STUDIES IN ENGINEERING EDUCATION

Applying Concepts from Political Science and Economics to Advance the Study of Engineering Education

THEORY

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VIRGINIA TECH PUBLISHING

ABSTRACT

Background: There are myriad social, political, and economic factors that influence decision-making processes in and around engineering education. Although the engineering education community may study those processes and their effects using a variety of quantitative and qualitative research methods, a more systematic use of concepts from political science and economics could help advance the study of engineering education.

Purpose: In this article, we outline concepts and tools from the study of political science and economics that can help clarify aspects of the engineering education system that many researchers may already intuit by providing precise language and analytical formalisms to describe and explain aspects of engineering education more directly.

Scope: By way of introduction to the field of engineering education, we begin by outlining definitions. We then illustrate six main phenomena within engineering education where researchers can potentially apply these ideas to further understand and improve elements of how we educate engineers.

Conclusions: By focusing on the political and economic factors influencing engineering education, researchers, faculty members, administrators, and/or stakeholders can have an alternative set of conceptual tools at their disposal for studying, analyzing, and changing engineering education systems.

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KEYWORDS:
politics; economics; engineering education; organizational analysis

TO CITE THIS ARTICLE:
Katz, A., & Main, J. (2022). Applying Concepts from Political Science and Economics to Advance the Study of Engineering Education. *Studies in Engineering Education*, 3(1), pp. 28–52.

INTRODUCTION

During an address at the National Academy of Engineering, MIT President Charles Vest (1995) drew attention to a simple observation: engineering education is continuously shaped by social, political, and economic factors. More specifically, higher education is subject to the forces of political economy – a term used to describe "the study of the social relations, particularly the power relations, that mutually constitute the production, distribution, and consumption of resources" (Mosco, 2009, p. 24). The focus on these social relations is part of what differentiates political economy from traditional economics (Drazen, 2002, p. 5). Those social relations can be among different units of analysis, from governments, organizations, groups of people, or families (Arndt, 1983). In the *Oxford Handbook of Political Economy*, Weingast and Wittman (2006, p. 4) underscore the flexibility of this political economy framework to consider different units of analysis and enable methodological heterogeneity. For example, applied to public education, political economy might consider how cycles of "economic austerity" affect public funding of higher education (Carpentier, 2015) or how schooling reproduces class structures (Bowles & Gintis, 1977; Brint & Karabel, 1989). In this paper, we suggest that the research community can apply a similar framework to engineering education systems to provide further insight into the professional formation of engineers.

How does this political economy approach apply to engineering education? We suggest that the political economy of engineering education is the constellation of power relations that determine resource allocation in engineering programs. It is about understanding how groups of people both external to the university – such as government officials, industry representatives, and the public – and internal to the university – such as administrators, faculty members, and students – interact and make decisions about resources – such as time, money, energy, and space – in engineering education.

Research on the political economy of engineering education will consider the power relations and dynamics informing decisions on resource allocation in engineering education organizations. The study of political economy is a distinct area of study combining ideas from political science and economics. In this paper we suggest that the engineering education community can directly borrow these interdisciplinary ideas for understanding decision making in engineering education ecosystems, yet without going fully to the realm of political economy per se. Simply leveraging those foundational concepts from political science and economics offers an important set of concepts for anyone impacted by these education systems to consider because focusing on political and economic factors can highlight forces that may overtly or subconsciously influence decisions that directly affect the formation of future engineers. These decisions can range from curriculum committees' approval of a mandatory undergraduate class on engineering ethics to tenure promotion decisions that college administrators make about activities they value for advancement to government agency decisions about which areas to prioritize for research funding.

Our goal here is to suggest that accounting for political and economic factors can help provide additional interpretation of issues typically studied using other perspectives. These are relevant ideas for researchers because they provide a set of constructs for framing problems that have historically tended to receive less attention. They are important ideas for administrators because it helps identify root causes of issues that they face in their roles. Finally, familiarity with these ideas is important for reformers because it suggests why some of the attempted or proposed remedies to problems in the system may be either worthwhile or ineffectual. In other words, accounting for political and economic considerations that impact engineering education offers tools for everyone involved in the system to address the problem of how to understand (and change) behaviors and decision-making processes that they observe among participants in engineering education.

PURPOSE AND FORMAT

In the following sections, we start with an elaboration on these definitions. From there, we proceed to a review of prior works delineating the political and economic factors of higher education and how those factors have manifested in engineering education. For this, we focus on statements from national organizations (e.g., American Society for Engineering Education and NAE) due to their visibility by the broader community and ability to provide perspective of engineering education ecosystems. We then outline a research agenda for further investigating the effects of political and economic factors on engineering education. We organized the overview by elaborating on six different phenomena. The goal of this work is to introduce ideas from interdisciplinary fields to aid our understanding of engineering education. Naming these ideas can help the engineering education community incorporate them more explicitly into how we study engineering education. The act of naming is powerful, whether it relates to negotiating objectives among individuals (Merry, 1990) or simply identifying aspects of our environment and thereby creating common ground (Milstein, 2011). A functional lexicon and shared mental models can help the engineering education community analyze some of the associated phenomena more effectively (Mathieu et al., 2000; Stout et al., 2016). With these tools in mind, participants in the system will be better equipped to bridge the three-part disconnect among their own experiences, how they process those experiences, and what they can do about the root causes of those experiences.

To emphasize a point made above, although the ideas that we review in this paper can all focus on the engineering education system, they vary in their level of analysis within that system. For example, some ideas focus on individual actors – students, faculty members, department chairs, and the like. Other ideas focus more on organizations – departments, colleges, universities, professional societies, government agencies – or the environment external to engineering education – private industry or governments. Furthermore, not only do the ideas vary in their prescribed level of analysis, but they also range in applicability across settings. Some ideas may apply in smaller departments at private universities (or, conversely, large departments in land-grant university settings) while other ideas may apply equally well in many different organizational contexts. This varied applicability of the levels of analysis should strengthen its appeal to a broad audience, allowing readers across the spectrum to find something meaningful they can apply in their own work, wherever they are. Thus, by the end, the reader should feel equipped to span the spaces between some of their lived experiences in an area of the engineering education system, how they cognitively process those experiences, and where the community might enhance the system for educating engineers.

POSITIONALITY STATEMENT

The authors have a combination of education and training in economics and public policy. One of the authors has graduate training (as part of their graduate work in a public health program) in environmental economics and policy. Following that training they also worked on helping to develop industrial sector air pollution regulations for the Environmental Protection Agency. Developing those regulations involved applying that economic training and familiarity with the political processes implicated in developing regulations. Those experiences transpired prior to the author's shift into the engineering education field and inform their perspectives on engineering education. The other author earned her PhD in learning, teaching, and social policy, and Master's degree in Administration, Planning, and Social Policy. She applies concepts and research approaches from economics and education policy to the study of issues in engineering education. She examines structural barriers to access to and equity in engineering education.

ILLUSTRATING DEFINITIONS

There are numerous dimensions to consider when characterizing the political and economic factors affecting engineering education. In Figure 1, we have illustrated some of the various relevant pieces – level of analysis, unit of analysis, social relations, and resources. For example, we have listed example levels of analysis to be governmental, departmental, and individual levels. Similarly, we have listed examples of kinds of resources such as time, money, space, and energy. These listings are intended to be an initial building block rather than an exhaustive taxonomy.

Following the definition of political economy in the Introduction section, accounting for political and economic phenomena in engineering education should have two focal points: (1) social relations (especially power relations) among groups of people involved in engineering education systems and (2) resource allocation. Example questions considering these factors include: How do state and federal governments appropriate funds for research that universities and faculty

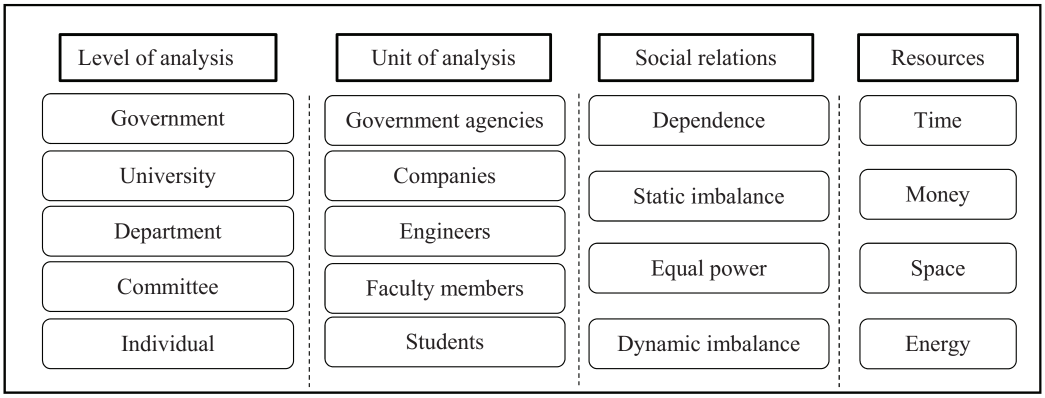

Figure 1 Dimensions (rectangle boxes) and example variables (rounded boxes) to consider in study of political and economic factor affecting engineering education.

members compete for? How do governmental decisions shape relationships among faculty and universities competing for limited resources? How do faculty members on search committees in engineering departments decide whom to hire (a human resource decision), and what informs their hiring priorities? How does a curriculum committee incorporate feedback from industrial advisory boards, alumni, current students, and the surrounding community to determine how to allocate time in the curriculum? In each of these examples, social relationships and processes contribute to resource allocation decisions at the individual and organizational levels.

Figure 2 provides an alternative depiction of the same conceptual model but with the modification of rendering the phenomena as windows through which we can see social relations affecting resource allocation decisions. By "phenomena" we broadly mean a recurring set of patterns in decisions, behaviors, and/or outcomes. Faculty members choosing to emphasize a skill in their course because their industry contacts say it is important, students choosing one major over another due to career prospects, or hiring committees selecting one candidate over another because they have a higher likelihood of gathering research funding are all examples of these phenomena. The metaphor of a window represents how the phenomena provide a lens that frames certain kinds of interactions in engineering education. In this picture, the phenomena can transpire within or outside of the university and at different levels – such as governmental, industrial sector, or department. Again, the people and groups interacting with each other in social relationships make resource allocation decisions. The resource allocation decisions then influence (illustrated with dashed arrows) subsequent phenomena. With these subsequent phenomena, the pattern repeats, providing new windows into more social relations among people making resource allocation decisions. The main purposes of the figure are to highlight: (1) how the phenomena function as windows into the political and economic factors shaping engineering education, (2) how social relations affect resource allocation, which can then influence subsequent phenomena, and (3) how these different levels may interact within the larger engineering education ecosystem.

