Collaboration in Design Teams: How Social Interaction Shapes the Product

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Modern interdisciplinary design demands that engineers learn to work well in teams. Teamwork requires individuals to express ideas and misgivings, listen, negotiate, etc., that is to collaborate. Engineers need to be aware of various characteristics of collaboration so that they can identify successful and poor strategies within their own work practice.

Engineering design students at Stanford University, commenting on the usefulness of design process models and prescriptive design methods in their seven-month design project, noted that while the models and methods told them what to do, they provided little insight into how to do it. In particular, students wanted more help with group dynamics, solution development and project management.

The Delft Protocol Analysis Workshop presented us the opportunity to examine a two-hour long videotape of a team of practising designers developing a preliminary solution for a product that mounts luggage onto a mountain bike. Videotape allows us to take a close, careful look at how the moment-to-moment activity steers the course of the design solution. Through repeated observation, analysis and discussion we can develop a better understanding of how professional designers do such things as collaborate, develop design solutions and manage their work. This chapter explores the collaboration of
the design team. Early in the session the designers reveal different solution agendas and different ways of working. They reconcile their differences through effective collaboration. We find that the content of the evolving design depends heavily on negotiation strategies, among other more subtle and ubiquitous social processes. We describe how the design evolves through designers’ negotiation strategies and through topic shifts prompted by the design activity itself.

1 Video Analysis Method

We made a deliberate attempt to come to the tape with an open mind, trying to consider several facets of design activity, sometimes looking at long segments of tape to get a broader perspective, other times looking at short segments over and over again. We took a qualitative approach focusing on describing designer interaction, rather than a quantitative approach focusing on counting design acts or design content. In the quantitative approach, which is most common in design protocol analysis, the researcher develops a coding scheme that categorizes the design activity by topic and then spends the bulk of the research effort coding, quantifying and analysing the data looking for interesting patterns in graphs or informative statistics. We considered the design activity to be so rich that reducing the activity down to a set of categories without considerable qualitative analysis of the raw data would make considerable assumptions about what was important and run the risk of overlooking interesting aspects of the activity. We needed to immerse ourselves in the raw video data until interesting patterns emerged because we did not yet know what to look for. So we took the approach of Video Interaction Analysis, in which an interdisciplinary team observes tape segments looking for standard and interesting practices. The team stops the tape frequently to discuss hypotheses and it tests them by reviewing the tape segment. Only those practices confirmed by interdisciplinary scrutiny that occur repeatedly in different parts of the tape are admissible in the analysis. Using this method we did develop a scheme of categories. It is intended to illustrate our interpretation of collaboration in the design team. We illustrate the scheme against five minutes of raw transcript data so that the reader may evaluate its merits. However we do not attempt to quantify the scheme.

The analysis team consisted of four researchers with engineering design and design research backgrounds. Watching the
tape for the first time to make general observations, all team members found it difficult not to engage in designing the product. We were drawn into judging the content of each proposal. With each viewing, more facets of the activity appeared. In particular, it helped us to watch the tape with an interdisciplinary team of social scientists, anthropologists, computer scientists and engineers. The tape served as a catalyst, provoking recall of hypotheses based on experience from outside the tape as well as from within. Repeated video watching determined which hypotheses were validated by several occurrences of supporting events in the tape.

The time limit and restricted setting of the protocol for the purpose of video taping emphasized certain aspects of design such as time pressure and decision making, whereas other aspects such as information gathering, organizational context, the ability to mull over ideas or engage in opportunistic solutions were restricted or removed from context. All participants felt out boundaries of what was within the ‘rules’ to a greater or lesser extent. Collaboration was chosen for analysis both because of our interest in this area and because it was considered relatively insensitive to the protocol design. The analysis explores how the group works together under the given conditions, whatever they might be. Also, it became evident that social interaction strongly influenced the content of the emerging product.

2 Analysis Overview

Section 3 introduces the members of the design team. As the session progresses the designers reveal quite different preferences towards ways of approaching the design problem. Furthermore, the designers reveal preferences for different types of solution. These differences in ways of working and solution preferences require the designers to negotiate skillfully a solution. Section 4 describes how the design discussion transitions from one topic to another. It describes the designers’ negotiation strategies. It describes how they express their commitment to proposed solutions. Section 5 summarizes our analysis of the collaboration.

