

Translating Critical Design: Agonism in Engineering Education

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Arts and design have always been entangled with the political world. In the most banal sense, systems of patronage from the political elite have served as major drivers for economic and popular success of artists, poets, and designers since before the founding of the Roman Empire; in return, the produced craftwork served to heighten the prestige, power, and political-ideological frameworks of the patrons.¹ However, design in the twentieth century exhibited an explicit engagement with politics derived from the ideological frames of designers themselves, including the various leftist and internationalist orientations of the Bauhaus school²; the efforts of postwar West German designers to distance German everyday life from the wounds of Nazism³; and Lance Wyman's explorations of the tension between Mexico City's modernist aspirations and its postcolonial present in the design of the 1968 Olympic logo.⁴ Importantly, the goal of the designers behind these schools, movements, and products was not to manifest politics through advocacy for certain politicians, policies, or slogans; in other words, they were not a series of campaign buttons or "Make America Great Again" hats. Instead, these design practices acted to reframe the ways in which users of artifacts understand the competing interests, ideologies, and worldviews that underpin the designed and built world.

Borrowing from political theorist Chantal Mouffe, Carl DiSalvo demarcates these different politically charged design strategies as "design for politics" and "political design."⁵ According to Mouffe, "politics" refers to the everyday discourses, actions, and procedures that serve to administer and govern social systems.⁶ Meanwhile, the "political" represents a deeper dynamic present in all human societies: the struggle or competition among multiple, overlapping, yet incommensurable worldviews that lead to unresolvable ideological conflict and debate. Mouffe labels these unresolvable ideological struggles, which constitute "a forever looping contestation" among diverse persons and groups in any social system, as "agonistic."⁷

- 1 Francis William Kent, Patricia Simons, and John Christopher Eade, *Patronage, Art, and Society in Renaissance Italy* (Austria: Humanities Research Center Austria, 2006).
- 2 Hans M. Wingler, *The Bauhaus: Weimar, Dessau, Berlin, Chicago* (Cambridge, MA: MIT Press, 1969).
- 3 Paul Betts, *The Authority of Everyday Objects: A Cultural History of West German Industrial Design* (Berkeley, CA: University of California Press, 2004).
- 4 How much of this exploration was intentional or post-hoc is still debated. See e.g., Emmet Byrne, "Radiant Discord: Lance Wyman on the '68 Olympic Design and the Tlatelolco Massacre," *The Gradient* (2014), <http://blogs.walkerart.org/design/2014/03/20/lance-wyman-mexico-68-olympics-tlatelolco-massacre> (accessed May 7, 2017).
- 5 Carl DiSalvo, *Adversarial Design* (Cambridge, MA: MIT Press, 2012), 8–9.
- 6 Chantal Mouffe, *The Return of the Political* (London: Verso Books, 2003).
- 7 Mouffe, *Return*, quoted in DiSalvo, *Adversarial*, 5.

DiSalvo thus categorizes designed artifacts aimed at creating specific institutional or administrative action, like the “Make America Great Again” hat, as “design for politics.”⁸ Conversely, design practices that serve to act adversarially by revealing and complicating the diverse ideological frameworks that underpin agonistic politics are categorized as “political design.”⁹ The Bauhaus school, postwar West German design framework, and 1968 Olympics logo, then, at differing scales, were some of the paradigmatic agonistic political design practices of the twentieth century.

Resulting in part from the influence of DiSalvo, Anthony Dunne, and Fiona Raby,¹⁰ some of the more popular twenty-first century instantiations of political design in the creative design disciplines are associated with speculative and critical design (SCD). SCD practices, more commonly found in academic and gallery design spaces than in the marketplace, are theoretically driven design strategies that place the symbolic and semiotic properties of designed objects above their “functional” properties.¹¹ SCD methodologies encourage design practitioners to experiment with “design for debate”—with the use of designed products and spaces to spur conversations among users and audiences.¹² Ideally, these conversations question the social and epistemological—and therefore political—*status quo*.

