An Exploratory Study of Power Dynamics and Feedback in Design Reviews

Mr. Mitchell James Cieminski, Franklin W. Olin College of Engineering

Mitchell J. Cieminski was born in Fontana, CA in 1995 and grew up in Greeley, CO. He received a B.S. in electrical and computer engineering from Franklin W. Olin College of Engineering in Needham, MA in May 2017, and currently studies science and technology studies at Rennselaer Polytechnic Institute. In 2014, he worked at Insper University in São Paulo, Brazil as a Junior Partner and visiting student to their developing engineering program. His research interests include community education and the relationship between technology and society. Mr. Cieminski is a member of the Society of Women Engineers (SWE) and the Institute of Electrical and Electronics Engineers (IEEE). He has previously served as President of Olin College's SWE chapter.

Dr. Alexandra Coso Strong, Franklin W. Olin College of Engineering

Alexandra Coso Strong is an assistant professor of systems design and engineering at Franklin W. Olin College of Engineering. Prior to starting a faculty position at Olin, she was a Postdoctoral Fellow at Georgia Tech's Center for the Enhancement of Teaching and Learning. She completed her Ph.D. in 2014 in Aerospace Engineering at Georgia Tech. Alexandra received her B.S. in Aerospace Engineering from MIT and her M.S. in Systems Engineering from the University of Virginia. Her research interests include engineering design education (especially in regards to the design of complex systems), student preparation for post-graduation careers, approaches for supporting education research-to-practice.

An Exploratory Study of Power Dynamics and Feedback in Design Reviews

Abstract

A key event in many engineering and design learning environments is the design review, in which students present project work to solicit feedback from reviewers like instructors, peers, and outside visitors. Previous research on design reviews demonstrates how feedback affects student growth and task achievement. However, there is limited research within engineering education that examines the relationship between feedback and other features of a design review. One such feature is the power dynamics between the student and the instructor, which may be germane to the review outcome. The purpose of this exploratory study is to investigate the extent to which power dynamics are related to the design review feedback. Using previously-collected video recordings of design reviews in an undergraduate mechanical engineering design course and an undergraduate industrial design course, an in-depth exploration of two formative design reviews (one from each course) was conducted. Open coding methodologies were applied to examine power structures and to capture the critical incidents related to power dynamics, while existing classification schemes were used to identify the types of feedback that occur within and around these incidents. Some feedback types were found to be commonly used by instructors to disrupt design reviews. Furthermore, the findings suggest that students adopt a relatively restricted set of approaches to interact with the reviewers in design reviews, and even in more-equitable reviews, students can have limited effect in achieving their discursive goals. Overall, the results of this exploratory research study can be used to provide educators with an increased awareness of the relationships among feedback, power dynamics, and project contexts and to support future research about power dynamics within design learning environments.

Introduction

A key event in many engineering and design learning environments is the design review, in which students present project work to and solicit feedback from instructors, peers, and/or outside visitors. Feedback is the central teaching and learning component of the review. In particular, it is the feedback that makes the review relevant to student learning in the context of the project work and the course, by simultaneously communicating to students both how they are currently performing and what their goals should be (Hattie & Timperley, 2007). The focus of this communication could include the specific project the student(s) is/are working on or their development as engineers and designers. The feedback students receive during a project not only affects their course-related achievement, but also the skills and work habits they learn and the identities they form (Kluger & DeNisi, 1996; Hattie & Timperley, 2007; McNair, Paretti, & Groen, 2014).

Many models of feedback imply that the context in which feedback is delivered, in addition to the content of that feedback, affects student reactions to it (Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Littlejohn & Foss, 2011). For design reviews, feedback is noted as having several types and purposes, though research is limited on the effectiveness of various feedback types (Dannels & Martin, 2008) and the relationship between feedback and the contextual features of a design review.

One potentially important feature of design reviews is the dynamics between the student and the instructor, which outside of the context of design reviews is known to impact the long-term development of students' engineering knowledge and attitudes (Tonso, 2007). In a design review, the instructor often plays dual roles of experienced designer and evaluator, which creates a power distance between the student and the instructor that may be germane to the review outcome. Dannels and colleagues (2011) note that relational tensions underscore the ways students perceive their experience within design reviews and suggest that feedback should be explored in the context of those tensions in order to influence learning. Thus, the purpose of this exploratory study is to investigate the extent to which the power dynamics within the design review are related to the design review feedback. We identify major power-related events in cases of design reviews in mechanical engineering (ME) and industrial design (ID) contexts and connect those events them to analysis of the feedback given by review participants. The results of this exploratory research study will be used to increase awareness of and give language to how feedback, power dynamics, and project contexts are related.

Background

To properly situate this research, we first give an overview of design review discourse in the two disciplines investigated. Next, we define feedback within the context of educational activities and describe how it is implemented. We then provide a brief history of research on design review discourse, especially feedback, emphasizing the critical perspective that that research has generally taken. Then, we examine the relationship of this research to prior work that used the same dataset, and the motivation to analyze the reviews under the lens of inter-relational power dynamics. Finally, we introduce a theoretical framework for analyzing power dynamics.

Design Reviews and Disciplinary Differences

This study examines discourse in two contexts: a mechanical engineering (ME) project design review and an industrial design (ID) project design review. These two disciplines have different histories and practices, with engineering emerging from war- and infrastructure-building, and design coming from science-based and arts-based traditions (Lande & Oplinger, 2014). Though both fields use design thinking and activities, engineering often emphasizes specialized roles and mathematical thinking (Lande & Oplinger, 2014) while design has more consideration of the holistic relationship between functional, emotional, and aesthetic aspects of a design (Yilmaz & Daly, 2016).

Design scholars occasionally recognize a distinction between review genres: the more-formal engineering "design reviews" and design's "design critiques" (Cardella, Buzzanell, Cummings, Tolvert, & Zotowski, 2014, p. 2). For the purpose of this paper, and to avoid confusion, we will instead term these genres "engineering design reviews" and "design critiques," while reserving the unqualified "design review" as encompassing both genres. When distinguished in this way, engineering design reviews are conceived of as having the purpose of assessing the quality and verifying the status of a design. Originating in industrial contexts, they can be considered as design process elements to evaluate and control engineering activities, or as elements to make explicit and communicate design decisions and rationale. In contrast, design critiques emphasize the use of feedback to inform the design and the socialization of students into communication

modes and practices of professional designers (Cardella et al., 2014). The distinguishing factor between these genres might be the place of obtaining approval as an element of the review: engineering design reviews often exist for reviewers to give explicit approval to move on with the process, while reviewers in design critiques give suggestions on how to move on in the process (Connor, 2014). Given the distinctions between the two contexts of interest, we believe an exploratory and comparative analysis across the different disciplines and review types will provide a foundation for future work on power dynamics in design reviews.

Feedback

Hattie and Timperley (2007) defined feedback in an educational context as "information provided by an agent regarding aspects of one's performance and understanding" (p. 81). The framework that they proposed was broadly based on psychology's Feedback Intervention Theory, which argues that feedback from an agent such as the self, another person, or an information source has the power to regulate behavior by changing the *locus of attention* in the feedback recipient's thoughts toward issues the feedback regards (Kluger & DeNisi, 1996). In Hattie and Timperley's framework, feedback is conceived primarily as a mechanism intended to reduce the gap between goal and performance. Because it relates goals and performance, feedback simultaneously communicates information regarding three aspects of a project: the goals, the current performance, and the ways to move toward the goal. Their model also acknowledged that feedback can be accepted, modified, or rejected, and that therefore has varying degrees of power to close this perceived gap.

