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Social Impact in Product Design, An Exploration of Current Industry Practices

Though academic research for identifying and considering the social impact of products is emerging, additional insights can be gained from engineers who design products every day. This paper explores current practices in industries used by design engineers to consider the social impact of products. Forty-six individuals from 34 different companies were interviewed to discover what disconnects exist between academia and industry when considering a product's social impact. These interviews were also used to discover how social impact might be considered in a design setting moving forward. This is not a study to find "the state of the art," but considers the average engineering professional's work to design products in various industries. Social impact assessments (SIA) and social life cycle assessments (SLCA) are two of the most common processes discussed in the literature to evaluate social impact, both generally and in products. Interestingly, these processes did not arise in any discussion in interviews, despite respondents affirming that they do consider social impact in the product design. Processes used to predict social impact, rather than simply evaluate, were discussed by the respondents. These tended to be developed within the company and often related to industry imposed government regulations. To build on this study, the findings herein should be further validated for executives, managers, and engineers. A study specific to these roles should be designed to understand the disconnect better. Additionally, processes should be developed to assist engineers in considering the social impact of their products. Work should also be done to help educate engineers and their leaders on the value of considering the social impact in product design. [DOI: 10.1115/1.4045448]

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1 Introduction

Literature and historic research show a long tradition of analyzing the economic and environmental impacts of designed products; yet, there is a lack of data and resources related to social sustainability—a pattern within the engineering field that will need to change to address new and evolving challenges facing society [1]. Engineers stand in a position to pioneer best practices in accounting for a holistic view of sustainability, where "Sustainability Engineering is poised to propel the industry into a future that combines permanence, profitability, as well as livability" [2]. As engineers design with all aspects of sustainability in mind, they are likely to create effective and desirable products while also influencing the world's economic standing, environmental state, and social well-being. While the former two are well researched in the realm of engineering design, social well-being is yet to be as thoroughly discussed in the academic literature [3]. The value of these methods to engineers, however, is to more fully inform their design decisions [4]. Though designing engineered products and systems from a social well-being perspective is an emerging topic in the *literature*, this paper seeks to understand to what extent designing for social impact is found in *common industry*. The goal is to understand how those who design products consider the social impacts of those products. Included within this objective is to uncover the measurements and tools used to enable social impact design. The goal is not to review the state of the art in social impact design but to simply understand the degree to which common engineers currently consider the social implications of their designs. In this paper, the terms engineer and designer will mean those who have a significant role in defining and designing a product, structure, or industrial process.

1.1 Overview of Sustainability. As defined by the 1987 Brundtland report, a sustainable development is "to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" [5]. In many cases, this has been broken into the three pillars of sustainability: economic, environmental, and social impacts [6,7]. By empirically researching how engineers and designers consider sustainability, the benefits can be increased as a better understanding of social impact within a sustainable design is defined.

1.2 Assessing the Social Impact of Products. Social impact refers to the effect that an engineered product has "on the day-to-day quality of life of persons" [8]. Specifically, the research of this project centralizes on the social impacts identifiable at the product use level. Beyond the scope of this study is the social impact an organization produces throughout the supply chain of a given product or the programs instituted for community outreach.

This understanding of social impact establishes the purpose of this study, which is to determine the current standing of social impact design and assessment within the engineering and product design sector. To address this subject, work was conducted by an interdisciplinary team of researchers from the Mechanical Engineering and Social Science disciplines to provide initial findings on the current practices of engineers in product design for social impact. This was done through the use of interviews with industry professionals. While social sustainability research may be lagging behind economic and environmental sustainability, current practices within the engineering field may prove that social sustainability is being increasingly accounted for.

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2 Literature Review

Recent work by the authors seeks to develop a holistic picture of what the current state of social impact is for product design. A three-tier approach has been implemented to gain a wide breadth of understanding on this topic. These tiers include a review of (1) the literature [9], (2) products in use [10], and now (3) industry practices. Each of these viewpoints combined together provides insight beyond what a single approach alone would give. Understanding current industry practices is particularly interesting because there are likely differences between what is published by academics and what practicing engineers actually do [11]. To this end, the current paper is one step toward understanding the gap between academic literature and industry practice on the topic of social impact modeling in product design. In addition, this paper seeks to provide a baseline understanding for what is most common among practicing engineers in regards to considering the social impact of their products.

2.1 Engineering Design and Social Impact in Academia. The literature provides processes and methods for engineers and other stakeholders to use when *evaluating* the social impact of their products [12,13]. One of these tools includes methods such as social impact assessments (SIA). Specifically, efforts have been made to evaluate the social impacts of the large-scale public projects and services, such as transportation systems [14]. Esteves et al. give an insightful overview of SIA in their work as it is applied in general and not specifically for engineered products [15]. Social life-cycle assessments (SLCA) is another method found in the literature. Work by Jorgensen et al. and the SETAC life cycle initiative have provided overviews of how to perform SLCA [16,17], while Siebert et al. and Gmelin and Seuring have shown how it can be applied to products specifically [18,19]. Besides concerns regarding the usability of both SIA and SLCA [20], in many cases, SLCA is considered for the supply chain of products, and little focus is given to products in use and the impacts on those users [21,22]. While work to define social impacts in the supply chain are equally important, they are outside the scope of this paper.

