses of citizen responses?

Several objections to this type of open-framing approach could be raised:

1) Because it's not aligned with the decision-making context, open framing will not produce actionable outputs for decision makers.
2) Without vetted technical information, citizens could be misinformed about or misunderstand the relevant issues, which are frequently complex, abstract, and/or difficult to understand.
3) Once expert views are introduced, citizens will alter their perspectives in deference to these views.
4) Open framing and the subsequent data analysis add a significant time burden to the pTA process, which is frequently time-sensitive.
5) Hosting focus groups and analyzing their output is cost-prohibitive, particularly with the fairly tight budgets of typical pTA projects.

The Expert and Citizen Assessment of Science and Technology (ECAST) network, in partnership with the Kettering Foundation, recently tested these hypotheses with an open-framing project on driverless vehicles. ECAST held two sets of two three-hour focus groups on driverless vehicle adoption. The first set took place in the rural town of Cumberland, Maryland and the second took place in Baltimore. The first session was an open-ended, "concern-gathering" approach (Rourke 2014), where participants discussed their hopes and concerns for self-driving vehicles. The second session was a more structured

deliberation, and participants' concerns were mapped against categories of issues raised by experts and other stakeholders.

Both focus groups far exceeded our expectations with their high level of engagement, quality of dialogue, diversity of insights, and usability of the collected data and information for the development of the issue guide. Participants generated rich, localized information that diverged in interesting ways from the "national conversation" about how driverless cars could affect their lives.

Although some of the objections noted above must be addressed, given the value of this method observed in this project, we are committed to incorporating it into the ECAST design process. This presentation will discuss how the open-framing method allowed us to hear diverse opinions that diverged from the national conversation, and how this method can be integrated into traditional pTA efforts. We will discuss how open framing can help generate deliberation materials that better reflect citizen concerns while remaining responsive to a client's decision-support needs.

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Title: Expertise and Participatory Technology Assessment: Going Beyond Laboratory Studies to Understand the Expert/Lay Divide

Authors: David Tomblin, Jen Schneider, and Mahmud Farooque

How engineers should relate to democracy is a topic of ongoing academic and policy interest. President Obama's Open Government Initiative primed technical experts from several agencies to experiment with participatory technology assessment (pTA), a deliberative method for eliciting lay citizen input prior to making policy decisions (Sclove, 2010). Technical expert involvement with pTA opened up an opportunity to expand on what we understand as expertise, which traditionally has been defined through observations derived from laboratory studies (e.g., Collins, 1985; Latour, 1987). One of the major findings from this foundational research that is relevant to our study is the deconstruction of the fact/value dichotomy – the notion that experts can generate knowledge that is divorced from socio-political circumstance – and the related maintenance of the expert/lay divide. Expert involvement in pTA design and implementation is an interesting place to study the expert/lay divide because experts are directly confronted with the value-laden nature of knowledge production, bringing into tension the exclusionary authority of expertise on the one hand and the inclusive nature of democracy on the other (Turner, 2014; Durrant, 2011; Grundmann, 2017).

This study seeks to explore the value of pTA as a boundary object that challenges the linear model of knowledge production and expertise. We define a boundary object here as an assemblage of instruments, activities, and procedures where multiple epistemic cultures can come together and maintain their unique identities, negotiate existing and evolving institutional narratives, while still being able to exchange ideas (Star and Griesemer, 1989). We use three cases of government agencies adopting pTA in partnership with a boundary organization, Experts and Citizens Assessment of Science and Technology (ECAST), to explore how existing and evolving institutional narratives influence expert interactions with pTA development and implementation. Each agency's narrative associated with adopting pTA represents a particular technocratic story that implicitly laments upholding the expert/lay citizen divide while simultaneously performing boundary work to protect the legitimacy and authority of expertise (Gieryn, 1999). NASA saw pTA as a way of broadening its relevance to the public and increasing its portfolio of initiatives to ***democratize*** missions. The Department of Energy adopted pTA in the aftermath of 30 years of failing to site a permanent nuclear waste repository (Yucca Mountain) through ***top-down, technocratic*** approaches. NOAA found the ***science-centered model*** of education ineffective at convincing large segments of the U.S. population (including decision-makers) of the importance of addressing climate change and sought pTA as a process for transitioning to user-centered science.

This study builds off previous work that uses boundary metaphors to understand expertise in the policy arena (Hoppe et al., 2013) and presents a theoretical framework for challenging standard presentations of the expert/lay divide and understanding the multiple ways that experts negotiate procedures and outcomes of pTA in different organizational contexts.

Key Words: Participatory technology assessment, boundary object, boundary work, technocratic, expertise, NASA, Department of Energy, NOAA, democratization of science and technology

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Ethics in Citizen Science: Lessons from the Flint, MI Water Crisis

Siddhartha Roy and Marc Edwards, Virginia Tech

The citizen science collaboration between Flint residents and the Virginia Tech "Flint Water Study" team helped uncover the Flint Water Crisis and a Legionella outbreak in large buildings. Those scientific findings, contributed to a Federal Emergency declaration in January 2016, hundreds of millions of dollars in relief, an internationally acknowledged case of environmental injustice, and resignations or criminal indictments for some responsible public officials. Following this triumph, when the responsible government agencies rededicated themselves to making amends and helping Flint recover, citizen scientists dealt with biases and conflicts of interest that are well-known to conventional scientists. Examples of concern included 1) collection of non-representative data and public health messaging, that interfered with official messages and created unnecessary fear amongst residents about the safety of water used for bathing and showering, 2) undisclosed financial conflicts of interest by citizen "scientists" coordinating collection and interpretation of data, and 3) misrepresentation or falsification of data to garner relief resources, support possible litigation or prove unconventional hypotheses. The results highlight the importance of quality control safeguards in citizen science, which are especially relevant in the midst of a crisis given the lack of peer review in publicly shared data, presumed altruistic motives of participants, and difficulties of media outlets to differentiate good science from bad. A code of ethics for citizen scientists may be helpful in revealing financial conflicts of interest, mitigating pressures that could cause confirmation bias in participants, and managing expectations for "citizen science" projects.

Why engineers must be more than problem solvers.

Thomas SIller, Gearold Johnson, and Russell Korte

Karl Popper once gave a talk titled "All Life is Problem Solving" which is now published in a book of the same title [1]. His focus included the need for humanity to be entrepreneurs in addressing new challenges. This phrase of being problem solvers has become a common rhetoric when defining the engineering profession. This has become so common that it has become a normative ontology for engineers. It is our intent to dispute this view that engineers are normatively problem solvers. We do agree that much of what engineers do can be considered problem solving but it is an insufficient characterization of the profession. Stated quite simply, if engineers solved problems they would go away but clearly the areas engineering addresses continue to be issues for humanity. But let's be clear, engineers do solve problems. To clarify our position requires that we look carefully at the level of problem definition to understand where problems are solved or not solved. In previous work [2], we described problem definition as ranging from being local to regional to eventually at a global scale. At the same time, we drew parallels between this scale and one that characterizes engineers as working as specialists (local) to the more global interdisciplinary engineers. Our original model focused on the problem definition component, we now want to explore the importance of the ontological view of engineers as problem solvers and its implication for interdisciplinary work.

Interdisciplinary efforts have become more important as the challenges to humanity, e.g. climate change, poverty, etc. have become so complex. Calls for disciplines to work together to 'solve' these problems are common. This leads naturally to how do we get disciplines working together -and of particular interest to us is how to train future engineers to work with other disciplines. Lately we have been encouraged by an approach in the health care professional training known as Interprofessional Education (IPE). This approach brings future professionals together during the education stage to learn from, about, and with each other. Others have focused on the need to develop better communication between the disciplines, often by developing common terminology that can bridge the gap between disciplines. Our goal is to now add ontological views as another aspect needed to be explored if disciplines are to be successful working with each other. It appears that today the need to understand the philosophical views of different disciplines plays an important role in encouraging interdisciplinary efforts. This is where we believe this view that engineers are problem solvers is important to explore. Other disciplines that engineering needs to interact with, especially social sciences, do not share this view that all problems can be solved. We have advocated that a view that problems need to be managed rather than solved would result in closer alignment with other disciplines. By better understanding different disciplines' philosophies a basis for working together can be created.

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The Middle Way Evolution of Engineering Design

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Vincenti argues that engineering is not simply applied science. Engineering design of artifacts and systems, does not result from the mere applications of scientific knowledge. "Scientific knowledge is a wonderful tool. But it doesn't tell you how to build an airplane."

Bucciarelli applied Wittgenstein's approach to explore the engineering design process. "Structural engineers speaks of stress and strain; of displacement, stiffness, and load path. Electronics engineer speaks of power, voltages and currents, analogue and digital, resistance and capacitance. Their languages and objet worlds are incommensurable. They lack a common, objective language. How do they communicate? This is an unresolvable problem. How then to make sense of the successful design of an electro-mechanical artifact or system? How to make sense of the outcome, of the technological reality?

I point out that these languages and object worlds are formally complementary. Modern quantum theory tells us that particle mechanics and wave mechanics are complementary. The languages and the object worlds of these two mechanics, as well as the engineering disciplines that rly on them are also complementary. There are no common conceptual or operational denominators.

When mechanical and electrical engineers manage to work together to create novel electro-mechanical artifacts and systems it cannot have been through any sort of simple applied science design strategy. Besides their design process being mysterious, we will be unable to make sense of the resulting technology in terms of either the mechanical or electrical languages alone.

The successful engineering design process as well as the ontology of engineering reality cannot be reduced to, cannot be understood in terms of idealized scientific realities.

By extending Bucciarelli's arguments with reference to complementarity we see that the successful design process (viz. itself a technique) advances by the 'middle way' – between the idealized, scientific, mechanical extremes. The products, the technological artifacts and technological systems, necessarily embody complementary features and can be characterized as 'middle ground' realities.

Complementarity is ubiquitous and is involved in all successful design – from the design of the irrigation of our fields, the design of our houses, our cities, the design of our businesses and economic policies and to the design of our political and moral system.

Human socio-economic systems are technological systems. The imagined structure and function of free market individualism and socialism suggest two complementary design

ideologies. Oakeshott observes that all real societies embody both individualist and socialist structures and functions. Haidt captures the 'essential tension' in real societies and the expected 'talking passed each other'.

Bohr clearly recognized the connection between quantum theory and the structure and function of reality. The central image on his coat of arms is the Taoist yin-yang diagram. Dawkins and Falkowski have explored the question of the design and the evolution of the design of the biosphere.

Gallie characterized the socio-economic design dialogue as involving 'essentially contested concepts'– such as justice and fairness? Connolly commented that once the design participants realized that they were dealing with essentially contested concepts "enlightened dialogue could begin".

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Integrating ethics into the Grand Challenges

The "new engineering education paradigm" of the Grand Challenges emphasizes five competencies engineers need to address such "societal problems" as providing fresh water and inexpensive power for all. These goals are ethical, but the new paradigm fails to emphasize the skills required to achieve them and, in particular, achieve them ethically.

We have designed an introductory course on Fresh Water, that emphasizes those skills and others that are essential — critical thinking, creative problem-solving, working in teams, making clear presentations, reading and summarizing complex articles from a variety of disciplines, recognizing and resolving ethical issues that permeate engineering practice, learning how to do research, and ensuring that solutions be economically viable.

Students are immediately immersed in problem-solving. Each must find a problem regarding fresh water they want to investigate and then sell it to the class in a brief presentation explaining its importance. Five or six winners are chosen by ballot. Each student selects a winner and then works in teams of four or five to solve the team's problem. The end product is a poster the teams present — stating the problem (using the assertion evidence approach), the current condition (benchmarking other solutions), a root cause analysis, the goal, an implementation plan (showing a business plan), and a follow-up for problems that may arise.

Meanwhile they are reading articles from various disciplines regarding fresh water and writing one-page micro-essays on each, stating the thesis and the arguments for it. These are graded on how well they understood the article. We then discuss the issues raised by the article for that week. For instance, how should we distribute Colorado River water? Is water a commodity? A common good? How can we distribute too little to too many and yet be fair and avoid the tragedy of the commons? As this example shows, we emphasize ethical aspects of the cases we read about, and each team is required to do an ethical assessment of the solution it offers: how well does it address the problem chosen? Why is it better than other possible solutions? What are the downsides? Can they be mitigated?

We — an engineer and a philosopher — rarely lecture, but are there to help the teams when they need guidance and to lead discussions on the wide variety of topics the essays raise. The student evaluations are universally positive — no doubt because all their other introductory classes are lectures, and in this one, as one student put it, probably not recognizing the irony, "It's the first class I've ever had where I got to teach myself!"

The question we pose is whether engineers agree in the assessment our students give the course. After providing further details, we will solicit critical and helpful comments to see if this course can serve as a model for other introductory courses in the Grand Challenges.

Teaching Engineering Ethics in the Chinese Context: Understanding Instructor Perceptions of Engineering Ethics Education at Chinese Engineering Universities

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In the past decade, governmental agencies, universities and programs, policymakers, and educators in China have been striving for reforming and "globalizing" the engineering ethics curriculum. The national call for transforming curriculum and instruction for engineering ethics has become more imperative than ever due to China's recent campaigns for enhancing its global manufacturing competitiveness (e.g., the Made in China 2025 Initiative). Scholars have proposed various strategies for improving the teaching effectiveness of engineering ethics including by integrating "global forms" (e.g., case studies, ethical codes, applied ethics approach) into the Chinese context. Nevertheless, limited empirical research is available that examines the alignment of these strategies and the cultures of engineering education in China such as the instructor perceptions of engineering ethics education. We argue that understanding how Chinese instructors perceive engineering ethics instruction is crucial for better reflecting on the assumptions and limitations underlying current local practices, evaluating the feasibility of adopting global forms, and formulating teaching strategies sensitive to the Chinese context. In this study, we systematically reviewed the engineering ethics literature and teased out a list of most "contested" questions in engineering ethics education (e.g., who are qualified for teaching engineering ethics; whether ethical theories such as deontology, utilitarianism, virtue ethics should be taught). By using these questions as guideline, we conducted semi-structured interviews with 12 Chinese engineering ethics instructors trained in three different fields: STS (Science, Technology, and Society) and philosophy of science and technology engineering, and Marxist studies and ethical theories. We also compared our findings with how non-Chinese instructors responded to these questions in the literature. This paper is expected to shed light on the cultures of engineering ethics education in China and provide insights into formulating effective policies and teaching strategies conducive to the Chinese context. We also hope this paper can provide implications for graduate education research in the global context. For instance, this paper may help scholars better understand the previous ethics education experience of Chinese graduate students in STEM fields in American universities which has not been systematically studied in the STEM education literature, let alone foreign-born scientists' and engineers' data have not been captured as a separate category in many National Science Foundation (NSF) and other governmental agency reports in the United States.