Feedback in Design Reviews

Until the late 2000s, research on feedback as an element of design education, particularly within design reviews, was rather limited, with the notable exceptions of Anthony's (1991) and Frederickson's (1990) initial examinations of communication within architecture education's design juries. More recently, the drive for deeper understanding of the role of feedback in design reviews has included a series of papers by Dannels, Housley Gaffney, and Martin which identified common types of design review feedback (Dannels & Martin, 2008), explored the deeper meanings of feedback beyond its relationship to a project (Dannels, Housley Gaffney, & Martin, 2008), and examined student perspectives on how feedback contributed to design review climate (Dannels, Housley Gaffney, & Martin, 2011). Central to this research was a critical approach to analyzing design review communication, where feedback was considered as a communication tool for both project and relational information. By exploring not only the student experience within a design review but also these communicative tools used to support student and project development, Dannels and colleagues increased awareness of the design review experience and also provided initial framing for considering how to improve design reviews as educational experiences for students. This study complements the literature through its emphasis on the first-person student perspective and the discursive goals and actions that exist within a design review.

As we think of improving design reviews for students, it is important to recognize the diversity of student experience in design reviews: there are several different modes of interaction among students and reviewers (Frederickson, 1990), and even students who describe their experiences of design review climate similarly had different affective outlooks on that climate (Dannels et al., 2011). These findings indicated that there are elements of design reviews that affect student

experience beyond attitudes or actions alone. While there are relatively limited elements of communication (*e.g.,* feedback types, tones, and purposes) common in design reviews, there are multiple ways that these elements interact with one another to create unique reviews, where each participant may experience the review differently.

In 2014, at Purdue University's Design Thinking Research Symposium 10 (DTRS 10), researchers explored a shared dataset of recorded and transcribed design reviews and collectively analyzed them to advance understanding of design thinking and learning (Adams & Siddiqui, 2013). Within these studies, researchers examined the use of feedback and other discourse across design disciplines (Lande & Oplinger, 2014; Yilmaz & Daly, 2016), and the student-instructor interactions in design reviews as ambiguity-navigating (Cardella et al., 2014), the role of coaching (Adams, Forin, Chua, & Radcliffe, 2016), and the identity-forming activities of a review (McNair et al., 2014). Additional research is necessary, however, to understand the underlying tensions in a design review and the relationship between those tensions and feedback and student-instructor interactions. Currently, there is limited information about the causes of the variant student experiences in design reviews. Although design review discourse continues to be conceived as both instructional and relational, the relationship between the relational elements, the instructional elements, and other elements of the review remain unclear.

Power as an Analytic Lens

In this present study, we examined the ways that a design review's communication elements interact with one another through the use of a "power in discourse" lens. Investigating power in language is a way to understand the interpersonal meaning of a text by connecting the text to its context (Bartlett, 2014). Bartlett's (2014) motivation in developing this approach was a desire to change how minority groups are perceived and understood. In this approach, one's power in a given context is conceived as their "ability to get things done" (p. 180): not a static property of actors, but an emergent and dynamic interpersonal quality of the actors' relationship to their situation (Bartlett, 2009). One model that can be used to understand how power and situation mutually develop through discourse is Bartlett's Positioning Star of David (see Figure 1).

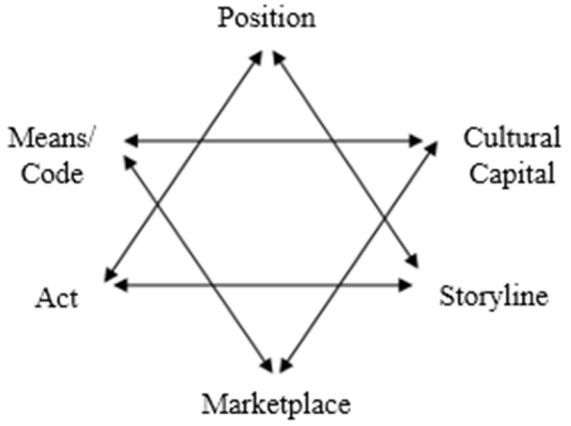

Figure 1. Bartlett's Positioning Star of David (adapted from Bartlett, 2014, p. 12). The interrelationship of (discursive) act, position, and storyline described by Positioning Theory (Harré & van Langenhove, 1999) is constrained by a second interrelationship of means, cultural capital, and marketplace. Together, these provide a way to think about constraints and affordances of discourse and how they relate to power.

The Positioning Star of David is considered an extension of Positioning Theory (Harré & van Langenhove, 1999), which recognized (discursive) *acts* as adopting *positions* that make sense of and against a broader *storyline* of what happens around the act and what the act regards. For example, a persuasive speech might adopt a number of positions (*e.g.,* claims and value judgements) that make sense of the circumstances in which they are delivered. Both the act and the position then become a part of the storyline in which they exist, creating an interrelationship among the three. Bartlett's addition of a second interrelationship among *means/code*, *cultural capital*, and the social *marketplace* (*i.e.,* audience) introduced a way of thinking of situational aspects that affect the positioning triangle (Bartlett, 2014). These aspects (*i.e.,* the way one speaks, their contextualized status, and their audience's perception) were constraining or enabling the acts, positions, and storylines that were available to occur (Bartlett, 2014). Together, these six elements provide a way to consider *power* as an emergent and situational quality: as the ability for a speaker to successfully adopt a position within their context.

Research Design

The aim of this exploratory study is to examine the following research question:

> *To what extent and in what ways are the power dynamics within a design review related to the design review feedback?*

Specifically, we studied two design reviews in undergraduate settings to identify critical incidents (Hughes, Williamson, & Lloyd, 2007) related to power by describing the discourse of the review using the "Positioning Star of David," as a tool to understand the constraints and affordances context places on discourse (Bartlett, 2014). After identifying critical incidents, we qualitatively coded the feedback types used by instructors and students according Dannels and Martin (2008). Finally, we used within- and cross-case methodologies to describe the relationship between the power dynamics and the types of feedback used in each design review.

Research Site and Sample

To conduct this investigation, we examined previously-collected video recordings (Adams & Siddiqui, 2013) of design reviews in two project-based courses at a large public university: (1) an undergraduate mechanical engineering design course and (2) an undergraduate industrial design course. These courses were selected because they represent two common review genres/formats within engineering learning environments (*i.e.*, engineering design reviews and design critiques).

In the mechanical engineering (ME) course, the design reviews were somewhat formal in structure and done primarily to report to and obtain approval from the (single) instructor. They were examples of the engineering design review genre previously discussed, consisting of a presentation in front of coursemates from other teams and the instructor. In this senior design capstone course, students were given flexibility in defining their goals and outcomes and expected to justify project decisions made throughout the semester to their instructor. Some of the course projects were done in conjunction with external clients, and all project teams from different sections of the course competed to receive an award. The instructor was explicitly recognized as taking on a manager and evaluator role of the students' engineering teams; the course syllabus instructed students to "treat your instructor as you would your boss in your first job. Treat your teammates as you would your colleagues in your first job." Each review in this

section of the dataset was primarily a student-led presentation with faculty interjections and evaluation of the project at the end.

In the industrial design (ID) course, the design reviews took on a more conversational tone and resembled examples of the design critique genre. The half-semester individual project was done in conjunction with a corporate client, and the students competed for one or more monetary awards and internships from the client. The reviews in the ID course included a variety of reviewers, including the two instructors and external visitors who were employees of the client. There was an evaluative element of many of these reviews, more so when representatives of the client were reviewing, though evaluation given in the formative reviews was more often intended to guide future progress rather than express approval or disapproval of the students' project work.

Data Sources

The collected video recordings include several design reviews, spanning different students, reviewers, and project phases. We were able to view videos of design reviews, read transcripts of them, (in some cases) read student presentation materials, and examine the related course syllabus. Given the dataset's use at previous symposia, we were able to benefit from other publications that analyzed the same sources (*e.g.,* Lande & Oplinger, 2014; Yilmaz & Daly, 2016), gaining additional insight about the reviews and confirming or challenging our analysis.