Additional concerns have risen that social sustainability is not given as high of a priority as economic and environmental sustainability [23], as well as other concerns that most measurements are not comparable across products. Work has been done toward developing metrics that may show quantifiable insights regardless of the product type or industry [24]. Others have become concerned with tools relying too heavily on biases and that systematic errors may be influencing the accuracy of these methods [25]. Some methods show promise but may be limited in scope to just the manufacturing and supply chain of products [26].

Less discussed in the literature are methods for *predicting* social impact in early design stages [27]. This is of particular importance because the decisions made in the product design stage are said to influence 80% of sustainability impacts [28]. The processes that do exist focus on full sustainability, which includes not only social impacts, but economic and environmental as well [29,30]. Even these contributions acknowledge the need to improve design tools for social impact prediction.

While most methods seek to characterize the impact a product has had from gathering historical data of the product in use, there are very few tools available to assist in predicting impacts and informing engineers/stakeholders before production. The literature in this area may not be as developed as other disciplines in engineering, but some resources are available to practicing engineers if they desire it, as shown in the works cited above.

There are methods, such as ethnography, that try to understand the target population prior to the product design [31]. Additionally, Chen et al. developed a tool to more effectively consider multicultural factors in the new product development [32]. These methods are well developed, but there is no consideration to how widely they are adopted in the industry.

A foundational study of this paper is provided by Rainock et al. [9]. Rainock et al. established 11 social impact categories specifically for products. These categories were developed through a literature survey that aggregated social impact assessment studies, empirical studies, and other studies that provide similar lists. This paper utilizes these 11 categories as a basis for the broad spectrum of potential social impacts a product may have on a person or community. These social impacts include population change, family, gender, education, stratification, paid work, health and & safety, human rights, social networks and communication, conflict and crime, and cultural heritage and identity [9].

2.2 Social Impact in Industry. Only a few have published details regarding the penetration of these social impact processes into the industry. Garay and Font show that social responsibility is becoming more important in today's business environment, but many say budget constraints appear to prevent them from participating fully [33]. Jørgensen et al. looked at the feasibility of SLCA from a company's perspective showing that companies lacked a "resource-efficient" process that could look solely at the use stage of their products [34]. Short et al. found that companies in Europe show great interest in designing for sustainability, but lack the knowledge of how to best implement it [35]. Many methods discuss industry methods to sustainability, but focus only on tools to consider environmental impacts. Kalish et al. sought to understand the state of methods considering full sustainability (including social) in industry; they acknowledge a focus in their work on environmental sustainability because the industry is directing most of its efforts there [36].

2.3 Observations From the Literature Review. While significant efforts appear in the literature for considering the social impact in general, there appear to be limited tools for applying it to product development and design. Additionally, most tools seek to only evaluate an impact that has already occurred instead of trying to predict the social impacts that may result from a potential design. The area of prediction is especially important to product engineers who have many design decisions to make before moving toward prototyping or launch. In this paper, we seek to understand what tools, if any, exist and are in use by industry professionals to either evaluate or predict the social impacts of their products. We do this through the use of in-depth interviews with current engineers working in the industry. We have limited our scope to the product use stage and have excluded from our discussions with participants, the impacts their products have during manufacturing or end of life. Section 3 outlines the method used for engaging in these interviews while Sec. 4 reports on the results.

3 Methodology

Aligning with the goal to gain a deeper empirical understanding of the role social impact takes within the sphere of product design, empirical studies were conducted that utilized social science research methods to collect and analyze data on products created within the engineering sector.

3.1 Research Design. This empirical study centers on interviews conducted with 46 professionals who design products in various industries within the United States. The following process was followed to build the research strategy:

(1) Develop initial research topics
(2) Identify and contact industry professionals/companies for interviews
(3) Conduct interviews
(4) Transcribe and code interviews
(5) Analyze codes and identify common themes