3 Roles and Solution Preferences

As if in a novel or play, the characters begin to reveal themselves in their opening lines (Transcript 1). Kerry, who has worked on products for bikes, bids to look at the hardware
(comment no. 1). John, who often steps back to look at the process, counters by proposing that they develop a shared understanding of the problem (comment no. 2).

**Transcript 1**

[All sitting at table with problem statement]

00:07:00

1 K what do we need? I guess we should look at their existing prototype huh?

2 J yeah, em, let me think we could also just sort of like try to quantify the problem because what’s your understanding of the problem first of all?

Throughout the early stages of the session Kerry is engaged by the existing hardware and concepts. She seeks to ground the problem by examining the existing hardware and concepts in detail (Transcript 2; comments 1, 3, 6, 8). John observes this process and then bids to work back at a higher level to get a broad view of the process they will follow before diving in (comment 9).

**Transcript 2**

00:19:00

1 K yeah you have to put a lot of tension on to these em bolts ‘cos that’s the opening is in the direction of the

2 I right

3 K loading the force it’d be nice if you could have the forks coming more like that so that

4 I right

5 J mm mm

K the bouncing

7 J it sounds like

8 K these’d have to be self-attached

9 J it sounds like in a way we’re starting to move on to ideation already but uh have have we kinda fleshed these major things out or

Transcript 3 illustrates how John begins to seek out ambiguity in the problem statement (comments 5, 9). He negotiates for
flexibility in wanting to consider internal and external frame backpack designs as well as all types of mountain bikes (comment 22). Kerry seeks to ground the problem, countering that the problem statement suggests that they only consider the HiStar external frame backpack (comments 4, 12, 14, 16, 18). Ivan’s role is emerging as one of arbitrator. He considers both positions and falls to either side. As we enter Transcript 3 they are discussing the backpack...

Transcript 3

00:09:00
1  J OK I missed that
2  I which part did you miss?
3  J oh the fact that I thought I picked up that they were going to that they were conceiving of making an internal frame pack but em I guess that’s not what they’re saying you’re saying that they make external frame packs currently?
4  K mm hmm they make external
5  J does it say that they want to stick with that or
6  I well it doesn’t say anything about going uh external or internal so that I think that you raised a good point
7  K they just yeah
8  I yeah that we have that freedom right now
9  J OK maybe we could get something that we’re gonna propose to them that if it has any advantage in this application right
10 I sure
11 J OK
12 K but they wanna use it with this external frame backpack it looks like
13 I right with this well let’s see
14 K because the HiStar this is a best-selling backpack the mid-range HiStar
15 I right and they have their best-selling bike right
16 K they’ve decided to develop an excs accessory for the HiStar
17 I yeah
18 K this is the HiStar backpack the HiStar (holding sample backpack)
00:10:00
19 J where do you see that?
20 I at the top here
21 K very beginning
22 J yeah here it is on the basis of this marketing report HiAdventure has decided to develop an accessory for the HiStar and these are the two kinda functional criteria it says a special carrying fastening device that would enable you to fasten and carry the backpack on mountain bikes and then the device would have to fit on most touring and mountain bikes so it doesn’t sound like it’s specific to this one

Kerry has managed temporarily to gain an agreement from John and Ivan that they design for the HiStar backpack. But in the last statement of transcript 3, John, in agreeing to designing for the HiStar opens up a bid to design for most touring bikes (comment 22). This is counter to an earlier suggestion in 00:08:00 by Kerry to ‘make it a special mountain bike so it could have the stuff required attached’ something to it’, tacitly agreed to by the group.

Kerry’s preference to try to pin down part of the solution is repeated throughout the tape, as is John’s preference for preserving ambiguity. Table 15.1 illustrates their design solution preferences for key issues.