Case Selection

The focus of this analysis is an in-depth exploration of two formative design reviews, one from each course. These reviews were selected on the criteria that they a) occurred before the project was completed (*i.e.,* they were *formative*) and b) included the most types of power-related discursive patterns displayed in the course they were selected from (*i.e.,* they were *representative*). To determine representativeness, we watched and read each of the three formative ME and 17 formative ID design reviews in the dataset. For each review, we performed an initial coding of major power-related critical incidents (this process is described in more detail in the subsequent section). Because of the smaller dataset available for the ME course, we also watched and performed an initial coding of the three final design reviews to improve understanding of the course's common discourse. The genre of these final reviews was not fundamentally different from that of the formative ME reviews, and they had similar types of power-related events.

We then grouped and categorized each of these power-related incidents to generate an initial list of incident types for each course. Finally, we selected one formative design review from each course that included the most different types of incidents demonstrated within that course. The selected design reviews both demonstrated the most common incident types from their respective courses and included incident types unique to that review. Because of this, we believe these reviews are not only representative of the recorded design reviews we watched but, to some degree, of the variety of discourse the reviews could have contained. Notably, we selected an ID review in which the instructor served as the sole reviewer.

Data Analysis

In each review, open coding methodologies (Miles & Huberman, 1994; Strauss & Corbin, 1990) were used to examine power structures and to capture the critical incidents related to power dynamics. Then, the feedback within each power-related critical incident was coded and categorized using existing classification schemes (Dannels & Martin, 2008). Lastly, the feedback types were compared to the critical incidents in which they occurred using single-case study methods, and the design reviews were compared to one another using cross-case methods (Yin, 2003). The analysis methods are described in detail within the remainder of this section.

Generally, a *critical incident* (CI) is defined as an event that "makes a 'significant' contribution, either positively or negatively to the general aim of the activity" (Flanagan as cited in Hughes et al., 2007, p. 51). Critical incident analysis is a methodology originally developed by John Flanagan (1954) that focuses on the identification and analysis of an activity's critical incidents as a way to understand the activity and develop practical outcomes. We designed and implemented a variant of critical incident analysis that allowed us to identify power-related critical incidents in discourse and analyze them through the lens of feedback.

Using the Positioning Star of David (Bartlett, 2014) as a model for power in discourse (see Figure 1), we defined a *power-related critical incident* as "any instance in which a person attempts to adopt a position that changes the storyline and succeeds or fails in doing so, and the scene around that instance."

To understand if any given statement was such an instance, we had to understand the position(s) that a speaker was attempting to adopt, the mutual storyline (both past and future) that the speaker and their audience perceived, and how the statements were connected to other nearby statements. To do this, we generated positioning commentary for each statement made by either students or instructors by asking "what position is the speaker attempting to adopt?" and "what discursive approach does the speaker use to attempt to adopt this position?" Generating this commentary involved a consideration of what was being said aloud, nonverbal cues such as facial expressions and hand gestures, and the student work product that was available to us. Because of this, the positioning commentary to some extent captures multiple meanings of the text of the review: experiential, interpersonal, and textual (Bartlett, 2014), while emphasizing the interpersonal meaning. After creating the positioning commentary for the review, we grouped the statements into time-delineated "scenes" and briefly described each scene. From these scenes and positioning commentary, we identified the power-related CIs.

To capture our second dimension of analysis, feedback, the statements in each CI were coded using existing classification schemes for the type of feedback used (See Table 1) (Dannels & Martin, 2008). We also coded the statements with the feedback's targeted level as described Hattie and Timperley: *Task, Process, Self-regulation,* and *Self* (2007). We separated the *Task* level to three sub-levels to denote the field of discourse: *Task Deliverable* (student-generated artifacts accompanying the review), *Task* (the project being reviewed), and *Meta-Task* (the design review itself, or the discourse within it). An example that illustrates the separation of these sub-levels can be seen in an imagined design review in which a student brings a drawing of their design to the instructor. If the instructor gives feedback about the drawing itself, it is *Task Deliverable*, while if it is on the design the drawing represents or their progress in the project, it

is *Task*. Finally, if the instructor provides feedback about the way the student presents the drawing, the feedback is *Meta-Task*.

Table 1. Feedback type codes (adapted from Dannels & Martin, 2008, p. 143-147).

Code	**Definition**
Judgement	"Critics reacted to what they saw and **rendered some assessment of its quality**. This feedback was **evaluative in tone** and often included some form of interpretation but also conveyed an assessment of the design … [It] typically incorporate[d] an interpretation of or observation about the design … [and] provided students with an idea of the critics' views about that particular observation or interpretation."
Process-Oriented	"Critics made statements or asked questions about the **student's design approach or process** … [It] provided students with insight or observations about the process that they might have used or could use to create the design."
Brainstorming	"Critics essentially **asked questions** or **made statements about future imagined possibilities** for the design. These questions … were not necessarily intended to be answered but were more **rhetorical in nature** … [it] often took the form of what-if questions that served to help the student imagine other possibilities for their design product."
Interpretation	"Critics **reacted to what they saw** and tried to **make sense of the concept** or product … critics tried to make sense of the design they were viewing—sometimes making sense of the features of the design and other times making sense of the design concept."
Direct Recommendation	"Critics gave **specific advice** about a particular aspect of design … [It] was focused, purposeful, and usually specific. It usually dealt with **particular design features or structures**. Although some of this feedback concerned the design concept, most feedback in this category focused more on design form."
Investigation	"Critics **requested information** (typically by questioning) about the design or the design process. [It] **necessitated a response** … the tone that the critics used in their questioning clearly indicated that they wanted a response (as opposed to the tone of the critic's questioning in the brainstorming and identity-invoking feedback, which clearly indicated that the questions were rhetorical."
Free Association	"Critics made **reactive, associative statements about the design** … These statements often started with "It reminds me of" or "This looks like" and represented the ways in which the critics, as viewers, saw the design … [It] provided students with critics' immediate reaction to their design."
Comparison	"Critics contrasted the design or design process with something else … Although free-association feedback also represented a kind of comparison, it was reactive (spontaneous) whereas **comparison feedback was strategic (focused, intentional)**. [It] provided students with a way to see their design in relation to something else such as a well-known designer's creation or another student's design project."
Identity Invoking	"Critics made statements or asked questions to **suggest that students consider the larger picture of themselves as designers in a future professional community** … [It] pushed students to consider themselves within the larger context of the design profession—that is, to consider either the realities of being a designer (*e.g.,* with angry clients) or the philosophical nature of who designers should be."

Finally, each incident was explored more deeply to uncover emerging relationships among the power dynamics and feedback types. The critical incidents within each case were categorized into *critical behaviors*, and each behavior was described in terms of feedback types that occurred in instances of that behavior. The behavioral categories were established primarily within-case, but compared to the categories of the other case to ensure comparability of the reviews. Feedback types were considered in comparison with the types of positions with which they were delivered, and identified within the Positioning Star of David as the code used for a discursive act. The notable findings of this exploration are described in detail in the subsequent section.

Results and Discussion

Across the two reviews, we analyzed 30 critical incidents (CIs) from the ME review and 41 CIs from the ID review. From these CIs, we identified and defined 14 power-related critical behaviors (CBs), and 22 sub-behaviors (SCBs), which are defined in Table 2. Each use of feedback in the review was categorized based on the literature and related to one or more CBs. The results describe three specific features relating feedback to power dynamics in these reviews: (1) certain types of instructor feedback can be used to disrupt reviews, (2) students use a relatively limited vocabulary of feedback types, which seem to be limited by the design review format and tacit expectations of student behavior, (3) students can demonstrate power in similar ways to instructors, but they do so in a less effective way. This section provides an in-depth discussion of each finding and concludes with a summary of the findings.