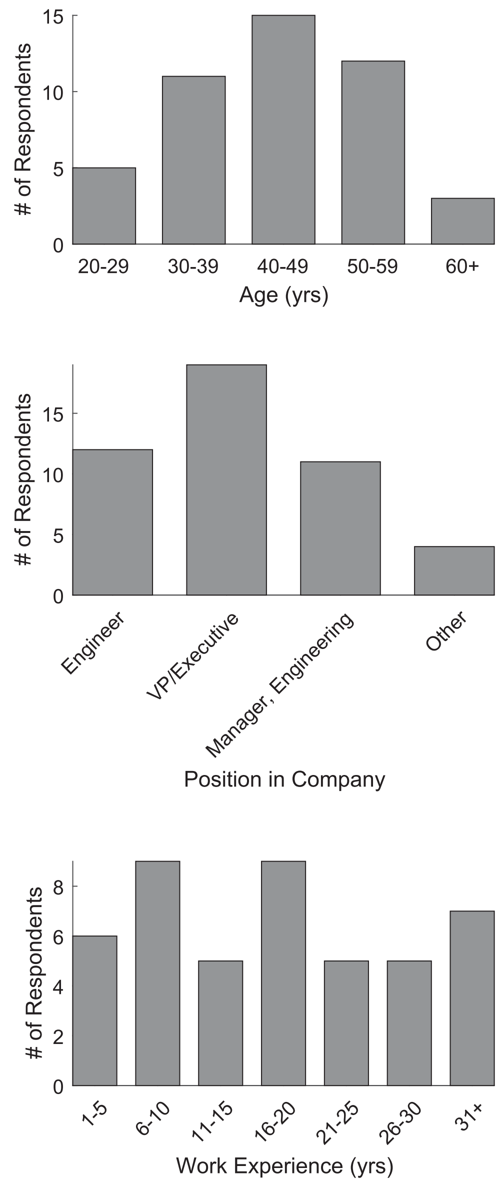

Fig. 1 Demographics of individual respondents

The initial discussion topics of the interviews constituted the extent to which engineers and product designers considered social impacts in the design process, which social impacts they considered, and whether they have procedures in places for measuring, predicting, and evaluating those social impacts among end-users. Prior to the interviews, the following research topics were constructed:

(1) Discover if companies have processes in place to consider the social impacts of the engineered products they design.
(2) Evaluate whether engineers consider social impacts other than those that have a direct negative health and safety impact.
(3) Discuss the tools that engineers have to measure the social impact of their designs.
(4) Of the tools available, understand if they are applicable across industries or only useful for measuring specific social impact types.

The use of in-depth interviews was employed as the preferred research method for exploring these topics [37]. As is common within qualitative research, the use of typical case sampling was employed when creating the sampling frame of the study [38]. While using typical case sampling, the emphasis was given on treating each interview as a unique case that informs the ultimate research topics [39]. Direct effort was given to find cases that represented various sectors, company sizes, and industries among the organizations contacted and selected for an interview.

A variety of organizations fall within the product engineering and design sector, of which this paper is interested in. To represent this variety, special attention was given to identifying specific organizations from a wide variety of industries. Included among the companies contacted were organizations that develop products related to the following industries: agriculture, construction, consumer products, defense, industrial, infrastructure, manufacturing, medical, mining, software, transportation, and water. One individual working as a consultant to product development industries was also interviewed. The only criterion that was common among all participants is that they were currently, or had in the past, worked as a full-time engineer or designer to define a product, process, or structure. Thirty-seven of the participants were educated in an engineering field while 29 of those were specific to mechanical engineering. Other fields include industrial design, architecture, chemistry, biology, business management, and information systems. Potential participants were first contacted (generally via e-mail) and asked if they would be willing to give a 20–30 min interview about the types of product design tools they and their company use in product development. The social impact focus of this study was not mentioned until after participants accepted the invitation. This was done to avoid bias toward those most involved in social impact design or participant rejection based on a perceived lack of expertise in the field of social impact. Any knowledge or experience on the subject of social impact design prior to the interview would have been by chance. The only requirement was that of prior product design experience in general.

A conscious effort to provide a national perspective was maintained, although 19 of the 34 companies identified for interviews were located in Utah due to proximity to the researchers. An additional seven companies were located in California and four in Michigan. Other states include Illinois, Indiana, Massachusetts, and New York. When in-person interviews were not feasible, phone interviews were conducted instead.

Forty-six interviews were conducted over the course of 18 months and were then analyzed according to the proposed methodology. Figure 1 shows demographics for individual respondents while Fig. 2 shows information for their companies. This sample of 46 individuals represents a diverse set of professionals/industries and is adequate to begin exploring the research topics.

Though random sampling was not employed within the context of this study, the practices of generalization are not beyond the scope of the project. Just as is best practice within qualitative research, findings can lead to logical rather than statistical generalization [40]. It is assumed that the cases and individuals presented within this study are typical of engineers and designers throughout the sector and their shared experiences are valuable contributions to the ongoing conversation centered on the role social impact assessment plays within the field of product design.

3.2 Procedure. Each interview, whether conducted locally or remotely, was directed by the use of a set interview guide. Emphasized in the interview guide were subtopics that addressed each research topic specifically. The two conductors of the interviews were encouraged to use the interview guide not as a rigid lineup of questions, but rather as a tool to direct the conversation. Though the order of subtopics and connected questions were left to be decided upon by the interviewer, stress was given to address each point at some point throughout the interview to maintain consistency across the interviews. Interviews were audio recorded and lasted 30 min on average, with some being as short as 20 min and others lasting over an hour.