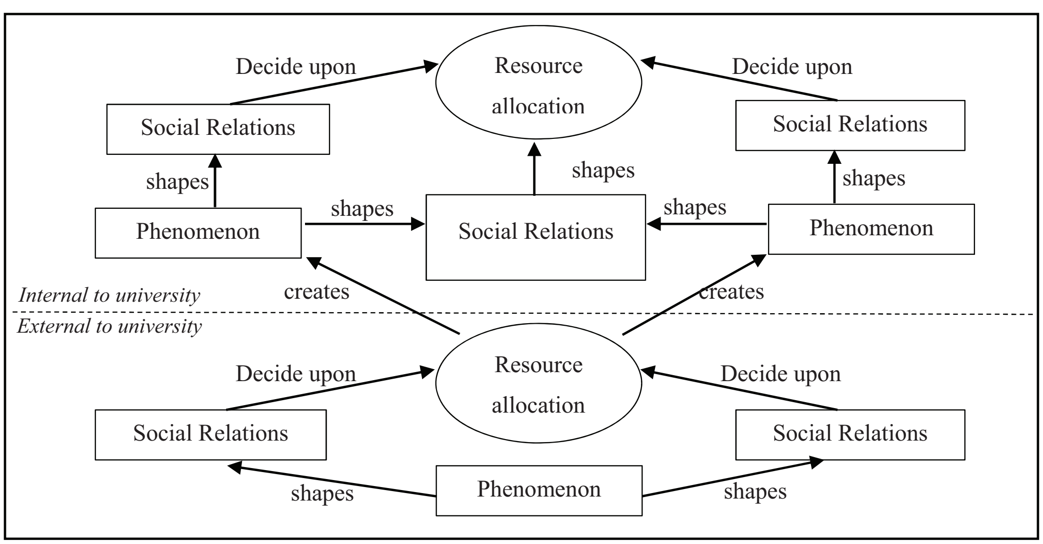

Figure 2 Connections between phenomena, social relations, and resource allocation.

These behaviors, decision-making processes, and factors (i.e., phenomena) run the gamut and can include topics from curriculum committees' approval of a mandatory undergraduate class on engineering ethics to budget decisions that college administrators make about specific programs, as mentioned before. Even though it often goes without direct attention, the confluence of these social, political, and/or economic factors has been influencing engineering education for almost a century, as Table 1 illustrates with examples of national reports dating back to 1930. These national reports come from organizations including the American Society for Engineering Education (ASEE), the Engineers' Council on Professional Development (ECPD), and the National Academy of Engineering (NAE).

Table 1 Examples from national reports on engineering education alluding to the political economy of the engineering education system.

SOURCE	QUOTE	INTERPRETATION
Wickenden (1930)	*"Engineering education reflects our national genius for quantity production. Pressed to get a maximum result in a minimum of time, engineering educators have borrowed, half unconsciously, from the management methods of industry. The essence of the scheme consists in first visualizing the process as a whole. Then dividing it into major steps in a logical progression and finally breaking the work down into small units to be done in a definite sequence, under prearranged conditions and with the materials supplied precisely when needed and in the most convenient form, the task sequence to be carried out under close supervision, with continuous inspection and grading of piece parts, and the rewards to be paid in terms of a standard task with quality bonus." (p. 109)*	Engineering education has borrowed the Taylorist philosophy of industrial production to guide decisions in engineering programs.
Rising above the Gathering Storm (Committee on Prospering in the Global Economy of the 21st Century (U.S.) & Committee on Science, Engineering, and Public Policy (U.S.), 2007)	*"Our culture has always considered higher education a public good—or at least we have seemed to do so...Now, however, funding for state universities is dwindling, tuition is rising, and students are borrowing more than they receive in grants. These seem to be indications that our society increasingly sees higher education as a private good, of value only to the individual receiving it." (p. 31)*	Shifts from viewing higher education as a public good to a private good, reflected in funding levels and public attitudes, which is consistent with larger political economic trends to reduce public spending in favor of private funding through market competition.
Phase I Report (ASEE, 2014)	*"One respondent noted that there is a market for universities to help teach engineers business skills and provide lower cost options than business school." (p. 17)*	Curricular decisions being influenced by supply and demand due to market relationships of exchange established between engineering departments and employers as well as increased expectations of graduating engineers to be ready for market competition upon graduation.

To anyone participating in the engineering education system – such as faculty members, students, college administrators, government officials, or professional engineers – prior documented examples of these factors may sound familiar. For example, others have previously observed that: budgetary constraints limit the kinds of student support programs that a campus teaching and learning center can offer (Frantz et al., 2004); the interpersonal dynamics between faculty members can create a hostile environment for other faculty members in the department (Campbell & O'Meara, 2013; Committee on Science, Engineering, and Public Policy (U.S.), 2006); accreditation bodies inform specific curricular and pedagogical decisions that faculty members make (Lattuca et al., 2006); or a university's board of governors might want to influence curricular decisions (Kosak et al., 2004). These highlight just some of the ways in which social, political, and economic factors contribute to the interpersonal dynamics of actors in engineering education, affecting behavior and decisions throughout education systems. Moreover, accounting for political and economic factors when studying engineering education helps us to further examine the likely root causes of observed phenomena in engineering education. This perspective has the power to help us holistically understand these phenomena as connected and intertwined, rather than as isolated decisions. Even though these factors affect decision-making processes and behavior throughout engineering education systems, there has not yet been a concerted and sustained examination of the political economy of engineering education to date. This may be a potential consequence of a broader ideology of depoliticization in engineering that extends to engineering education (Cech, 2013; Cech & Sherick, 2015). Others have pointed to that ideology as a way that students may view technical problems as apolitical. One could imagine how a similar ideology might extend not only to engineering work but engineering education as well. If that were true then it would help explain the gaps among (a) the observations and experiences that we have of political and economic phenomena affecting engineering education systems, (b) how we think about those phenomena, and (c) what we can ultimately do to perpetuate or change conditions that engender those phenomena. The three-part disconnect among observations, analysis, and action underscores a particular problem facing the engineering education community. Namely, specific phenomena may affect individuals and groups in the system and, even if we can sense that a problematic situation exists, we do not tend to use explanatory lenses to frame the underlying phenomena.

REVIEWING LITERATURE AROUND THE POLITICAL ECONOMY OF ENGINEERING EDUCATION

To review the aforementioned political and economic factors influencing engineering education, it is first instructive to consider the political economy of higher education since engineering education is part of that system. Therefore, we begin with a brief review of some aspects of the political economy of higher education before proceeding to a more specific focus on engineering education. The engineering education review focuses on both national reports and articles where the political economy of engineering education has either received direct or indirect attention.

The Political Economy of Higher Education

The political economy of higher education affects engineering education in part by forming the larger structure within which engineering education operates. Metaphorically, it forms the waters in which engineering education swims. Since the higher education system has myriad power relations that implicate resource allocation within the system, one should first consider the political economy of higher education in order to understand that of engineering education.

The current political economy of higher education may best be understood in the context of a post-1970 neoliberal shift in economic paradigms (Olssen and Peters, 2005). Neoliberalism is a political economic philosophy that combines a classical economic emphasis on free market exchange with a liberal political philosophy that prioritizes individual liberty (Harvey, 2005). That conception of liberty is often biased toward a version of negative liberty defined by an absence of bodily interference rather than a more capacious positive liberty characterized by the presence of opportunity and options (Berlin, 1969). From an ideological perspective, this paradigm shift is fundamental because neoliberalism normatively prescribes a minimal role of state intervention in all aspects of life, including education (Connell, 2013). In place of governmental programs supporting public interest projects in the name of the public good, the market is assumed to achieve efficient outcomes, often nebulously defined.

Under the grip of this philosophy, the political economy of higher education subsumes topics like academic capitalism (Münch, 2014; Slaughter & Leslie, 1997), state funding cuts (Li, 2017), education financing (Garritzmann, 2016), universities behaving like corporations (Washburn, 2005), replacing the notions of education as for the public good with private good (Williams, 2016), students being treated like consumers (Bunce et al., 2017), and other market-like behavior in higher education (Leslie & Johnson, 1974; Newman & Jahdi, 2009). As Slaughter and Leslie (2001) define it, academic capitalism consists of behaviors from university faculty and administrators to compete for limited financial resources (e.g., funding). The rise in academic capitalism corresponds with a decrease in public funding as governments shift to a private model in education (Geiger, 2011; Teixeira & Dill, 2011). Predictably, shifting toward academic capitalism pursuant to changes in government funding and public support consequently determines how faculty members allocate their time (Liefner, 2003; Taylor, 2001). There is little reason to believe engineering education is immune to these trends.

Taken together, the scenario depicted and experienced is a simple one: governments withdraw funding for higher education in the name of austerity (McLendon, Hearn, & Mokher, 2009) and free market competition (Leslie & Johnson, 1974), bolstered by an argument that the state has no place in supporting higher education (Archibald & Feldman, 2010). Amidst this backdrop, the political economy of engineering education exists. Departments compete for funding from colleges and university administration. These departments also hire faculty members who can bring in funding to help fill the gap left from states reducing their funding appropriations. Faculty members then compete for research funding to supplement constricted budgets. The shrinking budgets then shape other decisions among actors in engineering education systems. Overall, this political economy creates dynamics among actors in the system where the market logic predominates and begins to shape decisions throughout the system. Yet, this need not be the case. Those choices are not predetermined. These are choices in engineering education that arise from other choices in higher education, which likewise arise from choices outside higher education. Options exist but availing ourselves of them would require deviating from our current trajectory and the prevailing mode of market-based pursuit of efficiencies. In particular, reframing about the goals and purposes of engineering education would be needed. Such an articulation could provide a model that supersedes some of the counterproductive incentive structures created by the seemingly dominant paradigm.

The Political Economy of Engineering Education

Prior work related to the political economy of engineering education has frequently involved either specific studies on one aspect of the engineering education system or generic observations about the relationship between engineering education and social, political, and/or economic factor(s). We will consider several examples below that can help demonstrate the ways in which the political economy of engineering education has appeared in writing, often without specifically being named as such, despite its persistent presence in the background.