When identifying CBs, language was required to describe the participants' roles within the any given behavior. It was noted that some CIs seemed to 'belong' to the students and some to the reviewers. One way to generalize these roles was to consider one participant as the *initiator* of each CI, and the other participant(s) as the *respondent*. The *initiator* of a particular CI is the participant who adopted the position against the timeline, as per our definition of a power-related critical incident. In all cases, when a student was the initiator, the instructor was the respondent, and vice versa. Table 2 describes the CBs that were observed in the design reviews, along with, in some cases, sub-behaviors, that divide the critical behavior into a few variants. The frequency of each SCB is reported for each review.

Table 2. Description of Critical Behaviors (CBs) and their sub-behaviors (SCBs). The CBs are categorized into behaviors that occur in both reviews and in only one of the two reviews, The frequencies of CIs within each SCB are reported for each of the two reviews (ME and ID). Within each SCB, the review participant who serves as the initiator (Init) is listed in the last column: *S* if only students initiated, *I* if only instructors, *B* if both students and instructors, and *N* if not applicable.

CB	Critical Behavior Description	SCB	ME	ID	Init
Behaviors in both ME and ID					
Inquire about Design	The initiator asks a question about the design, either to clarify an unclear aspect or for some unknown purpose. The respondent answers the question, and further discussion does not occur.	With Judgement	4	1	I
		Without Judgement	6	4	I
Identify Problem/ Deny Problem	The initiator points out a potential problem with the design. The respondent denies the problem, arguing that the problem is nonexistent or already solved. The initiator may suggest a solution to the problem they have identified.	Accept Denial	5	1	B
		Reject Denial	1	-	I
		Skeptical of Denial	1	-	I
Request Specific Advice	The initiator requests specific advice on an aspect of their design or process.	Specifically Reply	1	4	S
		Defer Advice	-	2	S
Briefly Judge	The initiator judges a claim that has just been made, with simple acknowledgement from the respondent or no response regarding the judgement.		1	4	B
Ignore Statement	The initiator ignores the feedback or comment that another participant makes. Either the initiator *Actively* ignores the comment by speaking about another topic, or *Passively* ignores it by being silent when the other expects a response.	Active	1	2	I
		Passive	-	2	B
Suggest and Acknowledge Suggestion	The initiator makes a suggestion and the respondent acknowledges the suggestion without evaluating its quality.		3	2	I
Dispute Claim	A claim has been made. The initiator then disputes that claim. The person who made the claim then becomes the respondent by either *Asserting*, *Modifying*, or *Conceding* their claim.	Assert Claim & Conditionally Accept	-	1	I
		Modify Claim & Accept	-	1	S
		Concede Claim	1	1	B
Suggest and Clarify Suggestion	The initiator makes a suggestion and the respondent asks questions to understand the suggestion. The initiator and respondent could go through multiple suggest-clarify cycles in a single CI.		2	1	I

Table 2 Continued. Description of Critical Behaviors (CBs) and their sub-behaviors (SCBs). The CBs are categorized into behaviors that occur in both reviews and in only one of the two reviews, The frequencies of CIs within each SCB are reported for each of the two reviews (ME and ID). Within each SCB, the review participant who serves as the initiator (Init) is listed in the last column: *S* if only students initiated, *I* if only instructors, *B* if both students and instructors, and *N* if not applicable.

CB	Critical Behavior Description	SCB	ME	ID	Init
Behaviors in ME only					
Identify Problem, Accept Feedback	The initiator points out a potential problem with the design and suggests a solution, and the respondent explicitly accepts the suggestion.		2	-	I
Falsely Anticipate Negative Feedback	The initiator anticipates that the potential respondent will point out a problem with the design, but the respondent does not do so. This CB may happen verbally or nonverbally.		2	-	S
Behaviors in ID only					
Mutually Modify an Idea	Both parties examine an idea and consider it, iteratively modifying it and interpreting the other's modifications. As this is a mutual process, the initiator/respondent roles are undefined.	Reviewer's Idea	-	7	N
		Student's Idea	-	1	N
Relate to Another Project	The initiator relates the task, feedback, or topic of conversation to their other experiences as a designer.		-	4	B
Mutually Shift Topic	The initiator suggests that the topic be changed, and the respondent changes the topic accordingly.		-	2	S
Judge Self	The initiator judges their own claim, and the respondent makes the same judgement of the same claim.		-	1	S

Disruptive Feedback

A critical incident was considered *disruptive* if the position that began the incident interrupted another speaker or substantially changed the subject of conversation. Between the two reviews, 23 CIs were identified as disruptive, 20 of which occurred in the ME review (87%), and 3 of which occurred in the ID review (13%). Disruptive critical incidents were all initiated by the course instructor when providing feedback about the the task (n=16) or meta-task (n=7) through *Investigation* (n=14), *Direct Recommendation* (n=7), or *Process-Oriented* (n=2) feedback. A summary of disruptive CIs is found in Table 3.

To further understand these disruptions, we will examine examples of the most common types of interruption, *Investigation* on the *Task*, and *Direct Recommendation* on the *Meta-Task*. We will also examine the *Suggest and Acknowledge Suggestion* CB, which uniquely uses other feedback types as the disruptive mechanism.

Table 3. Summary of disruptive critical incidents and the feedback used to initiate them. All disruptive critical incidents were initiated by the instructors. The frequencies of the critical incidents are recorded for each review.

Critical Behavior (Sub-Behavior)	Disruptive Feedback Type	Disruptive Feedback Target	Freq. ME CIs	Freq. ID CIs
Inquire about Design (with Judgement)	Investigation	Task	2	1
	Direct Recommendation	Meta-Task	1	
Inquire about Design (without Judgement)	Investigation	Task	5	2
	Investigation	Meta-Task	1	
Identify Problem/Deny Problem (Accept Denial)	Investigation	Task	2	
	Direct Recommendation	Meta-Task	2	
Identify Problem/Deny Problem (Reject Denial)	Investigation	Task	1	
Identify Problem/Deny Problem (Skeptical of Denial)	Direct Recommendation	Meta-Task	1	
Suggest and Acknowledge Suggestion	Direct Recommendation	Task	1	
	Process-Oriented	Task	2	
Dispute Claim (Concede Claim)	Direct Recommendation	Meta-Task	1	
Identify Problem, Accept Feedback	Direct Recommendation	Meta-Task	1	

Disruptive Feedback: ***Investigation - Task.*** In the following example from the ME review, the instructor interrupted by asking a question that was not directly related to what Student 1 was discussing. Although, broadly speaking, this question does have to do with the project's operation (what the student was talking about), it focuses on a contingency for non-function, which the student did not allude to as a possibility. The instructor's investigation of the students' design at this point is used to both interrupt and change the subject, though it does so with the aid of the advancing slide as a natural breaking point. A different student responds to the question than the one originally speaking, and the CI ends with the interrupted student resuming their portion of the presentation. These speaking roles further indicate that incident was disruptive. Between the two reviews, 13 disruptive critical incidents (57%) began in ways similar to this, including all of the disruptive critical incidents from the ID review. It is interesting to note that

both examples from the ID review were disruptive in that they changed the topic of discussion, but did not interrupt the student *per se*. Rather, the reviewer used a natural break in the review to change topics.

Excerpt from *Inquire about Design (without Judgement)* CI (ME review)	
Student 1	This is how the fish will be operated … We just place it in water, and if the gyroscope and IMU are already correct, we don't have to readjust it, but if it's not, we kinda have to recalibrate it using a push button to reset the gyroscope. And after that with [students advance slide] -
Instructor	So if something [students revert slide] malfunctions and it sinks, how do we retrieve it?
Student 2	Oh, for when I do the safety review, I'm just gonna have kind of like a safety line.

Disruptive Feedback: *Direct Recommendation - Meta-Task.* In the following excerpt from the ME review, the instructor interrupts by giving a clear instruction to the students to change the topic of discussion and the slide that they are presenting. It was classified as a disruptive beginning of a CI because it both interrupts and changes the subject of discussion. Less extreme forms of this disruptive feedback include "Hold on just a second," and "Run that again, real quick." This type of feedback also was occasionally used to *end* a critical incident by instructing the students to "Continue" or "Go ahead" in their presentation. The only critical incidents in which the instructor ended the incident with such a recommendation were disruptive incidents, providing evidence that the instructor recognized that the review had been disrupted. The timeline-controlling use of *Direct Recommendation* feedback was unique to the ME review.