Before questions regarding social impact were asked, the interviewer would give a brief prompt to help explain what social impact is and the scope that this study would be considering. Interview questions were formatted in such a way as to include

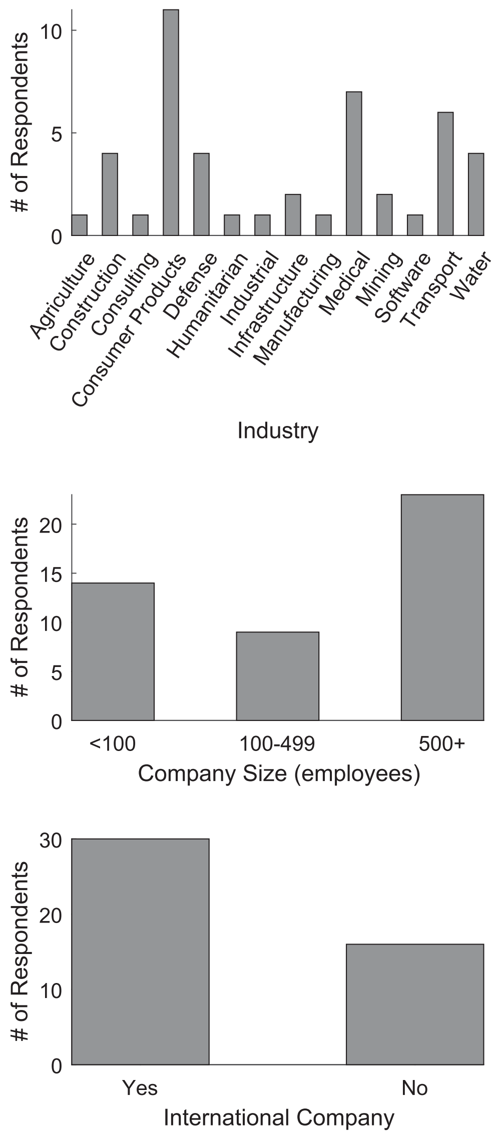

Fig. 2 Demographics of representative companies

open-ended questions about how individual engineers and the organizations they have worked for navigating considering, designing for, and assessing social impact. In particular, open-ended questions were presented that required the interviewee to consider if their product influenced such social impact categories as described by Rainock et al. [9]. Respondents had access to a handout with the list of 11 product social impacts developed by Rainock et al. to reference as they responded to each question.

Once the interviews were conducted, transcriptions of the interviews were completed by both interviewers as well as through a third-party transcription service. After the transcription was finalized for an interview, the two interviewers began the coding process [41].

Initial coding of each interview followed an open coding method. Here, various themes began to surface in relation to the research topics. The researchers allowed findings to emerge from the coding process itself rather than code strictly to prior-identified themes. Allowing emergence while coding left the process open to unexpected findings and themes. Once repeated themes were initially identified from the open coding process, the researchers began employing an axial coding method to better define the emerging themes [42]. In all, just under 10,000 unique coded segments were analyzed.

The final method used during this step of the procedure was selective coding [43]. To avoid bias, two researchers coded each interview looking for separate sets of codes. Throughout each interview, the main distinguishable themes apparent from the previous two coding steps allowed the researchers to focus on concepts and findings tailored to the research [44]. In connection with the selective coding process, specific effort was directed toward identifying strong examples for select themes that effectively represented the findings of the research.

4 Results and Discussion

The following sections are segmented by each research topic with an accompanying section for the results related to that topic. Immediately following the results is a brief discussion for each research topic regarding the findings with observations from the interviews.

4.1 Research Topic 1: Discover If Companies Have Processes in Place to Consider the Social Impacts of the Engineered Products They Design

4.1.1 Results. This research topic considers if companies have processes in place to consider the social impacts of the engineered products they design. When directly asked if they consider the social impacts their products, 95.6% of the interview respondents answered affirmatively. It turns out the majority of companies interviewed do have some processes in place to consider the social impact of their products.

4.1.2 Discussion. The supporting statistic for this topic is overwhelming evidence showing that engineers do have some processes to consider the social impact of their products. The nature of this topic required a binary response of if the company does or does not have at least one process to consider social impact. That is to say, 95.6% of the respondents consider social impact at least to some extent, while it will be shown in further discussions that simply the existence of a process rarely equates to a rigorous consideration of social impact.

A further discussion of the types of processes used by these companies is found later in this section.