Keywords: Instructor perceptions; Engineering ethics education; The Chinese context; Global engineering education; Cross-cultural comparison

The place of Philosophy in Engineering degree programs

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From the arising of 'Philosophy of Engineering' twelve years ago in the first meeting of philosophers and engineers at MIT in 2006 and the first Workshop on Philosophy and Engineering at Delf University of Technology (2007), a still downing but increasing awareness of its relevance as a philosophical discipline (with its own academic community and research agenda) has been taken by the academic world. It still remains to be seen what kind of impact it is going to have in the future of the Engineering practice. In order to reach such an impact, a special attention should be taken to the processes of initial training of prospective Engineers at the universities. In this paper I would like to focus on the place of the teaching of Philosophy in the context of Engineering degree programs, attempting to answer to three questions: (1) Is it really relevant to teach one or more philosophical subjects in the Engineering degree programs? (2) If it is relevant, should it play a supplementary or rather a fundamental role? And (3) if it plays a fundamental role, how it has to be taught in order to be perceived as such by the prospective Engineers? My proposal is that, given the very nature of Philosophy as a discipline that has to do with the fundamentals of being, knowledge and behavior, Philosophy of Engineering must be conceived at least as one of the subjects traditionally considered as 'basics' for an student of Engineering programs, like Mathematics and Physics. Indeed, the reflection on the epistemological and ethical basis of the Engineering practice should provide a more profound and a more articulated understanding of the traditional Engineering subjects (e.g. Mechanics of Fluids, Statistics, Robotics, etc.) rather than a mere – even if very interesting – complementary information. If the task of an Engineer is, in a way, to be able to generalize and apply the knowledge of various disciplines in order to diagnose and solve certain problems efficiently, it cannot be detached from a solid notion about human development, besides a solid notion on technical or economic development as well. And there are several reasons to think that a solid notion about human development should better come from a philosophical reflection on the ethical, political and epistemological implications of the Engineering practice.

Key-words: Philosophy of Engineering, Engineering Education, Human development.

Engineering Ethics without Engineers? How Western Philosophy Might Learn from Engineering Ethics in Taiwan

Author: Bono Po-Jen Shih

Keyword: Engineering ethics, engineering education, linguistic philosophy, Taiwan, gong cheng

Abstract:

This paper engages with a dominant thought more or less explicit in Western engineering ethics that "without engineers making decisions, there can be no engineering ethics." (Davis, 2007) The study seeks to contextualize contemporary engineering ethics and education in Taiwan and explains and defends the phenomenon when discussion of engineering ethics sometimes goes without engineers playing a key role or making decisions.

First and foremost among the issues is a linguistic philosophical perspective necessary to understand engineering in the Chinese language, or *gong cheng*, as a polysemous word including meanings of scheduled tasks, buildings, public works, and a credential-based profession responsible for designing, manufacturing and maintaining modern technologies. In this sense, engineering ethics is also ethics of technological activities and of technology. Responsibilities and commitments in engineering ethics not only applies to professional engineers, but can extend to all personnel involving in engineering work, sometimes without an engineer currently in charge of making decisions.

In learning engineering ethics, non-engineer participants and technology are not only the context professional engineers need to learn about when they are making ethical decisions. They are also the subjects engineering ethics directly address. The inclination to include critical players who are not engineers per se in engineering ethics is reinforced by the socioeconomic context of Taiwan as a highly populated technological society with a legacy of less strict regulations and the rapid growth during the "Taiwan Miracle."

Even though engineering ethics and education practice in Taiwan sometimes fail to delineate proper responsibilities of professional engineers, the eclectic approach to including non-engineers and technology as the scope of engineering ethics has several advantages to offer. In ethics theory and teaching, it helps bridge microethics and macroethics that are often separate in Western engineering ethics discussion. In practice,

it also transforms individual responsibilities into collective awareness and sustained support for ethical decisions and precaution principles in engineering that are so needed in a technological society like Taiwan.

SESSION III

Narrative knowing and engineering: a case from the intersection of biology and engineering

Dominic J. Berry

A recent special issue of *Studies A* (v. 62) has made the case for the fundamental narrative form of much scientific knowledge. My paper extends this programme into engineering, allowing us to make new contrasts and comparisons between the distinct professions, collections of disciplines, and epistemologies that make up the sciences and engineering. In particular I focus on the connections between narratives, epistemic goals, and collaboration. The intersection between biology and engineering is one that some key philosophers have already begun to develop systematically, most notably Bill WImsatt. Building on these foundations I bring to the surface the ways in which narrative has perhaps always been present in our accounts of engineering knowledge.

My case is based on interviews and ethnographic observation that took place between 2015 and 2017 with a research group composed of biologists and engineers. Their project is dedicated to understanding how seeds fly. We come to a deeper understanding of how such a collaboration is facilitated and made to cohere by greater attention to the narrative form in which knowledge is recorded and communicated. These are features of engineering work that are ripe for further exploration, allowing us also to further integrate philosophical, social scientific and historical work. With these purposes in mind, I end by extending the story historically, to consider the role of narrative in earlier biological engineering projects.

Travis Babikoff and Devlin Montfort, Oregon State University

Epistemic Practices in Engineering

Epistemology in engineering helps us understand how engineers make choices. Their epistemology provides the unspoken basis of what can be considered good practices in their fields, and is therefore very important to understand. However, epistemology in engineering is difficult to deal with due to its dialogical nature. The fact that the epistemologies of engineers are context-bound and cultural has presented persistent methodological challenges. To address these issues, we have developed a means of investigating the epistemologies of engineers by using epistemic practices and dialogical semi-structured interviews. By utilizing this method of interviewing, we were able to investigate the participant's epistemic stances by contrasting alternative epistemological conceptions. This allowed us to codify and more efficiently clarify the epistemic stances of the interviewees than some traditional interviewing techniques.

Epistemic stances are how knowledge is used in a specific instance to inform the actions an individual takes, why they made that decision, and what that decision means to them. The way epistemic stances are connected by common themes, such as justifications, constitute an epistemic practice. Epistemic practices in engineering examine an individual's personal understanding of what constitutes knowledge, and how knowing something works.

Questions such as what an engineer needs to know, how to teach them what they need to know, and what characterizes engineering are of central importance to understanding the epistemic practices that engineer's hold. To investigate these questions we have developed an interview protocol based on participants' own experiences in engineering, such as describing a time another person was involved in their decision making process, and how that person played a role in affecting their decisions. Using their responses, we developed interview questions around the information they provided and interviewed a set of professional engineers, engineering students, and engineering faculty. The transcriptions of the interviews were audio-recorded, transcribed, and analyzed using systemic functional linguistics. This analysis connected epistemic stances via common themes to establish a set of epistemic practices prevalent among engineering students, faculty, and professional engineers. We then characterized and compared the epistemic practices of professional engineers to engineering students. This process revealed how students' epistemic practices are developing, and furthermore how they should develop in accordance with the epistemic practices that professional engineers hold.

Our analysis of the epistemic practices obtained through these interviews has resulted in the development of a transparent and transferable approach to studying epistemic practices and will be used as a basis for comparison between engineers and engineering students. Using the data collected in this study has allowed us to begin testing and implementing curricular materials to address conceptual understanding in a way that helps shape student's epistemic practices towards those of professional engineers. By examination of where students begin from an epistemological point of view to where they will need to be as professional engineers, we have been able to establish an informed model of students' epistemic practices and how they develop into the engineers that will be needed in the future.

Tara Gonzalez *

Technology Readiness Levels: a common language or a common pain?

Vannevar Bush's 1945 report *Science: The Endless Frontier* stated "new products and new processes do not appear full-grown … [they] are painstakingly developed by research in the purest realms of science;" thus introducing the linear model of innovation into the lexicon of the U.S. federal government. As the name implies, the linear model relies on a forward path from basic scientific concept progressing to applied laboratory work and ultimately leading to a technology development, in this order. Many scholars, including the recent work by Narayanamurti and Odumosu, argue that the U.S. government's categorization of science as "basic" and "applied" is not conducive to how great scientific and technical advances take place.

I will present on one aspect of the linear model that has become deeply rooted in the government: Technology Readiness Levels (TRLs). TRLs were developed by Stan Sadin at NASA Headquarters in 1974 as a way to discreetly categorize the stages of technology development. Measured on a scale from 1-9, in TRL 1 the basic principles are observed and reported and a TRL 9 a system was proven through successful mission operations. Since their inception, TRLs have become a pervasive basis for federal R&D funding policy in scientific and engineering agencies including the U.S. Department of Defense, U.S. Department of Energy, NASA and others, despite scholars' misgivings about the linear model. An argument commonly made in defense of TRLs is that they represent a "common language" of technology development, in which all parties will understand what has been done and what is left to do to bring a product to market.

To evaluate the impact on TRLs in various program at NASA and the U.S. Department of Energy, I used a mixed methods approach to assess the plans for developing technologies as well as the perceived needs for new technology in the future. I interviewed managers and engineers involved in developing TRLs about their experiences with technology development and the effect that the TRL framework has on their work. I explored instances where program managers are restricted to work on technology development to defined, discreet TRLs in order to continue project funding. My work seeks to identify if there is a single most appropriate method of defining technology development to advance federally funded R&D, or if this "common language" cannot actually exist.

** All views and opinions expressed in this paper are the views of the author and do not necessarily represent the U.S. Department of Energy, NASA or the United States Government.*

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Exploring knowledge, values, rationale and how they influence engineering and technology: The case of the Atlantic Coast Pipeline

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Forum on Philosophy, Engineering, and Technology
Topic: Track 1: Philosophy of engineering and technology

Abstract

This project started the day an engineering graduate student knocked upon my door and asked me, "What makes a good pipeline versus a bad pipeline?" This normative question regarded a proposed pipeline designed to transport liquefied natural gas in a 42" diameter steel tube under high-pressure from West Virginia to coastal Virginia and North Carolina. The proposed Atlantic Coast Pipeline was being reported in local news organizations because of a proposed route running through a nearby county. In the spirit of shared learning, we considered the types of questions that might arise as we probed the larger normative question. Those discussions spurred us to make connections and garner support from additional colleagues. A set of research questions were deliberated and the group agreed to explore the societal processes that authorize (or reject) pipelines; demographic characteristics of communities that may (or may not) host pipelines; the values held by potentially affected communities related to eminent domain, outdoor recreation, and trust; and their perceptions of risks posed by the proposed project. Data from a direct survey instrument (n=272), public workshops (3 events), as well as geographic information and publically reported media and research reports offered evidence for our inquiry. The research team worked to uncover how pipelines are procedurally brought into existence through federal permitting processes, which differ greatly from processes in other contemporary nation-states. That inquiry revealed the forms of knowledge and normative criteria privileged in the engineering designs and by public entities with formal institutional authority. The values of material and energy efficiency guide designs that reflect 'straight line' thinking, rather than systemic or network-oriented design. The aspirations for control and authority informed the proposed route selection and eliminated many possibilities of co-location or shared infrastructures. The demographic characteristics reveal an undercurrent of preferences to distribute greater risks in aging, rural communities. The process showed which stakeholder could offer resistance that directly influenced the design (e.g. US Forest Service), while other stakeholders' views were rather ineffective (e.g. Friends of Nelson County). This project offers an approach to combat the notion of "disengagement" as discussed by Erin Cech's 2014 study of engineering education. The shared inquiry offered insights into what counts as legitimated information and how engineering designs of largescale infrastructure systems can re-engage with issues of place, demographics, and societal values, which are often deemed ancillary factors in a "rational" engineering decision-making process. Understanding the philosophy of engineering and the technologies created (or not created) demands shared inquiry into the processes through which social and political organizations bring technologies into existence (or not) and an understanding of the knowledge, values and rationale that undergird those processes.

Towards a Darker Future?
Designing Values into the Next Generation of Streetlights

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Taking into account the shifting terrain of technical and moral factors, this paper will articulate morally engaged design principles for the adoption of 'smart' light-emitting diode (LED) streetlights. We are on the precipice of a major revolution to outdoor lighting, which will profoundly change how we light cities at night. The various forms of electric lighting that have dominated the 20th century are poised to be replaced by LEDs, which has been described as a shift from electric to *electronic* lighting (Gandy, 2017). Concurrent to LEDs is the introduction of a variety of smart sensors to streetlights, adding another dimension to the shift towards electronic outdoor lighting (e.g., Juntunen, et al., 2015; Shahidehpour, et al., 2015). The controllability and, most important, the efficiency of smart LED lighting has fostered the rapid development and uptake of this technology, with an increasing number of cities across the world undertaking lighting retrofit projects (De Almeida, et al., 2014; NAP, 2016). For example, a retrofit to smart LED streetlights is planned for Washington, DC, making this a timely and relevant topic for *fPET 2018*.

In addition to developments in lighting technology, the values influencing, and influenced by, nighttime lighting are likewise undergoing a paradigm shift. Emergent concerns over the costs and impacts of light pollution, and relatedly the disappearance of darkness, are radically altering the moral landscape through which evaluations of nighttime illumination take place (e.g., Bogard, 2013; Edensor, 2017; Gaston, et al., 2015; Meier, et al., 2014, Stone, 2017a). This complicates the adoption of new lighting technologies, as current retrofit strategies – while championing lower costs and energy efficiency – are expected to exasperate the adverse effects of light pollution, and may ultimately lead to greater energy use (Kyba, et al., 2014; Kyba, et al., 2017).

This confluence of technological innovation and changing moral evaluations creates complex challenges for a ubiquitous but critical urban infrastructure. Yet, it also offers a rare opportunity to re-imagine how and why we light our nights in the 21st century, and to envision and enact new strategies. To articulate design principles for smart LED lighting, this paper will apply the framework for nighttime illumination proposed in Stone (2017b), which defines the value of darkness and categorizes it into nine *prima facie* obligations. Through applying this framework, I will propose that the functionality of electronic lighting can be exploited in ways that supersede a narrow focus on efficiency and achieve a broader range of environmental values. This paper will end with a brief reflection on future challenges to operationalizing such a framework for public lighting, specifically how environmental values compliment or conflict with other values intertwined with lighting, such as safety (e.g., Haans & de Kort, 2012; Peña-García, et al., 2015), as well as (dis)values associated with smart systems, such as privacy and surveillance (e.g., Kitchen, 2016).