Excerpt from *Identify Problem/Deny Problem (Skeptical of Denial)* CI (ME review)	
Student 3	Next we'll start connecting electronics, stuffing that *[inaudible]* into the PVC pipe, then that's when you to do all your waterproofing so you won't –
Instructor	Okay back, back to the 48 then. [students revert 2 slides] Looking at that servo again, if this is an accurate representation, I don't think that moment arm's gonna, even in the slot's going to rotate that.

Disruptive Feedback: *Direct Recommendation* and *Process-Oriented - Task.* Both of the following examples are the initiating lines of disruptive *Suggest and Acknowledge Suggestion* critical incidents in the ME review. Incidents within this behavior were the only disruptive critical incidents that began using neither *Investigation* nor *Direct Recommendation* feedback. Instead, both interrupt by making a suggestion. Since one is a suggestion for the design and the other for the student's particular process, they are coded as different feedback types. It is interesting to note that both recommendations are simply acknowledged by the interrupted student rather than clarified as in the *Suggest and Clarify Suggestion* critical behavior, which was never classified as disruptive. However, the *Suggest and Acknowledge Suggestion* CI occurs in the ID review in a non-disruptive way. This potentially suggests that students in the ME review would only respond to a suggestion in a lengthier form if the suggestion was not disruptive.

Excerpt from *Suggest and Acknowledge Suggestion* CI (Direct Recommendation example) (ME review)	
Student 4	And then, then we drill holes on the PCB, and, ah, we have wires c-, comes out connect to other electronics.
Instructor	Okay. So what I was saying is on that cap that's screwed you're probably gonna need an O-ring.
Student 4	Okay. So after we finish the PCB ...
Excerpt from *Suggest and Acknowledge Suggestion* CI (Process-Oriented example) (ME review)	
Student 5	So that's where we'll make a male mold and we'll just heat the plastic and vacuum, use vacuum to pull the plastic around that.
Instructor	You'll probably have to CNC that male mold.
Student 5	Right. So we're gonna ...

Discussion of Disruptive Feedback and Critical Incidents. Altogether, disruptive feedback was more common in the ME design review than in the ID review. The only sort of disruptive critical incident that occurred in the ID reviews occurred when the instructor asked a question about the design as a means of changing the subject. The discursive patterns for these interruptions were less severe than those in the ME review, as they typically occurred during a natural pause or break in the conversation. It is possible that the prevalence of disruptive critical incidents in the ME review is a result of the review format itself, which is a formal presentation rather than an informal discussion of the design such as the ID review. The instructor is forced to interrupt the presentation in order to provide feedback, unless they are specifically invited to give feedback or if they are already speaking.

The unique use of *Direct Recommendation - Meta-Task* is also likely an artifact of the ME review format. The design review presentation had been practiced by the students, had an associated timeline-like artifact (the slidedeck), and was presented as somewhat immutable. Although this format has the advantage of relative completeness (that is, the review covers all the topics that the students intended to be reviewed), it dissuades extensive discussion of project components beyond those that are presented. Thus, the reviewer must interrupt the presentation to discuss something within it, or change topics in order to discuss something not in the presentation. The recommendations are analogous to controls on a video player; the instructor *pauses* the presentation to discuss something outside the presentation, *rewinds* it to an earlier topic, *replays* a part of the presentation to understand it better, and even occasionally *resumes* the presentation. However, the instructor does not alone have the ability to control the presentation: the students can choose to resume the presentation, limit the disruptiveness of the instructor by limiting their response, or pause the presentation themselves by asking for feedback directly. While this did not occur often, there were a few instances within the ME review where students invited feedback or attempted to anticipate a problem. The instructor's control of the presentation is unique in its use of *Direct Recommendation* as a controlling discursive mechanism.

Feedback Available to Students

Throughout both the ME and ID reviews, the students gave feedback to the reviewers on their proposals, suggestions, and their feedback itself. However, while the instructors had a range of

feedback types to use, students used a more limited feedback vocabulary. Students in the ME review exclusively used *Investigation* and *Interpretation*, while the ID student used *Investigation*, *Interpretation*, and *Judgement* regularly. In a few critical behaviors, the ID student also used *Brainstorming*, *Process-Oriented*, *Identity Invoking, Free Association*, and *Comparison* feedback. A summary of the feedback used by the students in the two reviews is found in Table 4.

Table 4. Frequency of feedback types used by students throughout the entirety of each review. The ID student delivers substantially more feedback, and notably uses *Judgement* while the ME students do not.

Feedback Type	ME Review Frequency	ID Review Frequency
Investigation	11	16
Interpretation	4	16
Judgement	0	17
Other	0	6

***Investigation* and *Interpretation* as Student-Available Feedback.** Students in both reviews regularly asked their reviewer questions to solicit particular feedback or information about their design or process (*task*), or to clarify the reviewer's feedback (*meta-task*). Student use of *Investigation* feedback spans most critical behaviors, but is especially relevant to *Requests Specific Advice* and *Suggests with Clarifications*. For example, a student might ask "should I put [the prototype] together here, or should I put it together there?" to solicit advice, or "Do we pay him?" to clarify a suggestion.

In both of these CBs, the students actively engaged in the feedback by soliciting it or attempting to understand it. Similarly, *Interpretation* feedback was used as a way for students to actively engage in the feedback from their reviewers, especially in highly engaged CBs like *Mutually Modify an Idea* and *Requests Specific Advice*. The more-limited use of *Interpretation* in the ME review seems to be related to the relatively unambiguous nature of the ME instructor's feedback (that is, it does not require much interpretation to be understood), especially in their use of direct recommendations over other more-ambiguous suggestion mechanisms. *Investigation* and *Interpretation* feedback served a similar role when used by students: they allowed the students to adjust the feedback they were receiving to be relevant to their needs and understanding of their own design.

***Judgement* as Student-Available Feedback.** The major difference between the ID student's and the ME students' use of feedback during the reviews was the ID student's regular use of *Judgement* feedback, largely targeted towards the *Task* and *Meta-task*. The student assessed the quality of both their own design and the instructor's feedback. This judgement was both positive and negative, such as "That's a good idea, OK," and "That [doing a process-oriented suggestion made by the instructor] would get on my nerves." Student-given *Judgement* feedback spanned critical behaviors in the ID review, but seemed to fall into one of four major uses: to evaluate the instructor's process or design suggestion as good or bad, to acknowledge or express appreciation

for the instructor's feedback, to point out an error in the instructor's feedback, or to judge oneself (see Table 5).

Table 5. Major positions adopted by the ID student's *Judgement* feedback in the review, and the critical behaviors those positions occurred within.

Positions adopted by *Judgement* feedback	**Associated Critical Behaviors**
Evaluate the instructor's process or design suggestion (feedback) as good or bad	*Requests Specific Advice (Specific Reply)*
	Mutually Modify an Idea
Acknowledge or express appreciation for instructor's feedback	*Suggestion with Acknowledgement*
	Briefly Judge
	Relate to Another Project
Point out error in instructor's feedback and evaluate their response to the disagreement.	*Dispute Claim (Modify Claim and Accept, Concede Claim)* (when student-initiated)
Judge oneself	*Self-Judgement Concurred*

Of these, a particularly interesting case of the use of student's *Judgement* feedback is in *Requests Specific Advice (Specific Reply)*. When used in this critical behavior, the *Judgement* always comes at the end of the CI, much as it does in *Inquire about Design (with Judgement)*. Drawing an analogy between the critical behaviors, we see similar structural components (question → response → judgement), but the roles are reversed (this idea of role reversal is explored in a subsequent section) between student and instructor, and the question changes from the instructor investigating the design (*e.g.,* "How tall is this … ?") to the student investigating the opinion of the instructor (*e.g.,* "Do you think I should … ?"). An example of this comparison is in Table 6.