4.2 Research Topic 2: Evaluate Whether Engineers Consider Social Impacts Other Than Those That Have a Direct Negative Health and Safety impact

4.2.1 Results. This second research topic allows a deeper analysis of the interviews and shows to what extent the full breadth of social impact is being considered. Recall that when asked what impacts they considered, respondents had access to the 11 social impact categories provided by Rainock et al. [9]. When asked what impacts they considered, respondents would offer several different categories from the list of options provided. Every respondent identified at least two separate impact categories while most respondents identified more. Despite bringing up many different types of impacts, however, the general focus of their conversation remained on health and safety.

Figure 3 depicts, by word count, the amount each impact category was discussed as a percentage of all impact category discussions. This figure reveals that 35.6% of social impact category conversations were focused on health and safety, with the next most discussed topic being employment at 11.6%. This means that respondents are almost three times more likely to talk about the health and safety impacts of their products over any other impact the product may have. Alternatively, the least discussed impact category is population change (technologies that assist or cause migration in/out of a geographic location) at 2.4%.

When the data behind Fig. 3 is explored more deeply, a disconnect begins to appear between front-line engineers, engineering managers, and executives. The data as shown in Fig. 4 shows that executives spent more of their conversations discussing other impacts instead of focusing so heavily on health and safety. The standard deviation of the impact category percentages when filtered for just the responses

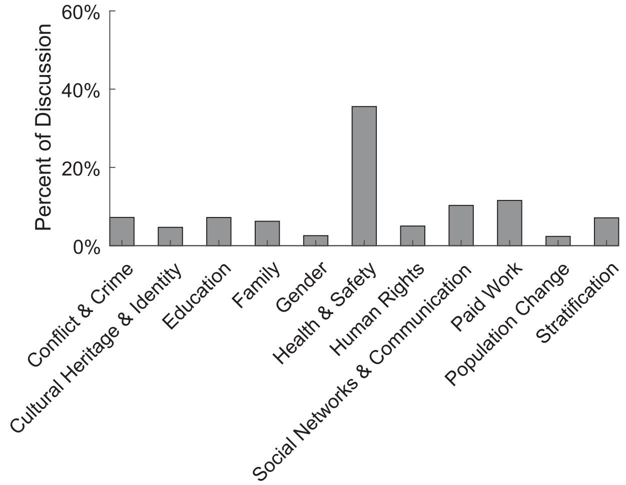

Fig. 3 Percent of discussion (by word count) for social impact considerations in each category

of executives(Fig. 4(*a*)) is only 4.5%. Conversely, the engineer appears to more heavily emphasize health and safety considerations. The standard deviation of the impact category percentages relating to the engineers (Fig. 4(*c*)) is 13.3%. The response for managers appears to be a mix of both engineers and executives, not as irregular as the engineers, but also not as consistent as the executives. The standard deviation for the manager's impact category percentages (Fig. 4(*b*)) is 10.1%. Figure 5 plots the standard deviation of the data for each position mentioned above.

4.2.2 Discussion. An under-emphasis on impacts outside of health and safety could be occurring either because these impacts are more easily recognizable than any other, or the engineering tools to consider it are well developed and generally accepted. Respondents agreed that impacts regarding health and safety are regulated by governments and industry standards more heavily than any other category, which may have an impact on a company's responsibility to consider it. Additionally, the role of a professional engineer is often to ensure designs for products, systems, and structures are safe, which may cause other impacts to be under emphasized.

Regardless of why responses focused on health and safety, nearly all products have far more impacts than this. For example, the impact of home appliances on gender stereotypes and family relationships is well documented [9]. It is true that home appliances such as electric irons, gas-powered ovens, and washing machines can have serious safety implications if carelessly designed, but tools and discussions to help consider impacts on gender stereotypes and family relationships may have helped discover alternative designs as well. Additional processes need to be developed to bring more balance to the under-served categories, such as population change, gender, or cultural heritage and & identity. Developing new processes focused on these categories may help engineers understand the full scope of possible impacts their product may have.

Of the executives interviewed, they tend to have a more holistic view of what impacts are important to their company with a standard deviation of almost one-third of the size of the engineer's data. The disconnect between upper-level management and their engineers is evident in the data. The hierarchical structure that is commonplace in many well-established companies may be diluting the vision and goals by the time it reaches the engineers. This is true for our data; however, with a low sample size being represented it is difficult to generalize this to the larger population. Removing the health and safety category from the engineer's data reveals how emphasized it is as the standard deviation for engineers drops to 2.8% in this scenario. Standard deviations for all three segments without health and safety data can be found in Fig. 6.