The group’s roles are summarized in Table 15.2. Clips throughout the paper will illustrate the development of these

**Table 15.1** Design solution preferences. Two of the three designers exhibited consistent preferences on how to approach the problem

<table>
<thead>
<tr>
<th>Pin down solution (Kerry)</th>
<th>Preserve ambiguity (John)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design for HiStar backpack and Batavus Buster bike</td>
<td>Design for various backpacks and mountain bikes</td>
</tr>
<tr>
<td>Focus on rear placement (most promising candidate)</td>
<td>Consider all possible placements</td>
</tr>
<tr>
<td>Design for a fixed position</td>
<td>Make device adjustable</td>
</tr>
<tr>
<td>Use emerging industry standard attachment method (braze-ons)</td>
<td>Use attachment method usable by all bikes</td>
</tr>
</tbody>
</table>

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4 Making Progress - Foci and Transitions Mediated through Social Interaction

4.1 Designing from Context
Table 15.2 Designer roles. These emerged during the first quarter of the design task

<table>
<thead>
<tr>
<th>Ivan</th>
<th>John</th>
<th>Kerry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whiteboard manager</td>
<td>Theorist: abstracts process from context</td>
<td>Bike expert and use: advocate</td>
</tr>
<tr>
<td>Arbitrator</td>
<td>Uses process rationale as commentary to keep group on track</td>
<td>Seeks out context and detailed knowledge</td>
</tr>
<tr>
<td>Timekeeper/ keeps group on track</td>
<td></td>
<td>Seeks to ground the design with specific solution alternatives</td>
</tr>
</tbody>
</table>

roles. Ivan gradually emerges as an organizer, timekeeper and occasional arbitrator between John and Kerry. He manages the whiteboard lists and generally keeps the group on track. Are these roles predetermined or adopted? From the tape we cannot know whether the characters play the same roles in other design situations. Nor can we tell how the emergence of one role depends on that of another. However, it is likely that a certain amount of compensating occurs, each designer seeking to fill in gaps they perceive in the group approach. Kerry exhibits behaviour noted by Guindon² to be consistent with that of domain experts, quickly pruning the search space to promising solutions. In Section 4 we characterize how the individuals reconcile their different positions to engage in effective collaboration.

4 Making Progress - Foci and Transitions Mediated through Social Interaction

4.1 Designing from Context

Many researchers have characterized design as being opportunistic or chaotic, moving fluidly between requirements and details in response to information or ideas uncovered that are worthy of immediate exploration². The session is replete with designers abstracting from the context to gain perspective and seeking context to ground the design with affordable, manufacturable alternatives. They develop requirements by consider-
ing candidate solutions and user scenarios and tinkering with hardware. For example, requirements for easy attachment, low centre of gravity and strap containment all emerge from the context of the problem, by working with the backpack around the bike or examining the user specifications. (The structured design methods do not address how to seek out alternatives and generate solutions from the context of the problem.)

As the design team negotiates the problem space, each designer makes bids to have issues they think important discussed by the team. Having called focus on an issue, the other designers might engage in the focus, adding ideas towards a partial solution. The content of design then evolves through discussions adding incremental solution additions, use scenarios, justifications and information-seeking questions. The designers acknowledge other contributions with nods and short phrases or they call into question an aspect of a proposed solution. They align themselves with various aspects of the evolving solutions and approach and distance themselves from others. We looked for evidence presented in the videotape that designers were happy with the alignment of the team and, if not, how they sought to change it.

We characterize the design discussion as focusing in on issues and then transitioning topics. However, there is evidence that the designers are continuously engaged in multiple activities at different levels. Although they focus in on issues, they continuously monitor the progress of the solution from the point of view of various requirements and solution alternatives. They reflect on their course of action, monitoring and modifying their process. There is evidence that they monitor their team-mates’ utterances and actions on a moment-to-moment basis and moderate their talk accordingly. It is difficult to represent such a rich process in a scheme of categories. However, we have chosen to do so to try to illustrate how the evolution of the design content is governed by the social interaction in the team.

A scheme to describe how the design discussion focuses and transitions are mediated through social interaction is proposed in Table 15.3. Before offering an example of the use of the categories in this scheme, a few notes regarding their status and purpose are appropriate. The categories draw upon those used by other researchers, such as Guindon's 'partial solution' term, but are not an exact copy of any one set. Many different
Table 15.3  Classification Scheme for Focus and Transition.
Categories are chosen as an aid in conveying the notion of focus in a group setting by enabling a more detailed examination of the video, particularly the utterances.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>call-focus</td>
<td>Asks for attention, attempting to focus the group around an issue of concern</td>
</tr>
<tr>
<td>start-partial-solution</td>
<td>Begins to describe a solution or specification proposed for consideration</td>
</tr>
<tr>
<td>add/refer-to-partial-solution</td>
<td>Adds or refers to some detail or constraint in the current partial solution or specification</td>
</tr>
<tr>
<td>use-scenario</td>
<td>Illustrates a proposed detail, with a usage scenario</td>
</tr>
<tr>
<td>justify/refer-to-higher-principle/req.</td>
<td>Gives rationale, referring to requirements, higher principles or standard practices.</td>
</tr>
<tr>
<td>call-into-question</td>
<td>Asks for reconsideration of some part of a partial solution, justification, process etc.</td>
</tr>
<tr>
<td>acknowledge</td>
<td>Shows that one is paying at least partial attention, using, e.g., a short utterance or a sentence completion</td>
</tr>
<tr>
<td>needs-information</td>
<td>Expresses a need/request for some information or further filling-in of a detail</td>
</tr>
</tbody>
</table>