Another case is when a student's *Judgement* feedback was used in *Dispute Claim* CIs. Most commonly the instructors were the ones who Dispute Claims made by the students. However, twice in the ID review, the student disagreed with the instructor's claim, using *Judgement* to point out an issue with the claim and to evaluate the response of the instructor to the incident. For example, in one case, the student judged an instructor's suggestion as infeasible, disputing the claim that the suggestion was desirable.

The claim structures used by the student mimic that of an instructor-initiated CI classified as *Identify Problem/Deny Problem*, in which the ME instructor used a series of *Investigation* questions to identify problems in the students' design, and evaluated their responses to his questions. This comparison is illustrated in Table 7. Again, these critical behaviors are somewhat analogous in structure (problem-identifying question → response → evaluation), but differ in the type of disagreement that arises and the way the respondent responds to the disagreement

Table 6: Comparison of similar claim structures between an ID *Requests Specific Advice (Specific Reply*) CI that ends with the student expressing *Judgement* and an ME *Inquire about Design (with Judgement)* CI.			
Excerpt from ID *Requests Specific Advice (Specific Reply)*		Excerpt from ME *Inquire about Design (with Judgement)*	
ID Student	I mean I could just make it out of wood, couldn't I? Just like -	ME Instructor	How are you gonna get that [printed circuit board] made?
ID Instructor	Yeah … you're probably gonna go an inch and a half [begins drawing], inch and a half with a, a half-inch space around it, you know, just to laminate it up to your two inches …	ME Student	Here at the electrical shop, maybe.
ID Student	Okay. That might be nice.	ME Instructor	Okay.

Table 7. Comparison of similar claim structures between an ID student-initiated CI and an ME instructor-initiated CI.			
Excerpt from ID *Dispute Claim*		Excerpt from ME *Identify Problem/Deny Problem*	
ID Student	Is [Instructor 2] in there right now? He usually doesn't get here till 10:30 'cause he stays so late. He stays really late.	ME Instructor	So doesn't that mean there's a fairly low margin to keep the fish upright?
ID Instructor	Oh, okay.	ME Student	As far - well, it is weighted downward ...
ID Student	That's okay [laughs].	ME Instructor	Right. What is …

***Brainstorming*, *Process-Oriented*; *Comparison*, *Free Association*, and *Identity Invoking* as Student-Available Feedback.** The ID review is also distinguished by the student's use of other feedback types. These feedback types are grouped into two feedback scenarios: those used for *Mutually Modify an Idea* and *Briefly Judge* (*Brainstorming* and *Process-Oriented*), and those used for the student-initiated *Relate to Another Project* (*Comparison*, *Free Association*, and *Identity Invoking*). In both of these uses of feedback, the student uses the feedback in the same way the instructor uses the same feedback types earlier or later in the same CBs. This indicates that these are socially established uses of these feedback types, and are roughly equally available to the student and the instructor within the ID review (both engage in *Mutually Modify an Idea* CIs, and they initiate an equal number of *Relate to Another Project* CIs).

Discussion of Feedback Availability. The notable differences in feedback use between the ME and ID students was the ID student's increased use of feedback generally, unique and frequent use of *Judgement* feedback, and use of feedback in *Mutually Modify an Idea* and *Relate to Another Project* CBs that mirrors that of their instructor. Again, these differences are likely driven by design review format. The more-formal power distance within the ME review

encourages respectful listening and deference to the instructor's feedback, while the back-and-forth and mutual play of the ID review encourages the student to not only listen to the instructor's feedback, but to critically consider it and create their own feedback in a similar manner.

In this way, the ID review served not only as a way to improve the project, but also to develop the student's professional identity and practices, as they engaged in reviewer-like behavior (Adams et al., 2016). There was a climate of *Collaboration* (Dannels et al., 2011) between the ID student and instructor: they worked together to create new feedback that neither of them alone could generate. The mutual use of *Identity Invoking* feedback in the ID review reinforces this climate, as both the student and instructor acknowledged the other's personal and professional experiences as industrial designers. It is difficult to determine if this climate is the result of the more-active review environment created by particularly welcoming or low-formality discursive patterns within the review, or constructed in the course environment outside of this review. In any case, the active format and collaborative climate allowed for the student to give feedback and develop their professional identity, in contrast to the environment of the ME review.

Students Displaying Instructorly Behaviors

As shown in Table 2, some critical behaviors were initiated by only students, and others by only instructors. However, there were a few examples of critical incidents within a single behavior being initiated by both students and instructors. In each of these CBs, half or more of the times the behavior occurred was instructor-initiated. Being commonly initiated by instructors, we termed these behaviors *instructorly behaviors*, and compared student uses of these behaviors to those of the instructors. Though this behavior might be considered role imitation or role-reversal, there were times when the student would display a given behavior without being preceded by instructor performance of that behavior in the same review.

The ID student was the only student who used instructorly behaviors. Within each critical behavior that showed this role-reversal, the student tended to adopt the initiating position in a less effective way than an instructor would, and would adopt the position with more limited success than instructors sometimes would (resulting in being categorized as a less-active or less-successful sub-behavior). The *success* of the adoption of a position was evaluated by the extent to which the position is opposed or unopposed, and the extent to which all participants considered the position to be correct at the end of a critical incident. The behaviors identified as instructorly were *Identify Problem/Deny Problem*, *Briefly Judge*, *Ignore*, *Dispute Claim*, and *Relate to Another Project*.

***Identify Problem/Deny Problem* as an Instructorly Behavior.** Of the eight critical incidents classified as *Identify Problem/Deny Problem*, only one was initiated by a student. Interestingly, this was also the only CI within this critical behavior that came from the ID review. It was of the sub-behavior *Accept Denial*, the least successful way for the initiating position (that is, the identification of a potential problem) to be adopted (the initiator accepts the denial of the problem, instead of insisting that the problem will exist). The initiating position itself was presented in a more-indirect way than the ME reviewer presents some initiating positions within the same CB.

Table 8. Comparison of a student-initiated *Identify Problem/Deny Problem (Accept Denial)* CI with one initiated by the instructor. The initiating position is more accommodating to disagreement in the student-initiated CI.

Excerpt from ID *Identify Problem/Deny Problem (Accept Denial)*		Excerpt from ME *Identify Problem/Deny Problem (Accept Denial)*	
ID Student	It'll look a little bit - it won't look as good as the bottom, is that okay?	ME Instructor	What prevents the fish from taking a nose-down attitude when it's just going horizontal?
ID Instructor	Yeah.	ME Student	The uh, we have two preventative measures ...
ID Student	Okay [laughs].	ME Instructor	All right, okay.

As seen in the example quotations above (Table 8), the way the ID student identified a potential problem accommodates denial or dismissal of that problem. They did this by identifying the problem by means of *Interpretation* feedback, and then asking if the problem would be acceptable in the final implementation through *Investigation*. In contrast, the ME instructor identified the problem through *Investigation* feedback, which demanded a response to (and acknowledgment of) the problem itself, not its acceptability. The respondents to the ME CI must defend their position, while the ID respondent is allowed to simply give their opinion. Furthermore, the framings of the questions posed to the respondents lead to different forms of response. The ID instructor voiced their denial of the problem as agreement, while the ME student (in a way) voiced their denial as disagreement.

***Ignore* as an Instructorly Behavior.** The *Ignore* critical incident initiated by the ID student is notable as an example of the *Passive* sub-behavior that it displays. The student simply failed to acknowledge the feedback the instructor was giving. This is differentiated from the CIs that form the *Active* sub-behavior because the student did not ignore the comments of the instructor by speaking over them. It is also differentiated from the other *Passive* CI, in which the student asked/joked about an email she received, and received no response from the instructor. Since this was ignoring an *Investigation* (which by definition necessitates a response), this was a more-contrary position than the student adopted by failing to listen.