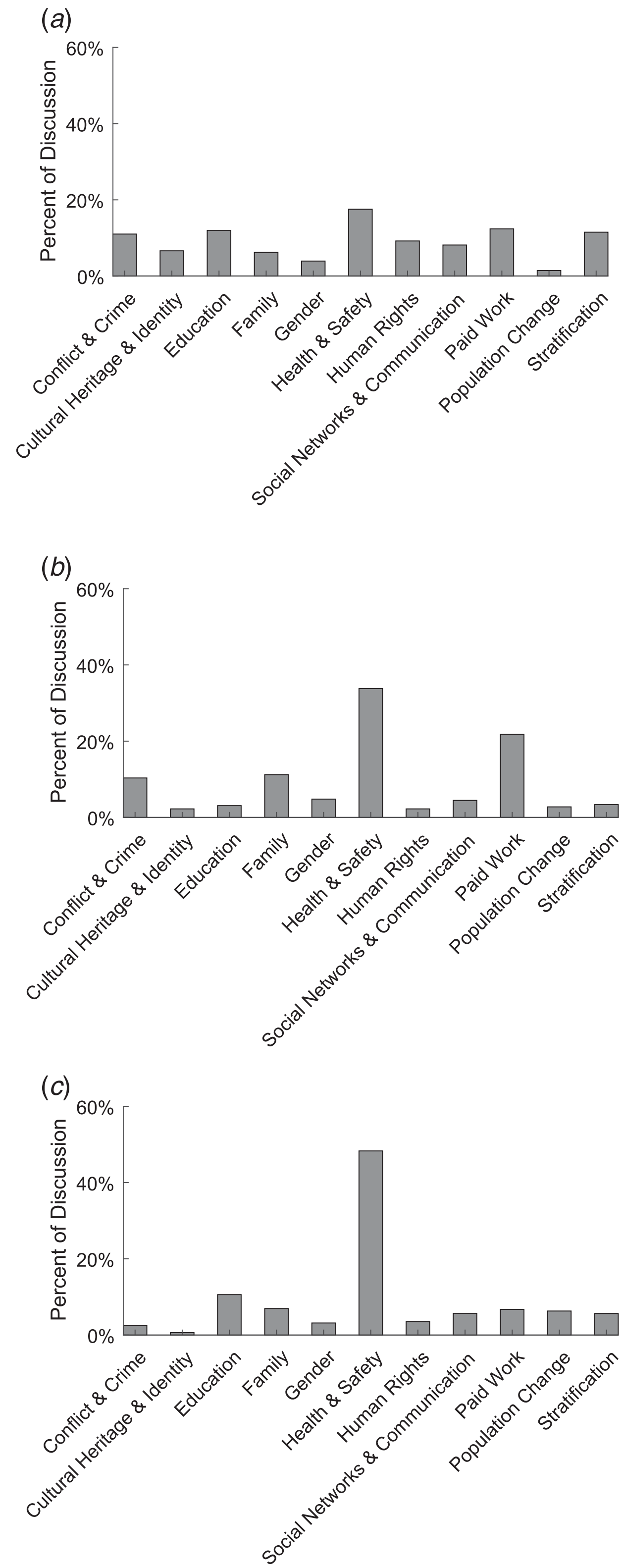

Fig. 4 Percent of social impact considerations segmented by job title: (*a*) executives, (*b*) managers, and (*c*) engineers

4.3 Research Topic 3: Discuss the Tools That Engineers Have to Measure the Social Impact of Their Designs

4.3.1 Results. All the processes discussed in the interviews were categorized as either "measurable" or "non-measurable." If the process had a clear quantifiable value as an output then it was

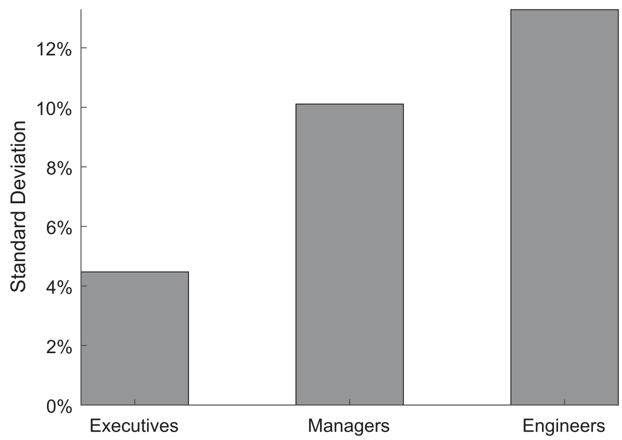

Fig. 5 Standard deviation of percent of discussion (for social impact categories). Data are separated by what position the respondent holds in their company.

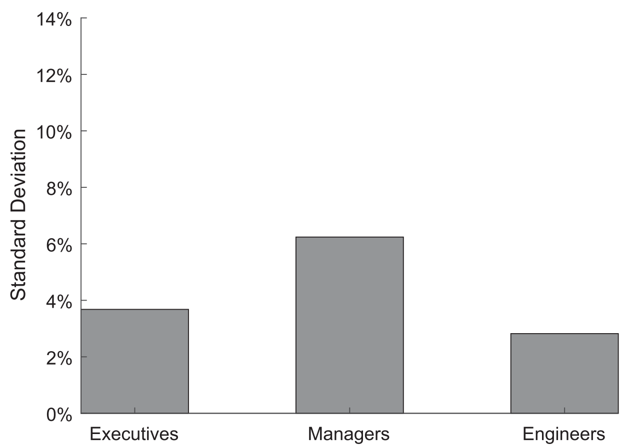

Fig. 6 Standard deviation of percent of discussion (for social impact categories) with the health and safety data removed. Data are separated by what position the respondent holds in their company.