coding schemes are possible, each appropriate when taking a particular point of view on the subject material. We make no claim that these categories are entirely mutually exclusive; many of the phrases in the transcript carry some force in more than one of the categories. However, the ambiguities are few enough that classification and interpretation provide useful insight into the dynamics of the group and problem.

Our presentation focuses on a five-minute piece of transcript, 70 minutes into the design session. The team members are attempting to persuade each other of the merits of their suggestions on rack attachment. We begin by looking at how the content of the discussion evolves. Then we examine the social interaction at work.
The segment begins with several calls-for-focus on the issue of where and how to attach the rack to the bike (Transcript 4a: comments 1, 3). Kerry then outlines a basic proposal for a partial solution (comment 4), with a use scenario to justify it; this is in part a restatement of one of the options that has already been identified. J and I offer acknowledgments (comments 5, 6) indicating that they now share her focus on this partial solution. Then, in a series of statements (comments 7, 9), K adds details and justifications to this proposed solution, which I and J acknowledge. J then calls a piece of the proposed partial solution into question (comment 10), offering some alternatives to a detail that is being considered; K and I bolster the initial proposal (comments 11, 12) with several references to both scenarios and broad principles such as strength and reliance on standards. Acknowledgments (comments 13, 14) indicate that each continues to be engaged by the focus.

Transcript 4a

[K and I have been looking at attachment to the bike. K leaves the bike to see if she can read Dutch on the drawing, noted by J. J and I are now around the bike and K is at the table]

[01:10:30]
1 I let's see we're just thinking of
2 J of what (laugh)
3 I we were thinking of ways of er put the bracket here

[K moves towards bike]
4 K this is our idea of orientation so that we can get our bedroll without having without to move the (inaudible)
   [gestures with hardware]
5 J the roll back I agree with that
6 I right
7 K and then em I think it makes a lot sense to have a good compression member to hold this portion up
8 I mm mm
9 K and then then I think we can do that reliably kind of a la Blackburn rack use their kind of [points to standard attachment feature location on bike]
10 J does it do we really wanna use these lugs for speed
of disassembly or does it make more sense to like just have something that like a plastic ferrule or something that goes around this that you

[ 01:11:00 ]

11 I this is probably a bit stronger

12 K this is strong and er Allan wrenches are pretty standard
to be carrying around on

a y'know

13 J bike anyway

14 K on a bike on a bike

15 I Blackburn, they include it with the (inaudible) just throw it in there (inaudible) Allan wrench is practically free

you're paying fifty dollars for that so you just include it and these threads are standard or else you just include it in that tube

16 J yeah

17 K mm mm

4.4 Strategies of Persuasion

Notice that John and Kerry demonstrate commitment to their ideas and adopt persuasive strategies. The designers masterfully invoke the support of neutral parties such as common sense, higher principles or theories, and expert or standard practices to support their opinions. These serve to depersonalize the debate, in addition to being means of persuasion and explanation of rationale.

Common sense

Appealing to common sense is a tactic to build support for an idea from commonly held beliefs. Kerry's suggestion 'it makes a lotta sense' in Transcript 4a (comment 7) prefaced with 'I think', suggests she is embarking on a persuasive strategy but is open to negotiation. John counters with the same strategy in comment 10 suggesting of his idea: 'does it make more sense?'

Higher principles/ requirements/theories

Appealing to higher principles, theories or requirements also appears frequently in designers' efforts at persuasion. In comment 9 Kerry suggests 'I think we can do that reliably'; in comment 12 'this is strong, Allen wrenches are standard.' John counters with 'do we really wanna use these lugs for speed of disassembly' in comment 10 and 'it just doesn't seem real elegant...
to me' in comment 21. These higher principles or broad requirements serve as both explanation and means of persuasion.