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Robots as Others Expectations Moral Agents: From Human to Interactive Relationships

The conception of robots as moral agents is often criticized. Moral agents are thought to be (1) individuals with a subjective life with which others can enter into some type of relationships and (2) able to make autonomous decisions on the basis of some ideas of right and wrong. Both (1) and (2) make it possible for moral agents to be held morally accountable for their actions, that is, emotionally or rationally criticized with an aim of reformation.

The argument against robots as moral agents thus concerns emotional subjectivity and autonomy or free will. First, those who reject robots as moral agents argue that robots do not have subjective emotional states. People, who do have subjective emotional states, thus cannot participate in emotional relationships with robots, something they can do with human moral agents. Second, it is pointed out that robots do not have autonomy or free will. Robots do not act on their own intentions or purposes. The purposes of robots spring wholly from their engineering designers or programmers. Thus robots cannot be held morally accountable or subjected to emotional or rational criticism with an aim of reforming them.

The conceptions of moral agency on which these arguments rest deserves to be reconsidered. Consider, first, the issue of emotional subjectivity. When humans perform actions, their emotional states are not directly visible to others, nor are their intentions and purposes. As a result, when making moral judgements about others, what we use are expectations about their actions and intentions — which always leaves some level of uncertainty in such judgments. The emotions and intentions of others are necessarily to some extent our projections. This anthropomorphism is especially pronounced in military and medical areas, where robots are regularly felt to be human-like moral agents.

Second, even when robots are designed and programmed by engineers, it is not always possible to predict precisely what behaviors they will exhibit, any more than it is possible to predict the behaviors of autonomous human agents to which we attribute free will. Indeed, people often talk about intelligent machines such as autonomous vehicles and caring robots as performing moral actions independently their engineer designers and programmers. Finally, the more sophisticated robots are increasingly able to learn from their experience. This means that in principle there is no reason why they could not be held morally accountable for their actions, that is, criticized with an aim of reformation.

I thus argue for a new conception of moral agency. For a robot to be a functional, anthropopathic moral agent, those who interact with it need only decide to treat it as a moral agent, that is, as having subjectivity and free will. Their expectations in these regards are sufficient. The classical conception of the moral agent as possessing its own emotions and intentions is transformed into what I call an others-expectation moral agent. In concrete, everyday human-robot interactions, a moral agent need not be defined by the moral states or free will of a subject, but interactive relationships.

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Testing Technologies for Space: The Case of the Kepler Technology Demonstrator

Before the Kepler Space Telescope was approved for full development into the exoplanet-finding tool it ultimately proved to be, its advocates first had to prove that the technology could work in the environment of space. The transit method of exoplanet detection required that the telescope's CCDs be able to distinguish incredibly small disruptions in emitted starlight. NASA in fact rejected the Kepler proposal multiple times and required various technology demonstrations before the mission was finally approved. The final hurdle required the construction of a Kepler Technology Demonstrator (KTD) that would simulate both the transits and the "noise" of space, and would test the CCD technology in this environment. This paper looks at the KTD and asks the following questions: What technical challenges had to be overcome in order to adequately simulate the mission objectives and perceived hurdles, and how were these overcome? How were technological and bureaucratic needs distinguished and addressed? What, if any, benefit to the final design of Kepler was gained from the KTD experience? This paper draws upon written reports from the KTD team as well as interviews with its two primary members.

On the philosophy of planning in asset-intensive maintenance campaigns

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Abstract

ISO 55.000 (2014), the international standard for physical asset management, proposes a novel understanding of maintenance. It aspires to address the entire life cycle of assets, advocating predictive maintenance strategies that surpass preventive approaches to benefit from advances in monitoring and intervention. It transfigures departmental boundaries of organizations to recommend a nested structure centered on physical assets that reach up to a systemic purview of organizational management.

Maintenance backlogs in large organizations include tasks that far surpass the possibilities of routine maintenance. Maintenance campaigns capable of keeping backlogs manageable have progressively become an industry standard. Campaigns may occur regularly or irregularly, address the backlog as a whole or focus on one particular aspect.

Maintenance campaign planning and execution remains hostage to an organization's philosophy of planning – what can, or should, be planned.

To offer a polarity.

One perspective presupposes that it is possible to plan maintenance activities down to the last detail and timing in anticipation. A plan is best the more detailed in action and time it can be.

Another assumes that there is an inherent limit to what can be planned. Beyond a certain point, or in view of probable or possible variability, it is necessary to concede that decisions will be made by those involved *ad hoc*. A plan is best the more it supports adaptation.

The prevalence of one or another perspective is contingent to the entropic stage of the assets of an organization. Fundamentally, this has to do with the inherent nature of the objects of planning. Some are amenable to human will. Some are beyond its reach.

This paper discusses maintenance in asset-intensive organizations, offering a perspective that considers maintenance activities in light of the philosophy of planning, outlining consequences and discussing Brazilian examples.

Philosophical Observations and Applications in Systems and Aerospace Engineering

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Abstract:
This paper will describe several examples of recent practices in systems engineering and aerospace engineering research and development that should be of interest to the philosophy of technology community. These examples include cases in which philosophical and social concepts and practices are (or can be) implicitly or explicitly used in engineering, and cases that philosophers have investigated and found of interest in the past.

There are several cases in which philosophical and social concepts have been explicitly used in engineering. Computer scientists use what they call "ontology" in the artificial intelligence and engineering process optimization communities. Engineers attempting to establish new engineering disciplines have used "philosophy-like" rigor in defining key terminology to establish core disciplinary concepts. In new theories of "system health management" and of systems engineering, sociological and cognitive concepts are used to ensure that the propensity of humans to make mistakes is baked into theory and practice.

Engineers implicitly use some philosophical practices. Rhetorical ploys are quite common. One common practice is to change key terms to distinguish one engineering approach or practice from another. This is often used as an attempt to gain control of a newly forming discipline or to successfully compete against other approaches to acquire funding. Quantification is also a key form of engineering rhetoric. Attempts to create engineering disciplines, establish an engineering organization, or win an argument about a design or operational method can succeed or fail depending on the ability to generate and present quantitative results.

I will also present some recent examples of "philosophically interesting" topics that have been and continue to be investigated by philosophers. One set of topics relates to axiomatic and model-based approaches to systems engineering disciplines, and the role of "laws" in science. Another relevant topic is that of borrowing theories such as that of control systems to other domains such as fault management and systems engineering. Issues of the cost of acquiring knowledge for new systems so as to reduce risks will be discussed. Finally, the nature of engineering provides useful insights into issues that have been of great importance in the philosophy of science. As the purpose of engineering is to build systems to achieve goals, goal-directed thinking and hence teleology is becoming increasingly important in intelligent system design. Another interesting aspect of engineering is that engineers have both a "God-like" view of their system in that understand its "purpose" as well as its internal design and workings. Despite this, those systems frequently perform in unexpected ways, proving that engineers design and build

“complex” systems that exhibit unintended and unexpected behaviors. This has often been discussed under the concept of “emergence” and also of “engineering disasters”. I will argue that “emergence” is another word for “ignorance” or limits to human knowledge, and that sociological concepts such as “normalization of deviance” should be reconceived as a pitfall in the necessary practice of learning from operational experience.

Mamadou Seck and Miguel Angel Toro Jarrin, Old Dominion University

Understanding Practical Problems in the Technological Age

Problems are the element of our consciousness that link the actual and the desired. They signal our dissatisfaction with the present that spurs our resolve to change it. The problems we perceive and articulate, as well as how we articulate them, are important determinants of the actions we will take by means of technology to transform our world. The interplay between how we collectively perceive the world, how we perceive ourselves, and our awareness of technological possibilities -- thus our culture-- is what leads to our recognition of problems. In turn, the problems that we recognize guide our technological action in the world.

Given that our models of the world (us and technology included) are always imperfect and that our ability to predict depends on the quality of our models, it follows that technological action will always change the world and our culture in ways that we do not fully anticipate, and therefore lead to imperfect worlds in which we are bound to discover new problems. We thus find ourselves in a circularity between technology and culture in which, the way we pose problems is central: the problems we pose depend on our culture and the technical solutions we implement in response to those problems change our culture.

In an age of technological risks (bio-engineering, energy and climate, automation and AI, etc.) when major societal transitions are required to face those challenges, we must develop a deeper understanding of the relationship between society, problems, and technology. This deeper understanding will help us to approach technological debates with more clarity and to better understand the axiological thrust behind the artifacts that we create. I believe that the path to a more ethical use of technology is more likely achieved by a richer understanding of problems in engineering practice than by sprinkling ethical codes on already established ways of practicing engineering.

Problem definition has remained cursory in engineering research and practice, often adopting a purely objectivist stance. This paper proposes a richer formulation of problems using concepts borrowed from pragmatics, social cognition, and rhetoric, and discusses some of the implications brought about by this new formulation. Section 2 discusses the current practice of problem posing in engineering, section 3 discusses the roles that technology plays in problem solving, section 4 introduces our theory of problems and a resulting taxonomy of technological action, section 5 summarizes the findings from this formulation effort and charts a path forward.

Software and Metaphors: the hermeneutical dimensions of Software Development

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Traditionally, the most recognizable characteristics of software engineering are related to logical constructs, algorithmic thinking, and mathematical frameworks for optimizations; they are indeed at the heart of the practice. Nevertheless, an exclusive focus on them misses a fundamental aspect of the practice relating to its capacity to reinvent and reshape how humans act and experience the world. And this creative dimension has an intrinsically hermeneutical dimension.

In the first part of this paper, we propose a phenomenological approach that describes how signs of this hermeneutical dimension can be recognized in the evolution of software engineering techniques. The evolutionary path of these techniques may be an effect of the increasing recognition that a critical part of software engineering is not merely the result of a set of analytical and algorithmically-driven procedures. However, it still requires a hermeneutical approach to achieve its ultimate social goal of enhancing human experiences through technological artefacts.

The second part of this paper is devoted to a philosophical consideration of the findings of the initial descriptive approach in which we focus on the process of creating a new software entity or functionality. As we shall discuss, it involves a hermeneutical task to interpret the actions in the world that will be affected by the software being developed. The software developer is the hermeneut, and the considered objects are actions and experiences humans can perform or have in the world, actually or potentially.

To do so, we will use as our theoretical framework the works on hermeneutics of the French philosopher Paul Ricoeur[1]. As David Kaplan[2] mentioned in his article about "Paul Ricoeur and the Philosophy of technology", Ricoeur did not turn his attention to the "empirical dimensions of technology". Nevertheless, Kaplan lists five aspects of Ricoeur's work that are relevant to the philosophy of technology. The first of them is his "hermeneutic philosophy". Kaplan highlights Ricoeur's well-known discussion of how meaningful actions can be considered as texts: "The model of the text"[3]. Ricoeur's central objective is to apply the hermeneutical methodology initially related to written texts also to human actions. By doing so, he proposes a new theoretical framework for hermeneutics that goes beyond texts and also encompasses human agency. This reframing of the hermeneutical scope allows us to consider how the creation of software artefacts can be seen as an interpretation of the reality. The concepts of fusion of horizon by H.G. Gadamer[4] and metaphor by P. Ricoeur[5] will be the basis of this inquiry.

We conclude by suggesting how productive imagination intrinsic to the metaphorical creation plays a significant role in the development of the software based on the developer's interpretation of actions. When one considers the software products as re-descriptions of interpreted action, the imagination of the developer is essential to create a new synthesis between the actions interpreted and his technological horizon.

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More than new technical devices: a semiotic look at the digital transformation of industry

During the past decade, various programmatic writings have predicted that industry will undergo revolutionary changes in the course of the digital transformation. New engineering approaches in the context of the internet of things, cyber-physical systems and big data are expected to open up radically new paths of technical development. They will not only allow the creation of new kinds of technical artefacts, but also alter the process of technical design. In the future, engineering will accordingly be less concerned with the creation of static devices with a determinate function. It will instead revolve much more around the continuous evolution of larger superstructures whose parts have to be updated and adapted in short intervals. A clear distinction between design and maintenance tasks in engineering will become increasingly difficult and the work of engineers will rely much more on interactions with other groups of people involved with technology.

In this paper, we study the effects of the digital transformation on manufacturing processes in industry, where a large number of different programmes have been started to support the introduction of novel technology. We focus in particular on transitions in engineering practice from old to new design and maintenance procedures. We propose that these transitions cannot be appropriately described as an adoption of a new toolset of engineering, but that they rather have to be compared to learning a new language. As such, they require a deeper semiotic study of the way how meaning is attributed to technology.

Observations in different companies allow us to describe the learning process in more detail. All these companies have started projects to implement new technical solutions which involve cyber-physical systems and big data. We look at the way how employees of the companies and their business partners gradually gain “fluency” in the new, digital “language”. We discuss the importance of “active speaking” in contrast to “passive listening”, not only to get a better grasp of the new vocabulary and grammar, but also to motivate the engagement with the new language instead of sticking to the old one. Furthermore, we look at the involvement of new interest groups in engineering, such as maintenance technicians and device users. Their involvement turns the attention to the collective effort necessary to make the transition and the media that allow participation. We present different examples of such media which either support design or maintenance activities.

Our findings let us believe that the language-based approach can add an important new perspective to the study of engineering and technology. Current theories of technical artefacts and their design do not seem able to give a full account of the dynamic and fluidity of the digital transformation, especially when it comes to participatory activities in which engineers engage with other groups of people involved with technology.

SESSION IV

Maarten Franssen, Delft University of Technology

Philosophy of engineering and philosophy of technology: separation or integration?

The development initiated by the 'empirical turn' in the philosophy of technology have led to both an increased interest of philosophers in what engineers are doing and an increased participation of engineers in philosophical reflection on technology. This development, far from simply 'perfecting' the philosophy of technology, raises questions about the unity and coherence of the discipline of philosophy of technology – basically the question how the philosophy of engineering and the philosophy of technology hang together.

Technology has two sides. The instrumentality side concerns the totality of human endeavours to control their lives and their environments by interfering with the world through using things in a purposeful and clever way. The productivity side concerns the totality of human endeavours to brings new things into existence that can do certain things in a controlled and clever way. Philosophy of technology before the empirical turn focused almost exclusively on the instrumentality side, taking the availability of all outer instruments for granted. Representatives of the empirical turn have advocated and attempted to execute a shift to the productivity side.

Neither faces the question what perspective can unite the two sides. For the study of instrumentality, it is unclear how it is relevant whether the things made use of in controlling our lives and environments have been made by us first; if we could rely on natural objects to serve our purposes, the analysis of instrumentality and its consequences would not necessarily be affected. Likewise, for the analysis of what is involved in the making of artefacts, and how artefacts are to be understood, it seems irrelevant how human life, culture and society are changed as a result of them.

