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An Exploration of Conflict Asymmetry in a First-Year Engineering Design Project Team

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An Exploration of Conflict Asymmetry in a
First-Year Engineering Design Project Team

Abstract

Conflict is an inherent part of collaboration in engineering design teams. Engineering education researchers and practitioners have developed resources to help students understand the types of conflict and various conflict management strategies. Despite this, students continue to struggle to mobilize this knowledge to resolve conflicts within their project teams. One reason for this barrier may be that most previous research and interventions have assumed conflict to be symmetrical across all students involved (i.e. all students perceive the conflict in the same way), which recent work indicates may not be the case [1]. This work aims to better understand the complex processes involved in the perception and management of conflict in student project teams by investigating the (a)symmetrical nature of conflict within student teams and what the implications of this (a)symmetry are on conflict management outcomes. This work will answer the research questions: (1) How do students' perceptions of conflict experiences converge and diverge from their team members? And (2) What are the consequences of this (mis)alignment for conflict management outcomes? This work employs multiple perspectives research (MPR) to gain a more nuanced and fulsome understanding of the occurrence of conflict within a project team. Data from semi-structured interviews with three students within a first-year project team was collected following the conclusion of the term. Interview data was analyzed using thematic coding and compared and contrasted to determine congruence and divergence of conflict experiences. Results show that both symmetrical and asymmetrical conflicts were present in the project team over the term. Symmetrical conflicts were more likely to be managed effectively than asymmetrical conflicts. This research showcases the complexity of conflict experiences in a student project team and highlights the need for a more nuanced understanding of conflict experiences. Implications for engineering education researchers and practitioners are included.

Introduction

Conflict is a natural consequence of students working closely together in engineering project teams. There has been a recent surge in conflict literature on engineering student project teams, with a particular focus on the relationship between conflict type (i.e. task, process, or relationship) and team performance [2] - [4]. Process and relationship conflict has been found to be detrimental to team performance [5], so engineering education researchers and practitioners have developed resources and interventions to help students understand the types of conflict and various conflict management strategies they can use to manage these conflicts effectively. Resources such as conflict management course modules embedded in design courses [6], and conflict management workshops [3], [7] - [9] have been implemented with varying levels of effectiveness. Despite these initiatives, some students struggle to mobilize this knowledge to manage conflicts within their own project teams.

One reason for this barrier may be that most previous research has considered conflict to be symmetrical across all students involved (i.e. all students perceive the conflict in the same way). Work by Jehn et al. [1] has highlighted that in reality, conflict is most likely asymmetrical and is experienced differently by each person involved. This asymmetry may alter conflict perceptions and conflict management approaches taken by students [1]. A better understanding of the nature of conflict (a)symmetry in engineering student project teams is required to assist students in recognizing and managing conflict effectively within their teams.

Background

Symmetrical and Asymmetrical Conflict

Conflict is considered to be disagreement between team members and is typically divided into three types: "task conflict" involving conflicts about the content of the work to be performed, "process conflict" involving conflict about how the work is performed, and "relationship conflict" involving interpersonal incompatibilities [4]. Although task conflict has generally been found to be beneficial for team function [4], [10] and process and relationship conflict have generally been found to be detrimental to team functioning [4], further research has shown that there may be complexities in these trends that were originally not considered, such as when conflicts are not perceived equally between parties [1].

Conflict asymmetry is defined as the difference in perceptions of conflict among involved parties [11], [12]. Jehn et al. [1], found that asymmetrical conflict should be considered the norm compared to symmetrical conflict, particularly in relationship conflicts. Consequences of asymmetrical conflict include decreased team performance and creativity [1]. To support students in managing conflicts within their project teams, it is critical to understand when conflicts are asymmetrical and what additional steps should be taken to manage asymmetrical conflicts. Previous work on conflict asymmetries has focused on task and relationship conflict [1], while not addressing process conflict. In the engineering education literature, conflict asymmetry has largely been overlooked, which may have significant implications for the resolution of conflict by students [1].