A third persuasive strategy is to appeal to established methods by established experts. Kerry in comment 9 suggests 'I think we can do that reliably kind of à la Blackburn rack use their kind of [attachment]' An even stronger appeal is made outside this section of transcript in the 62nd minute: 'I mean if you really need adjustment I think all these Blackburn racks would have adjustments'.

**4.5 Commitment**

Before continuing with Transcript 4, a brief transcript from earlier in the session during brainstorming illustrates how differently the designers behave before they develop a strong commitment to a solution. The speakers are much more committed to their positions in Transcript 4a than in Transcript 5.

In Transcript 5, J is seated on the bike and K is experimenting with backpack position, while I lists on the whiteboard. I repeats sentences as he writes on the whiteboard (comments 4, 6) explicitly communicating his interpretation of what J and K are doing. K places the backpack in several positions suggested by J, offering advice like 'see if you can steer' (comment 8). In Transcript 5, the designers offer little commitment to each statement, prefacing statements with 'maybe', 'what about', 'would it be too funky to'. They are proposing suggestions that don't necessarily constitute opinions and paying extensive attention to communicating their actions. Calls to question, accompanied by rationale, are quickly agreed to (comments 1, 2, 3). The designers complete each other's sentences, perhaps to communicate that they understand the other's concerns. There are no justifications or reiterations of position.

Once designers begin to preface statements with 'I think' or 'my opinion is', they are clearly in the realm of offering an opinion. However, depending on the context or intonation, these can be interpreted as either 'I think, but I don't know for sure' or 'I think and I don't care what anybody else thinks'. Thus there are several linguistic cues to determine the speaker's level of commitment to a proposition, as described in Schiffrin

As they begin to embark on strategies of persuasion, parties may lessen commitment in the interests of negotiation, using phrases like 'it seems to me' and 'the way I see it'. 'It seems to me' rather than 'I think' somewhat lessens the control of the
speaker, serving to depersonalize the debate. Skilful use of persuasive strategies, paying attention to communicating assumptions and appropriate moderation of commitment, maintains the negotiation process.

Transcript 5

[J is seated on the bike and K is experimenting with backpack position, while I lists on the white board]

00:27:00

1 K so we want to put it in there but I let's see if you get

[K places backpack near triangle]

2 J yeah you'd never really be able to
3 K you wouldn't be able to get your knees pedaling
   OK now what about maybe we ought to have a prototype that kinda has it this way

[K places backpack at rear, behind J]

4 I is it facing for? yeah that's right facing forward
5 J would it be too funky to have it on the like projecting from the front wheel?
6 I handlebars? yeah try that
7 J or off this handlebar stem even because that's fixed but if it's off the handlebars you know it's like an old bike basket that way like the Wizard of Oz (laugh)

[K places backpack on handlebars]

8 K See if you can steer. It tends to
9 J well, you could turn it long ways
10 I or if you could get it down low where the

4.6 Opportunistic Strategies of Persuasion
  - Give and Take

We return to Transcript 4, where the group is still engaged in focusing on rack attachment. In Transcript 4a, Kerry backed by Ivan has tried to persuade John that they should use the standard hex bolt attachment method. John remains uncon-
vinced (Transcript 4b: comments 18, 20), using the higher principle of elegance as a reason for his doubt, and Ivan and Kerry again offer justifications for the initial proposal (comments 21, 22). Each designer is maintaining their position. There is evidence of an impasse.

During this impasse, Kerry bids to shift the debate to more neutral territory (comment 23). She assumes tacit agreement on the issue of primary attachment with hex bolts (using Allen wrenches) and then seeks to address John’s concern about elegance elsewhere in the design, offering several possible alternative solution details for secondary attachment. John joins the new focus with an alternative partial solution to secondary attachment (comment 24). Kerry has been successful in shifting the debate by using an opportunistic strategy of give and take. Seeing the discussion had reached an impasse she sought to move to another part of the design space, taking tacit agreement on primary attachment and giving ways to address the elegance concern through other means.