As this paper traces, SCD tries to act as political design by creating affective and epistemological tension in its audiences—particularly by focusing on pointed topics, such as global warming, labor rights, and gender inequality. However, SCD’s prominent role in academic and gallery spaces places it in a particularly unique institutional and pedagogical double-bind with regard to its ability to effect political change. On the one hand, SCD’s prevalence in the academy affords it the ability to push for the transformation of design education toward a more politically oriented, “deskilled,” pedagogical model with the potential to infuse political design into the professional world.¹³ On the other hand, the results of SCD, which often appear in gallery spaces aimed at art and design audiences, do not easily afford application into non-academic design practices and, because of their limited target audience, might in fact not do much political work at all outside of academic spaces.¹⁴ Even within the academy, the style of SCD’s provocations can serve to alienate potential disciplinary allies in the SCD political project, such as colleagues in engineering, computer science, and other science/technology/engineering/math (STEM) spaces—spaces that have much to gain from SCD. Thus, although SCD produces provocative artifacts

8 DiSalvo, *Adversarial*, 9.

9 Ibid.

10 For Dunne and Raby’s influences in design and art, see, e.g., Anthony Dunne, *Hertzian Tales: Electronic Products, Aesthetic Experience, and Critical Design* (Cambridge, MA: MIT Press, 2006); and Anthony Dunne and Fiona Raby, *Speculative Everything: Design, Fiction, and Social Dreaming* (Cambridge, MA: MIT Press, 2013). “Speculative and Critical Design” as a term was coined by Luiza Prado and Pedro Oliveira, “Questioning the ‘Critical’ in Speculative and Critical Design,” *Medium*, February 4, 2014, <https://medium.com/a-parede/questioning-the-critical-in-speculative-critical-design-5a355cac2ca4> (accessed (May 1, 2017).

11 Matt Malpass, “Criticism and Function in Critical Design Practice,” *Design Issues* 31, no. 2 (Spring 2015): 59–71.

12 Anthony Dunne, “Design for Debate,” *Architectural Design* 78, no. 6 (2008): 90–93.

13 Pablo Helguera, *Education for Socially Engaged Art: A Materials and Techniques Handbook* (New York: Jorge Pinto Books, 2011), 83.

14 Matt Keim, “If Political Design Changed Anything They’d Make It Illegal: Review Essay on Carl DiSalvo’s *Adversarial Design*,” *Design Philosophy Papers* 11, no. 1 (2013): 31–38.

and installations, the practices and proliferation of these objects often are so removed from the social context they aim to critique, or are designed for so particular an audience, that they actively, if inadvertently, undermine their own politically transformative potential.¹⁵

Here, I articulate a possible future for SCD that aims to address SCD's double-bind—the repositioning of SCD as the design of material/agonistic *platforms* rather than the design of objects. Platforms in this context are defined as social, institutional, and infrastructural systems that encourage and afford political design across multiple design disciplines in a translative way. By translative, I mean that SCD platforms must account for and bridge radical epistemological differences among design disciplines, including those disciplines that might have an innate aversion to “political” content. This accounting-for requires more than just the expansion of SCD's audience; as Latour argues, every transportation of meaning, content, and information is also a translation.¹⁶ Similarly, every translation of content is inherently transformation of that content. Translating SCD across epistemic regimes and across disciplines thus requires a transformation of SCD itself.

Finally, I trace the introduction of an SCD platform approach to an already existing interdisciplinary design program: the Programs in Design and Innovation (PDI) at Rensselaer Polytechnic Institute in Troy, NY. PDI serves as a particularly salient example of the challenges of incorporating SCD platforms in interdisciplinary spaces: It is a creative design program, housed entirely within a social science department—the Department of Science and Technology Studies—and is largely populated by students who also are majoring in engineering and who intend to enter the engineering profession upon graduation.

What Is Political Design?

DiSalvo's labeling of certain design practices (e.g., critical making, adversarial design, and SCD¹⁷) as political design implies that other design practices of a less provocative nature, or, those that are more affirmative of the political status quo, are *non-political*. However, as science and technology studies (STS) scholars have long argued, every designed artifact, system, and process is enmeshed within larger structures of political power and thus participates in the political world.¹⁸ In practice, every stage of various design processes furthers normative, ethical, and ontological arguments—implicit and explicit claims about how the world *is*, how the world *should be*, for *what purpose*, and for *whom and what*. When designers narrate potential use cases for a product, they envision not only the product and its affordances and constraints, but also the local

15 Ibid., 38.

16 Bruno Latour, *Reassembling the Social: An Introduction to Actor–Network Theory* (New York: Oxford University Press, 2005), 106–09.