Conflict in Engineering Education

Conflict and conflict management are particularly critical in engineering project teams, where students work closely and intensely together over a term to generate a solution to an ill-structured design project. Neumeyer and McKenna [13] found that the main conflicts within engineering design teams involve all three conflict types, including conflicts of commitment (i.e. process conflict), different ideas about the project direction (i.e. task conflict) as well as different working styles and personalities (i.e. process and relationship conflict). Parreti [14] found that conflicts within Capstone engineering teams fell into five major categories: design decision, workload imbalance, capability deficiency, personality, and miscommunication. Neumeyer and McKenna [15] also found that conflict can result in a healthy sharing of diverse perspectives that can lead to a more innovative solution in design teams. Properly managed task conflict has also been linked to creativity and increased satisfaction in group members while generating solutions to ill-structured problems, such as those used in design courses [16]. Neumeyer and McKenna [13] found that the conflict management strategies used by students directly impacted creativity, future team interactions, and the final product. Neumeyer and McKenna [13] discuss that regressive conflict management strategies such as scapegoating and avoiding degrade these team outcomes, while progressive conflict management strategies such as deferring judgment and brainstorming can improve these team outcomes. Students must implement progressive conflict management strategies to effectively manage conflicts and obtain beneficial team results. As far

as the authors of this work are aware, the concept of conflict asymmetry has not been studied in the engineering education literature.

Interventions to Improve Conflict Management in Engineering Education

A variety of interventions have been designed to improve conflict management within engineering student project teams. A common strategy to manage conflict within engineering student project teams is through the direct intervention of a member of the teaching team. Paretti [14] found that there were generally two approaches for this type of intervention, the first is a faculty member meeting with the whole team to address the conflict as a group, and the second is a faculty member meeting with just the student(s) at the heart of the problem. These strategies are most effective in smaller classes where the teaching team can take a hands-on approach with all teams encountering conflict. In larger classes, this becomes much more difficult. To support large numbers of students with little teaching team intervention, strategies to increase conflict management and conflict resolution skills in engineering student project teams have been implemented through scenario-based workshops [7] - [9], teaching modules [17], and case studies [7]. These interventions help students develop skills to recognize and manage conflicts without the direct intervention of the teaching team. Although the interventions presented have resulted in high levels of cognitive learning among engineering students [7], some students continue to struggle with implementing conflict management skills within their project teams. This may be due to a limited understanding of the dynamics of conflicts and unequal perceptions of conflict between students within their project teams, which can hinder their ability to manage conflicts effectively [1].

Research Purpose

There is a gap in the current literature regarding whether conflict within project teams tends to be symmetrical or asymmetrical, and what the consequences of this (a)symmetry might be on conflict management outcomes. This work aims to fill the literature gap by investigating the nature of (a)symmetry in engineering student project teams and the implications of this on conflict management outcomes.

Research Questions

Our overarching goal of this work is to determine if conflict asymmetries are present in engineering student project teams, and how these asymmetries affect the conflict management outcomes within the team. We will answer the following research questions:

(1) How do students' perceptions of conflict experiences converge and diverge from their team members?

(2) What are the consequences of this (mis)alignment for conflict management outcomes?

Method

Research Design

This work aims to understand how various students within a first-year engineering design team perceive conflict and if the (mis)alignment of conflict perceptions affects conflict management outcomes. We employ Multiple Perspective Interviews (MPIs), which is a research methodology involving interviewing members of a group separately and triangulating their accounts during analysis to gain insights into the group's functioning as a whole [1]. Semi-structured, open-ended interview protocols were developed for use in this study. The protocols were aimed at understanding if and how internal and external factors including, but not limited to, conflict, affected the engagement of individuals within their student project team. To minimize the effect that our protocol had on data collection, it was designed to provide a structure through the order and wording of key questions, while maintaining flexibility for both the interviewer and interview to probe student experiences with further questions or additional details when required [18]. This work is part of a larger research project studying factors affecting student engagement in engineering student project teams.