Although the current paper is styled as a review of tools for members of the engineering education community and a foray into a novel area of research, prior work has looked at some of these discrete issues before. For example, Noble (1979) argued that the American engineering education system was created to serve American corporate and economic interests. Layton (1971) discussed a similarly close connection between engineering and corporate interests (with less of a focus on education). In each case, economic circumstances facing industry reverberated into how engineers were educated. Other authors have looked at similar connections between engineering and corporate interests (Carlson, 1988; Veblen, 1965; Zussman, 1985). Rather than looking at strictly industrial influence, Lucena (2005) looked at the effects of national policy initiatives in the defense industry in the name of military protectionism and how those permeated through engineering education. In each case, authors examined the extant relationships in engineering and how their roles in the economic order of a society can and do shape decisions in engineering education.

We suggest that there is fruitful ground in this area to continue to account for political and economic factors in engineering education. The ideas in such an approach can lay foundations for an area of research focused on organizational and institutional dynamics and change within engineering education. In the past, the engineering education community has discussed departmental and institutional change from: top-down approaches and emergent approaches at both the structural and individual levels (Besterfield-Sacre et al., 2014; Doten-Snitker et al., 2021; Henderson et al., 2011); curricular change as an iterative process involving multiple stakeholders and incentives to ensure institutionalization (Clark et al., 2004); and a larger culture of innovation in education through improved resources, workloads, and rewards (Jamieson & Lohmann, 2009). Despite these kinds of prior publications, a more sustained focus and refined frameworks could further advance the diagnoses of the dynamics and to improve the conditions in engineering education systems.

Within the engineering education literature, journal articles and national reports periodically contain allusions to the political economy of engineering education without using that terminology. These are some of the social, political, and economic factors that Vest (1995) referenced. Historically, the reports and articles have ranged in their focal topic from curriculum to incentive structures and many other subjects in between. We will review some of these publications to highlight the relevance of the political economy framing for the engineering education community. The underlying theme in these examples is that the engineering education community already recognizes some of these factors at play in the system.

Reports

Allusions to the political economy of engineering education abound in national reports on engineering education that have spanned the past century. The examples in Table 1 illustrate the sustained existence and relevance of the political economy of engineering education.

The role of industry in these reports is another aspect of the political economy of engineering education. Starting with the composition of report committees. The 1985 National Academies report from the Committee on the Education and Utilization of the Engineer "consisted of 26 members and 9 panels with more than 50 additional people drawn from business, industry, and education" (National Research Council, 1985). The same is true of other reports, whether it is CEOs of Fortune 100 companies in *Rising Above the Gathering Storm* (2007, p. ix) or corporate representatives with various titles in *Educating the Engineer of 2020* (2005, p. 180). The pattern is familiar: economic imperatives in the form of increased international competition and threats to sustained economic growth – broadly portended in the 1983 report *A Nation at Risk* – translate into pressures on companies for skilled employees. Companies then communicate demands to engineering programs through several channels. Engineering education as a whole then responds in ways that alter decisions and behaviors among administrators, faculty, staff, and students. This is part of the political economy of engineering education.

Journal Articles

In addition to national reports, researchers in engineering education have also alluded to political economy, though without naming it explicitly. Their articles discuss an array of different topics in engineering education research. Those topics include curricular decision-making, faculty incentive structures, department-industry relationships, structural change, and implicit supply and demand models. Any of these articles and studies could link to political economic forces but they do not explicitly consider it. In other words, the analysis we propose is not necessarily unfamiliar to the research community, and we are simply suggesting that making the implicit more explicit could facilitate understandings and changes within engineering education.

Starting with curricular decision making, a 2014 study cited the importance of funding for influencing the utility value that faculty members place in their expectancy-value motivations for engaging in research-based instructional strategies (Matusovich et al., 2014). More broadly, Watson called for a more efficient use of resources when translating research into practice for future generations of engineering education (Watson, 2009). In 2010, Borrego et al. reported that department chairs cite lack of financial resources and faculty time as two reasons for poor diffusion of instructional innovations (Borrego et al., 2010). These are just a few examples of political economic factors shaping research and practices in engineering curricula.

Political economic factors also transmit signals that inform faculty decision making. For example, Splitt (2003) discussed the role that rewards and incentive structures can play in shaping how college administrators and faculty members approach teaching. In a 2009 study of whether engineering education research constituted a discipline, community, or field, participants pointed to reward structures like tenure and research grants as significant factors in deeming engineering education a discipline (Jesiek et al., 2009). This example suggests that these factors may not only influence decision making but also function as a demarcation – people in the field compete for research funding just as other fields (subject to the same political and economic factors) do. Further complicating the role of incentive structures is the fact that they can change over time. For example, over the past 50 years, universities have shifted toward a more research enterprise model (Park, 2011). This translates to a stronger emphasis on generating funding through external grants and intellectual property. With that shift comes a change in the incentives that faculty members and administrators face.

On the social and political side, department-industry relationships can contribute to the shape of engineering education as Denton (1998) discussed regarding the role of departmental partnerships with government and industry being important for determining new education standards and impactful research. Before that, Black (1994) outlined specific pressures that industry placed on engineering education, manifesting as a combination of social and economic factors that affect the system. He even explicitly named popular practices like total quality management and continuous process improvement that engineering education could use to promote change. In these scenarios, the political economic circumstances facing industry create demands that the engineering industry passes on to engineering education, which in turn influence relationships and decisions in how engineering programs, departments, and classrooms operate. This can create tensions, as industry-side demands may run contrary to university's own priorities for their students. We further elaborate on this point below in the supply and demand paragraph. To be clear, these are not predetermined relationships with foregone conclusions; rather, they are the consequence of specific political decisions and can therefore benefit from the added clarity provided by using a political economy lens.

Regarding structural change, in a 2012 report, threats to a department's market position – a notion reflecting the broader political economy of higher education mentioned above – among other departments within the broader academic field were cited as a significant factor for driving change (Graham, 2012a). This means that departments' competition for resources was affecting decisions of whether it pursued changes – and which specific changes it pursued. Furthermore, perception and marketing were two important factors when considering what determined adoption of those changes. In the absence of external funding, those adoptions often did not survive (Graham, 2012b). This demonstrates how economic factors impinge upon higher education in the guise of resource dependence and competition and are directly implicated in affecting social relations in engineering education.

A supply and demand model of education is also implicit in articles about engineering education. For example, national economic competitiveness writ large has redefined the demand for desirable engineering competencies that graduates should have upon graduation (J. Lucena et al., 2008). McMasters (2004) described this same impetus to develop human resources to meet industry's demands from the perspective of the aerospace industry. He describes "steps that we within the broader technical community (industry, government and academe) can and should take to assure an adequate future supply of well-prepared engineering graduates for the full range of employers who have need for such talent" (p. 353). The supposed end goal in this operational model is job-ready engineers, achieved through a supply-and-demand relationship between governments (or industry) and engineering departments. Educating larger numbers of engineers to meet industry demand is also part of one argument used in studies focusing on broadening participation in engineering (i.e., broadening participation in engineering not necessarily in the name of equity and social justice but rather because some students represent an "untapped resource") (Dasgupta & Stout, 2014).

Despite the clear presence of social, political, and economic factors shaping manifold areas of engineering education, as noted in the preceding sampling of journal articles, we in the engineering education community tend not to use the conceptual frameworks afforded by focusing on the political economy of engineering education. We suggest here that borrowing such ideas and frameworks may help the engineering education community follow the path toward characterizing the system in which we operate more effectively.

POLITICAL AND ECONOMIC CONCEPTS FOR ANALYZING ENGINEERING EDUCATION

The following section describes phenomena for approaching studies in engineering education from alternative perspectives that account for political and economic factors. The phenomena are intended to provide a select, manageable list rather than an exhaustive litany of theoretically available concepts and frameworks. We encourage the research community to challenge and expand this list in future work. Sustained scholarship in this area will improve how we understand the internal and external logics, imperatives (e.g., graduate more students, publish more papers, reduce operating costs), incentives (e.g., increased funding, tenure, better grades), and objectives in engineering education systems. Such logics, imperatives, incentives, and objectives drive resource allocation (e.g., time, money, space, energy) and decision making (broadly construed) throughout these systems, thus making it important to have functional perspectives to study them.

CONCEPTUAL TOOLS FOR CHARACTERIZING PHENOMENA IN ENGINEERING EDUCATION

A phenomena-based approach is one way to focus on political and economic factors in engineering education, but it is not the only approach. Other approaches could be more theoretical or more empirical. Here we suggest a phenomena-based approach because the phenomena provide specific vignettes for the community to identify in their own work. These phenomena represent a set of observable patterns and outcomes that manifest from the relationships and interactions between actors within the engineering education system. This stylized definition of phenomena derives from Bogen and Woodward's (1988, p. 317) description of phenomena from a philosophy of science perspective as consisting in a number of causal factors that generate observable data. Phenomena can range in nature from objects, states, and processes to more complex, compound functions. Thus, phenomena in the engineering education system are objects, states, and processes that generate data which a researcher (or anyone else) might observe, hence the leading definition above. The phenomena provide a window into the mechanics and/or consequences of behaviors in engineering education. It is important to note that these phenomena are produced rather than pre-ordained, meaning that they are not inevitable. In theory, there exist alternative configurations of the system in which those phenomena do not arise because actors in these governmental, industrial, and educational systems have made different decisions. This is an ambivalent note. On the one hand, it means that change is possible. On the other hand, it means that people made choices that put us here in the first place and may continue to do so unless the process is disrupted.

The relevance here of an ontological discussion about phenomena is to delineate the objects of study under the phenomenon-based approach. Actors, relationships, and decisions in and around the engineering education system can generate observable data that represent token phenomena for researchers to study and characterize as part of this overall project. The phenomenon-based approach prescribes observing specific sets of relationships and decisions in the system and how those determine resource allocation. Studying these phenomena can help amass data that in turn characterize the political and economic factors more broadly. Such a characterization can then help provide a new framework for understanding the mechanics of the system that shapes future engineers. This project can also highlight potential areas for intervention.

The discussion for each phenomenon in this section begins with a definitional overview. Accompanying these overviews are hypothetical examples in which those phenomena may manifest. Finally, we provide sample questions to demonstrate how the research community could sustain a more concerted project to characterize how political and economic factors drive decisions in engineering education by examining each of the phenomena.