17 Matt Ratto, “Critical Making: Conceptual and Material Studies in Technology and Social Life,” *The Information Society* 27 (2011): 252, and DiSalvo, *Adversarial*, 9.

18 See e.g., Langdon Winner, “Do Artifacts Have Politics?” *Daedalus* 109, no. 1 (1980): 121–36.

sociotechnical milieu within which the product will be embedded.¹⁹ As Anne Burdick illustrates, the speculative designs that Microsoft creates in its promotional video, *Microsoft Productivity Future Vision* —“in which people from around the world engage in a seemingly effortless workflow facilitated by an omniscient system that anticipates their needs as they move between Asian subways to African taxis to North American homes”²⁰—argue for a particular social and political vision. Although *Future Vision* is not explicitly intended as political design, the video serves to advertise—and make desirable—Microsoft’s imagination of the economic and social roles that ambient technology should occupy. This future, rather than any specific digital-material user interface seen in the video, is what Microsoft is intending to design and sell. Through the imagining of a presumed desirable technological future, Microsoft is actively fashioning a future social world.

Despite the multicultural and cosmopolitan overtures in their videos, Microsoft’s imagination of the future reflects a particular Western, capitalistic, techno-centric normative regime. This observation is not necessarily an indictment of Microsoft; drawing on feminist standpoint epistemology, Sandra Harding argues that *all* viewpoints and understandings of the world are inflected through the experiences, culture, and material existences persons and social groups inhabit.²¹ That Microsoft’s idealized world would exhibit a well-meaning, if limited, vision that espouses Western capitalistic values is not surprising. However, the desirability of this glossy world or of the political and economic conditions that underpin it should not be presumed to be universal.

That the vision of our future is contested recalls Mouffe’s characterization of anti-agonistic politics. For its intended audience, Microsoft’s vision of the sociotechnical future does not read as a designed, imagined, or constructed future at all; instead, it reads as natural and inevitable. It operates by foreclosing for its audience the possibility of other futures and trajectories. It is political in that it sets a technosocial agenda, and it is powerful because it ignores the cacophonous voices that call for futures that are radically “other.” Although Microsoft does not label *Future Vision* as political, it is in fact a deeply political design that affirms a specific kind of technological hegemony. Not coincidentally, it reinforces the epistemological lens of those in social power—it leverages the dominant epistemological platform.

In contrast, agonistic political design places incommensurability at its core: It embraces the political that occurs because of the different worlds and experiences that give rise to competing ideological frameworks. In other words, political design celebrates the irreducibility and untranslatability of one’s experience into another’s by highlighting social constructions of the world that are

19 Victor Margolin, “The Product Milieu and Social Action” in *Discovering Design: Explorations in Design Studies*, Richard Buchanan and Victor Margolin, eds. (Chicago: The University of Chicago Press, 1995), 122.

20 Anne Burdick, “Meta! Meta! Meta!: A Speculative Design Brief for the Digital Humanities,” *Visible Language* 49, no. 3 (2015): 13–33.

21 Sandra Harding, “Rethinking Standpoint Epistemology: What Is ‘Strong Objectivity?’” in *Feminist Theory: A Philosophical Anthology*, Ann E. Cudd and Robin O. Andreasen, eds. (Oxford: Blackwell Publishing, 2005).

made invisible by dominant knowledge regimes. It desires an infinite variety of fundamentally different future worlds; agonistic political design aspires to be the space where these different speculative and normative futures churn.

SCD methods are currently in vogue for designers seeking to provocatively imagine divergent sociotechnical futures. Anthony Dunne and Fiona Raby's *Designs for an Overpopulated Planet, No. 1: Foragers* offers one example of SCD.²² This photographic and installation series showcases a consumer-oriented, mass-manufactured, "external digestive system," that process food now too poisoned or polluted for unaided human digestion.²³ Another example is the cheeses that Ginsberg and her colleagues cultured from bacteria harvested from various locations on human skin.²⁴ Each of these materialized design concepts speculates about a future world through implication: What kind of world must exist for these designs to be necessary? Such practices thus invert the kinds of worlds made manifest through Microsoft's design fictions; if Microsoft aims to help imagine a utopian, consumerist world made manifest by technology, then Dunne and Raby aim to help viewers picture the imagined future terror of the Anthropocene made real by these same technologies. Both *Overpopulated Planet* and human cheese reveal the kinds of terrifying products that apocalyptic scenarios make mundane; the conceptual tension that arises from this disjunction is SCD's participation in the agonistic political. Rather than suggesting concrete solutions, SCD seeks to create the space for alternative and subversive futures and ontologies, for diverse and unsettled ways of re-imagining and reconfiguring our social, material, and environmental worlds. SCD thus echoes what DiSalvo calls a design strategy for agonistic pluralism.²⁵