Interviews were conducted with individual students privately, with the hopes of providing a safe space for students to speak freely about their experiences. These interviews were conducted within three weeks following the conclusion of the Winter 2023 term. All interviews were recorded and transcribed via Zoom. Following the interviews, the researcher manually edited the automatic transcription to ensure accuracy. At the beginning of each interview, the researcher read through the ethics protocol with the students, reminding them that their interview was entirely voluntary and confidential. Semi-structured interviews were conducted using the

interview protocol described previously. Interviews had a duration of 30 minutes. Specifically, this work examines the symmetry (convergence/complementary) and asymmetry (divergence/dissonance) of conflict experiences.

Study Context

This work takes place in the context of a large, first-year engineering design course at the University of Toronto. This design course is split into two separate, term-long design courses, and all first-year engineering students, regardless of discipline, participate in this course. The course had a total of approximately 950 students enrolled. This study takes place in the second (Winter) term. All students within this course have previously taken the Fall term course where they were placed in teams to complete a four-month design project. In the winter term, students were placed in different teams of 4-6 students. Teams were randomly created by the course coordinator, based on the tutorial section that students were assigned to.

Students were provided with a short conflict management training module to instruct students on the types of conflict (task, process, and relationship) and how certain types of conflict are beneficial to team functioning while others are not. The concept of conflict asymmetry was not introduced. In the event of extreme teamwork issues such as high levels of conflict or unmanageable conflict, teamwork support instructors were available to assist teams as required.

Participants

All students within a randomly selected design team were invited to participate in the interview. Out of the six students invited, three students agreed to participate. This team was composed of three women and three men from the Mechanical and Industrial Engineering Department. Participation was entirely voluntary and students were compensated $15 of the school currency for their time. A breakdown of the participants is shown in Table 1, below.

Table 1. Pseudonyms and demographic data for participants

Pseudonym	Team	Gender	High School in English?	Engineering Discipline
Anna	A	Female	Yes	Industrial
Bethany	A	Female	Yes	Industrial
Choi	A	Male	Yes	Mechanical

Data Analysis

To begin, the transcripts were coded for conflict experiences, defined by points in time or over some time where there was a disagreement between one or more team members. One conflict experience was considered to be from the initial conflict or perception of conflict, through attempts to manage the conflict (if applicable), through the resolution of the conflict (if applicable). Conflict experiences were organized and sorted based on the source of the conflict. Once sorted, conflict experiences with the same source were compared and contrasted to those of the other students. This procedure requires flexible shifting between singular accounts as individual stories, analyzing dynamics within and between different accounts, and trying to make sense of divergent and convergent data [18]. It is at this point in the analysis that we can see experiences converge and diverge between students. From this analysis, groups of experiences were interpreted via the four interpretative outcomes as outlined by Sande and Roer-Strier [19, p. 242-248]:

1) *Same story, same meaning (convergent):* experiences are described in the same way, from the same or very close perspectives

2) *Same story, different interpretation (hybrid of convergent and divergent):* experiences are described in the same way but from different perspectives

3) *Missing pieces (complimentary):* information that is critical to understand but was not included in others' accounts

4) *Unique information (divergent/dissonant):* information that only one student provides

These interpretations were then analyzed to investigate common themes and conflict outcomes across convergent and divergent experiences. Convergent accounts indicate symmetry in the conflict experience while divergent accounts indicate conflict asymmetry.

Results

We found that students discussed a variety of conflicts that developed within their team, and there were both convergent and divergent accounts of these conflicts. A summary of conflict sources and convergence/divergence is included in Table 2, below.