In total, for this section we have identified six phenomena that provide a view into some aspect of engineering education either directly or indirectly. We claim that these phenomena can arise as the consequence of larger ideologies and phenomena such as academic capitalism, dictating a market-oriented decision-making process. Decisions made under that pretense then have ramifications that permeate throughout engineering education. The identified phenomena themselves exhibit collections of social relations that influence allocation and use of certain resources. Those social relations can be among students, faculty members, departments, committees, universities, and industry. In Table 2, we present each of the six phenomena, a brief description of the phenomenon, the relevant social relations that develop with the phenomenon, and resources affected by the social relations that manifest pursuant to that phenomenon.

Table 2 Phenomena from the political economy of engineering education.

Abbreviations: Dept.-department; Eval-accreditation evaluator; Cmte.-committee; Ind-industry.

* Relations between actors/groups/organizations in the system are depicted with a hyphen.

PHENOMENON	DESCRIPTION OF PHENOMENON	RELEVANT SOCIAL RELATIONS*	IMPLICATED RESOURCE(S)
1. Market-like behavior	Supply and demand model, students as consumer, marketing and recruitment	Student-Dept; Student-Faculty; Student-University; Dept.-Faculty	Faculty time; Curriculum time; Student time; Money
2. Competition for prestige and reputation	Programs and universities compete for prestige that enable better ability to compete for resources	Dept-Dept; Public-Dept; Faculty Member-Faculty Member	Faculty time; Faculty Member research budget; Dept budget
3. Outsourcing	The decision from department A to call upon department B to teach something in department A's curriculum	Dept-Dept; Comm-Dept; Dept-Faculty Member (e.g., adjunct faculty)	Faculty time; Dept. budget
4. Program governance	How engineering programs receive and maintain accreditation and approval	Dept.-Eval; Dept.-Faculty; Faculty-Faculty	Faculty time; Curriculum time
5. Job markets and hiring	Departmental and company hiring decisions	Dept.-Industry; Cmte.-Industry; Dept.-Faculty	Faculty time; Dept budget; Curriculum time; Student time
6. Institutional isomorphism, entrepreneurship, and inertia	How faculty members relate to each other through committees or various policies and programs	FacMem-FacMem; Dept.-Dept.; University-Dept.	Faculty time; Dept budget; Student time

To be clear, many of these phenomena are the downstream consequence of upstream political choices about resource allocation that are part of the political economy of engineering education. The conceptual model in the figures illustrates how these different levels of analysis can influence each other. The phenomena can be external or internal to the university. They can arise from governments pushing for more students to study engineering (Blackley & Howell, 2015) to drive economic innovation (Denney, 2011) and promote national economic growth (Maloney & Caicedo, 2017). On an ironic note, however, while governments may have the impetus for economic growth and competition (and pushing for certain student outcomes accordingly), they also offer limited support due to the aforementioned political economic paradigm (i.e., neoliberalism) that constrains state intervention in the education sector (Klees, 2008; Shore, 2010). As a result, things like academic capitalism become more prevalent in higher education (and engineering education by extension). In turn, that phenomenon of academic capitalism helps to engender some of the phenomena described in this section.

1. Market Behavior

The marketization of engineering education entails the same instances in higher education writ large, viz., treating students as consumers, prioritizing mechanisms to generate funding, and generally treating engineering education as a market good – something to be produced and sold. Examples of relevant sub-phenomena under the market behavior tent include (a) marketing and recruitment and (b) supply and demand relationships. These patterns are symptomatic of a broader political economy in which the logic of markets, decentralized coordination, minimally regulated enterprise, and ostensibly free exchange predominates (Harvey, 2005). The general philosophy is one of maximizing individual freedom (a notion commonly left underdetermined (Skinner, 2003)) and the supposed best way to do this is with markets. Embedded within the broader political economic paradigm, engineering education consequently exhibits the same patterns of values and behaviors among universities, departments, students, companies, and governments. Take ethics, for example. Engineering ethics may be treated as simply another item to include or exclude in the curriculum as the market demands, under this orientation. If it behooves marketing and recruitment efforts to emphasize engineering ethics then programs will incorporate ethics more intentionally, but if the converse is true then engineering ethics may never receive the overt attention that it deserves from faculty members and programs.

1.A. Marketing and Recruitment

Departments specifically adopt practices to attract students into their programs, especially during moments of waning student enrollment or floundering finances. This creates specific kinds of relationships among faculty members in a department and between departments (or universities) and prospective students. For example, consider a context in which engineering programs have a general first-year program and then students choose majors in their second semester. Departments may use an introductory seminar course to advertise their program to first-year students to entice them to pursue a degree in that department. Doing so would thereby affect decisions about the material included within engineering courses, and therefore it is a relevant phenomenon to consider in characterizing how political and economic factors influence engineering education.

Sample Questions:

- To what degree do marketing decisions drive curricular or pedagogical changes in undergraduate engineering programs?
- To what extent does discourse about marketing of programs reveal about underlying political economic assumptions?
- Are there common themes in programs' marketing and recruitment efforts for attracting new students?
- Is there a potential crowding out effect from other topics receiving more curricular time in the name of appealing to students?

1.B. Supply and Demand

The concept of supply and demand is a common fixture in microeconomics. Depending on one's perspective and unit of analysis, both supply and demand of a variety of resources can emanate from any number of actors. In the political economy of engineering education, the supply of particular courses can be influenced by demand from students, for example. Additional examples include (i) the demand-side phenomena that originate from students and employers for certain learning opportunities to develop specific skill sets and (ii) the supply-side phenomena from faculty members and departments offering specific courses that creates a general transactional arrangement in engineering curricula. Publications that rank programs can also play a role in driving demand, which is related to the concept of prestige and reputation (below). Relations among industry, students, departments, and faculty members then determine curriculum time allocation (which in turn can affect faculty and student time allocation). As noted in the Phase 1 Report (2014, p. 17), "there is a market for universities to help teach engineers business skills and provide lower cost options than business school."

Analyzing these phenomena of supply and demand can potentially beg the question of the underlying motivations for such demands – what generated a particular preference set and what was the reason for that? Characterizing this aspect of the political economy of engineering education also raises the question about the consequences of elasticities of supplies and demands. These could be fruitful areas for critical investigation in the future.

Sample Questions:

- Under what formal and informal circumstances do students feel empowered to express demands on programs to discuss specific concepts or topics in the curriculum?
- Similarly, under what circumstances are programs more likely to accede to (or ignore) student and prospective student requests?
- Moreover, under what conditions will students ignore the logic of supply and demand and cite other principles to justify their actions?

2. Prestige and Reputation

The construction and maintenance of reputation and competition for prestige is another phenomenon relevant to the political economy of engineering education. While there are different theories with discrete operationalizations of prestige (Wegener, 1992), in an economic sense, reputation is defined as an assessment that some actors in a system make about a subset of another actor's (actor A) characteristics based on A's actions (Noe, 2012, p. 115). In higher education, Rosinger et al. (2015) have discussed the effects of what they term the "prestige economy" on interdepartmental dynamics and segmentation of high-resource departments and low-resource departments within universities. Sometimes, this transpires by universities spending money to increase their rankings (Bhattacharjee, 2011). Other times this can happen with faculty members allocating their time as part of the prestige economy (Blackmore & Kandiko, 2011). Returning to the definition of political economy, the study of social relations that determine resource allocation, struggles for prestige and reputation are within the study of political economy because those social relations determine who gains (or loses) reputation; social relations construct prestige, which departments struggle to accumulate by spending their resources.

In engineering education, the prestige and reputation phenomenon can manifest as the result of departments building their reputation for "producing high quality engineers", a reputation evaluation that companies make when considering whether to hire that department's students. A department could want to foster a reputation among companies for educating engineers whom they will want to hire. In turn, that impetus to develop such a reputation informs decisions about how and where to allocate time and energy in the program.

At the individual actor level, this phenomenon can also transpire as the reputation that some faculty members have among their colleagues based on their title. The implication here is that title is a signal of prestige, which both enables resource use and influences the faculty member's own resource allocation in an effort to maintain and advance that title. Finally, in addition to faculty member reputation among other faculty members, faculty member reputation among students based on their teaching ability could be another source of reputation and prestige. That reputation then affects students' choices for which classes and which section offerings to take.

The common theme in each of these examples is that prestige and reputation are driving behaviors among actors in the system related to how they manage their own resources and those of the system more generally. As with the supply and demand phenomena above, this competition for a positive reputation can cut both ways. On the one hand, programs trying to foster a reputation among companies will want to have companies know they educate certain kinds of engineers. On the other hand, if companies do not actually value those characteristics among their employees, then programs *could* in turn abandon parts of their curricula. Therefore, a comprehensive research agenda to characterize the political economy of engineering education should account for reputation and prestige at the individual- and group-level within the system – how it is built, the effects of those signals on perception, the consequences of these perceptions, etc.

Sample Questions:

- How do faculty members in a department think about their program's reputation for educating engineers capable of ethical decision making, and how does that affect their collective decision making to allocate time in the curriculum to ethics?

- More generally, how does a program's reputation affect the resources that it can receive?
- To what degree is the Matthew effect – concisely stated as "the rich get richer" – that Merton (1968) described in science, and Perc (2014) further elaborated, also in effect in engineering education? This could potentially be relevant with engineering education departments strategically placed in colleges of engineering rather than colleges of education. The underlying idea behind that move would be the impetus for more prestige driving decisions about curricular or even programmatic structure.

3. Outsourcing

The process of outsourcing can involve hiring an external organization to produce something which was previously produced internal to the deciding organization (Bhagwati et al., 2004). How one delineates organizational boundaries in this context given the centrality of the internalize versus externalize decision is pivotal in determining what constitutes outsourcing. Within engineering education, this can be the decision to have a faculty member within the department teach a course versus coordinating with another department to have one of their faculty members teach the course in question or hiring an adjunct faculty member. The social relations implicated here are those between departments in a university and among committees within a department as they decide how to allocate their budgets and curriculum time. Alternatively, rather than outsourcing students' education to another department within the university, some faculty members may find it more appropriate to rely upon students' future employers to provide some aspects of their education.

In all of these scenarios, outsourcing decisions revolve around comparative advantage of one department or organization over another. The department may collectively ask whether it is easier to outsource instruction of a topic or course rather than committing their own resources to teaching that course. That decision may partially be informed by where expertise does and does not exist within the department, but it can also stem from the broader way in which resources flow within a university. While this decision follows an understandable logic, it can also have unintended consequences of disconnecting the content and segmenting the curriculum overall. Consequently, this division of labor may have observable effects on engineers' formation. The general model of producing quality-assured students ready to contribute to a competitive workforce stems from the view of universities as metaphorical factories, noted in Table 1 in the Wickendon Report's discussion of a Taylorist philosophy of education (NB: Taylor was a 19th century engineer known for prioritizing efficiency). The phenomenon is an indication of at least two things: first, applying the same models for economic development in industry to student development in education wherein human capital is simply another resource to invest in; second, the distribution of resources in universities in connection with academic units can enable and even justify these outsourcing decisions, thereby distorting the decision-making process through an outsized consideration of cost in lieu of other considerations such as student learning.