Because the functionality of SCD ostensibly manifests through semiosis rather than utility, SCD methodologies are often pedagogically and disciplinarily associated with methods in conceptual art, although also distinct from them. Raby and Matt Malpass each have written extensively about SCD's simultaneous drawing on and distancing from artistic practice; SCD's strength, Raby argues, is its potential to reach audiences through the incorporation of critical thought into objects normally associated with the mundane. She writes that "while critical design might heavily borrow from [art] methods and approaches, it is definitely not art. We expect art to explore extremes, but critical design needs to be close to the everyday."²⁶ Malpass argues that SCD operates differently than art because of its hybridization of conceptual and

22 Anthony Dunne and Fiona Raby, "Designs for an Overpopulated Planet: Foragers," 2009.

23 Anthony Dunne and Fiona Raby, *Speculative Everything: Design, Fiction, and Social Dreaming* (Cambridge, MA: MIT Press, 2013).

24 Alexandra Daisy Ginsberg, Jane Calvert, Pablo Schyfter, Alistair Elfick, and Drew Endy, *Synthetic Aesthetics: Investigating Synthetic Biology's Designs on Nature* (Cambridge, MA: MIT Press, 2014).

25 Carl DiSalvo, "Design, Democracy and Agonistic Pluralism," *Proceedings of the Design Research Society Conference* (2010), <http://www.drs2010.umontreal.ca/data/PDF/031.pdf> (accessed May 1, 2017).

26 Fiona Raby, "Critical Design," in *Design Dictionary: Perspectives on Design Terminology*, Michael Erlhoff and Tim Marshall, eds. (Boston: Birkhauser, 2008), 95, quoted in Malpass, "Criticism and Function," 63.

utilitarian constructions of function.²⁷ However accurate Raby's and Malpass's claims, and despite the SCD's engagement with the everyday, it remains that SCD practitioners often rely on arts paradigms as vehicles for inquiry. SCD works are largely produced and exhibited in academic, artistic, and gallery installation spaces, and investigations of SCD artifacts often are found in creative design and arts academic journals.

Thus, while SCD has characteristics and audiences that distinguish it from arts practices, it can fall prey to the same problems that plague the conceptual arts—namely, that SCD remains inaccessible to those outside the academy or to those not vetted within art and creative design worlds.²⁸ SCD demands of its audience very specific kinds of knowledge to perform its critical function: understandings of design history, visual and textual literacy, specific—yet flexible—cultural constructions of value, and the time necessary to devote to experiencing and digesting design interventions. Although SCD practitioners have certainly produced provocative objects, the ones provoked are often other creative designers and not the general public or academics in other disciplines. Most crucially, SCD may not even reach the disempowered social groups most directly affected by the foreclosing of radically alternative futures—the very people agonistic political design aims to support. In effect, SCD artifacts do agonistic work, but for a narrow audience.

Engineering Agonistic Design Platforms

This critique is not intended as a condemnation of the intents and practices of agonistic political design or of SCD. Rather, it is intended as a call for the iteration of SCD methods to translate more broadly. These iterations involve building literacy for critical design work across multiple audiences, as well as transforming SCD's focus to build more materially and culturally accessible spaces and platforms for agonistic political design.

The translation discussed here is both conceptual and practical. Conceptually, recasting SCD as the building of social and institutional *platforms*, rather than of objects, calls for a broader definition of the kinds of political work that design can do—the acknowledgement, for example, that the worlding work done in *Microsoft Future Vision* is just as political as Dunne and Raby's adversarial provocations. This acknowledgement requires that we broaden our understandings both of the kinds of disciplines and publics that can participate in SCD and of the diverse forms that SCD might take when used by these diverse groups. The practical