Table 2. Conflict Sources And Triangulated Interpretation

Conflict Source	Triangulation Interpretation	Conflict Symmetry	Conflict Type
Time on Task in Meetings	Same Story, Same Meaning (Convergent)	Symmetrical	Process
Low Attendance	Same Story, Different Meaning (Convergent and Divergent)	Asymmetrical	Process/Relationship
Initial Personality Clash	Missing Pieces (Complementary)	Symmetrical	Relationship
Completing Work by Deadlines	Unique Information (Dissonant)	Asymmetrical	Process/Relationship

Same Story, Same Meaning: Time on Task in Meetings

All three interviewees discussed that a major source of conflict for their team was difficulty staying on task during team meetings. These team meetings occurred once per week and the main purpose of the meetings was to organize the team and work together to complete tasks. These meetings were created and scheduled by the team and held outside of class hours. Students expressed that although these team meetings were intended to be productive, the students experienced conflict regarding staying on task during the meetings. Anna described:

> "Our main problem was that sometimes during team meetings… we would team bond too much. So we get sidetracked, and then end up not doing the work which is what happened most of the time, but like it wasn't necessarily like a bad thing, because again,

we got closer as a team, so we worked better with that. But then again, we weren't really doing much work."

Similarly, Bethany described:

"We would literally like get so off topic, we'd just talked about like other things instead of the work. And we're just like, good with the work like that, so really friendly we would always say like, 'Oh, that's enough team bonding guys. We have to get the work done'."

Choi also described:

"We had weekly team meetings, and then we honestly sometimes they weren't the most productive. But I think we were able to just like get our ideas together on what we wanna achieve during the week, even if we didn't get that done in the meeting, and through that, we were able to like basically stay on top of the deadlines."

It appears that all students within the team recognized that there was an issue with staying on task in team meetings, but described the conflict in a light-hearted manner. They all expressed that they were friendly with one another and that the conflict was not necessarily a bad thing.

The team decided to manage this by using team meetings for work division and team bonding, with most of the technical work being completed asynchronously. Choi described that meetings were used to divide work such as "You're supposed to do this at this time, and then I'll help with this and so forth… most of the actual work happens outside of the meetings". He added that " I don't know if it's the most productive way to do things. But it worked for us." Anna described that "we ended up doing lots of the work, like, asynchronously because we found that work best for us". Due to the symmetry and shared conflict experience, the students were able to work together to solve the conflict in a way that was satisfactory for all students involved.

Same Story Different Meaning: Low Attendance
The team struggled with conflict over poor attendance from some team members. There was one student in particular who frequently missed meetings, which caused conflict for the students who were present at the meetings. As discussed, these meetings were created and scheduled by the team and held outside of class hours, therefore there was no instructor-level enforcement of attendance. Bethany and Choi mentioned this conflict in their interviews, while Anna did not mention this conflict at all. This may be because Anna did not remember this conflict occurring

or did not want to mention this conflict for other reasons. We will therefore examine the conflict experiences of Bethany and Choi. Bethany described:

> "There were a few complications with, like, certain team members just not showing up… In the beginning, it was kind of like a slow… [snowball effect] where [the team] was kind of laid back on it. [The student] kinda didn't show up a few times, but it's like it's fine like, sometimes things happen you don't know where things are… Because we're like, yeah, we're just starting out like, no biggie... But it just kind of kept going."

Choi also described the conflict:

> "We had one team member, they weren't very frequent in coming to the meetings, because well, they had some exciting circumstances like to go to a conference, and then they were sick quite a bit."

Both Bethany and Choi described the actions of the absent student similarly, however, there were differences in how these actions were interpreted and reacted to emotionally. Bethany expressed that she was frustrated with the situation, stating that the missing student "can't keep doing this" and expressing that "I feel like he could have done more". In contrast, Choi expressed "It was understandable… sometimes they would miss meetings, but honestly … we didn't care. We were able to sort that out, so it didn't make a huge impact." Choi added that low attendance "was unfortunate. But [we] can't really blame that person." Choi had a much less intense reaction to the conflict than Bethany, which contributed to the asymmetry of the conflict experience.

This conflict was not actively managed by the students, and the absentee student continued to miss meetings throughout the term with little repercussions from the team. This may be due to the fact that the differences in the perception of the conflict resulted in only Anna feeling strongly about the conflict, while Choi did not feel the need to manage the situation. Anna may have been hesitant to manage the conflict because she did not feel that the rest of the team supported her to do so.