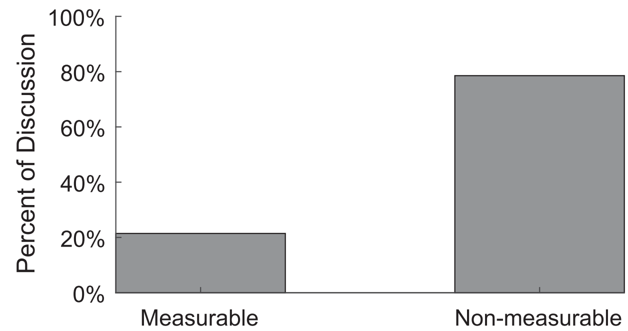

Fig. 7 Proportion of all processes discussed by respondents that are measurable or non-measurable

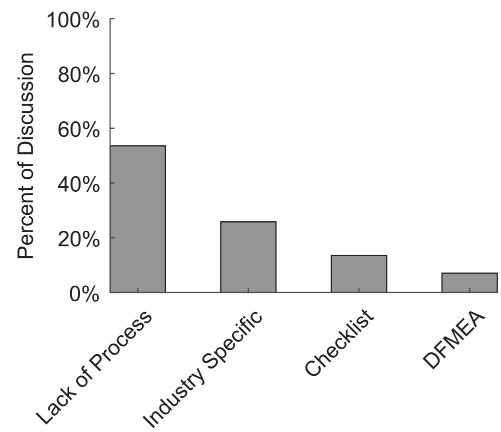

Fig. 8 Proportion of conversation time spent on social impact processes

considered measurable. Figure 7 shows the proportion of measurable to non-measurable processes discussed by the respondents.

Nearly 80% of the discussion on processes were regarding unquantifiable processes. Most common among those that were measurable were checklists and design failure modes and effects analysis (DFMEA), which is a common tool to consider the safety of a given product [45].

4.3.2 Discussion. This furthers the dialog that engineers have insufficient means to understand and predict the impacts of their products. In most cases, the non-measurable processes required a large amount of intuition to determine if the breadth and depth of the impact consideration was sufficient.

4.4 Research Topic 4: Of the Tools Available, Understand If They Are Applicable Across Industries Or Only Useful for Measuring Specific Social Impact types

4.4.1 Results. While many respondents showed great enthusiasm for the types of social impact they consider, the data uncovers a surprising lack of coverage with their processes. Figure 8 shows that the majority of conversations about what specific processes were used resulted in a discussion regarding a lack of processes. "Lack of Process" accounted for 53.6% of the discussion with industry-specific processes taking 25.8%. "Industry-Specific" processes are ones that are considered too specialized to be useful outside of that industry. Checklists and DFMEA may be industry agnostic, but they combine for only 20.7% of the processes discussed. Most checklists were developed within the company to ensure compliance with government regulations.

4.4.2 Discussion. The results from Fig. 8 inform research topic 4 as the majority of processes discussed are only usable in the respondent's specific industry. Additionally, while checklists and DFMEA are also used, only DFMEA arrives at a quantifiable value potentially useful in cross-product/industry comparison. Even some of the most common social impact processes found in the literature (SIA, SLCA) are not found among the list practices currently applied by engineers to products in the industry.

This is a major problem for those desiring to quantify social impacts. To relate this to other pillars of sustainability, there are no measurements for social issues similar to dollars for economic issues or CO_2 emissions in environmental impacts. Whether or not a measure such as this is desirable or useful for social impact is beyond the scope of the current paper. The lack of a widely accepted measurement causes difficulty in comparing the true impact of a product both positively and negatively on a person's day-to-day quality of life.

The difference between predictive and evaluative processes was an important distinction for the interviews. Predictive processes were generally specific to an industry and had little value in comparison across different industries or even across different products within an industry. The exception to this was DFMEA, which has been used extensively in design activities for years.

Worth noting, are other processes used by companies that are less common. The Social Economic Environmental Design (SEED) process used by architects is an impressive and comprehensive view of sustainability. This process, however, is currently tailored only for the design of buildings. Other processes tended to include experiments that the designers would conduct post-product release to quantify the impact. Every instance of these experiments brought forth in the interviews were to understand a health or safety impact of some kind. With the exception of SEED, no processes were given that measured an impact outside of health and safety. Whenever other impact categories were considered it was through intuition-based design.