27 Malpass, "Criticism and Function," 64.

28 Howard S. Becker, *Art Worlds* (Berkeley, CA: University of California Press, 2004), xi.

implications of designing agonistic SCD platforms necessitate a recognition that a universally translative SCD platform is impossible. The very nature of agonistic politics precludes the possibility of universally adaptable, neutral social institutions or infrastructures that do not favor certain worldviews at the expense of others. Appropriately designed SCD platforms, then, must always be built on the social and epistemological contexts of the persons engaging in the platform's construction, even as SCD platforms try to broaden and complicate these very same contexts.²⁹

I developed an experimental SCD platform discussed here in the context of PDI at Rensselaer Polytechnic Institute. PDI originated as a collaborative effort among faculty in the Department of Science and Technology Studies (STS), the Department of Mechanical Engineering, and the School of Architecture. PDI was aimed at synthesizing the creative design approaches of architecture and industrial design with the technical skills of engineering, all while having students be immersed in STS's social analytic of the built world.³⁰ Now hosted entirely within the STS Department, PDI serves about 130 undergraduate design students across four years and offers a sequenced, studio-based core course every semester. The vast majority of the program's students—nearly 98%—are dual majors (design + a second major), ensuring a multidisciplinary classroom experience in every PDI studio. Partially because of Rensselaer Polytechnic Institute's context as an engineering-centered institution, partially because of the training of recent directors of the program, and partially because of student interest, about 70 percent of PDI students combine their design majors with a mechanical engineering major. The distribution of the remaining 30 percent varies from year to year but tends to be populated by dual majors with business management, graphic design, systems engineering, computer science, and sustainability studies.

Although the PDI curriculum largely comprises interdisciplinary design studios, it is not an industrial design program. PDI studios are focused on providing spaces for design students to learn and deploy humanities, social science, and STS critique through hands-on work that draws on the technical skills fostered in the student's second major. At its best, PDI has enabled students across disciplines who are drawn to the political commitments of the social sciences to translate these commitments into material form. For example, Ecovative Design is a biomaterials company founded by PDI graduates that specializes in producing mushroom-based, biodegradable alternatives to Styrofoam. Often, PDI has served as an "Engineering Plus" model for many of our engineering dual majors, augmenting their "concepts"-focused engineering curricula (e.g., calculus, physics, thermodynamics,

29 For an understanding of "appropriate design" relevant to this context, see e.g., Dean Nieusma, "Alternative Design Scholarship: Working Toward Appropriate Design," *Design Issues* 23, no. 3 (Summer 2004): 13–24.

30 The intellectual and pragmatic history of PDI is outlined and chronicled in Frances Bronet, Ron Eglash, Gary Gabriele, David Hess, and Larry Kagan, "Product Design and Innovation: Evolution of an Interdisciplinary Design Curriculum," *International Journal of Engineering Education* 19, no. 1 (2003): 183–91.

etc.) with studio spaces where they can apply their engineering knowledges—and with enough social science “flavor” to give some insights into improving product usability and broaden problem definition. The program’s standard educational outcome of graduating STS-inflected engineers capable of translating among engineers, marketers, and users is certainly something to be proud of, but the “Engineering Plus” model of PDI risks undermining the identity of the program as a truly inter- and multi-disciplinary design educational space.

To more deeply integrate interdisciplinary design practices into the core of the program, I tried to incorporate SCD to varying degrees into several of my PDI studio classes. However, I quickly discovered that “non-translated” SCD practices, methods, and theories, which appeal to students and researchers in creative design disciplines, are markedly foreign to, and at times hostilely received by, the engineering-oriented students in PDI.

The lukewarm to allergic responses to SCD approaches in PDI might not be particularly surprising; SCD rarely addresses engineering design practices, and engineering education has largely become disengaged from non-utilitarian approaches of all kinds. Outside the use of the word “design,” drawing explicit intellectual and historical connections between the creative design disciplines and the more instrumentalist practices of engineering design can be difficult—particularly when the design process is framed in the latter case as a series of decision-making procedures intended to systematize design to specification. For example, following the engineering design process helps engineers to ensure that all designed elements of a built system meet material tolerances, are within cost ranges specified by clients, and achieve desired functional results. One of the most commonly taught engineering design textbooks even dedicates a chapter to help determine whether hiring an industrial designer for its products is “worth it” for an engineering firm.³¹

In truth, engineering epistemology—across industry and educational contexts—is largely instrumentalist.³² Engineering education, even at the graduate level, tends to presume that students seek to enter the private or corporate sector, and thus presumes a consumerist, corporate context for design work. For instance, “the user” and “the customer” often are used interchangeably in engineering design classes. Hands-on, studio-based design experiences—the backbone of creative design education—are heavily deemphasized, if not omitted, in favor of the development of decision-making matrices and methodological, step-by-step advancement through the design process. User-centered design in engineering contexts rarely moves beyond human factors and ergonomics, and even engineering for development

31 Karl T. Ulrich and Steven D. Eppinger, *Product Design and Development*, 3rd ed. (New York: McGraw-Hill/Irwin: 2004), 187–208.