What is more, for the productivity side alone, we can conceive of philosophy of engineering as the philosophy of a practice, similar to the way the philosophy of science sees it as practice. On the instrumentality side, in contrast, our use of objects can hardly be isolated from the totality of human existence as taking place in modern society. Philosophy of technology cannot be the philosophy of a practice, because that practice would cover almost anything we do. Technology is a totalizing phenomenon rather than a practice.

Some may favour an independent philosophy of engineering, leaving philosophy of technology to continue focusing on the totalizing phenomenon of technology. That, however, would be a mistake. Engineering as a practice is much deeper integrated into the forms of organization of society than science. Whereas scientists publish their results, engineers sell them. The consequences of this for engineering methodology and epistemology have hardly been studied.

Any form that the philosophy of engineering will adopt, therefore, must be open to 'the other side' in order to adequately understand its subject. As a consequence, there is both a possibility and a task for the philosophy of engineering to contribute to the unity and coherence of an overall field of philosophy of technology. I will present several suggestions on how philosophy of engineering can contribute to this.

Christopher French, Pactera Inc.

Constructing Carnap as Conceptual Engineer in the World of Data Science

When Rudolf Carnap designed inductive logics in the 1950s and 1960s, he designed them as conceptual tools to help clarify and systematize Bayesian Decision Theory; it is in this sense that Carnap, when he was at UCLA, engaged in Conceptual Engineering. He wasn't in the business of arguing how science should be done, or how science is done. Instead, he looked at past and current scientific practice in order to construct conceptual tools which anyone could use to help systematize and clarify the existing networks of scientific concepts.

In this talk, I take a closer look at what it means to be a conceptual engineer in practice, from the point of view of Data Science. In addition to negotiating with business teams, choosing the right software/hardware tools, and choosing the right statistical visualizations, Data Scientists may also have to design their own statistical concepts -- concepts designed to help solve the practical problems of dashboard users. But for the Data Scientist to be successful, they have to wear many hats: they must successfully navigate the worlds of engineering, statistics, UI design, project management, quality control, human resource management, and so on.

I argue this flexibility to adopt new roles, to adopt and merge new perspectives, is what is required for successful Conceptual Engineering, and that Carnap's failure to fully adopt this role agnosticism explains his failed attempt to adequately Conceptually Engineer inductive logic.

Jet Engines, Design Teams and the Imagination: Designing as Playing Games of Make-Believe

Michael Poznic, Claudia Eckert, Rafaela Hillerbrand & Martin Stacey

Abstract:

Designing as a social process is fundamentally concerned with the creation of plans for artifacts that do not exist or the adaptation of existing objects to new purposes or new appearances. This involves both determining what the object might be and what properties this potential object will have given that certain assumptions about it are true. The members of a design team interact with these potential objects through models. This raises intricate ontological and epistemological questions about the nature of the emerging design of these artifacts. This paper proposes to conceptualize designing as playing games of make-believe, in which what one is allowed and encouraged to imagine is governed by socially agreed rules and constraints.

Kendall Walton (1990) argues that works of fiction such as novels are "props" that serve together with "principles of generation" as constraints on what is to be imagined in games of make-believe. The content of the imaginings can be expressed in certain statements that are "fictionally true". The approach of Waltonian fictionalism has been adopted by philosophers of science, notably by Roman Frigg (2010) and Adam Toon (2012), to make sense of how scientists use models to understand the world. In science there are actual physical processes that exist independently of the models; in design it is not clear whether the product of design always exists independently of the models through which it is generated. So far philosophers have been concerned with applying fictionalist ideas to the use of models to understand reality rather than with models to change the world or the construction of the models themselves. By contrast we aim to study *design models* through the lens of Waltonian Fictionalism. In particular we look upon design as the development of representations of artifacts, where the representations grow and change, and the artifacts they represent are specified through an iterative process involving series of increasingly more precise models, which are simulated, prototyped, tested and eventually manufactured. Different teams work in parallel during the iteration with assumptions that converge towards something feasible.

We will discuss a case study of the design of components of jet engines. The design task is done collectively where different design teams contribute to the creation and evaluation of the design of these components. The different designers make different assumptions and have to carry out decision-making negotiations to agree on what can and cannot be done with the design. Decisions taken about the next round of iteration become part of a game of make-believe in the sense that there is social agreement that the decisions constitute part of the constraints that govern what can legitimately be imagined.

Taking the purpose of design models to be generators and constraints on what aspects of the design are allowed and imagined to be gives us a way to think about how models are used in designing. We do not need to assume an untenable view that models have actually existing targets rather than the hypothetical or imagined targets that they often have in design.

Keywords: Design Models, Fictionalism, Games of Make-Believe

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Revisiting Schön's Reflection-in-Action in Transforming the Practice of Engineering Education

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On December 31, 2010, the author left the security of a tenured and distinguished professorship at the University of Illinois to start a coaching, training, and change leadership consulting firm (threejoy.com) to help transform engineering education. The author's belief in the need for a more integrated approach to engineering education is documented elsewhere (Goldberg & Somerville, 2014), but the practice-filled journey since 2010 has increasingly led to the conclusion that the ills of engineering education—and the education of practitioners more generally—are (1) systematic, (2) deeply embedded in the current culture of a higher education, and, (3) in part, resistant to change because we've not properly labeled the difficulty.

This paper briefly retraces some of the author's steps moving from an embedded faculty change agent to becoming a change consultant and coach, including key milestone's in practice and the way in which the author's view of core skills has changed. From the iFoundry initiative (Goldberg et al., 2008) to training and practice as a leadership/executive coach at Georgetown University in 2011, the development of certain kinds of *soft* skills has seemed central to success of these practical efforts. The author has labeled these skills *shift skills,* both to cast-off the label "soft" and to indicate that the changes required are subtle shifts in commonplace everyday communication, thinking, and feeling skills. The paper highlights some of the ways in which such commonplace skills as *noticing, listening, and questioning* (NLQ) can be shifted through appropriate practical training to become more effective.

Although this evolution of thinking and practice was natural enough, the author has struggled with articulating the importance of these shift skills in the education of engineers (and their educators). A recent rereading of *The Reflective Practitioner* (Schön, 1983), however, was helpful in reframing the author's experience in a manner that seemed both philosophically (epistemologically) and practically important. In particular, in that text Schön contrasted the dominant paradigm of practitioner knowing, what he called *technical rationality,* the idea that well understood theoretical knowledge is learned and then applied, with what he argued was a more practically prevalent kind of knowing, what he called *reflection-in-action.* The paper briefly reviews the key distinctions, considers them as *polarities* (Johnson, 1992), connects them with Sarasvathy's model of entrepreneurial thinking or *effectuation,* and then highlights their significance for bringing about an robust reform of engineering education and possibly the education of other practitioners as well.

This review pays some interesting dividends. Not only does the analysis highlight key steps in engineering (and professional) education change, it gestures at key directions for adapting the functions of the university to the digital revolution and for alleviating the omnipresent "crisis in the humanities," simply by taking Schön's distinctions more seriously in university practice.

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Self-reflection for Activist Engineering

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Abstract for fPET 2018, University of Maryland, College Park

Activist Engineering: Changing Engineering Practice by Deploying Praxis[1] was an initial attempt to piece together high-level thoughts on applying the idea of *praxis* to engineering, to reform 1) ideas of responsibility; 2) engineering education, interdisciplinarity, and knowledges; 3) and problem definition in engineering. The goal of activist engineering is to get engineers to step back from their work and be able to ask and have a conversation about the question, "What is the real problem, and does this problem 'require' an engineering solution?" Being able to adequately answer this question, and be in dialogue with the people affected by technical interventions thus moves the engineer beyond merely being someone who takes orders to design a technical system to one who is actively engaged—and will likely have a vested stake in—the technical system designed. However, my co-authors and I gave little practical guidance on how to conduct activist engineering. This paper is a step in the direction of such guidance.

It may be too much to ask for all engineers to be the kind of engineering activists I conjure in my head or from the anti-Vietnam days[2], but at the very least, I think it is absolutely essential that all engineers be explicit about their own assumptions and political ideologies when engaging in engineering work. I provide a list of questions that engineers might start with for this self-reflection to better understand their motivations for doing engineering, and to be in better relationship with the stakeholders of their engineering work. The questions are specifically related to considerations engineers must make regarding the social, environmental and ecological, economic, and peace implications of their work, along with questions about alternative, non-technical interventions to the problem at hand.

This guide is certainly not comprehensive, not least because praxis is flexible;[3] each situation within which engineering is done and decisions are made is likely different. These questions are meant simply to jog the engineer's creative juices, and to start a dialogue with those affected by engineering work, including communities, non-profits, governments, and industry. I believe that each engineer should, in the end, be able to answer the questions: Why are you an engineer? For whom do you work? What is the full measure of your moral and social responsibility?[4]

Keywords: activist engineering, self-reflection, praxis

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Kathleen Vogel, University of Maryland, School of Public Policy

Bringing the National Security Agency into the Classroom: Ethical Reflections on Academia-Intelligence Agency Partnerships

Academia-intelligence agency collaborations are on the rise for a variety of reasons. These can take many forms, one of which is in the classroom, using students to stand in for intelligence analysts. Classrooms, however, are ethically complex spaces, with students considered vulnerable populations, and become even more complex when layering multiple goals, activities, tools, and stakeholders over those traditionally present. This does not necessarily mean one must shy away from academia-intelligence agency partnerships in classrooms, but that these must be conducted carefully and reflexively. This paper hopes to contribute to this conversation by describing one purposeful classroom encounter that occurred between a professor, students, and intelligence practitioners in the fall of 2015 at North Carolina State University: an experiment conducted as part of a graduate-level political science class that involved students working with a prototype analytic technology, a type of participatory sensing/self-tracking device, developed by the National Security Agency. This experiment opened up the following questions that this paper will explore: What social, ethical, and pedagogical considerations arise with the deployment of a prototype intelligence technology in the college classroom, and how can they be addressed? How can academia-intelligence agency collaboration in the classroom be conducted in ways that provide benefits to all parties, while minimizing disruptions and negative consequences? This paper will discuss the experimental findings in the context of ethical perspectives involved in values in design and participatory/self-tracking data practices, and discuss lessons learned for the ethics of future academia-intelligence agency partnerships in the classroom.

Brian Dewhurst*

Engineering at what cost, to what purpose? The US federal budget process as a site for responsible innovation and engineering ethics work.

This presentation will overview how the budget process works with a focus on NASA and the U.S. federal agencies' process for deciding engineering and science budget priorities. For those studying engineering, the rationale for studying the budget process may not be obvious. The budget process is the cornerstone for laying out plans which will then be used to hold the agency accountable and to describe the agency's proposed value for society. When there are scarce resources, managers must decide on what they care about and value and choose among projects. In some ways budgeting is the preeminent policy process for any agency, as the allocation of resources is where the 'rubber meets the road' for prioritization (Sarewitz 2007). Budgeting also raises significant challenges about how to synchronize budget with technical engineering plans. In reviewing the history of aerospace cost growth, Kranz and Dyer argue that managing a complex system within constrained budget and schedule totals gets at the limits of human rationality and capability (Kranz and Dyer 2015, Wiltshire et al 2017). Regardless, analysis to inform budgets and technical planning always continues, and occasionally good budgeting can significantly shape the future trajectory of engineering work through careful analysis.

I will provide suggestions about how engineering ethics and responsible innovation (collectively summarized here as RI) scholars can tweak and augment the budget process. The rationale for this can be simply put: If an outside scholar or government manager wants RI issues to be important to an agency, then it needs to be part of budget process. To broadly transform engineering efforts, RI may need to become a factor in how agencies select and fund projects, with discussions across multiple levels of management and planning needed to properly connect budget decisions to technical plans. The multi-year nature of federal budgeting also must be considered, with the need to give early initial guidance prior to starting a year's budget process in order to try to get the necessary technical data to make meaningful high-level budget trades.

Based on my analysis, I will expound on changes and work needed for RI to potentially change the budget process. First, institutionalizing RI into the budget likely requires the need to train even thoughtful budget analysts, which is already difficult as many analysts struggle with the art of how to connect cost to technical plans. Second, if one wants to have rich discussions of the ethical implications of competing engineering tasks, typically resources must be spent to create the time and effort of assessing them from a societal and ethical perspective. Requesting that agencies fund such work (with as with the Human Genome Project's dedication of a percentage of funds to Ethical, Legal and Societal Implications research) may be important. Third, getting buy-in at both the working level of technical planning as well as at agency leadership, due to the need to get programmatically viable plans. Lastly, public budget documents (known as Congressional Justifications) reflect an important site for public debate on an agency's plans, and can be a beneficial point of focus for RI advocates to request RI-related detail and to in turn applaud agency efforts on RI.

*Opinions and views expressed in this article reflect the views of the author and do not necessarily reflect the views of NASA or the United States Government.

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"Can Saying Make It So?" J. L. Austin and the Philosophical Foundations for the Modern Construction of the Role of Communication in Engineering Practice.

Rick Evans

In my last fPET paper, I stated that current engineering communication theorists understand communication as "socially situated practice," as context-bound everyday social action. (Parretti, McNair and Leydens, 2014). Furthermore, I claimed that Wittgenstein in ***Philosophical Investigations***, in particular, through his presentation of the "language-game" was a possible (if unacknowledged) source for that understanding. He states that "the term 'language game' is meant to bring into prominence the fact that the *'speaking' of language is part of an activity* (italics my own)" (Wittgenstein, 2009). Indeed, recent research into communication in engineering contexts finds "there is something intrinsic about engineering practice that requires extensive interaction with other people" (Williams & Figueiredo, 2014).

In my current paper, I propose to focus on another philosopher of language, J. L. Austin. Along with Wittgenstein, Austin was troubled by the prevailing understanding of "language as an abstract referential system" (Potter, 2001). Wittgenstein's response was to issue a directive: "…don't think, but look" and by looking "bring back words from their metaphysical to their everyday use" (Wittgenstein, 2009). Specifically, he encouraged us attempt to "get a clear view," to focus on what is important – "seeing what is in common," those "family resemblances" or the "rules we follow" in order to play language games (Wittgenstein, 2009). That is exactly what Austin attempted to do.