***Dispute Claim* as an Instructorly Behavior.** As previously mentioned, the two *Dispute Claim* critical incidents initiated by students fall into the sub-behaviors of *Concede Claim* and *Modify Claim and Accept*. Though *Concede Claim* was the most successful SCB within *Dispute Claim* (when compared to *Modify Claim and Accept* and *Assert Claim and Conditionally Accept*), the way the student presented the disagreement was less direct than when the instructor did so (Table 9). The ID student introduced the disagreement as an *Investigation* with room to assert the original claim, while the ME instructor introduced their disagreement as a disruptive *Direct Recommendation* (see earlier discussion of disruptive feedback). Thus, the student again initialized the critical incident in a more-indirect way than the instructor did.

Table 9. Comparison of the ID student-initiated *Dispute Claim (Concede Claim)* CI with the one initiated by the ME instructor.			
Excerpt from ID *Dispute Claim (Concede Claim)*		Excerpt from ME *Dispute Claim (Concede Claim)*	
ID Instructor	I'd like, see if [another instructor]'s there, ask him right now does he have any resources where you could get some metal	ME Student	The mission statement and organizational chart hasn't changed much.
ID Student	Is [he] in there right now? He usually doesn't get here till 10:30 'cause he stays so late. He stays really late.	ME Instructor	Let's, ah, for practice let's re-introduce everybody
ID Instructor	Oh, okay.	ME Student	Okay. I'm [name]. I'm the team leader ...
ID Student	That's OK [laughs].		

The other two *Dispute Claim* SCBs were both less successful forms of this CB. The *Modify Claim and Accept* SCB was initiated only by the ID student (meaning the claim is modified by the instructor), and the *Assert Claim and Conditionally Accept* SCB was initiated only by the ID instructor (meaning the claim was asserted by the student). It is not obvious which of the corresponding initiating positions was less successful, so we will refrain from comparing them by that metric. However, the way the disagreements were presented are again contrasted. In the student-initiated CI, the student disagreed with a claim by expressing skepticism in a form of *Judgement* (*i.e.,* "I don't know [about that]."), while the instructor disagreed with a claim by providing a contrary *Direct Recommendation* (*i.e.,* "I wouldn't let 'em sit on it just in case."). The *Direct Recommendation* implies that only acceptance or denial of the recommendation are valid responses, while the tepid *Judgement* almost explicitly allows for a middle way.

***Relate to Another Project* as an Instructorly Behavior.** The last critical behavior in which the industrial design student took on the role that the instructor often takes is *Relate to Another Project*. Both the instructor and student initiated this CB an equal amount (twice each). However, the way and purpose of initiating this CB appears to be different. While the instructor related their own feedback about material choices (design decisions) to their experience seeing and working with those materials, the student related the instructor's *Process-Oriented* feedback to processes they had experienced before, once to a class and once to a previous internship/job as an industrial designer. Both the student's and the instructor's *Comparisons* and *Free Associations* are *Identity Invoking*, in that the design review participants related to one another by reference to shared experiences as industrial designers and visual artists. But, by virtue of their respective positions and experiences, and judging from the responses they correspondingly received, the instructor's examples seem more instructive and useful to the student's disciplinary development, while the student's examples seem like an attempt to establish identity and demonstrate competence. This behavior can be viewed as a sort of credentialing ritual that contributes to the "socialization of students into the discipline" (p. 2) that Cardella and colleagues (2014) recognize as a part of design review communication.

Summary of Findings

The power-related critical behaviors, presented in Table 2, represent several archetypical behaviors in design reviews. These behaviors included some that were witnessed in other design reviews during the case selection process, as well as a few behaviors that are seemingly unique to these two examined reviews. While this is not an exhaustive list of power-related behaviors that occur within design reviews, many of these possible power-related behaviors could easily occur in design reviews of similar formats. This list serves as a starting point for further critical incident analyses of design reviews in the future.

The in-depth exploration of these critical incidents highlighted *disruption* as a way of asserting power over an established timeline by demanding that attention be drawn from it. Of the examined design reviews, disruption overwhelmingly occurred in the ME design review, likely because of the limitations of the presentation-style format. Disruptive instructor behavior occurred by means of feedback: either interrupting *investigation*-style questions, timeline-controlling *direct recommendations* on what should be discussed in the review, or suggestions in the form of *brainstorming* and *process-oriented* feedback that were quickly acknowledged.

The analysis of these two reviews also revealed how certain types of feedback are available for students to use during design reviews, while other types of feedback seem largely inaccessible. While students in the ME review strictly *investigated* or *interpreted* the feedback of their instructor, the student in the ID review used those types of feedback and additionally *judged* the quality of their design and the instructor's feedback. The ID student also used other types of feedback in certain scenarios, suggesting that while some feedback from students was generally welcome and relevant, other feedback was more situationally dependent, allowed, or necessary. This finding furthers the notion that the format and tacit rules of the design review restrict the types of interactions that may occur.

Finally, the critical behaviors that emerged from the analysis identified moments where certain students may act in instructorly ways, exercising power in ways similar to their instructors. Yet, when students attempted to exercise this power, their approach was less effective and as a result, they were less successful in adopting their intended positions. While this behavior was only witnessed by the student in the ID review, it is possible that there are underlying factors for this behavior, both the acts themselves and the way they happen or are successful. The instances of the student exercising instructorly power also suggest that some types of feedback are more effective than others in adopting positions, at least in these contexts.

When taken together, these findings provide an initial framework by which to consider feedback as a tool for students and instructors to exercise power, and examples of how that tool can be used in some contexts. Feedback types can be considered a *code* in the sense of the Positioning Star of David (Bartlett, 2014), implying that the feedback can constrain and create affordances for certain positions, acts, and timelines, while feedback availability itself is related to and constrained by the cultural capital of the speaker and the perception of their audience.

Limitations

When considering these results, it is important to recognize the inherent limitations of this study and its design. The results are limited by the development of the methodology; the methodology was designed around the already-available dataset, not the research question alone. The analysis method has a large potential for introducing systematic bias; although the feedback code development was done collaboratively, subsequent analysis and result synthesis was completed by the first author individually with the second author serving as a skeptical peer reviewer (Creswell & Miller, 2000; Miles & Huberman, 1994). The first author may have made random or systematic errors that went unnoticed in the review process. Finally, the results are limited by the data collection method, since the reviews were conducted at a single university, and the researchers' knowledge of the context of the examined reviews is limited to what was recorded in the dataset. The use of two disciplines allowed for comparison across design review formats, yet the exact implementation of these formats may not be aligned with those used more generally. As such, these results are not necessarily generalizable to other design reviews or other disciplines, though they could certainly be used as conjectures to orient further investigation toward generalizable results. Similar research on other reviews of the same disciplines could strengthen the generalizability of these findings.

Implications

Through this study, we aimed to develop recommendations for future work to consider these relationships across more engineering disciplines and design education settings. Ultimately, we hope the results of this research can (1) help instructors better understand how their feedback in a design review can support students' development as engineers, and (2) enhance student awareness of their educational experiences, enabling them to better articulate what they need.

Implications for Practice

Design students, instructors, and other reviewers should recognize that design reviews can be understood through a lens of shifting power dynamics. The Positioning Star of David can be used by design review participants to understand what is going on in a particular moment of a design review, and potentially lead to less confusion and more clear articulation of what occurs in design reviews. Furthermore, awareness of feedback placement in a framework for power dynamics could affect how students and instructors give feedback. For example, if power equity is desired, using certain feedback types in a disruptive manner could be intentionally avoided by instructors to allow other participants increased control over their design review. Alternatively, it could be intentionally used by students as a way to command the immediate attention of design review participants. In this way, instructors and students can give increased attention to the relational aspects of design review discourse.