32 Dean Nieuwsma, “Conducting the Instrumentalists: A Framework for Engineering Liberal Education,” *Engineering Studies* 7, no 2-3: 159–63.

(E4D), although well-intentioned, works more as a Band-Aid solution to global economic inequality, rather than seeking to initiate conversations about the structural causes of impoverished spaces.³³ Political, aesthetic, and theoretical conversations in engineering design still are limited and often are systematically excluded as “outside the scope of” the learning outcomes.

Although engineering design still embodies a clearly distinct and more utilitarian set of practices and epistemologies than those seen in the creative design fields, continuing to deny engineering a place in the design pantheon is becoming more difficult. Copies of Donald Norman’s *The Design of Everyday Things* are increasingly found in engineering design classes—a major cultural shift for a design field that has long prioritized technical capabilities and cost efficiency over user-friendliness in the design process.³⁴ Although engineering has not yet widely experimented with SCD, fits and spurts of political and social action can be seen in engineering design research and education. Many of these initiatives center on reframing engineers’ understanding of the epistemic and political biases of engineering itself. For example, E4D encourages design and manufacturing teams to take material resources, local knowledge, and cultural values into account when constructing technological infrastructures in non-Western, underserved contexts.³⁵ However, even these initial movements into the social and political dimensions of design are often underpinned by instrumentalist, atheoretical frameworks. E4D presumes technological solutions to social problems, and its methods often are incapable of accounting for—and addressing—the systems of power that underlie the “divide” between the developed and underdeveloped world. In other words, E4D seeks social transformation without acknowledging the need for epistemological translation.

Despite its general lack of social or political analysis, design pedagogy’s emergence in engineering spaces presents an opportunity for creative designers to engage with engineering practices in a way that makes evident the politics of engineering practice, while also leveraging engineering design spaces to create agonistic SCD platforms. In PDI, studio-based critical design pedagogy provides engineering students with the space to challenge, experiment, and play with the core instrumentalist, capitalist, and militaristic epistemologies that underlie engineering.³⁶ The goal in synthesizing approaches to SCD and engineering design in PDI is to empower both creative designers and engineers to re-imagine the kinds of spaces where design and engineering *belong*, and therefore to re-imagine the *skillsets* of designers and engineers.

33 Dean Nieuwsma and Donna Riley, “Designs on Development: Engineering, Globalization, and Social Justice,” *Engineering Studies* 2, no. 1 (2010): 29–59.

34 Donald A. Norman, *The Design of Everyday Things* (New York, NY: Basic Books, 1988).

35 Juan Lucena, Jen Schneider, and Jon A. Leydens, *Engineering and Sustainable Community Development* (San Rafael, CA: Morgan and Claypool Publishers, 2010).

36 Ethan Blue, Michael Levine, and Dean Nieuwsma, *Engineering and War: Militarism, Ethics, Institutions, Alternatives* (San Rafael, CA: Morgan and Claypool, 2013).

SCD in PDI

Readings from SCD and political design introduced across PDI's studio sequence have been conceptually challenging for PDI students. Most PDI students have experience incorporating STS and other theory in their projects only instrumentally, typically by using STS to enhance product utility or to identify underserved users. PDI students needed a dedicated course to grapple with political design and SCD, but they had no room for additional courses in their plan of study as engineering education requirements severely restrict the curricular flexibility of our engineering dual majors.

The Senior Design Capstone course, offered in students' eighth semester, provided a logical place in the PDI curriculum to deeply engage with SCD methods. Students in Capstone are more experienced designers and scholars than early-career students, and Capstone has traditionally required a deep dive into STS literature to frame students' designed objects. SCD methods were introduced to students as a way to help them translate STS critical analysis into material form.