Sample Questions:

- What are the effects of outsourcing in engineering education?
- Are some topics (e.g., professional writing) more likely to be outsourced in the curriculum compared to others? If so, why, and what are the consequences of those outsourcing decisions? In other words, to what degree will students or faculty members use the logic of employing someone else to complete a task that they themselves might otherwise complete, and what are their justifications for doing so?
- In the eyes of faculty and administrators, where do the boundaries exist for permissible outsourcing?
- Do particular funding mechanisms or resource dependencies correlate with levels of outsourcing (or attitudes toward outsourcing)?

4. Program governance

Oversight and regulation of engineering education can come in several forms. One such form is actual governmental agencies such as the Department of Education. A second type of regulatory body can be private organizations like certain accreditation boards. In engineering, the Accreditation Board for Engineering and Technology (ABET) is a significant actor in that arena, at least in the United States. A third example is professional organizations, in a more indirect sense, by means of establishing and promulgating professional standards. In turn, those professional standards influence accreditation standards, but they also influence licensing requirements. As a result, if an undergraduate engineering program wants to prepare its students to obtain a Professional Engineering license, then it will most likely shape its curriculum to adhere to those standards and educate their students accordingly. This creates relationships of dependence between engineering programs and accreditors, which shapes how programs allocate various resources.

4.A. Government oversight

The topic of government oversight will vary heavily among different countries. Government oversight is any formal or informal input from a governmental organization to an engineering education system. In the United States, one might expect oversight from the Department of Education at the federal level or state legislatures. An example of government oversight on public universities: credit hour limits, often to reduce time and cost associated with engineering degrees. Those limits then constrain programs' curricula, causing faculty to omit certain courses and topics. Thus, pressures from political bodies can motivate decisions on how to allocate time in the curriculum. The phenomenon of government regulation is therefore one dimension of the political economy of engineering education.

This is not just a phenomenon of government actions in the United States. Take the United Kingdom for a second example. In particular, Shelton (1982) discussed government oversight and academic freedom in the United Kingdom. Among other things, he observed that "the basic rationale for government involvement is a recognition of the role of engineers and engineering in national industrial and economic performance" (Shelton, 1982, p. 221). He then proceeded to expound upon this government oversight aspect of the political economy of engineering education:

> "The approach varies from country to country, but all governments have to work through the existing framework for organising, financing and managing higher education and for the registration of engineers. Governments can of course seek to change this framework to enable them to pursue their policies more effectively" (Shelton, 1982, p. 222).

In other words, governments have various mechanisms at their disposal to regulate engineering education in the name of accomplishing their objectives. Those objectives may vary, but they are commonly economic. The objectives then establish relationships among actors in engineering education, which renders this a phenomenon in the political economy of engineering education. This example from British engineering education illustrates an important point: although government can regulate engineering education in their respective jurisdictions, the details may look different depending on the objectives and economic circumstances facing those different places.

Sample Question:

- How do different national government oversight structures and political philosophies shape the engineering education systems of their respective countries?
- Are those broader national philosophies correlated with certain patterns regarding specific topics in undergraduate engineering programs in those countries? Work in this area would follow the example from Kabo et al. (Kabo et al., 2012) comparing the U.S., Sweden, and China or Lucena et al. (J. Lucena et al., 2008) comparing the U.S., Latin America, and Europe.

4.B. Accreditation oversight

Periodic accreditation visits from ABET play a substantial role in the oversight and regulation phenomena of the political economy of engineering education. One can hardly understate the importance of ABET in this characterization of the engineering education system. Obtaining a professional engineering license often requires graduating from an ABET-accredited engineering program. Moreover, many job postings specifically look for graduates of accredited programs, regardless of whether those recruits have a P.E. license. The importance of graduating from an ABET-accredited program creates a substantial role for oversight and regulation by ABET. Unsurprisingly, this oversight can be cited as the impetus for decision-making in engineering programs regarding which topics are covered in undergraduate curricula, and to what extent. In most of these cases, accreditation plays a role in the regulation phenomenon of the political economy of engineering education by informing relationships that affect how programs allocate curricular time. This is consistent with pressures reported elsewhere that occur from ABET and its ability to change the form of engineering education (Bjorklund & Colbeck, 2001).

Sample Question:

- How would an alternative accreditation oversight body gain leverage in a space heavily dominated by one organization?
- Alternatively, what are the economic pressures on ABET that partially contribute to their efforts to establish a more global presence in program accreditation?
- Are there patterns in how programs handle that part of their curricula that are correlated with characteristics of the department (e.g., department size, organizational structure, discipline)?

4.C. Regulatory capture

Regulatory capture is the phenomenon arising from specific groups having disproportionate influence over regulatory bodies (Bó, 2006). Such regulatory bodies include ABET for education and professional organizations for the profession more generally. If one construes internal university rules and requirements as regulations, then placing department representatives on university curriculum committees can also be a form of regulatory capture. For example, this can arise in the form of one department member sitting on the faculty senate and course approval committee, which facilitates the approval of an engineering economics course over the objection of the economics department and their claims of redundancy. Economic conditions affecting universities are shaping group and committee decisions about resources in engineering departments. These are telltale ingredients of phenomena in the political economy of engineering education.

Sample Questions:

- What are examples of specific efforts from actors to influence the regulation of instruction by outside actors – e.g., accreditation bodies, university officials, governmental agencies, etc. – that their departments experience?
- Moreover, what are common themes underlying the motivations, successes, and failures of those efforts?

4.D. Regulatory burden

Regulatory burden is the set of costs that accrue to an organization as a consequence of the organization's efforts to maintain compliance with regulations (Helm, 2006). In engineering education, one can study the overhead of compliance with ABET, for example. Accreditation site visits notoriously entail an abundance of paperwork and require multiple stakeholders' time and attention.

The ABET example is just one conceivable example of regulatory burden in engineering education. In a broader sense of political economy, this idea of regulatory burden is perceived as a negative phenomenon because it assumes that regulation is a burden. Under a neoliberal ideology, regulation is rarely justified, and even then only to ensure proper functioning of a market. Thus, when regulations do exist, one can easily frame them as burdensome. Of course, the regulation itself will sometimes come from the desire to create a common denominator among programs. That move translates to faculty members within a department needing to coordinate amongst each other how they will demonstrate compliance. This can explain how faculty members, operating within the political economy of engineering education might see regulation with this regulatory burden perspective.

Sample Questions:

- Are there associated behaviors that one observes consequent to regulatory burden in other contexts aside from accreditation? For example, is there intentional lobbying to change the regulations or shirking from faculty members (especially in a patterned manner, such as from faculty in certain disciplines or at a certain rank) to placate overseers on behalf of the faculty members?

5. Job markets (Hiring patterns and decisions)

Hiring decisions represent a pivotal allocation of resources for an organization and present clear opportunities for political and economic factors to influence decision making. They define the organization's personnel and shape future outcomes for the internal operations in manifold ways. There are at least two areas in which this general concept is relevant to engineering education. First, there are specific hiring preferences and patterns that companies exhibit. Second, there are specific hiring decisions that universities exhibit. Each of these can affect engineering education in specific, potentially unintended ways compounded by the academic capitalist competition for prestige (partially garnered through increased research funding) and reduced departmental budgets leading to academic precarity and adjunctification (Charfauros & Tierney, 1999; Courtois & O'Keefe, 2015; Reisel, 2018). In turn, these can affect how topics are discussed in engineering programs by placing certain external expectations on programs and internal personnel with differing understandings of what those topics mean.

5.A. Hiring Decisions by Companies

This topic analyzes how the hiring decisions that companies make end up providing feedback signals to engineering departments, which in turn modify their curricula and student outcomes to align with the industry's desired traits. These hiring decisions can range along the kinds of employment opportunities from co-ops to internships to full-time, post-graduation employment. As with supply and demand, the main idea here is that the relationship between engineering programs and industry can affect allocations of faculty time, curriculum time, student time, and money, influencing which courses are taught and the larger learning objectives they are designed to achieve. For example, if companies come to a department and say "we want students who understand the nuances of communication in team settings" then departments could predictably respond by adjusting their curricula to make communication and teamwork more visible in the departments' courses.

Sample question:

- How do engineering programs elicit and respond to industry feedback for prospective employee hiring preferences?
- Are there patterns in who (or who is not) among the potential employers surveyed such that some group's preferences have outsized influence on departmental decision-making and resource allocation?
- Where does Topic X fit into these feedback loops from industry?

5.B. Hiring Decisions by Departments

Decisions at the department, college, and university levels, which themselves can be the result of input signals from university administration and priorities, are another example of a specific resource allocation issue – personnel – that alters the state of engineering education. Two specific ways in which this can manifest is the hiring of adjunct faculty and the preference for research faculty in lieu of faculty with professional work experience in industry. Adjunct faculty and professors of practice may be more likely to have substantial industry experience in comparison with research-intensive tenure-track faculty. As a result, they may be less inclined to discuss particular topics or less aware of practice-specific elements such as the importance and prevalence of ethical issues throughout engineering. Consequently, this can change the state of engineering education by affecting personnel who alter the content of specific courses. That cascade from hiring practices to different faculty composition to course content can culminate in developing engineers with noticeably different educational backgrounds compared with engineers who had more design-oriented or profession-oriented instruction rather than theory-based instruction.

Seely (1999) described a similar trend in the early to mid-twentieth century as universities hired European faculty and federal grants increasingly funded research efforts. This combination cascaded into a more analytic approach to engineering and a shift away from design. As universities shift toward supplementing government-subsidized funding with research funding, they can begin to shift their hiring practices to recruit more research faculty. In other words, that continued trend of the competition for funding dictating department hiring, which in turn shapes program curricula, is continuing relatively unabated.