Transcript 4b

18 J just doesn’t I dunno
19 K (inaudible)
20 J it just doesn’t seem real elegant to me but
21 K I think the issue that I think kinda remains is
22 I you could use it yeah like a one cent screw versus a
23 K mm mm and then the issue that I think kinda remains is
   how to get this attached nicely to some portion of
   the bike back here and that’s where you wanna get
   come up with your nice injection mould bracket that
   really works well or has a little bit of product identity
   maybe from a product standpoint from a marketing standpoint might be cool if there’s some
24 J maybe [01:12:00] maybe you put this down down to
   the er what d’you call them lugs [lifts backpack
   frame into vertical position] and then you er have a
   it strap that goes around your waist and you
   don’t need to attach to (inaudible)
25 I oh yeah
26 K yeah that could be cool
4.7 Transitions

In addition to an opportunistic means of persuasion through give and take above, Kerry’s topic shift away from the primary attachment to secondary attachment serves to avoid or postpone conflict in the group, since the group is at an impasse. Several other types of topic transition are identified in this section.

The group encourages John’s partial solution for secondary attachment, but he then calls it into question and no-one protests. This appears to be mutual recognition that the idea is not worth further consideration at this time. Rather than state as much, the idea simply loses steam. (Processes such as listing also tend to lose steam as ideas become exhausted.) This opens an opportunity for a bid for focus which Ivan takes and so a transition of focus occurs. In Transcript 4c, Ivan calls for focus (comments 31, 33) on a discussion of rack width, which has caught his attention as John gestures with the backpack frame. He develops a concern that the rack might be too wide for general riding, drawing upon the context of rack use.

John follows up with a question confirming Ivan’s concern and Ivan bids to look for marketing information to answer their concern. He moves to the table to look for information on marketing research, and the group follows. As Ivan searches for the information, John also calls for focus on a current use scenario of bungee cords (comment 42) drawn from the comparison with the partial solution the group was working on; Ivan pursues his focus bid in parallel, rather than giving full attention to John’s proposal. John laughs occasionally at his suggestions and prefaces them with ‘maybe’ indicating he has a low level of commitment. Kerry offers acknowledgments and supporting comments but does not engage in developing the idea. There is some sense of exploration in the conversation but nobody bids to change the topic except for John himself, indicating the group
is not unhappy with the process or that perhaps they are relaxing. One topic seems to prompt another. The current usage of bungee cords prompts the concern that their product must compete with that, leading to the notion that they could purchase rather than manufacture a good solution, leading to a request for information on the manufactured rather than sales cost, leading to an assumption about the manufactured cost as a percentage of the sales price.

Ivan does not find information in the marketing survey relating to rack use to resolve the issue of rack width, but this is never explicitly stated within the group which is now following along with John’s comments. The group does not return to the issue of rack width for another 25 minutes. It is worth noting that information seeking often halts a focus in the activity. Further, when the designers find information they often do not use it in ways observable to us, and if they do not find it, still they often return to a different topic. Information seeking serves to broaden the designers’ knowledge of options, yet it rarely adds to the knowledge space in a predictable way, which perhaps explains why transitions of focus often occur during information seeking.

The group eventually and repeatedly returns to issues, such as positioning, attachment and materials, indicating that these are key issues to them in the design problem. This perhaps indicates their ability to shift topics effectively to stay productive. Hales\(^5\) argues that design managers need to ‘window out’ and ‘window in’, ‘concentrating effectively on the detail, while at the same time keeping the wider context in mind, a crucial aspect of managing engineering design’. In transitioning from topic to topic and yet returning to key issues, we see evidence of how a group manages itself in monitoring the broader problem yet focusing to define details, through social interaction.

**Transcript 4c**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td><strong>what</strong> what I was thinking is</td>
</tr>
<tr>
<td>32</td>
<td><strong>(laugh)</strong></td>
</tr>
<tr>
<td>33</td>
<td>if we have like a like a Blackburn rack the only problem—that I see with it if you put that back up</td>
</tr>
</tbody>
</table>
here [J raises backpack frame back to vertical position so the width is visible] is that it's fairly narrow I mean you don't want a rack that's this wide