Given the instrumentalist epistemological frames of the engineering-oriented students in PDI, SCD artifacts that operated too heavily within an arts paradigm, or that are perceived by students as "not functional enough," have gained little traction in the classroom. For example, Dunne and Raby's work was dismissed out of hand by most students as frivolous. However, PDI students' general embrace of material engagement dovetailed nicely with SCD methods using hands-on making techniques. In particular, critical making methods are salient for PDI students. Initially articulated by Matt Ratto, critical making as a form of political design emphasizes process over product³⁷; the embodied knowledge generated from the *act of making* itself becomes as important, if not more important, than the critical dimensions of the design concept. In Ratto's version of critical making, making becomes both the object of inquiry and the vehicle for inquiry. For many PDI students, framing the act of making as the translative vehicle for STS engagement has aligned with their relationships to their own education. Engineering students, even in engineering-design courses, rarely are required to materially construct any of their designs, which often disappoints "tinker-centered" learners. As such, many PDI students report feeling more fulfilled *as engineers* in their hands-on design studios than they do in their engineering lectures.

37 Ratto, "Critical Making," 253.

PDI students in the SCD iteration of Capstone use critical making methods to apply STS theory to the design and prototyping of a “critical design thesis object.” Students first review STS literature to make an argument, similar to a traditional social science thesis. They then design an artifact that—in and of itself—makes, extends, or supports their thesis argument. The SCD project serves as a unique challenge for PDI students. Although SCD projects and literatures with which they could engage were identified for the students, their deeply engrained engineering epistemologies and their prior design experiences have produced conceptual roadblocks. PDI students’ impulse, based on their prior experience, is to use their making skills to conceive and design an object that: 1) identifies a problem; 2) solves that problem; and 3) does so in a way that is intuitive for users. In contrast, the critical design project forces the students to: 1) identify a political problem; 2) design an artifact that makes that problem *more evident*; and 3) design the artifact in a way that forces its users to reflect on the goals of the design, rather than having the use be “intuitive” and hence call for no introspection. Furthermore, instead of having the Capstone students compose either a written thesis or a professional design report, students are required to write a “critical design document.” This document incorporates an STS literature review, as well as critical analysis and user-testing reflections, into the traditional design document format. The following section details one of the project results from the Capstone course, *Velcube*. Although the half-semester timeframe of the assignment and the students’ inexperience with more conceptual design work result in only a rough prototype of the artifact, it nevertheless showcases the divergent kinds of SCD approaches that can emerge from agnostic design platforms contextualized within STS/engineering design educational spaces.

Velcube

Designed and built by PDI students Alexia Ioannou, Xiaohan Li, and Sarah Bogdan, *Velcube* leverages STS literatures critiquing ableism.³⁸ Ableism, or the privileging of able-bodied people over persons with diverse body states, often manifests in the design world when artifacts are built to “fix” disabled bodies so that they function as similarly as possible to the perceived bodily norm.³⁹ Although these designs certainly are well-intentioned, prosthetic objects that aim to return a body-diverse person to a state of “normalcy” often perform ableist work by positing the “normal” body as an ideal from which the targeted user deviates. Anti-ableist designs, in contrast, celebrate the user, rather than positing solutions that bring that user closer to “normal.”

38 An earlier version of the *Velcube* description is in Dean Nieuwsma and James W. Malazita, “Making’ a Bridge: Critical Making as Synthesized Engineering/Humanistic Inquiry,” *Proceedings of the 2016 Annual Conference & Exposition of the American Society for Engineering Education* (2016), <https://peer.asee.org/making-a-bridge-critical-making-as-synthesized-engineering-humanistic-inquiry> (accessed December 14, 2017).

39 See e.g., Simi Linton, *Claiming Disability: Knowledge and Identity* (New York: New York University Press, 1998).

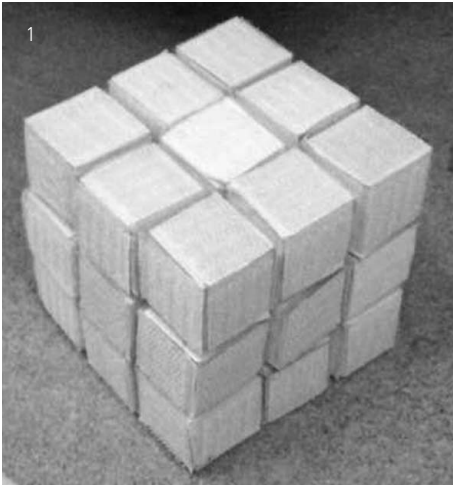


Figure 1
The assembled Velcube. Photo: Alexia Ioannou, Xiaohan Li, and Sarah Bogdan.