Shifts in the composition of faculty experiences can have implications in the classroom. One specific example of these effects is in the positive correlation between a faculty member's years of work experience and their likelihood to incorporate ethics into their classroom (Katz & Knight, 2017) – more years of work experience as an engineer was associated with faculty members reporting more incorporation of ethics and professional responsibility in their courses on a national survey of over 1,200 faculty members. The basic premise is that every person comes with their own interests that are also shaped by incentives. This affects the interests and autonomous/individualized decision-making processes of each faculty member, which potentially translates into different content in each course offering. Of course, at the time of hire, the main consideration of the department or university may be to recruit someone capable of generating research funding. In that picture, resource dependence drives hiring, which affects who is on the faculty, which then shapes what students learn due to the influence of personal interests in curricular decision-making.

Sample question:

- How has the political economy of engineering education shaped the hiring practices of engineering departments, and in turn shaped the content that students learn in the undergraduate curriculum as a function of what faculty members are most familiar with?
- Specific to engineering education, how has the organization of engineering education research (e.g., separate departments, faculty integrated within engineering departments) influenced hiring decisions and the development of engineering education as a field?

6. Institutional Isomorphism, Entrepreneurship, and Inertia

When studying political economy, one may focus on the generation and effects of institutions. An institution in this context is not synonymous with a university; instead, an institution is more abstract and expansive. Theoretically, an institution is any formal (e.g., rules, standards, regulations) or informal (e.g., norms, taboos, or culture) guideline that shapes behavior (North, 1991). These are colloquially deemed the "rules of the game" in the parlance of institutional theorists (Gertler, 2010). Three examples of the relevance and practicality of institutional theory for characterizing the political economy of engineering education are institutional isomorphisms, institutional entrepreneurship, and institutional inertia. Together, these phenomena describe how faculty members and departments will spend their money and time either to look similar (isomorphisms) or different (entrepreneurship) as they try to maintain legitimacy or distinguish themselves to compete against other faculty members or departments.

6.A. Institutional Isomorphism

Similar practices among discrete organizations are called institutional isomorphisms (DiMaggio & Powell, 1983). In engineering education, this can manifest as one program configuring itself similarly to another, possibly more prestigious program, to gain legitimacy or resources. Isomorphisms can further divide into coercive, mimetic, and normative variants. For example, departments may adopt a coercive isomorphism strategy when they depend upon other organizations, such as NSF or state legislatures, for resources and do not want to bring suspicion upon themselves by standing out in a dubious way. In addition to coercive isomorphisms, mimetic isomorphisms offer a popular strategy in the face of uncertainty from changing educational landscapes, industry demands, accreditation standards, leadership, and the like. A mimetic isomorphism can arise when a department tries to structure its curriculum or a specific course, for example, senior capstone, the same way as departments at peer institutions. That institutional isomorphism may arise because they believe there genuinely is no other way to run a senior design course. Alternatively, it could be the consequence of this mimetic isomorphism created by environmental uncertainties inherent in the political economy of engineering education (which itself is a product of broader economic landscapes in which paradigms like creative destruction (Schumpeter, 1942, p. 82) prevail). These ideas relate to the political and economic factors influencing engineering education because they illustrate the effects of operating in a system of unpredictable flux. As a result of needing to meet demands from industry and balance resources departments and faculty members may turn to mimetic or normative isomorphisms as ways to survive by emulating what peer organizations (whether that be other departments or other universities) are doing. This could help explain similarities that one observes among different departments in how they address persistent issues or topics both inside and outside of the classroom.

Sample Question:

- How have institutional isomorphisms affected engineering education program innovation, e.g., in areas like capstone design, over the past 30 years? For example, in an editorial in *Science*, Morgan (1990) called for more programmatic diversity enabled by loosened accreditation standards. The claim: stringent bean-counting practices in accreditation stymie innovative practices in engineering education. The corollary is that engineering programs can start to look the same – isomorphic. In other words, from the perspective of institutional theory, accreditation might increase coercive isomorphisms. Is Morgan correct that accreditation is the mechanism of action for observed isomorphisms in engineering programs, or are there some other causes? This is just one instance of several potential dimensions in the political economy of engineering education that generate these institutional isomorphisms.

6.B. Institutional Inertia and Entrepreneurship

The creation of new institutions within organizational settings is labelled institutional entrepreneurship (Pacheco et al., 2010). In engineering programs this may transpire in the form of a department initiating specific practices or traditions, such as requiring graduating seniors to join the Order of the Engineer. Another example might be an effort to incorporate a program in social responsibility. If the inspiration to create such a program originated from seeing other programs, then such an initiative may also be an institutional isomorphism. On the other hand, when these decisions are inspired without a desire to emulate other programs then they more likely represent institutional entrepreneurship.

Studying the political economy of engineering education, one may ask about the precursors or antecedent conditions that give rise to institutional entrepreneurship in engineering education. This is particularly germane to the efforts of reformers in engineering education who may want to encourage this institutional entrepreneurship and promulgate best practices related to developing engineers on a large scale.

Institutional inertia is a counterpart of institutional entrepreneurship – they can be viewed as two sides of the same coin. As the name suggests, institutional inertia is the obstinate persistence of an institution, especially in the face of efforts to change it. Examples can include intractability of curricula or pedagogical practices to updates, in part due to a status quo bias. Identifying institutional inertias is one task. A related task lies in identifying the reasons for institutional inertia. In some cases, it may be as simple as a lack of time and energy due to competing pressures on faculty members and a simple "if it ain't broke, don't fix it" mentality. As this mindset might suggest, institutional inertias may be a phenomenon in engineering education not through intentional action but rather through a crowding out of faculty members' time and energy in the push for more funding, more publications, and more students to the detriment of other outcomes. Due to other demands placed on that time and energy, faculty members lack the bandwidth to advocate and sustain institutional changes, which ultimately generates this institutional inertia.

Sample Question:

- What are the political and economic precursors that facilitate institutional entrepreneurship related to specific topics (e.g., design, teamwork) in engineering programs?
- As with the institutional isomorphism question, does the political economy of engineering education constrain (or incentivize) certain kinds of institutional entrepreneurship – e.g., starting a program on innovation, recruiting donors to fund a maker space, or adopting research-based practices for teaching an engineering course like thermodynamics?

LIMITATIONS

REIFICATION

By naming some of these phenomena one might invite the problem of confusing the model for the actual instances of interaction in the world. Reification is the process of making an abstract concept or idea more concrete. A classic example of this would be confusing a map of an area with that physical area itself, as expressed in the saying "the map is not the territory" (Korzybski, 1933, p. 58). A more relevant example in the present paper could be the act of turning "prestige" into a more tangible entity in the world rather than an agreed upon or recognized concept. The purpose of this paper is not to reify the aforementioned phenomena but rather to provide a model for thinking about social relations in engineering education and how those affect time, money, space, and human resource allocation decisions. As Box (1987) reminds us, "all models are wrong, but some are useful." The model here is the set of concepts from canonical study of political economy. The utility is in understanding constraints shaping engineers' formation. To guard against reification, we should maintain a level of reflexivity and apply a critical perspective to the work, continuously re-analyzing these ideas and the work they are doing for us.

NORMALIZATION

Discussing engineering education in these terms might also imply a normative stance that the underlying extant relations described by this framework are suitable. We do not intend to imply that position. Indeed, if anything, the spirit of this project is one of questioning the merits of those existing patterns. The critical task is in the same vein as the saying attributed to Bertrand Russell that "in all affairs it's a healthy thing now and then to hang a question mark on the things you have long taken for granted"; thus, the project questions the normative practices that abound and the narratives we construct to justify them.

CATEGORY ERROR

Understandably, some may balk at the notion of taking an entire framework from one discipline and applying it to engineering education. Such reservations may assert that this is a category error – an instance of confusing an object as belonging to one category and ascribing characteristics of that category to that object while in reality that object does not belong to the category and therefore does not inherit those characteristics (Ryle, 1937). In the present paper, the category error could be applying frameworks from political science and economics to how we study engineering education. While arguably true, in a pragmatic sense, if labeling these problems in such borrowed vernacular offers useful tools for thinking and improving current conditions in engineering education system then the framework's utility could outweigh downsides. Moreover, there is a successful precedence of leveraging work in one field of study to understand other fields. Essentially, these are tools for thinking about problems. Moreover, claims of applicability notwithstanding, this paper is not intended to politicize engineering education to an unwarranted level; however, ignoring the effects of social, political, and economic factors on engineering education does not nullify these factors' effects. They still exist whether or not participants in the system like it. Refusing to acknowledge these dynamics – whether it is promotion and tenure for engineering education research, interdepartmental curricular disputes for credit hours, student choices creating a demand for change, or industry representatives placing pressures on departments to teach particular skills – does not nullify their existence.

CONCLUSION

We have presented a set of conceptual tools to elucidate the social relationships that inform how time, money, space, and human resources are spent in engineering education. These tools deepen analyses of static and dynamic processes in engineering education by making visible the larger political and economic forces affecting higher education in general, and engineering education in particular. There clearly are relationships among the different actors, organizations, and institutions within the system. Those relationships establish individual and organizational priorities, preferences, and behaviors for how we allocate time, money, and human resources toward instruction in universities, colleges, departments, courses, and classrooms. This is a picture in which decision-making about resources is political, depending on the confluence of people, organizations, and environments to determine who gets what, how, and when – the very (pithy) definition of politics (Lasswell, 1936).

Anyone participating in the engineering education system in some way will most likely recognize the confluence of social, political, and economic factors that shape decision-making processes within the system. Sometimes those factors engender specific phenomena that have been studied in other contexts. By learning lessons from those prior studies, engineering educators, researchers, administrators, and professionals can refine how they view the engineering education system. In turn, that refinement might enable several outcomes: increased awareness of surrounding processes, improved decision-making, and new avenues for research in order to more clearly study the state of engineering education. Being mindful of factors associated with governance, labor, and relationships within the system, we can advance our understandings of change in engineering education, ultimately improving processes and outcomes in practice.

ACKNOWLEDGEMENTS

We thank Donna Riley, Alice Pawley, India Nair, and Brent Jesiek for their insight and feedback in the conceptual development stages of this work.

COMPETING INTERESTS

The authors have no competing interests to declare.

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REFERENCES

Arndt, J. (1983). The political economy paradigm: Foundation for theory building in marketing. *Journal of Marketing*, *47*(4), 44–54. DOI: https://doi.org/10.1177/002224298304700406

ASEE. (2014). *Phase I: Synthesizing and integrating industry perspectives* (Transforming Undergraduate Engineering Education). American Society for Engineering Education.