In his opening lecture at Harvard, the first of twelve, Austin (1962) posits a dichotomy, two kinds of utterances, the constative and the performative. The performative, he states, "is derived … from 'perform'… [and] indicates … the performing of an action," the alternative to "just saying something" (Austin, 1962). In the remainder of those lectures, Austin provides a taxonomy of the kinds of performatives and the conditions under which they can be understood as "happy" or "unhappy," valid or not. However, as he brings back words to their everyday use, Austin abandons this dichotomy "in favor of more general families of related and overlapping speech acts" (Austin, 1962). In effect, he states that "perhaps we have here not really two poles, but rather a historical development" and that "every genuine speech act is both" (Austin, 1962).

I believe with Austin that every genuine speech act is both and that, in fact, what we are experiencing is a historical development in our understanding of the role of communication in engineering and professional practice. I begin by providing a brief description of how, by attending to the "very widespread and obvious," Austin discovers what is in common, those resemblances, the rules (Austin, 1962). Next, I argue that instead of stating the aim of that development or forecasting its result, Austin illustrates how that development should proceed – "saying [indeed showing] what ought to be done rather than doing something" (Austin, 1962). Finally, I suggest that only through studying words in "their everyday use," as Wittgenstein encourages, and communication that "cannot fail to have been already noticed," as Austin elucidates, will we learn about that "something intrinsic about engineering practice that requires extensive interaction with other people."

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A Thousand and One Engineering Stories

Anne Meixner

Engineers thrive on working on and solving difficult problems. Not every engineer gets to build the Brooklyn Bridge [1], yet the design of every rivet in a bridge whether rural or the Brooklyn Bridge has a story worth sharing. Stories from everyday engineers can help others learn from their challenges, mistakes, practices and triumphs. In this presentation, I intend to demonstrate the value in collecting and sharing stories in a creative outlet that engages and motivates engineers in the workplace. In addition, this collection of stories can augment the existing literature on the philosophy of engineering.

As engineers we attend college to learn the fundamentals and current technology. In the workforce, we apply technology and contribute to developing new technology. We share our knowledge with our peers at work and at technical conferences. Yet along the way we learn something else-- craft. Like a trade apprenticeship, engineers share craft via adages, expressions of the trade and stories.

We share engineering stories over beers, coffee, meals that speak to the core of how engineers make the impossible possible and the everyday sustainable. Every engineer has at least one story describing craft. Technology provides the backdrop for this kernel of engineering wisdom. Hearing such a story a seasoned engineer may nod their head. A recent college graduate listens and stores away that kernel. A seed planted that makes them a better engineer.

We view these engineering stories as **untapped knowledge** that lacks a forum for wider dissemination. If collected, these stories can contribute to a **compendium of stories** that illustrate the craft of engineering. These stories support the fresh out of college engineer. These stories inspire and validate the seasoned engineer. Such stories provide the everyday perspective on the craft of engineering. Such stories augment the philosophical and epistemological works of the prolific Harry Petroski [2] and Samuel Fordham [3] and the recent writings of Guru Madhavan [4]. These vignettes of engineering work complement the longer biographical works that focus on teams of engineers [5-7] or individuals [8-12].

The Engineers' Daughter website provides a mechanism to share the craft of engineering. Not through technical manuals but through stories that quench one's curiosities. In phase one, the presenter shared stories from her own career. In phase two, we will publish stories from other engineers. As we began phase two a dilemma unfolded-- busy people don't have the time to write their story. Solution- we use the oral history practices of Studs Terkel [13] and Story Corp [14] to bring an engineer's story to life on-line. From July 2017 to October 2017 we collected audio from three individuals and ran a pilot story telling experience. These oral histories are being curated for publication starting in Feb 2018.

Collecting a thousand and one engineering stories—yes it's an audacious goal. But worthy of pursuit, because **every** problem solved has a **story**. A story that illustrates the human endeavor and passion for finishing the job.

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The Alchemy of Maintenance Art
By Caitlin Foley & Misha Rabinovich

Our dreams lead us on, and we would do well to cultivate the right dreams. Our media scape has been permeated by dystopian science fiction from the last century and the big budget films that draw upon them. As a lot of those dystopian predictions come true, perhaps we should ask: Are we are living in an age of self-fulfilling prophecies? Wouldn't our cultural imaginary benefit from being seeded with some utopic alternatives? Cultural producers such as the late Ursula Le Guin has urged us to take seriously the need to actively imagine utopic alternatives to the status quo (1). As we face off with a plethora of wicked problems e.g. climate change and oligarchy, perhaps we should take a step back and ask if more innovation is the answer. It seems to us that at this point in our development it is not technology that is our bottleneck. The true challenge lies in how we apply our technology and how we distribute the gains of innovation. We need a new shared vision, and the realm of cultural imagination is the domain of art. In our own artwork we strive to engage ideas and practices that involve sharing communities, livable ecologies, and the transmutation of waste. We believe that by embracing maintenance art, our work offers opportunities to explore pluralism in a playful and accessible manner. The Maintenance Art manifesto by Mierle Laderman Ukeles is more than four decades old, however it continues to inspire those who place it into the contemporary context of cultural and economic privatization.

In our artwork we create participatory installations, games, and happenings where audience participation is a key component of the work and its message. Our arcade-style game *Total Jump* trains people for a coordinated worldwide jump. The near impossibility of accomplishing a total jump combined with the ease and fun of training for it invites the audience to bridge the gap between a postmodern pluralistic world and the necessity of globally coordinated solutions in the face of the Anthropocene. Our *Shareable Biome* project is rooted in a fascination with microbiome theory and Western culture's recent adoption of the Fecal Microbiota Transplant (FMT) as a radically life-saving probiotic procedure. The rapidly increasing accessibility of this treatment is largely due to the work of maintaining microbial diversity by such groups as the nonprofit stool bank OpenBiome. The data that OpenBiome shared with us has been feeding our artistic research, visualizations, and lecture-performances. Like the bacterial culture in the gut, human culture is also threatened by monoculture run astray, e.g. the manosphere, the alt-right, etc. The ecological need for a diverse microbiome is a fertile analogy for a multitude of cultural struggles in which sharing communities play a key role.

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Marion Boulicault

Measuring the Success of Emerging Technologies: The Case of Brain-Computer Interfaces and the Illiteracy Metric

Brain-computer interfaces (BCIs) are implantable devices that allow for computer-mediated interaction between a person's brain activity and their environment. Examples of devices currently in development or use include those aimed at controlling prosthetic limbs, and the treatment of Parkinson's, epilepsy and depression. They work by analyzing brain activity (e.g. to determine an intention to move, or the beginnings of a seizure or depressive episode), and then translate that activity into action (e.g. the movement of a prosthetic arm, or therapeutic neurostimulation to prevent or mitigate a seizure or depressive episode).

Given cultural connections between the brain and identity, as well as worries about mind control, privacy and 'neurohacking' (to name a few examples), significant attention has been rightly paid to the ethics of BCIs. However, in this paper, I want to raise a question that I contend has yet to receive sufficient attention from philosophers and technology scholars: what are the ethical and political implications of the way we *measure* BCIs? In other words, what are the normative implications of the practices, instruments, and concepts that go into measuring and assessing the success of this emerging technology?

I ask this question via a case study of the use of a metric known as 'BCI illiteracy.' There exists a subset of the population who, despite continued training, are unable to use BCIs. This failure is usually due to problematic translation between brain activity and action - e.g. the BCI simply cannot accurately 'read' the brain signals produced by the individual, usually for unknown reasons. BCI researchers call this phenomenon 'BCI illiteracy' and report that it affects 15 – 30% of all BCI users (Thompson, draft). Drawing on research and methods in the philosophy of technology, the philosophy and sociology of measurement, and disability studies, I argue that the use of 'BCI illiteracy' as a metric for success encodes a problematic model of human-technology interaction. In particular, it places responsibility for the 'failure' on the individual BCI user, as opposed to the technological system. This has implications for how the BCI user perceives herself in relation to the technology, and also on how neuroscientists and engineers understand and engage in their work, and thus on how the technology develops. As such, the case of the BCI illiteracy metric illustrates how instruments and practices of measurement serve as significant sites for the interaction of science, technology and values.

Citations

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Is CRISPR-Cas Really Revolutionary? (Word Count: 496)

The new molecular tool, CRISPR-Cas, has made targeting precise stretches of DNA for editing much more common place in biology labs across the world. CRISPR (short for clustered, regularly interspaced short palindromic repeats) is a programmable, single-guide RNA that targets specific genes by base-pairing to DNA. A DNA-cleaving enzyme (Cas) is then recruited to the site and induces a double strand break, where DNA repair mechanisms rejoin the broken strands resulting in either the introduction or removal of nucleic acid bases to an organism's genome. This technology has made possible investigations that were at one time not possible. Today, CRISPR-Cas has been used for a myriad of purposes including genome-wide knockout screens, loss of gene function studies, and even human embryo modification. Many discussions emphasize CRISPR-Cas' exciting applications as if its development represents a "watershed moment" in genetics research (Baylis et al. 2016). It has been characterized as a "scientific breakthrough," an "exponential advance," and "unprecedented" (Travis 2015; Chari et al. 2017). Several commenters have raised ethical concerns about the possibility of do-it-yourself genome engineering projects carried out by non-experts, of the de-extinction of long lost species, of population-level genome changes, and of human germ-line modification (Smolenski 2015; Charo et al. 2015).

But is CRISPR-Cas really revolutionary? Understanding the advancement(s) this technology represents requires an appreciation of existing biological technologies. Many of the functions CRISPR-Cas enables researchers to carry out have been functions that other biological technologies have made possible. For instance, protein based gene-editing tools, such as Zinc finger nucleases and TALENs, are also capable of making precise changes to genomes and continue to be used widely (Geurts et al. 2009; Joung et al. 2013). Many initially expected CRISPR-Cas to have superior precision and fewer off-target effects than these other gene-editing technologies. Yet, as our understanding of CRISPR-Cas amasses, it has become increasingly apparent that researchers face many of the same limitations when using Zinc finger nucleases and TALENs (Schaefer 2017; Peng et al. 2016; Ma et al. 2017). All three gene-editing tools have variable success when it comes to minimizing unwanted off-target edits, when it comes to delivery into a host, and when it comes to replacing a gene sequence by homologous DNA repair.

CRISPR-Cas' advancement is not unprecedented gene-editing capacities, but rather the ease and cost-efficiency with which the programmable guide RNA is produced. The rate at which customized guide RNAs are made is immensely faster than the rate at which effective Zinc finger and TALE proteins can be synthesized. Furthermore, the cost of producing customized single-guide RNAs is more affordable than the cost of making other gene editing tools (Ledford 2015). These improvements are primarily responsible for the widespread adoption and expanded uses of CRISPR-Cas in many labs.

A proper understanding of the advancements made possible by CRISPR-Cas helps us see that it does not stand out from other gene-editing tools in many ways. Much of the acclaim and ethical concern attributed to CRISPR-Cas is properly attributed to other technologies as well.

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Solar Geoengineering: A Case Study in Slippery Slope Arguments Against Emerging Technologies

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Critics of emerging technologies sometimes appeal to fears of a slippery slope to argue that engineers and researchers should not pursue the technology any further. Genetic engineering, they warn, will lead to designer babies. Artificial intelligence, they predict, will lead to mass unemployment or even human extinction. Supporters of a particular technology tend to dismiss these arguments, but under what conditions are they worth taking seriously?

This paper uses the case of solar geoengineering as a case study in slippery slope arguments. Solar geoengineering is a proposed technique for limiting climate change. It would involve reflecting a small fraction of incoming sunlight back into space before it can warm the planet. While it seems likely that these technologies could reduce global warming, there would be distributional and intergenerational effects, adverse environmental side effects, and other ethical concerns. Near-term research, however, would not carry any of those risks.

Nonetheless, critics of solar geoengineering frequently use a slippery slope argument (SSA) to oppose even small-scale research into solar geoengineering, such as environmentally negligible outdoor experimentation. They warn that allowing such research will lead inevitably to some kind of undesirable deployment of solar geoengineering. This paper explains the logic needed for a cogent SSA against small-scale research. It collects and expands on five processes that have been suggested in the literature by which research might lead to undesirable deployment: vested interests that push for further research and eventual deployment; what Dale Jamieson calls the “cultural imperative” to deploy new technologies once they are available; a gradual process of “legitimation” or “normalization” of solar geoengineering; a “moral hazard”

effect that undermines climate change mitigation, thereby setting the world on an otherwise avoidable path toward solar geoengineering; and the enabling of rogue actors to deploy solar geoengineering unilaterally. It then analyzes the plausibility that each of these processes might lead us to an undesirable outcome, while drawing out some special complexities related to uncertainty and dynamic preferences. The paper concludes that while some of these processes will likely exert some pressure toward deployment, none of the proposed mechanisms seem especially powerful, and so while the SSA against solar geoengineering has some merit, it is far less powerful than critics of solar geoengineering often assume.

The talk will conclude by discussing how to apply the lessons from the case of solar geoengineering to other emerging technologies.

SESSION V

Title: The dynamics of perspective-taking in discussions on socio-technical issues

Ayush Gupta, Chandra Turpen, Andrew Elby, Thomas Phillip

The work of professional engineers is socio-technical, in that the technical solutions they produce have deep short and long-term impact on the social, political, and economic fabric of society at small and large geopolitical scales (Bucciarelli, 2008). As such, in most real-world engineering problems, stakeholders in any specific issue come from a huge variety of spheres representing, for example, business, government, policy, public and labor interests. Engineers often need to work with these different stakeholders in teams that are themselves inter-disciplinary. To create solutions that attend to welfare of the public and the different stakeholder interests in an ethical manner it is important that professional engineers be able to understand, empathize with, and represent multiple perspectives in the context of a specific issue (Brown & Wyatt, 2010). But changing perspectives, to look at a topic from some other actor's viewpoint can be challenging, especially if the viewpoints are in conflict, represent different interests, or draw on experiences situated in very different economic or political realities. So it is important to create models of how current and future engineers engage in perspective-taking in socio-technical contexts. This has been an underexplored topic in engineering education research. Drawing on King and Kitchener's reflective judgment model (1004), Ziedler et al. (2009) characterize how engineering students in clinical interviews argue when presented with multiple perspectives on a specific issue such as alcoholism. Adams' matrix of informed design characterizes how trajectories of expertise in design might be aligned with greater ability at taking multiple stakeholders into account. We aim to build on this work, by characterizing how future professional engineers negotiate multiple perspectives in the context of a socio-technical issue in a group-discussion setting over multiple days of discussion. Our data comes from video records of a cohort of 6 engineering students (seniors and graduate students) discussing the impact of introducing waste-management technologies in India under the Kyoto Protocol. The students met for 4 focus group sessions of 1.5 hours each. We draw on the notions of narrative analysis (Wortham, 2000) and stance (Goodwin, 2000) to attend to (i) how the different perspectives students are taking on position the stakeholders in different relationships with respect to each other and draw on broader socio-political ideologies, influencing how they evaluate the ethics in that specific situation and (ii) the interactional dynamics of the shifts in perspectives that are taken up by the students. Thus we aim to characterize empirically what it means to take on a perspective in discourse as well as the dynamics of how perspectives (and associated ideologies) are taken up and/or contested in the unfolding conversation. Through this we aim to build richer accounts of perspective taking in engineering ethics discussions and inform the design of learning environments for engineering ethics education.