Figure 2
Velcube playtesting. Photo: Alexia Ioannou, Xiaohan Li, and Sarah Bogdan.

The students' goal was to develop a physical game that celebrates neurodiversity, a positive conceptualization of diverse brain states and an alternative to the negatively inflected "mental disability." Velcube integrates STS, design theory, game theory, and psychological research to develop a tactile puzzle game that privileges pattern recognition, tactile sensation, and topological identification—skills that tend to be mastered more quickly by neurodiverse autistic individuals—over interpersonal negotiations and competition-based play. Velcube consists of 27 individual cubes that can be arranged into a larger 3x3 cube; a hook (scratchy) or loop (fuzzy) strip of Velcro is fastened to each face of each cube. (See Figure 1.) The ratio and arrangement of hook and loop cube sides appears to be random at first. However, these features in fact were methodically designed: Only one combination of cubes allows a player to construct the full-sized, 3x3 cube so that no same-type (hook-hook or loop-loop) sides are touching. Velcube was designed to be easily constructed out of everyday materials, so that users could download "open source" schematics of the design and build it for themselves.

In play-testing Velcube, players who approached the game by sorting the individual cubes into hook-loop orientation categories and then systematically assembling the larger cube were able to complete the game in 5 to 15 minutes. (See Figure 2.) Players who tried to assemble the cube by slowly building out from a corner piece and feeling their way through sculpting the final shape took anywhere from 30 to 60 minutes to finish the game. Pattern-based approaches, like those that neurodiverse autistic individuals would be more likely to apply to problem solving, appeared to be a quicker strategy for completing the game.

Velcube certainly is not a test for autism, and the basic premise of the project—namely, that autistic individuals can more easily complete the game—is not necessarily true. However, as an SCD artifact, scientific validity wasn't the goal; rather, Velcube acts as a probe, prompting users to explore the concept of neurodiversity.⁴⁰ While playing the game, all the players engaged in conversations with the design team and with the artifact itself. Every participant in the interaction began explicitly working through notions of neurodiversity and counter-narratives to ableism during play-testing sessions. Several players even reported back to the design team that their conceptualizations of varied brain states and disabilities had been challenged or changed through their play-plus-conversation. As Ratto notes, the generation of discussion and the grounding of social theory through material exploration is a core goal and political outcome of critical making.⁴¹

Conclusion

The PDI Capstone course was developed as an agonistic political design platform that could engage epistemologies and audiences outside of arts and creative design—specifically the hard-case of engineering. The intention was to use SCD as a vehicle to prompt these students to think more critically about the epistemic and political regimes that underpin engineering by engaging in design practices that are explicitly non-instrumentalist. To do so, SCD practices had to be translated to connect appropriately with students who were often hostile to or dismissive of artistic modes of inquiry and design. Although the initial iterations of the platform seem to effectively broaden engagement with SCD to audiences beyond creative design, whether these engagements can translate into sustained engagement with political design beyond the classroom remains to be seen.

Velcube and other projects developed through the SCD platform in PDI are not likely to find their way into an art or design gallery. Instead, the ongoing influence of SCD as an agonistic platform rests on its ability to transform the students who engage with this platform, rather than on the success or popularity of any given artifact instantiated through that platform. In the case of the Velcube team, one student is now pursuing a graduate degree in biomedical engineering with an eye toward developing products and interfaces that encourage users to reflect upon ableism—a research and career trajectory directly derived from her experiences with SCD in Capstone. Several other students who currently are employed as engineers have expressed interest in attending graduate school for industrial design or other creative

40 Elizabeth B.N. Sanders and Pieter Jan Stappers, "Probes, Toolkits and Prototypes: Three Approaches to Making in Codesigning," *CoDesign* 10, no. 1 (2014): 5–14.

41 Ratto, "Critical Making," 253.

design fields because of their newfound interest in SCD. Although the leveraging of critical making and STS as the theoretical foundations of an SCD platform might be appropriate only in the particular context of PDI, this case reveals that the strategy of appropriately transforming SCD practices is portable. This article has argued that unbinding SCD from the arts paradigm can allow SCD's agonistic provocations to translate across radically other disciplinary and epistemological frameworks beyond creative design.

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