4.5 Additional Results: General Themes. Stepping away from the quantifiable results, there is also a benefit to sharing anecdotal themes that emerged from the interviews. While each individual had differing perspectives regarding how designing for social impact should be carried out, nearly all respondents showed interest and excitement about the possibility of being able to do so better. The following four themes were found consistently throughout the interviews:

(1) Despite varying levels of consideration, the fact that nearly all respondents are concerned about the social impacts of their products is very promising for the field of sustainable design. The field will most likely only become more centralized as corporations, stakeholders, and consumers begin to demand socially responsible practices.
(2) Individuals wish to do more in regards to designing for social impact, but are constrained by the need to win financially in the market place. Designers continually expressed a desire to design for social impact more, but said it simply was not feasible to expend the time and resources to do it properly. To their credit, each company typically had two or three main social impact categories in which they were aware of and at least discussed in design meetings. Where the lack of ability came was in being able to diagnose more obscure impacts and their products' ability to affect those.
(3) A corporate culture that prioritizes social impact considerations must come from the top leadership and then filter down. A direct quote from one of the interviews stated "it can also take ⋯ a uniquely insightful and courageous leader to put a priority on something that increases cost, reduces the potential appeal of the product, [and] constrains the market around it." In many cases, the social mission is a part of the company mission, which allows extra cost to be given to maintain the brand's image.
(4) Professionals realize that consumers are increasingly demanding socially responsible products, which extends to the companies that sell them. Most interviewees brought this point up anecdotally. It was not clear if their direct consumers fell into this category, but the rise of benefit corporations and other movements appear to support this. The most common situation where this is true is for companies selling directly to consumers. For those that did work in a consumer-facing industry, respondents would often discuss social impacts from a marketing perspective, both in marketing message and other marketing research efforts the company had.
(5) Companies who mainly operate in a business-to-business landscape find it harder to have the freedom to consider the social impact of their products. This builds on item 4 as companies who designed products that were a part of a larger system or used in another corporate or industrial setting, had even more difficulty justifying the costs associated with designing for social impact. Generally, they were constrained with simply meeting the contract for the lowest cost. Again, most individuals expressed a desire to consider it more, but stated simply that the decision had to be left up to the client.

These themes point out the need for processes and tools that simplify and expedite the process of designing for the social impact elements of sustainability. The common constraint of cost and time is the reality that most companies operate in. To a company that does not specialize in social impact nor employs a social scientist to work with the product development team, an undertaking to characterize and predict the impact of their products would be daunting indeed. However, much can be done to communicate the value, facilitate the process, and improve the methods for designing for social impact so that any engineer can feel competent in doing so.

5 Conclusion

Current social and political trends may be causing more individuals to care about the social impacts of products, services, and regulations. Despite this, engineers appear to lack the necessary tools to consider the breadth and depth of possible impacts relating to their products. This is true in two ways: (1) design engineers do not equally consider the wide spectrum of impacts that their product could potentially have and (2) the tools necessary to quantify the level of impact a product has are either non-existent or severely underdeveloped across industries.

From these interviews, it appears that intuition is the basis for most social impact related decisions. This may explain why engineering projects for the developing world often have difficulty. The engineers may be relying on intuition for a context they have little, if any, experience with. However, there are many high impact investors/philanthropists that depend on rigorous metrics for the humanitarian work they are involved in. Potential future work should include working with these organizations to bring some of the metrics and processes to other industries. Progress can be accelerated as proper tools and measurements are developed and made available to engineers in the industry and not just in academia.

While it may be true that sophisticated processes exist to help engineers consider the breadth and depth of their product's social impacts, we can be skeptical about how widely adopted these processes are among practicing engineers. Even if there are a handful of companies out there with these processes in place, these interviews indicate that the majority of organizations likely have a desire to consider social impact more fully, but lack the necessary tools and resources to do so in a rigorous manner.

Processes designed for assisting engineers in considering social impact should be made more readily available to engineers in industry. If they are available and engineers choose not to adopt, then the current process should be altered to be more efficient and easy to use. Additional work can be done to help educate engineers and their leaders of the value in considering social impact during product design.

As more practical and applicable tools are developed to consider the social impact of products, designers will have the ability to design for these impacts as easily as they design for economic and environmental impacts now. The resources currently required to understand a product's social impact is a major inhibitor preventing engineers from evaluating and predicting it to the extent that they currently consider economic and environmental impacts. Additionally, the current state of the industry shows some singularity in its thinking about social impact among engineers, while their supervisors have a broader view of what social impact is. By neglecting the full spectrum of potential product social impacts, we are missing out on potential opportunities to improve the lives of individuals and communities more effectively. With new tools in hand, engineers can take a step forward in designing not only economically profitable and environmentally responsible, but also for the social well-being of people and communities throughout the world.

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