Missing Pieces: Initial Personality Clash
Bethany and Choi both discussed that an initial source of conflict amongst the team was feelings of personality clashes between students. Bethany articulated that she felt that "we were all…different." and "everyone was like, kind of not on the same page". She described a conflict

she had with one student in particular: "In the beginning, I actually talked to one of them, and I was like we might have some problems, because the way he talked [and] the way I talked was like different." Choi also mentioned initial conflict due to personality conflicts, describing that his first perception of one of his team members was that he "[didn't] know about this person". Choi added that one reason for this initial conflict was due to the online setting of the meeting. He described that "our first team meeting was online and … once stuff is online and like, I just have a hard time actually communicating stuff" and this affected how he initially perceived his team members. Bethany did not mention that the initial meeting was held online, or how this impacted her perception of the conflict.

Both Bethany and Choi articulated that the initial personality conflicts dissipated over time. Bethany noted that "as … time went along, everyone got really friendly". She also noted that time helped with the development of relationships and acceptance of one another's personalities. She expressed that "as we kept talking, [I was] like, Oh, actually like he's more agreeable like, Oh, yeah, I see [that he is]." Due to the natural dissipation of the conflict, active conflict management was not required.

Unique Information: Completing Work by Deadlines

The team also experienced conflict over internal deadlines for individual work. The team set internal deadlines typically 24 hours before the due date, to create a buffer to deal with any last-minute issues such as internet outages, sickness, etc. These internal deadlines were created and enforced by the team and not through the course instruction. It was therefore up to the students to hold one another accountable to complete their work by the internal deadline, in advance of the course deadline 24 hours later. Adherence to the internal deadlines resulted in varying conflict experiences among Bethany and Choi.

Bethany describes:

> "We would [set a] 12 A. M. deadline, and then it would be the next day, and it would be like 5 PM [and they would say] you can do your work now, and I'm like I wanted to do my work earlier so I could do stuff. But now I'm waiting for you to finish your work…I trusted them to get the work done, but I didn't trust them to get the work done on time. I was like they'll probably finish before it's due because we have to. But I don't know…

> There was a point where I was just doing stuff, and just like waiting for them to finish it. And then I'll just move stuff around and hope it's enough, because I had to like, do sketches of the proposed designs. But they weren't finished, so I couldn't sketch what was not there."

Choi described:

> "We were like, sometimes we'd set an internal deadline, but we'd kind of know that it was unrealistic then we [would] set an actual realistic deadline, and we always get our work done by then."

This is an example of dissonant or complete divergence of experiences. Bethany believed that the internal deadlines were set with the intention of the work being completed by that time, while Choi seemed to believe that the internal deadlines were "unrealistic" and that the work just had to be done by the "actual" deadline. Bethany voiced that: "I trusted them to get the work done, but I didn't trust them to get the work done on time." Meanwhile, Choi expressed that "I'd say, for the most part, we're pretty good about getting our work done on time".

This conflict was also not actively managed by the students and Bethany continued to struggle with the conflict throughout the term. Bethany expressed that others in the team did not see the problem with missing the internal deadlines, and she felt unsupported in trying to make any changes. This extreme disconnect in the perceptions and experiences of the conflict possibly contributed to the lack of understanding and management of the conflict.

Discussion

This work presents the methods used to collect and analyze interview data from students within an engineering student project team to qualitatively assess conflict asymmetries. Four sources of conflict, each with unique interpretations of triangulation were presented.

The key takeaways from this study are included here and discussed in detail below:

1) Both symmetrical and asymmetrical conflicts were present in the project team over the term.
2) Symmetrical conflicts were more likely to be managed effectively than asymmetrical conflicts.

Examples of symmetrical and asymmetrical conflicts were included in this work. *Same Story, Same Meaning* and *Missing Pieces* interpretations can be considered to be symmetrical conflicts: all parties involved appeared to have a similar perception of the conflict source and intensity of the conflict. *Same Story, Different Meaning* is an example of an asymmetrical conflict where the parties describe the conflict source in a similar way but internally experience the conflict differently. In the low attendance example described above, Bethany describes feelings of frustration regarding the conflict situation, whereas Choi does not express frustration and instead states that the team "didn't care". This is a clear example of asymmetrical conflict where Bethany is experiencing the conflict at a much higher intensity than Choi. *Unique Information* was the final example of asymmetrical conflict, where there was a clear dissonance between experiences and the students did not perceive the conflict source and therefore experienced the conflict intensity in the same way.