From deontological to interpretative: Self-reflection and recognition of others

Rider Foley and Araba Dennis, University of Virginia

Engineers are often taught that ethics entail adherence to codes of conduct offered by employers or specific engineering societies that inform the expectations for professional behavior. On the other hand, some engineers learn that research ethics are represented largely within the principles of Responsible Conduct of Research (RCR). Both of these approaches ask for engineers to learn, accept and conform to values that offered by external organizations. This is intended to support an individual's decision-making in the face of future ethical quandaries. Prior scholarship by Joseph Herkert suggests there is a multi-layered set of ethical obligations that range for micro-ethics to macro-ethics, which reflect the values and uphold the ethical obligations of professional societies. Authors van der Poel and Royakkers, whose work underscores how the "problem of many hands" gives rise to macro-ethical failures. This brings to light the notion that individuals or even large organizations are not solely responsible for unfolding innovation processes, implementation, and maintenance of engineered systems, as they lack complete control and authority.

The challenges associated with a lack of complete control or authority are often handled in one of two ways that align with distinct philosophies of engineering. The first of these is the pursuit of greater control as exercised by myriad forms of power and authority. The second approach, and the main focus for this paper, stands in stark difference to aspirations for greater control. This approach, advocated by Mitcham's recent article in Issues in Science and Technology is one of self-reflexivity and interpretation of broader social context that demands consideration for and learning about one's self and relations to others. This interpretative approach is often referred to as the "reflexive practitioner". While significant resources have been dedicated to case studies that support deontological ethics, there have been fewer resources committed to introducing practices of reflexivity into the philosophy of engineering.

This project shares four approach to develop the capacity within undergraduate engineering students to consider their own values, recognize the values of others and explore their relationships to the broader societal context. This paper reports on data from 65 students that drafted 1-page essays on the question, "What is engineering?" at the outset of a one-semester course and then responded to the same prompt 15 weeks later. The educational interventions on reflexivity included activities that supported the students' included written responses to semi-structured prompts, stakeholder and network mapping, role-play with character cards, and reflection on aspects of candor and humility. These initial results suggest that reflexivity is relatable and serviceable for engineers. Reflexivity is a key aspect of many scholar's frameworks for responsible innovation. This pedagogical approach aims to provide the space for students to move learning uncritical, duty-based ethical positions to a more interpretative, critically reflexive approach that acknowledges one's own values, the rules (institutions) and expected behavior (norms) and acknowledges the values of others in a given decision-context.

Applying Interpersonal Mental Models of Privacy to the Internet of Things

D.E. Wittkower

The overwhelming majority of contemporary discussion of privacy focuses on personally identifiable information as property, and research on privacy nearly always finds, in what is called "the privacy paradox," that users don't care enough and in the right way about "privacy" as it has been framed in legal and technical contexts. This is a strikingly normative perspective, assuming that users' mental models must be reformed in order to conform with legal-juridical models of privacy rather than designing systems to follow users' intuitive mental models. It might be productive in a number of different ways to instead first ask in what way people do in fact care about privacy and to design and redesign policies to afford this good rather than trying to change human values to conform to our legal-technical environment.

Following this initial framing, I outline an interpersonal phenomenology of privacy oriented by ethics of care, considering privacy as it appears in parenting, friendship, romantic and sexual relationships, and care for elderly and disabled persons. This phenomenology identifies three distinctive dynamics of privacy in interpersonal contexts. First, in considering maternalism and paternalism, we see that autonomy and privacy are traded against one another at either end of life, with the aging child requiring increasing privacy in order to feel self-determining, and the aging elder losing self-determination as privacy from caregivers becomes increasingly difficult to provide. Second, we see that maintaining differential levels of privacy toward different persons is a way in which some relationships are defined, this differentiation being a modulation of privacy described as 'intimacy'. Third, a distinctive form of consent emerges in interpersonal contexts, one which is always temporally and contextually specific—consent in interpersonal contexts always requires renewal and even once granted is still never a given.

These elements of the phenomenology of privacy in interpersonal contexts are then applied to a variety of kinds of IoT devices and systems will be discussed, chosen to represent a diversity of kinds of interactions and relationships within the IoT: GPS navigators, the Amazon Alexa virtual assistant, Nest, and two medical robots—PARO and RIBA. These applications are not thorough, but are intended only to indicate how rethinking privacy from users' mental models produces a somewhat different set of concerns than those currently discussed as "privacy concerns," casts those concerns differently, and indicates new directions for and kinds of reforms.

The most distinctive and useful of these differences are drawn together into conclusions on two major themes. First, we note that privacy in a legal-juridical context is commodified relative to privacy in interpersonal contexts. This is most apparent in the economies of information exchange: in the legal-juridical context, loss of privacy is framed as loss, where, in the form of intimacy, it may appear instead as a gain in interpersonal contexts. Second, the strongly divergent understanding of consent as needing constant renewal rather than being a box to be checked in clickthrough licensing seems to demand transformative reforms from companies interested in engineering ethics.

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Is an Engineered Life Worth Living for Humans?

This is an effort to think about both the engineering life and the engineered life. The argument, first, is that the life of the professional engineer and the lives of all of us who live in the world being progressively designed, constructed, operated, and maintained by engineers are closely related. Second, critical philosophical reflection on the engineering-engineered life has primarily taken two forms: externally (among non-engineers) this way of life has been assessed in social justice terms; internally (among engineers) reflection has focused on celebratory apologetics in conjunction with some attention to professional ethics. What is missing is a philosophical anthropological examination of engineering life, a sketch of which will be developed here.

In a well-known passage from the Apology, Socrates declares that "the unexamined life (ἀνεξέταστος βίος) is not worth living for humans" (38a). This is complemented in the Crito with a statement about humans should seek not simply to live (τὸ ζῆν) but to live well (τὸ εὖ ζῆν) (48b).

In the Nicomachean Ethics I, 5, Aristotle observes that most people identify the good (ἀγαθὸς) or well being (εὐδαιμονία) with physical pleasure (ἡδονήν), but that two other ways of life are the political (πολιτικὸς) and theoretical (θεωρητικός). The life of pleasure, as a way of life shared with animals, is not distinctive of humans. The political life, which involves the pursuit of honor or esteem (τιμή), because of its dependence on others, falls short of something more self-contained and thus higher, that is, the pursuit of theoretical or contemplative knowledge. Later at Nicomachean Ethics I, 7, and then again at greater length in X, 7, Aristotle defends at any length the life of theory or knowing as the highest form of the good.

One way of life Aristotle fails to consider is that of artisans or makers of physical artifacts, who are actually praised by Socrates in the Apology as more wise than either politicians or poets. Like engineers and unlike politicians (who manipulate others with rhetoric) or poets (who are possessed by the gods), artisans do know something, namely, how to make things. It was not until the modern period, however, that making began to be conceived as a distinctive and distinctively human way of life.

As the world progressively becomes an engineered artifact — and as our lives become environmentally, medically, socially, and genetically engineered — it is appropriate to ask ourselves to what extent this way of being in the world is truly human. One of the paradoxes of engineering experience today is that we simultaneously aspire to preserve who we have been (especially culturally, religiously, politically) and to innovate ourselves into something different (financially, socially, and even physically). Indeed, increasingly we undertake to design and plan out our lives after the manner of how engineers design artifacts or structures and plan out their construction, operation, and maintenance. Surely this suggests the appropriateness of subjecting the engineering way of life in its multiple manifestations to critical philosophical reflection.

Morphological Freedom:
Potential and Normativity in Transhumanism

Joshua Earle
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Article X of the Transhumanist Bill of Rights states that all “Sentient entities” ought uphold “Morphological Freedom” – the right to do with one's physical abilities or intelligence whatever one wants so long as it does not harm others. In this talk, I will unpack the notion of morphological freedom, exposing assumptions which I believe will lead to greater inequality, and a race to the top mentality. I will also discuss what “harm” is believed to mean in this context, and what ways in which that belief is lacking. Through historical analysis of previous morphological adjustment, including cosmetic surgery, sex assignment surgery, and body modification, I will put the lie to the notion that the option for diversity in bodily arrangements necessarily leads to said diversity. Also, drawing on critiques of the neoliberal subject/self, I will describe how upholding the diversity that Morphological Freedom seems to want is necessary for producing the ultimate apotheosis of humanity which Transhumanists desire: networked minds. This will require an ethical re-formation of selves, communities, and the entangled nature of humans and the world, and a mindful and nuanced engagement with our enhancement technologies.

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Constructing Situated and Social Knowledge: Ethical, Sociological, and Phenomenological Factors in Technological Design

By Damien Patrick Williams
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Designers, programmers, and others in the fields of technology and engineering are—recently, and with increasing speed and urgency—coming to understand that there are many ways that human biases can become problems within the fields of engineering, programming, algorithmic systems, machine learning, artificial intelligence, and design. This means that when we design, program, train, or deploy technologies, we must remember that we are coding their data sets and designing their parameters from human-centered knowledge bases and assumptions about the world.

In order to understand these assumptions and how they gets instantiated in our technological systems, we have to understand various social, psychological, and philosophical frameworks. We need to understand concepts such as intersectionality, embodiment, the extended mind hypothesis, epistemic valuation, phenomenological experience, and how all of these things come together to form the bases for our moral behavior and social interactions.

In this paper, I will highlight several questions which represent categories of knowledge developed out of the phenomenological lived experience of members of various groups of people. Questions such as: "How do you walk home? Where are your keys?;" "What do you do when a police officer pulls you over?;" and "What kinds of things about your body do you struggle with whether and when you should tell a new romantic partner?"

Via tools from intersectional feminist theory, feminist epistemology, disability studies, and phenomenology, I will use these questions to interrogate several assumptions about design, and to prompt the audience to think in a mode that may be unfamiliar to them. The audience will come to recognize that each of these questions represents a set of lived experiences and, in some cases, life or death concerns for people in the world and that, as such, these experiences must be understood and taken into account, when designing and deploying technological systems.

As long as humans are the ones doing the work of translating their experience and understanding of the world into technologies and into the languages that other technologies can understand, those humans need to take pains to work in far more diverse groups of people, privileging traditionally under-served groups of people, and their categories and constructions of knowledge systems. In this way, designers and engineers and their resulting technologies will be far more likely to include the perspectives of those people who understand not only the existence of these questions and their implications, but also the epistemologies and life strategies that they represent. This increased understanding will broaden and deepen our understanding of what our technological systems are and can do, for all of us.

"Online Manipulation: Is Transparency a Cure?"

Daniel Susser

Abstract: Scholars have worried for some time about the ways information technology can be used to influence our decision-making. Unprecedented levels of digital surveillance, by both governments and private firms, combined with rapidly advancing methods for algorithmically processing the collected information, raise deep ethical, political, and legal questions about how the insights gleaned can be leveraged to control us. Events around the world over the last two years—elections in the United States, Germany, France, and Kenya, the Brexit referendum in the United Kingdom, and so on—have thrust these previously academic issues into public consciousness. Two questions predominate: (1) How can we distinguish problematic forms of influence from acceptable forms? (2) How can problematic forms of influence be stopped?

In another paper, Helen Nissenbaum, Beate Roessler, and I address the first question, distinguishing manipulation from other forms of influence, such as persuasion, coercion, deception, and nudging, and defining manipulation as the process of subverting another person's decision-making powers by exploiting their cognitive weaknesses or vulnerabilities to impose a hidden influence on them. We use the term "online manipulation" to denote manipulative practices enabled by information technology. Implicit in our definition is an answer to the second question, a strategy to combat manipulation: if manipulation works by concealing itself, so that the manipulee is unaware that they are being influenced, then perhaps exposure—revealing the influence—will neutralize its effects. Indeed, this idea comports with the suggestion made by others writing about online manipulation, that a solution to the problems raised by these practices is to demand *transparency* about them.

In this paper, I examine transparency as a strategy for combatting online manipulation, with an eye toward both its promise and potential limitations. While exposing manipulative practices can, indeed, counteract them (knowing that we are being influenced can, to some extent, inoculate us against its effects), not just any disclosures will do. I argue that we must know a great deal about who is attempting to influence us, why, and what methods they are using. Efforts at transparency must be tailored to the specific computational techniques at issue in each particular case. Consequently, if such efforts are going to be effective, I argue data ethicists and policymakers must work together with data scientists to craft them. Furthermore, I argue that whether or not particular disclosures about online influence will work to safeguard us against it is, in part, an empirical question. Thus, I point to future research to be conducted by data ethicists in collaboration with social scientists.

From interpersonal trust to trust in technology itself: blockchain as a responsible design material

Yan Teng[1], Guowei Jiang[2]

Abstract: While human-to-human trust has been widely accepted as the dominant paradigm of trust relations, trust issues arising between human and technology itself (TTI) has often been overlooked and doubted in the mainstream trust discourse. Much of the literature challenges the conceptual viability of TTI by either arguing that technology itself can only embody reliance or by classifying TTI as merely a metaphorical form of interpersonal trust. The core argument of these beliefs lies in the notion that technology itself lacks mental states that are normally considered essential elements accounting for interpersonal trust relations. This paper proposes to validate the notion of TTI from a value sensitive design (Friedman et al. 2002, van den Hoven et al. 2015) standpoint that by embedding the epistemology of interpersonal trust in the conceptualisation of technology, technology could be a trustworthy entity on itself while mediating a broader network of trust relations. We argue that a distinct difference between interpersonal trust and human-to-technology trust is that while goodwill of the former trustee is shown by some moral language of giving trust, goodwill embedded in technology will eventually be embodied and externalized in functions and features that are designed for meeting specific social values, psychological needs, and user experience. Hence, we could say that those technologies that have functions or features manifesting the imparted goodwill could qualify as the potential objects of trust relationships.