If changing the power dynamics of design reviews is desirable, recognition of a design review's format as limiting the available interactions could lead to innovation in design reviews. It may be possible for review participants to define counternormative interaction "rules," such as "the instructor will be able to interrupt with only brainstorming feedback," or "the student will always be welcome to give direct recommendations to the instructor," and to use those rules to design new paradigms for design review formats. Improved awareness of the power dynamics of reviews can be used to identify interaction goals that have desirable outcomes for all review

participants, and can be used to monitor the success of any review format experimentation. These exercises in imagining potential futures could directly lead to improved design review formats, and, secondarily, change the dynamics of the learning environment outside design reviews by inviting students to be collaborators in curricular innovation.

Implications for Research

This study demonstrates the importance of a critical stance when studying design review discourse, and contributes to Dannels and colleagues' (2011) call for "exploring tensions within the student/critic relationship" (p. 112). Future research could adopt a similar stance, recognizing design review feedback as both communicating project information and relational information.

This study leaves us with more questions about power dynamics in design reviews than answers. Of special interest is how power dynamics play out in other design review formats, especially ones with external visitors as reviewers or increased student participation as reviewers. Might these other classes of reviewers act similarly and display similar power-related critical behaviors, or might they introduce new behaviors and new ways of performing them? Either result would give a greater understanding of the essence of design reviews.

Another area for future research is to consider the malleability of certain contextual factors. For instance, can a course simply change design review format? Could the relative cultural capitals of design review participants be redistributed? If certain elements constrain the power dynamics of a review, but different power dynamics are desired, it will be important to have an understanding of how those elements can change.

Conclusion

The purpose of this exploratory study was to investigate the extent to which the power dynamics within the design review are related to design review feedback. Using previously-collected video recordings of design reviews in two courses at a large public university, an undergraduate mechanical engineering design course and an undergraduate industrial design course, an in-depth exploration of two formative design reviews (one from each course) was conducted. Open coding methodologies were applied to examine power structures and to capture the critical incidents related to power dynamics, while existing classification schemes were used to identify the types of feedback that occur within and around these incidents.

Some feedback types were found to be commonly used by instructors in a way that disrupted design reviews. Asking questions about the design task, directing the students to speak about a particular topic, and giving suggestions toward the design task were all used at times to interrupt a design review. The mechanical engineering review format (*i.e.* a formal, planned presentation) seemed to necessitate interruptions, as the industrial design review contained fewer interruptions and demonstrated fewer types of interruptions.

Furthermore, emerging discursive patterns indicated that students have a relatively restricted set of ways of interacting in design reviews, and that even in more-equitable reviews, students can have limited effect in achieving their discursive goals. Asking questions to the instructor and judging the instructor's feedback were observed by students in both reviews, while only

industrial design students gave types of explicitly generative feedback that instructors often did, such as *Brainstorming* or *Process-Oriented* feedback. Furthermore, the industrial design student occasionally demonstrated behaviors typical of instructors in both reviews, though often in a way that limited the student's discursive success. This limited success may be related to particular feedback types that the student used to adopt positions.

This study complements existing studies on the different roles instructors play within a design review and literature on first-person student experiences in these reviews. In addition, it provides a starting place for considering how to re-design design reviews through restructuring norms in order to support student/designer agency and development in the design process.

Acknowledgements

The authors would like to thank Dr. Robin Adams, the Design Thinking Research Symposium 2014 organizing committee, and the data collection team for access to the rich common dataset. We also would like to think those who provided thoughtful reviews of draft versions of this paper and comments on its methodology and findings, especially Mel Chua, Dr. Amie Cieminski, Dr. Scottie-Beth Fleming, Cassandra Groen, and Dr. Alisha Sarang-Sieminski. Lastly, we thank members of our research team who supported this project in other ways: Tom Heale, Claire Kincaid, Steven Meyer, and Tehya Stockman.

References

Adams, R. S., & Siddiqui, J. (2013). Purdue Design Thinking Research Symposium (DTRS): Design Review Conversations Database. W. Lafayette, IN: Purdue University.

Adams, R. S., Forin, T., Chua, M., & Radcliffe, D. (2016). Characterizing the work of coaching during design reviews. *Design Studies, 45*, 30–67. http://doi.org/10.1016/j.destud.2015.12.007

Anthony, K. H. (1991). *Design juries on trial: The renaissance of the design studio.* New York: Van Nostrand Reinhold.

Bartlett, T. (2014). *Analysing power in language: A practical guide.* Abingdon, Oxon: Routledge.

Bartlett, T. (2009). Legitimacy, comprehension and empathy: The importance of recontextualization in intercultural negotiations. *European Journal of English Studies*. 13(2). 179-192. http://doi.org/10.1080/13825570902907219

Cardella, M. E., Buzzanell, P. M., Cummings, A., Tolbert, D., & Zoltowski, C. B. (2014). A tale of two design contexts : Quantitative and qualitative explorations of student-instructor interactions amidst ambiguity. *DTRS 10: Design Thinking Research Symposium,* 1-27.

Connor, A. Design reviews vs. design critiques. Retrieved February 10, 2017. http://www.discussingdesign.com/design-reviews-vs-design-critique

Creswell, J.W. & Miller, D.L. (2000). Determining validity in qualitative inquiry. *Theory into Practice.* 39(3), 124-130.

Dannels, D. P., & Martin, K. N. (2008). Critiquing critiques: A genre analysis of feedback design studios. *Journal of Business and Technical Communication*, 22(2), 135–159.

Dannels, D. P., Gaffney, A. K., & Martin, K. N. (2008). Beyond content, deeper than delivery: What critique feedback reveals about communication expectations in design education. *International Journal for the Scholarship of Teaching and Learning, 2*(2), 1–16.

Dannels, D. P., Housley Gaffney, A. L., & Martin, K. N. (2011). Students' talk about the climate of feedback interventions in the critique. *Communication Education, 60*(1), 95–114. http://doi.org/10.1080/03634523.2010.487111

Flanagan, J. C. (1954). The critical incident technique. *The Psychological Bulletin, 51*(4), 327-358.

Frederickson, M. (1990). Design juries: A study in lines of communication. *Journal of Architectural Education, 43*(2), 22–27. http://doi.org/10.1080/10464883.1990.10758556

Harré, R. & van Langenhove, L. (Eds.). (1999). *Positioning theory.* Oxford: Blackwell.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81–112. http://doi.org/10.3102/003465430298487

Hughes, H., Williamson, K., & Lloyd, A. (2007). Critical incident technique. In S. Lipu (Ed.), *Exploring methods in information literacy research. Topics in Australasian library and information studies, Number 28*, (pp. 49-66). Wagga Wagga, N.S.W.: Centre for Information Studies, Charles Sturt University.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin, 119*(2), 254–284. http://doi.org/10.1037/0033-2909.119.2.254

Lande, M., & Oplinger, J. (2014). Disciplinary discourse in design reviews : Industrial design and mechanical engineering courses. *DTRS 10: Design Thinking Research Symposium*, 1–22. Retrieved from http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1061&context=dtrs

Littlejohn, S. W. & Foss, K. A. (2011). *Theories of human communication.* Long Grove, IL: Waveland Press.

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks: Sage.

McNair, L., Paretti, M., & Groen, C. (2014). Learning and becoming in design reviews. *DTRS 10: Design Thinking Research Symposium,* 1–34. http://doi.org/10.1017/CBO9781107415324.004

Strauss, A. L., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques.* Newbury Park, CA: Sage.

Tonso, K. L. (2007). *On the outskirts of engineering: Learning identity, gender, and power via engineering practice.* Rotterdam: Sense.

Yilmaz, S., & Daly, S. R. (2016). Feedback in concept development: Comparing design disciplines. *Design Studies, 45*, 137–158. http://doi.org/10.1016/j.destud.2015.12.008

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks: Sage.