The sources of conflict found in our results were *Time on Task in Meetings, Low Attendance, Initial Personality Clash,* and *Completing Work by Deadlines.* These sources of conflict are aligned with past literature on conflict in engineering student project teams which found conflict in capstone design teams around design decisions, workload imbalances, and personality conflicts [14]. The students described both process and relationship conflicts within their project team. From our limited research, it does not appear that there is a clear relationship between conflict (a)symmetry and conflict type. Future research should be conducted to explore this further. It should be noted that all of these conflicts were generally low intensity and no major issues (such as a complete lack of participation from one or more team members) were present. The students felt that they were able to manage these conflicts within the team and did not attempt to utilize the course teamwork team to assist them.

We also notice that not all students mentioned all sources of conflict during their interviews. Anna only mentioned one source of conflict (Time on Task in Meetings) and did not mention any other conflict experiences. In contrast, both Bethany and Choi discussed four sources of conflict with varying levels of symmetry. There may be many explanations for this, including that Anna did not feel comfortable discussing the other conflict events, or that Anna did not personally

experience any other sources of conflict. Regardless, this disconnect highlights the importance of multiple-perspective interviews as the three other sources of conflict mentioned by Bethany and Choi would be lost if only Anna was interviewed.

Convergent conflict experiences were generally managed in a way that satisfied all team members experiencing the conflict. In contrast, divergent conflict experiences were generally not managed in a way that satisfied all students. This may be because the students were more confident in managing conflicts when everyone in the team was working towards a solution, rather than when only one student was responsible for advocating for conflict management by themselves. The social risk of communicating wants and needs that differ from other team members may be a barrier for students experiencing asymmetrical conflict.

Limitations

One major limitation of this work is that only three out of the six students within the project team participated in the interviews. This may skew our results as we cannot fully understand team conflicts from all perspectives. Conflict averse students may be less comfortable participating in this study. Despite this limitation, we believe that this work provides valuable insight into the phenomenon of conflict asymmetry in engineering student project teams, and further research is required.

Another limitation of this work is that interviews took place following the completion of the Winter 2023 term. This caused a possible substantial (up to 16 weeks) delay from the beginning of the conflict to the interviews. Due to this, students may have forgotten or minimized conflicts to themselves as they did not seem as important as they progressed through the term. Therefore, the students may only note the most impactful conflicts in their interviews. The results from this study are limited to the experiences of students within one project team in the first-year engineering context. Further research is needed to investigate if the results are generalizable.

Conclusions

Previous engineering education research has largely assumed conflict to be symmetrical, and therefore the interventions and supports for students have been designed to address symmetrical

conflict. The novelty of this work is that we find the presence of both symmetrical and asymmetrical conflicts in engineering student project teams and the symmetry of a conflict may be related to how it is managed by students within the team. There is a need to support students in recognizing and managing asymmetrical conflicts along with symmetrical conflicts. This work provides insight into the unique context of asymmetrical conflict in first-year engineering student project teams and has resulted in the following recommendations for engineering design course coordinators and instructors:

1) Develop student resources to recognize when conflicts are symmetrical or asymmetrical
2) Assist students in applying conflict management strategies to asymmetrical conflicts

This work also informs future engineering education practice and research. Instructors should avoid assuming symmetrical conflict in engineering student project teams and should consider how asymmetries may affect conflict perception and management. Conflict management training and interventions should be altered to address the effects of asymmetrical conflict on students and provide students with strategies to effectively manage asymmetrical conflict. Current research by the authors builds on this work by doing multiple perspective interviews with all students of a first-year project team, in hopes of developing an even deeper understanding of conflict asymmetries and their implications for all students within the team. Future work should involve the development and testing of conflict management training focused on asymmetrical conflict to strengthen the conflict management skills of students.

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