By articulating the proactive designed features of the blockchain technology, we further argue that people have already engaged in creating new technologies with embedded values, which aims at being trusted and promoting trust. Blockchain technology originates from the concept of crypto currencies like bitcoins with its effort to remove the authentication of a centralized third-party institution onto a Distributed Autonomous Organizations (DAO) where the objects of trust alternatively shift from human agency to a smart networking system. Emerging efforts have been found to extend the affordances of blockchains to build Decentralized APPs (DAPPs) based on the four core features of DAOs which we detected close relevance with the epistemology of trust in an interpersonal network: (1) Decentralized ledger distribution where each piece of record is restored and validated across the entire network. (2) Mutual consensus system where no change or rewrite is possible unless the majority of the stakeholders agree upon. (3) Smart contracts algorithm where transactions can only be executed based on the terms embedded in the database of agreements. (4) Ownership of data where every stakeholder has the right either to create, to protect or to share his personal ledger through an authenticated and verifiable routine. The affordances of such features of blockchain technology materialize the grounds of human goodwill like benevolence and conscientiousness (Jones 1996) which create a new form of algorithmic

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trust that could be used as responsible design materials to fit into a broader variety of trustee networks to mediate trust relations between people, things, data and ecologies (Nissen et al. 2017).

Key words: trust, interpersonal trust, trust in technology itself, blockchain, responsible design.

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Yvette Pearson (Old Dominion University) and Jason Borenstein (Georgia Institute of Technology)

Robots' Potential to Enhance Caregiving Virtues and Practices

In Shannon Vallor's *Technology and the Virtues: A Philosophical Guide to a Future Worth Wanting*, she discusses the ongoing "global empathy deficit," indicating that it is "not a novelty of the digital age" (Vallor 2016, 138). That said, Vallor also points out that depending on the type of technology and how it is used, it may contribute to sustaining, worsening, or improving this state of affairs. In our earlier work on robot caregivers, we argued that their use has the potential to lessen caregiving burdens and promote flourishing of both care recipients and human caregivers (2010). In this presentation, we will elaborate and expand on this earlier work, while addressing objections to the use of robot caregivers. Robots, among other technological interventions used in the context of caregiving, should complement and sustain good caregiving practices. Their use should foster the development of virtues related to caregiving, a goal highlighted in Vallor's work.

In this presentation, we will argue that shifting the emphasis of dialogues about human-robot interaction (HRI) from moral agency to moral patiency may serve as a useful first step toward (a) enhancing caregiving practices and (b) fostering care virtues in humans, including empathy. To demonstrate this, we will draw on empirical research showing the impact of child-robot interaction (cHRI) on children's interaction with other children and adults. We will also draw upon our earlier work on the impact of HRI on human-human interaction (HHI) among older adults. Against this background, we will discuss how the potential impact of treating robots as moral patients may affect the development of empathic concern for human beings. While we acknowledge that the use of robot caregivers (or robot companions in other settings) can raise significant ethical concerns, viewing robots as moral patients could positively impact HRI, HHI, and at least begin to address the empathy deficit.

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Title of the paper: PREHISTORIC STONE ARTIFACTS AND EPISTEMIC COMPLEXITY

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ABSTRACT

In his 1997 paper Dasgupta draws an interesting distinction between systematic and epistemic complexity. Dasgupta (1997), following Herbert Simon (1962), calls entities *systematically complex* when they are composed of a large number of parts that interact in nontrivial or complicated ways. Thus even if one knows the properties of the parts one may not be able to infer or anticipate the behaviour of the system as a whole. *Epistemic complexity* refers to the richness (i.e., the amount, variety, and newness) of the knowledge embedded in an artifact; it entails the (old) knowledge that is used in and the (new) knowledge that is generated by the making of an artifact.

Interestingly, there seems no direct connection between the two kinds of complexities. A high level of epistemic complexity does not necessarily follow a high level of systematic complexity (Dasgupta 1997). Prehistoric stone artifacts, choppers and hand-axes for example, which constitute 'First Technology' (Toth 1987), provide an exemplary case study of entities that are systematically simple (according to Simon's criterion) but in light of recent archaeological studies (see e.g., Toth 1987; Jeffares 2010; Stout 2011) they appear epistemically quite complex (according to Dasgupta's criterion). Contrary to popular perception, these early lithic tools were not created by simply "bashing two rocks together" (Leaky 1994, 38); instead, their emergence, i.e. their manufacturing process, consisting of actual flaking techniques (including core examination, target selection, core positioning, hammer-stone grip selection and accurate percussion) in addition to acquiring raw materials of appropriate size, shape and composition (Jeffares 2010, 165; Stout 2011, 1051), constituted quite sophisticated and original[i] knowledge.[ii] The knowledge generated during the making of these stone artifacts was basically the knowledge of how certain kinds of structural forms and materials function, behave, perform, and appear under certain conditions. Following Michael Polanyi (1962) Dasgupta (1997, 117) characterizes such knowledge as *operational principles.*

The present paper, divided into two sections, closely examines the nature of the epistemic complexity of one of the most widely distributed and longest-lasting early stone artifacts, namely, the Acheulean handaxe. Drawing on recent archaeological-prehistorical research the

first section aims to explore what kind of knowledge in the form of operational principles possibly had emerged during the making of these Acheulean handaxes. The second section seeks to understand how the making of these epistemically complex handaxes are possibly connected with the cognitive dimensions of early hominin technical activities. The voluminous archaeological record of stone tools, which has received little scholarly attention in mainstream philosophy of technology, is seen today as the richest source of evidence for the initial emergence of some form of hominin cognitive capacities (see, e.g., Wynn and Coolidge 2016; Moore and Perston 2016). The present study attempts to initiate a debate among philosophers of technology about whether or not these systematically simple but epistemically complex stone tools like Acheulean handaxes really played a critical role in the evolution of the early hominin cognitive abilities.

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[i] The creation of these early stone tools necessitated the production of new knowledge as there was no technological past to draw upon.

[ii] The term 'knowledge' is used here in the Popperian (Popper 1972) objective sense and is to be understood as an evolutionary product of intelligent hominin or human behaviour that can be criticized and modified inter-subjectively, and can improve by exosomatic (non-genetic) means our active adaptation to the world.

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Humans, Trees, and Ethics

Erik Nelson, PE, SE

As an engineer working with wood — specifically, designing wood buildings — I developed an interest in better understanding our relationship with trees, how our history with trees and forests has changed over time, and what we have learned from living alongside and with our forests. Not only do trees provide clean air, store carbon, stabilize soils, and provide food and shelter, they also help us be better human beings and give us a broader foundation for discussions of ethics.

I will present our complicated relationship with forests, which is fraught with success and failure, using American history as a guide. I will describe significant environmental movements and forest land pioneers, alongside related ethical traditions. For example, we changed from being afraid of the forests, as settlers, to land owners who exploited the land for economic gain, which eventually led to a timber famine.

As part of this history, our nation's first forester, Gifford Pinchot, led the early conservation movement using the ethic of utilitarianism. Later, naturalist John Muir confronted this utilitarianism with a preservation movement centered on virtue ethics and theology, but devoid of the idea that God's nature was primarily for human use. These different views led to some controversy, pitting the conservationist against the preservationist, and helped usher in a new ethical framework, one not simply based on human interactions. There was recognition that, for us to thrive, animals, plants and the land must thrive, as well.

This created a new type of ethic, one based on impacts to the land. Socrates, through Plato, asserted that people will do what is good, provided that they know what is right. What is right is now broader that human to human interaction, and for Leopold Aldo, an action is right if "it preserves the integrity, stability, and beauty of the biotic community." For him, there is a need to understand the complexity of nature and balance the risks and rewards of human action with wide ecological lenses, sharpened by the scientific study of nature. However, understanding how nature works, the evolutionary and survival processes, may also be contrary to an ethic based on human virtue. Leopold did not think of his land ethic as fixed doctrine, but rather something that evolves within a community of caring citizens. After all, he wrote, "nothing so important as an ethic is ever written."

Engineers, who design artifacts by reconstructing pieces and parts of the land—e.g., trees to create wooden structures—will be better served by reflecting on this history and these ethical traditions. I will provide examples of how Leopold's land ethic can help engineers make better decisions regarding the design and use of wood, as well as better evaluate the wood harvesting practices in the lumber industry. This talk will argue that all of the main ethical traditions—utilitarianism, deontology, and virtue ethics—can be strengthened by thinking beyond human interests to include the intersections of animals, plants, and the land.

Socio-materiality and modes of inquiry

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How can we understand the relationship between on the one hand engineers, technicians, designers, users of technology and on the other hand technological devises, products, and artifacts? In the philosophy of technology this relationship has been discussed extensively. Historically, philosophers have opted for explanatory strategies that span the spectrum from technological determinism to voluntarism. Contemporary theorizing of the problem has tried to avoid the extremes of the spectrum, and opted for a middle ground that leaves room for human agency while still recognizing the impact of technology on human activity. In Science and Technology Studies (STS) the question has been discussed as the 'social shaping of technology' and various theoretical frameworks have been put forward that stress the interwoven character of the social and the material, e.g. Social Construction of Technology (SCOT), Actor-Network Theory (ANT), and Agential Realism. Whereas there is general agreement in STS *that* the social and the material is related there is no general agreement about *how* the socio-material relationship should be understood.

Ontological, epistemological and methodological issues tend to be interwoven in complex ways as STS researches have construed the relationship in different ways. How we understand the relationship has implications for extant notions of materiality, technology, society, agency, morality, ethics, and our ability to come to know the world we live in.

This paper discusses the character of the socio-material relationship. The discussion will be guided by John Dewey's and Arthur F. Bentley's reflections on *Knowing and the Known* (1989/1948), as they distinguish between different levels of describing inquiry into the world we inhabit. At some levels of inquiry, we tend to construe the relationship between subject and object, ego and alter, in substantialist terms that render the relationship as one derived from preexisting separate entities, whereas on another more profound level of inquiry, the relationship itself is seen as the producer of difference, individuation, and substantiation.

Whereas some scholars have seen the approaches of substantialism and relationalism as contrasting on (post-epistemological) *ontological grounds*, this paper will argue with Dewey and Bentley that substantialism and relationism are *modes of inquiry* that aims for description and "…representation of the world itself as men report it." (Dewey & Bentley 1989/1948, p. 101). Following Dewey's pragmatist lead, it is important that we avoid dichotomies – also when we discuss modes of inquiry. Ontologizing the discussion about methods of inquiry might in fact prove to be unproductive as a traditional move towards 'first things'. Instead the discussion should look

towards ‘last things’, i.e. the experiential consequences of the activities involved in the process of inquiry. The paper will argue that substantialism and relationalism are modes of inquiry that serve different purposes, and that choosing one mode of inquiry over another can only be justified relative to the *problem* of the inquiry. Understanding the relationship between the social and the material thus presuppose a specification of the problem that trigger the process of inquiry.

SESSION VI

Marci Baranski, United States Department of Agriculture

The Green Revolution and Enduring Technology-Driven Approaches to Agricultural Development and Climate Adaptation

The Green Revolution-era approach to agricultural development was a top-down focus on technology and limited end-user engagement throughout the developing world. This has led to a focus on plant breeding over other forms of innovation and a withdrawal from farmer involvement (Douthwaite, 2002; Harwood, 2012; Baranski, 2015). Additionally, the Green Revolution package of modern seeds, fertilizer, and irrigation was tested under controlled experimental conditions but not under the average farmer's conditions. For example, new wheat varieties required precisely timed irrigation, while two thirds of India's wheat-growing region relied on rainfall for irrigation. This, among other factors, has led to a great disparity between agriculture in northwestern and northeastern India. Where northeastern India struggles with persistent poverty and low agricultural yields, the northwestern wheat-growing region enjoys access to agricultural markets and subsidies and higher standards of living. Today, a convergence of demographic, ecological, and climatic factors threaten India's wheat production system. The perceived success of the Green Revolution ensures that top-down technological innovations—e.g., the introduction of climate-tolerant crop varieties—have become the "go-to" solution. However, the top-down approach risks replicating the inequities of post-Green Revolution India. Further, there is a great opportunity cost to investing in technology-heavy solutions at the expense of implementing extant adaptation options, policy reform, and resource re-allocation.

Drawing on my archival and field research in northern India, this presentation demonstrates that the Green Revolution paradigm generates inequities that result in real harm to farmers, while its overwhelming dominance ensures that any attempt to address these inequities—for instance, including end-users in development—is doomed to fail. I introduce alternatives to the Green Revolution paradigm, such as participatory agricultural research and Boru Douthwaite's learning selection model, that engage end-users in technology development, and examine the trajectory of these alternatives within mainstream agricultural development.

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Zachary Pirtle*

Epistemology driving policy?: Project Hindsight and the role of empirical studies in informing debates on the linear model of innovation

Abstract: A potential role for the epistemology of engineering to help policy for engineering and science is through an understanding of innovation that can prioritize how research and development (R&D) investments should be made. Historians and philosophers of engineering have long debated the linear model of innovation, where improvements in basic science lead to applied science and subsequently technology and engineering advances. The linear model has both budget implications, in that research and development (R&D) budgets should be sized accordingly, and policy implications, in that new engineering advances should ideally be chosen based upon results from earlier scientific advances. The majority of historians are skeptical of the accuracy of the linear model (Pirtle 2013, Mowery and Rosenberg 1979, Szajnfarber and Weigel 2013), while others (Edgerton 2004) argue that the model in some ways is an intellectual straw man. Despite decades of scholarship, conversations among engineering managers often bemoan the lack of data and guidance to help guide R&D prioritization, and rhetoric at high levels of government still has not significantly moved beyond the linear model (Narayanamurti et al 2013).

I will explore policy options to get useful data to guide R&D funding, focusing on the controversial 1963-1969 Project Hindsight from the U.S. Department of Defense. Hindsight studied 20 weapons systems developments that occurred from 1947-1962 by having teams of researchers do case studies on the developments' histories. The Project Hindsight report is mentioned in major discussions of the linear model, with counter-studies and articles attacking its framework and rigor.

I will present the results of a detailed study of Hindsight, arguing that key timeframe and framework criticisms (Kreilkamp 1971, Mowery and Rosenberg 1979) are flawed. The major criticism about the too-short 20 year timeframe used in Hindsight's analysis is belied by Hindsight's data on the frequency of innovation events, which tapered off only a few years before authorization of a program. Criticisms of the framework of innovation events are more nuanced, but recent qualitative social science approaches to coding support and could augment what was done there. Interestingly, detailed analysis of the data in the several hundred page Hindsight final report (Insenson 1969) appears to be non-existent, which is remarkable as Hindsight had a comprehensiveness that has not been replicated in later studies. This analysis helps reinforce the suspicion that Hindsight has not been repeated more out of fear of political controversy rather than a criticism of research methods (Guston 2007).