Besterfield-Sacre, M., Cox, M. F., Borrego, M., Beddoes, K., & **Zhu, J.** (2014). Changing engineering education: Views of U.S. faculty, chairs, and deans. *Journal of Engineering Education*, *103*(2), 193–219. DOI: https://doi.org/10.1002/jee.20043

Bhagwati, J., Panagariya, A., & **T. N., S.** (2004). The muddles over outsourcing. *Journal of Economic Perspectives*, *18*(4), 93–114. DOI: https://doi.org/10.1257/0895330042632753

Bhattacharjee, Y. (2011). Saudi universities offer cash in exchange for academic prestige. *Science*, *334*(6061), 1344–1345. DOI: https://doi.org/10.1126/science.334.6061.1344

Bjorklund, S. A., & **Colbeck, C. L.** (2001). The view from the top: Leaders' perspectives on a decade of change in engineering education*. *Journal of Engineering Education*, *90*(1), 13–19. DOI: https://doi.org/10.1002/j.2168-9830.2001.tb00562.x

Black, K. M. (1994). An industry view of engineering education. *Journal of Engineering Education*, *83*(1), 26–28. DOI: https://doi.org/10.1002/j.2168-9830.1994.tb00112.x

Blackley, S., & **Howell, J.** (2015). A STEM narrative: 15 years in the making. *Australian Journal of Teacher Education*, *40*(7). DOI: https://doi.org/10.14221/ajte.2015v40n7.8

Blackmore, P., & **Kandiko, C. B.** (2011). Motivation in academic life: A prestige economy. *Research in Post-Compulsory Education*, *16*(4), 399–411. DOI: https://doi.org/10.1080/13596748.2011.626971

Bó, E. D. (2006). Regulatory capture: A review. *Oxford Review of Economic Policy*, *22*(2), 203–225. DOI: https://doi.org/10.1093/oxrep/grj013

Bogen, J., & **Woodward, J.** (1988). Saving the phenomena. *The Philosophical Review*, *97*(3), 303–352. DOI: https://doi.org/10.2307/2185445

Borrego, M., Froyd, J. E., & **Hall, T. S.** (2010). Diffusion of engineering education innovations: A survey of awareness and adoption rates in U.S. engineering departments. *Journal of Engineering Education*, *99*(3), 185–207. DOI: https://doi.org/10.1002/j.2168-9830.2010.tb01056.x

Bowles, S., & **Gintis, H.** (1977). *Schooling in capitalist America: Educational reform and the contradictions of economic life*. Basic Books.

Box, G. E. P., & **Draper, N. R.** (1987). *Empirical model-building and response surfaces*. Wiley.

Brint, S. G., & **Karabel, J.** (1989). *The diverted dream: Community colleges and the promise of educational opportunity in America, 1900–1985*. Oxford University Press. DOI: https://doi.org/10.1093/oso/9780195048155.001.0001

Bunce, L., Baird, A., & **Jones, S. E.** (2017). The student-as-consumer approach in higher education and its effects on academic performance. *Studies in Higher Education*, *42*(11), 1958–1978. DOI: https://doi.org/10.1080/03075079.2015.1127908

Campbell, C. M., & **O'Meara, K.** (2013). Faculty agency: Departmental contexts that matter in faculty careers. *Research in Higher Education*, *55*(1), 49–74. DOI: https://doi.org/10.1007/s11162-013-9303-x

Carlson, W. B. (1988). Academic entrepreneurship and engineering education: Dugald C. Jackson and the MIT-GE Cooperative Engineering Course, 1907–1932. *Technology and Culture*, *29*(3), 536–567. JSTOR. DOI: https://doi.org/10.2307/3105273

Carpentier, V. (2015). State education, crisis and austerity: An historical analysis through the lens of the Kondratiev cycles. In C. Aubry, M. Geiss, V. Magyar-Haas, & J. Oelkers (Eds.), *Education and the State: International perspectives on a changing relationship* (1st ed., pp. 78–102). Routledge. DOI: https://doi.org/10.4324/9781315772387

Cech, E. A. (2013). The (mis)framing of social justice: Why ideologies of depoliticization and meritocracy hinder engineers' ability to think about social injustices. In J. Lucena (Ed.), *Engineering Education for Social Justice* (pp. 67–84). Netherlands: Springer. DOI: https://doi.org/10.1007/978-94-007-6350-0_4

Cech, E. A., & **Sherick, H. M.** (2015). Depoliticization and the structure of engineering education. In S. H. Christensen, C. Didier, A. Jamison, M. Meganck, C. Mitcham, & B. Newberry (Eds.), *International Perspectives on Engineering Education, 20*, 203–216. Springer International Publishing. DOI: https://doi.org/10.1007/978-3-319-16169-3_10

Charfauros, K. H., & **Tierney, W. G.** (1999). Part-time faculty in colleges and universities: Trends and challenges in a turbulent environment. *Journal of Personnel Evaluation in Education*, *13*(2), 141–151. DOI: https://doi.org/10.1023/A:1008112304445

Clark, M. C., Froyd, J., Merton, P., & **Richardson, J.** (2004). The evolution of curricular change models within the Foundation Coalition. *Journal of Engineering Education*, *93*(1), 37–47. DOI: https://doi.org/10.1002/j.2168-9830.2004.tb00786.x

Committee on Prospering in the Global Economy of the 21st Century (U.S.), & Committee on Science, Engineering, and Public Policy (U.S.) (Eds.). (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. National Academies Press.

Committee on Science, Engineering, and Public Policy (U.S.). (2006). *Biological, social, and organizational components of success for women in academic science and engineering: Report of a workshop* (Committee on Maximizing the Potential of Women in Academic Science and Engineering (U.S.), National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, Eds.). National Academies Press.

Connell, R. (2013). The neoliberal cascade and education: An essay on the market agenda and its consequences. *Critical Studies in Education*, *54*(2), 99–112. DOI: https://doi.org/10.1080/17508487.2013.776990

Courtois, A. D. M., & **O'Keefe, T.** (2015). Precarity in the ivory cage: Neoliberalism and casualisation of work in the Irish higher education sector. *Journal for Critical Education Policy Studies*, *13*. http://discovery.ucl.ac.uk/1538710/1/13-1-3.pdf

Dasgupta, N., & **Stout, J. G.** (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences*, *1*(1), 21–29. DOI: https://doi.org/10.1177/2372732214549471

Denney, J. J. (2011). *Priming the innovation pump: America needs more scientists, engineers, and basic research*. DEFENSE ACQUISITION UNIV FT BELVOIR VA. https://apps.dtic.mil/docs/citations/ADA535501

Denton, D. D. (1998). Engineering education for the 21st century: Challenges and opportunities. *Journal of Engineering Education*, *87*(1), 19–22. DOI: https://doi.org/10.1002/j.2168-9830.1998.tb00317.x

DiMaggio, P. J., & **Powell, W. W.** (1983). The Iron Cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, *48*(2), 147–160. DOI: https://doi.org/10.2307/2095101

Doten-Snitker, K., Margherio, C., Litzler, E., Ingram, E., & **Williams, J.** (2021). Developing a shared vision for change: Moving toward inclusive empowerment. *Research in Higher Education*, *62*(2), 206–229. DOI: https://doi.org/10.1007/s11162-020-09594-9

Drazen, A. (2002). *Political economy in macroeconomics*. Princeton University Press.

Frantz, A. C., Beebe, S. A., Horvath, V. S., Canales, J., & **Swee, D. E.** (2004). The roles of teaching and learning centers. *To Improve the Academy*, *23*(1), 72–90. DOI: https://doi.org/10.1002/j.2334-4822.2004.tb00427.x

Garritzmann, J. L. (2016). *The political economy of higher education finance: The politics of tuition fees and subsidies in OECD countries, 1945–2015*. Palgrave Macmillan. DOI: https://doi.org/10.1007/978-3-319-29913-6_1

Geiger, R. L. (2011). Markets and the End of the Current Era in U.S. Higher Education. In P. Teixeira & D. D. Dill (Eds.), *Public Vices, Private Virtues? – Assessing the effects of marketization in higher education* (pp. 3–17). SensePublishers. DOI: https://doi.org/10.1007/978-94-6091-466-9_1

Gertler, M. S. (2010). Rules of the game: The place of institutions in regional economic change. *Regional Studies*, *44*(1), 1–15. DOI: https://doi.org/10.1080/00343400903389979

Graham, R. (2012a). *Achieving excellence in engineering education: The ingredients of successful change*. The Royal Academy of Engineering.

Graham, R. (2012b). The one less traveled by: The road to lasting systemic change in engineering education. *Journal of Engineering Education*, *101*(4), 596–600. DOI: https://doi.org/10.1002/j.2168-9830.2012.tb01120.x

Harvey, D. (2005). *A brief history of neoliberalism*. Oxford University Press.

Helm, D. (2006). Regulatory reform, capture, and the regulatory burden. *Oxford Review of Economic Policy*, *22*(2), 169–185. DOI: https://doi.org/10.1093/oxrep/grj011

Henderson, C., Beach, A., & **Finkelstein, N.** (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of Research in Science Teaching*, *48*(8), 952–984. DOI: https://doi.org/10.1002/tea.20439

Jamieson, L., & **Lohmann, J.** (2009). *Creating a culture for scholarly and systematic innovation in engineering education: Ensuring U.S. engineering has the right people with the right talent for a global society*.

Jesiek, B. K., Newswander, L. K., & **Borrego, M.** (2009). Engineering education research: Discipline, community, or field? *Journal of Engineering Education*, *98*(1), 39–52. DOI: https://doi.org/10.1002/j.2168-9830.2009.tb01004.x

Kabo, J., Tang, X., Nieusma, D., Currie, J., Wenlong, H., & **Baillie, C.** (2012). *Visions of social competence: Comparing engineering education accreditation in Australia, China, Sweden, and the United States*. 25.1463.1–25.1463.16. DOI: https://peer.asee.org/22220

Katz, A., & **Knight, D. B.** (2017). Factors related to faculty views toward undergraduate engineering ethics education. *2017 ASEE Annual Conference & Exposition*. https://peer.asee.org/factors-related-to-faculty-views-toward-undergraduate-engineering-ethics-education

Klees, S. J. (2008). A quarter century of neoliberal thinking in education: Misleading analyses and failed policies. *Globalisation, Societies and Education*, *6*(4), 311–348. DOI: https://doi.org/10.1080/14767720802506672

Korzybski, A. (1933). *Science and sanity: An introduction to Non-Aristotelian systems and general semantics*. The Science Press Printing Company. http://archive.org/details/sciencesanityint00korz

Kosak, L., Manning, D., Dobson, E., Rogerson, L., Cotnam, S., Colaric, S., & **McFadden, C.** (2004). Prepared to teach online? Perspectives of faculty in the University of North Carolina System. *Online Journal of Distance Learning Administration*, *7*(3).