There are still challenges in a Hindsight-like approach and ways for insights in epistemology to help guide such study, particularly in how to define key innovation events and the relationship between them. I will also explore political and social issues that limit any empirical study from being useful in informing R&D policy. Further, I will argue that

Hindsight data provides a richness that may help in in bridging and making accessible alternative models of innovation for practicing engineering managers.

*All views and opinions expressed in this paper are the views of the author and do not necessarily represent NASA or the United States Government.

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Paul Ceruzzi, Smithsonian Institution

Moore's law and Technological Determinism, Revisited

In 2005, the author published a paper in the journal of the Society for the History of Technology, regarding the implications for history of the advances in semiconductor capabilities, predicted by Gordon Moore in 1965. The paper argued that Moore's Law challenged that Society's consensus that technology was in part "socially constructed"—that technology does not proceed autonomously, that it does not impact (or "determine") society as it progresses. The author noted that the political and social events of the five decades since the publication of Moore's essay – the civil rights movement, the Vietnam War, assassinations, energy and environmental crises, etc.—seemed to have no effect on the steady, approximately 18-month doubling of semiconductor density. The author also noted that attempts to resist the automatic adoption of devices or software made possible by these advances failed. The paper cited two such examples, which in 2005 were debated among critics of technology and society, but which in the intervening years have become so commonplace that few realize there ever was a debate about their adoption. The example on the hardware side was the adoption of digital cameras over traditional chemical-based film photography. The example on the software side was the adoption of PowerPoint™ as an aid to presentations and lectures. Whereas acceptance of digital imaging could be argued on purely technical grounds (although that excludes the arguments of film photography as an art form), the rapid acceptance of PowerPoint, even in the face of serious criticism, is a better indication of the power of advancing digital technology to "determine" the social milieu.

This paper revisits that 2005 essay, and notes, on the one hand, the recent developments in semiconductors and computer power, and on the other, how historians of technology have responded to recent advances in computing. Semiconductor technology is shown to continue to advance, although issues of heat dissipation and the cost of fabrication plants have had an impact on that process. The massive acceptance of new devices and technologies enabled by these advances continues, however. The best example from recent history is the adoption of the smartphone and how it rendered the traditional telephone, music player, broadcast radio, paper maps, and other information media obsolete. We see that in 2005 criticism, no matter how well-argued, of the rapid acceptance of digital technology was fruitless. The paper concludes with suggestions for how one might address the issue of whether are lives are bound to be determined by these advances or not.

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January 10, 2018

Judgement, Engineering and Engineering Judgement

Dan McLaughlin

1. What is judgement? What is engineering judgement? How are the skills and activities of the "engineering profession" uniquely different from those common to everyone? In one sense, engineering judgement applies only to those technical skills and activities uniquely found within the field of engineering. In a broader sense, however, it also applies to other skills and activities common to non-engineers but which are expected to be exhibited by those in the engineering profession.
2. I will explore these perspectives by contrasting works by Michael Davis, Billy Vaughn Koen and Taft Broome and their views on the nature of engineering, judgement, and engineering judgement.
3. Davis proposes that engineering judgement is similar to the Greek term "*phronesis*" but ultimately rejects the equivalence of the two terms.
    a. The field of meaning of the English term "good judgement" and the Greek term *phronesis* overlap but have differences that Davis deems significant. These include that *phronesis* is a general term that is intended to relate to the whole of a virtuous life. The term "judgement" is used in a narrower way. A person can be said to have good judgement in one area of life but not in another. A person with *phronesis* displays that trait in all areas of life or he does not have *phronesis* at all
    b. To Davis, engineering is a profession. The term engineer only applies to a subset of the human race. Engineering ethics applies only to engineers and is not applicable to those outside of the profession. It seems that Engineering Judgement is a standard of judgement applicable only to engineers. *Phronesis*, on the other hand, is a standard applicable to everyone.
4. Koen, in contrast to Davis, sees the practice of engineering, not as the activity of a subset of the human race, but as a universal description of all the activities of mankind. If one takes this view then "engineering judgement" is synonymous with *phronesis*.
5. Broome proposes that engineers conceptualize the relation of mathematics to reality differently than scientists, mathematicians and the general public. Engineers operate in a "hyperreality" (Broome). This allows Engineers to exercise judgement in the application of scientific theory to reality in a way that is unique to those in the profession of engineering. This might fall under the greek category of *techne*, that is, technical skill.
6. Engineers can be said to have engineering judgement in the sense that no one but engineers can practice judgement within this hyperreality. This is a necessary condition, however it is not sufficient. Engineers are expected to be adept at other activities and skills common to many professions such as judging risk versus reward, problem solving and design.
7. Engineering judgement includes: 1. Unique judgement which applies to the specific technical skill (*techne)* unique to engineering. 2. Judgement in specific skills expected of but not unique to engineers. 3. *Phronesis* type of judgement applicable to all persons. And 4. The ability to utilize these three types of judgement simultaneously and symbiotically.

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Technology, Uncertainty, and the Good Life: Rediscovering Lessons from Ancient Philosophy

Tonatiuh Rodriguez-Nikl, Ph.D., P.E.

The engineering profession has been described as harnessing the materials and forces of nature for the benefit of humankind, a goal that it has accomplished over much of its history. However, contemporary challenges bring into question how well we can harness nature and to what extent technological artifacts are beneficial.

There is a well-known litany of examples of unintended consequences resulting from engineering projects. Systems researchers have shown that increasingly tight global networks result in interconnected risks and higher chances of catastrophic, cascading failures at a global scale. This goes beyond unintended consequences, which often have smaller effects than the original problem and might be engineered away, to the possibility that new technologies may prove far more disastrous than beneficial.

It is also unclear to what extent new technology benefits humankind. It would be folly to argue otherwise regarding early technological developments, such as clean water and antibiotics. Today in affluent countries, it is much harder to give technology the same level of importance. Eradicating polio is one thing; it is quite another to provide convenience and entertainment far above basic needs, especially when these levels of consumption negatively impact the environment and increase stress. This point becomes especially poignant when considering evidence that beyond a certain minimum, happiness and life satisfaction are uncorrelated with income.

It seems that we in the affluent West have an impoverished conceptual scheme for understanding our needs and the means to achieve them. Technology has become a secular religion, and we believe that it is the solution to all of our ills. We can see this at the individual scale, where we delegate our character development to life-hacking apps, and at the global scale, where many prefer to ignore climate change with the expectation that we will be able to geo-engineer the problem away. Although technology is not always the answer to our problems and may often cause even greater problems, we have become ill-equipped to think of challenges and solutions as anything but technological in nature.

These considerations describe the need for an interdisciplinary line of inquiry to catalogue what is known about our ability to control nature (e.g., complex systems theory) and both individual and collective well-being (e.g., psychology and the social sciences); and to reinterpret, within this context, the rich extant body of philosophical guidance. This focuses on the latter aspect, specifically: (a) the treatment of fortune in ancient philosophy; (b) the practical focus in ancient philosophy on actually living well, rather than impressing other philosophers with papers; (c) the concepts of *eudaimonia* (human flourishing) and *phronesis* (practical judgment); and (d) insight from some of the traditions that find meaning in areas other than continual pursuit of worldly pleasures, such as Stoicism, Epicureanism, Buddhism, and Christianity. Lessons from each of these are applied both to personal and professional settings in engineering and technology. Of special interest are the popular goals of sustainability and resilience, which face significant barriers that can be informed by the present discussion.

Eddie Conlon, Dublin Institute of Technology

How many kinds of Engineering Ethics?

The focus of this paper is the increasing diversification and fragmentation in approaches to teaching engineering ethics with Hess and Fore (2017) recently declaring that "there is neither a consensus ..regarding which strategies are most effective…nor which ends are most important" . There is increasing dissatisfaction with the dominant approach which relies on the use of case studies involving ethical dilemmas and focuses on professional code of ethics (Colby and Sullivan 2008). There have been calls to replace the dominant approach (see Conlon and Zandvoort 2011) with a focus on macro ethical issues (Herkert 2005); to focus on the daily routines of engineering/ design practice (Lynch and Kline 2000); to adopt approaches based on social ethics or aspirational ethics (Bowen 2009); and/or to engage with the philosophy of technology (Son 2008) or with Science and Technology Studies (STS) (Lynch and Kline 2000, Swierstra and Jelsma 2006). This has implications for both the development of the field as a coherent academic discipline and the way in which ethical problems are understood in engineering but also presents quite a challenge to those attempting to integrate ethics into engineering programmes.

Given a divergence in approaches it is necessary to develop tools to understand these different approaches and how they might relate to each other. Drawing on social theory, this exploratory paper attempts to do so.

Rather than focus on the detail of provision the aim is to explore the ontological assumption underlying different approaches to the subject by focusing on a number of binary categorisations which may be found in the literature: macro/micro (Herkert 2005); internalist/externalist (Lynch and Kline 2000, Verbeek 2008) and agency/structure (Swierstra and Jelsma 2006). The argument is simple enough in that how we see engineering ethics, and define its purpose, will inform our approach to teaching and researching it. This will, it is argued, rely on our social ontology: how we conceptualise social reality, including how we undertand the relationship between social structures and human action. A key focus in this paper is the manner in which different approaches address the individual responsibility of engineers and their capacity to meet their responsibilities in light of structural constraints that they might face. A related issue is how different approach choose to conceptualise these constraints.

Two main conclusions will be drawn. Firstly, there is a conflation of two issues in the demand to shift to a macro approach, and that the shift to broadening the scope of engineering ethics does not, of necessity, involve a focus on whether engineers are enabled or constrained, by the environments in which they work, to achieve the goals of the profession in holding paramount the health, safety and welfare of the public. Secondly, widening the scope of engineering ethics does not obviate the need to maintain a focus on the agency (and responsibilities of engineers)(Davis 2006). While arguing for a focus on agency/structure relations as the key analytic focus those teaching engineering ethics need to be aware of various problematic ways in which this relationship has been articulated in social theory. It will be argued that Critical Realism (Archer 1996) offers a way of examining this relationship by using "analytical dualism" to examine the "conditioning" role of the social structure but also the role of social actors in shaping that social structure.

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Ethics and Chatbots: Beyond Privacy and Rogue AI

Artificial intelligence (AI) is continuing to have a profound and indelible effect on human life. This includes non-embodied AI agents that are designed to interact socially with humans, often referred to as chatbots. Numerous ethical issues are emerging related to the design and behavior of chatbots. It does not take too long into a conversation about them before the issue of privacy is mentioned as a paramount concern. Worries about the existential threat of AI, which have even been uttered by luminaries in the technology world, often arise as well (Sparkes 2015). Of course, these are important to address. Yet many other ethical issues pertaining to AI, and chatbots more specifically, warrant attention. For instance, an important ethical issue raised by chatbots is the downstream employment effects that the technology could have. Moreover, chatbots may behave in ways that are difficult to predict; this point is illustrated by the recent case of the Facebook robots that invented a new language in order to streamline the goals they sought to achieve (Field 2017). User frustration is another relevant ethical issue, which is keenly illustrated by the anger people already express against automated customer service agents. Deliberate manipulation by users arises as well, an issue made apparent by the way in which Internet users directed Microsoft's Tay chatbot to utter racist slurs (Kleeman 2016). Other issues include bias, overtrust of chatbots, and potential effects of chatbots on human-to-human interaction.

Guidance for engineering and computing professionals regarding their responsibility for addressing such issues has traditionally been provided by IEEE, ACM, and other professional organizations through their codes of ethics. Recently, IEEE has focused more directly on AI and ethical design, through revisions to its code of ethics and through major initiatives such as *Ethically Aligned Design* (IEEE 2016). Within these contexts, the goal of this presentation is twofold: first, we will provide an overview of key ethical issues related to the design and deployment of chatbots. Second, we will discuss the associated ethical responsibilities of engineering and computing professionals (including design engineers, computer scientists, and others who are involved in the design, testing, and deployment of chatbots), and evaluate the adequacy of codes of ethics and other initiatives by professional societies in identifying and enforcing such responsibilities.

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Interdisciplinary Analysis of Engineering and Business Initiatives Involving Personal Privacy and Information Control: Implications for Consumer Participation

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Abstract

Large-scale information collection and dissemination practices are acquiring greater economic and political significance in the everyday lives of individuals. Privacy issues are becoming more complex as "big data" and machine learning replace traditional forms of dossier collection, statistical analysis, and archiving. This paper explores how a number of engineering and business initiatives have incorporated (or failed to incorporate) privacy concerns into their strategies for consumer engagement and service delivery, with an emphasis on the US and UK contexts. It analyzes personal reputation management services as well as the growing number of systems that purport to protect consumers from identity theft and related problems. The paper explores from an interdisciplinary perspective the social responsibility of engineers to deal with these privacy-related concerns in their systems design and implementation efforts.

The enormous amounts of data associated with social media systems and mobile applications as well as environmental systems such as water meters have increased the number of facial recognition, locational tracking, socioeconomic analysis, and related practices being conducted by corporations as well as governmental agencies. Corporations and governmental agencies often couple and reinforce their respective data-collection efforts, which can magnify the difficulty of discerning legitimate and actionable consumer concerns and mapping practical modes for addressing them. Consumers who pose requests as to what kinds of information is being held about them by organizations and as to how it is being used can be frustrated by the lack of specificity in the responses they receive (if any). This paper will explore from a critical perspective specific ways in which some organizations have often framed these consumer privacy issues as potential venues for product development and even entrepreneurship, seeking either to enhance existing products and services or develop new ones.

The paper projects some of the emerging controversies about consumer privacy that technological developments toward a cashless society (with applications such as Apple Pay) and autonomous vehicles (driverless cars) are engendering. In recent years, characterizations of privacy have often involved the concept of information control-- the ability of the individual to control the dissemination of personal information; expressions involving feelings of personal control are often intertwined in current privacy discourse. Few aspects of political and social lives are without dimensions that relate to privacy, and thus the dimensions of the expression of privacy-related feelings are of critical importance. Individuals who are deprived of privacy can be disempowered in their specific economic functions (such as obtaining credit and employment) as well as their larger citizenship interests. Privacy issues involving geographical information systems (GIS) can deal with the appropriateness of the modes for information collection about

location (including the use of drones), the incorporation of locational data in multiple applications and purposes, as well as the stewardship of data (for example, protection against security violations). The paper analyzes several case studies of engineering and business interaction with these issues; it contrasts US and UK approaches toward privacy concerns with those of the European Union (EU) and addresses implications for cross-border data flow.

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