Lasswell, H. D. (1936). *Politics: Who gets what, how, and when*. Whittlesey House.

Lattuca, L. R., Terenzini, P. T., & **Volkwein, J. F.** (2006). *Engineering change: A study of the impact of EC2000*. ABET, INC. http://www.abet.org/wp-content/uploads/2015/04/EngineeringChange-executive-summary.pdf

Layton, E. T. (1971). *The revolt of the engineers: Social responsibility and the American engineering profession* (Johns Hopkins pbk. ed). Johns Hopkins University Press.

Leslie, L. L., & **Johnson, G. P.** (1974). The market model and higher education. *The Journal of Higher Education*, *45*(1), 1–20. DOI: https://doi.org/10.2307/1980645

Li, A. Y. (2017). Dramatic declines in higher education appropriations: State conditions for budget punctuations. *Research in Higher Education*, *58*(4), 395–429. DOI: https://doi.org/10.1007/s11162-016-9432-0

Liefner, I. (2003). Funding, resource allocation, and performance in higher education systems. *Higher Education*, *46*(4), 469–489. DOI: https://doi.org/10.1023/A:1027381906977

Lucena, J. C. (2005). *Defending the nation: U.S. policymaking to create scientists and engineers from Sputnik to the "war against terrorism."* Univ. Press of America.

Lucena, J., Downey, G., Jesiek, B., & **Elber, S.** (2008). Competencies beyond countries: The re-organization of engineering education in the United States, Europe, and Latin America. *Journal of Engineering Education*, *97*(4), 433–447. DOI: https://doi.org/10.1002/j.2168-9830.2008.tb00991.x

Maloney, W. F., & **Caicedo, V.** (2017). *Engineering growth: Innovative capacity and development in the Americas* (SSRN Scholarly Paper ID 2932756). Social Science Research Network. https://papers.ssrn.com/abstract=2932756

Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., & **Cannon-Bowers, J. A.** (2000). The influence of shared mental models on team process and performance. *Journal of Applied Psychology*, *85*(2), 273–283. DOI: https://doi.org/10.1037/0021-9010.85.2.273

Matusovich, H. M., Paretti, M. C., McNair, L. D., & **Hixson, C.** (2014). Faculty motivation: A gateway to transforming engineering education. *Journal of Engineering Education*, *103*(2), 302–330. DOI: https://doi.org/10.1002/jee.20044

McMasters, J. (2004). Influencing engineering education: One (aerospace) industry perspective. *International Journal of Engineering Education*, *20*(3), 353–371.

Merry, S. E. (1990). The discourses of mediation and the power of naming. *Yale Journal of Law & the Humanities*, *2*, 1–36. DOI: http://hdl.handle.net/20.500.13051/7410

Merton, R. K. (1968). The Matthew effect in science. *Science*, *159*(3810), 56–63. DOI: https://doi.org/10.1126/science.159.3810.56

Milstein, T. (2011). Nature identification: The power of pointing and naming. *Environmental Communication*, *5*(1), 3–24. DOI: https://doi.org/10.1080/17524032.2010.535836

Morgan, M. G. (1990). Accreditation and diversity in engineering education. *Science*, *249*(4972), 969–969. DOI: https://doi.org/10.1126/science.249.4972.969

Mosco, V. (2009). *The political economy of communication* (2nd ed). SAGE. DOI: https://doi.org/10.4135/9781446279946

Münch, R. (2014). *Academic capitalism: Universities in the global struggle for excellence*. Routledge. DOI: https://doi.org/10.4324/9780203768761

National Research Council. (1985). *Engineering education and practice in the United States: Foundations of our techno-economic future*. National Academies Press. DOI: https://doi.org/10.17226/582

Newman, S., & **Jahdi, K.** (2009). Marketisation of education: Marketing, rhetoric and reality. *Journal of Further and Higher Education*, *33*(1), 1–11. DOI: https://doi.org/10.1080/03098770802638226

Noble, D. F. (1979). *America by design: Science, technology, and the rise of corporate capitalism*. Oxford Univ. Press.

Noe, T. (2012). A survey of the economic theory of reputation: Its logic and its limits. In T. G. Pollock & M. L. Barnett (Eds.), *The Oxford handbook of corporate reputation* (1st ed.). Oxford University Press. DOI: https://doi.org/10.1093/oxfordhb/9780199596706.001.0001

North, D. (1991). Institutions. *Journal of Economic Perspectives*, *5*(1), 97–112. DOI: https://doi.org/10.1257/jep.5.1.97

Olssen, M., & **Peters, M. A.** (2005). Neoliberalism, higher education and the knowledge economy: From the free market to knowledge capitalism. *Journal of Education Policy*, *20*(3), 313–345. DOI: https://doi.org/10.1080/02680930500108718

Pacheco, D. F., York, J. G., Dean, T. J., & **Sarasvathy, S. D.** (2010). The coevolution of institutional entrepreneurship: A tale of two theories. *Journal of Management*, *36*(4), 974–1010. DOI: https://doi.org/10.1177/0149206309360280

Park, T. (2011). Academic capitalism and its impact on the American professoriate. *Journal of the Professoriate*, *6*, 84–99.

Perc, M. (2014). The Matthew effect in empirical data. *Journal of The Royal Society Interface*, *11*(98), 20140378. DOI: https://doi.org/10.1098/rsif.2014.0378

Reisel, J. R. (2018, June 23). *Attacks on tenure: An engineering professor's experiences with public policy actions impacting higher education.* 2018 ASEE Annual Conference & Exposition, Salt Lake City, UT. https://peer.asee.org/attacks-on-tenure-an-engineering-professor-s-experiences-with-public-policy-actions-impacting-higher-education.

Rosinger, K. O., Taylor, B. J., Coco, L., & **Slaughter, S.** (2015). Organizational segmentation and the prestige economy: Deprofessionalization in high- and low-resource departments. *The Journal of Higher Education*, *87*(1), 27–54. DOI: https://doi.org/10.1353/jhe.2016.0000

Ryle, G. (1937). Categories. *Proceedings of the Aristotelian Society*, *38*, 189–206. DOI: https://doi.org/10.1093/aristotelian/38.1.189

Schumpeter, J. (1942). *Capitalism, socialism and democracy*. Harper & Brothers.

Seely, B. E. (1999). The other re-engineering of engineering education, 1900–1965. *Journal of Engineering Education*, *88*(3), 285. DOI: https://doi.org/10.1002/j.2168-9830.1999.tb00449.x

Shelton, W. (1982). Government and engineering education: Economic imperative versus academic freedom. *European Journal of Engineering Education*, *7*(1), 219–225. DOI: https://doi.org/10.1080/03043798208903656

Shore, C. (2010). Beyond the multiversity: Neoliberalism and the rise of the schizophrenic university. *Social Anthropology*, *18*(1), 15–29. DOI: https://doi.org/10.1111/j.1469-8676.2009.00094.x

Skinner, Q. (2003). A third concept of liberty. In B. Academy (Ed.), *Proceedings of the British Academy, Volume 117: 2001 Lectures* (pp. 237–268). Oxford University Press. DOI: https://doi.org/10.5871/bacad/9780197262795.003.0007

Slaughter, S., & **Leslie, L. L.** (1997). *Academic capitalism: Politics, policies, and the entrepreneurial university*. Johns Hopkins University Press.

Slaughter, S., & **Leslie, L. L.** (2001). Expanding and elaborating the concept of academic capitalism. *Organization*, *8*(2), 154–161. DOI: https://doi.org/10.1177/1350508401082003

Splitt, F. G. (2003). The challenge to change: On realizing the new paradigm for engineering education. *Journal of Engineering Education*, *92*(2), 181–187. DOI: https://doi.org/10.1002/j.2168-9830.2003.tb00756.x

Stout, R. J., Cannon-Bowers, J. A., Salas, E., & **Milanovich, D. M.** (2016). Planning, shared mental models, and coordinated performance: An empirical link is established. *Human Factors*, *41*(1), 61–71. DOI: https://doi.org/10.1518/001872099779577273

Taylor, J. (2001). The impact of performance indicators on the work of university academics: Evidence from Australian universities. *Higher Education Quarterly*, *55*(1), 42–61. https://doi.org/10.1111/1468-2273.00173

Teixeira, P., & **Dill, D. D.** (2011). Introduction—The many faces of marketization in higher education. In P. Teixeira & D. D. Dill (Eds.), *Public Vices, Private Virtues? – Assessing the effects of marketization in higher education* (pp. 3–17). Sense Publishers. DOI: https://doi.org/10.1007/978-94-6091-466-9_1

Veblen, T. (1965). *The engineers and the price system*. A.M. Kelley.

Vest, C. M. (1995). U.S. engineering education in transition. *The Bridge*, *25*(4), 4–9.

Washburn, J. (2005). *University, Inc: The corporate corruption of American higher education*. Basic Books.

Watson, K. (2009). Change in engineering education: Where does research fit? *Journal of Engineering Education*, *98*(1), 3–4. DOI: https://doi.org/10.1002/j.2168-9830.2009.tb01000.x

Wegener, B. (1992). Concepts and measurement of prestige. *Annual Review of Sociology*, *18*(1), 253–280. DOI: https://doi.org/10.1146/annurev.so.18.080192.001345

Weingast, B. R., & **Wittman, D. A.** (Eds.). (2006). *The Oxford handbook of political economy*. Oxford University Press.

Wickenden, W. E. (1930). A comparative study of engineering education in the United States and in Europe. In *Report of the investigation of engineering education 1923–1929* (Vol. 1). Society for the Promotion of Engineering Education, Lancaster Press.

Williams, G. (2016). Higher education: Public good or private commodity? *London Review of Education*, *14*(1), 131–142. DOI: https://doi.org/10.18546/LRE.14.1.12

Zussman, R. (1985). *Mechanics of the middle class: Work and politics among American engineers*. University of California Press. DOI: https://doi.org/10.1525/9780520314825

TO CITE THIS ARTICLE:
Katz, A., & Main, J. (2022). Applying Concepts from Political Science and Economics to Advance the Study of Engineering Education. *Studies in Engineering Education*, 3(1), pp. 28–52.

Submitted: 31 March 2021
Accepted: 29 April 2022
Published: 09 June 2022

Studies in Engineering Education is a peer-reviewed open access journal published by VT Publishing.

VIRGINIA TECH. PUBLISHING