34 J  
right
35 I  just for general riding
36 K  mm mm
37 I  but if you had one that was close and then you could just sorta
38 J  did it say that people would want to use it as a regular rack or is that a feature
39 I  mm mm
40 J  that we could incorporate
41 I  I imagine let's see where's the marketing research
42 J  I mean I'm sure what people do right now probably is go buy a bike rack and bungee cord this down on to the bike rack
43 I  yeah
44 K  mm mm that's definitely within the product target space
45 J  maybe we should sell them a Blackburn rack with two bungee cords for fifty-five bucks
46 I  (laugh)
47 J  so hey you're right in there they sell these for forty bucks so
48 K  mm mm you could buy some real nice bungee cords for that
49 J  the purchased solution (laugh) [ 01:13:00 ]
50 I  they say never make it if you can buy it out of a catalogue
51 J  no tooling (laugh) make back your tooling on your first order um but out of fifty-five dollars I'm wondering if there's any sort of price breakdown that um people want like you know in other words what's the manufactured cost if the sales cost is fifty-five dollars
52 I  yeah (inaudible)
53 J  is there any sort of um cost specification for we know the sales price is fifty-five dollars but um
54 K  landed cost or
55 J  the manufactured cost of the product is there a target for that
56 X  I'm sorry say again Kees
57 J  is there any is there
58 X  No, I'm asking for the my assistant to say again
have to estimate their own ratios OK yep you have to estimate your own
59 J oh we estimate our own ratios OK
60 K so we'll assume that is sell it to a retailer
61 J use the standard one fourth model

4.8 Process Prompted Transitions (Calls to Order)

In the short phrases that follow (Transcript 4d: comments 62–74), the group seems to be mentally relaxing, exploring the topic of acronyms for their own amusement rather than exerting themselves to resolve issues raised recently. Interspersed in this, Ivan makes three repeated bids for a new focus (comments 75, 83, 85), indicating he is ready to move on and not happy with the current process of the group, one of relaxation. He calls to focus on an issue of process: what should we do next? The group continues to wander but he finally engages them by specifically proposing to strike issues he considers resolved from the whiteboard list, bidding for focus with comment 96 (not shown): 'positioning have we thrown out the folds in the middle?' The group responds by attending to the issues he raises from the whiteboard list.

Transcript 4d

62 I yeah
63 K mm mm mm mm
64 J manufactured costs will be one fourth the the MSRP
65 I yeah
[01:14:00]
66 K manufacturer's suggested retail
67 J/1 suggested retail price
68 I yeah
69 K from a I at an IBD ... independent bicycle dealer
70 J (laugh)
71 I OK
72 J I always wondered what that footnote meant IBD
73 K IBD
74 J and now I know it means independent independent bicycle dealer
(laugh)
75 I let's get a stock of where we are
76 J OK ... so what's a quarter of fifty-five bucks or twelve er twelve fourteen bucks

4.9 Breakdowns and Arbitration
In Transcript 6 Ivan senses an impasse and actively jumps in as an arbitrator to negotiate the conflict between John and Kerry, who are committed to opposing positions. Following an extended discussion in which Kerry has proposed the bike dimensions will not vary enough to merit an adjustable solution, John makes a strong bid for an adjustable solution (comment 1). John supports his opinion with appeals to theory of good human factors and the absent users’ preference, indicating he is strongly committed to ‘it should be adjustable’. Kerry shrugs, indicating she has stated her position and will not offer any more argument. The standoff is apparent to Ivan who takes upon the role of arbitrator and offers a compromise: ‘whatever idea we come up with, we can look at ways of making it adjustable’. Since they are not making progress they defer the discussion of adjustability until there is a specific solution to consider and more progress can be made.

Having made a strong statement to which Kerry offers no response, John lessens his commitment with ‘em, that’s my opinion, opinion, not fact’, in apparent effort to lower any tension that may have arisen. John then shifts the topic.

Transcript 6

[00:60:00]

1 J I think good human factors says it should be adjustable
so that people can find the position they like

2 K [shrugs shoulders]
There are few stories in this session, perhaps because of the timeframe, but the designers use some techniques of storytelling. Schifrin offers a framework to describe how stories (or reporting) are used in persuasion, noting that story tellers use:

- Selective interpretation – recounting aspects of the event preferred by the narrator
- Evaluative devices – highlighting parts of the experience from the narrator’s perspective, to show the narrator taking an orientation to what is being talked about
- Deictic shifts – shifting time, place and participants from the conversational world (storytelling world) to the story world
- Contextualization – framing an event within the story world.

John’s ski pole story, in Transcript 7 (comment 2), though brief, appears to give a much more persuasive argument against selecting aluminium, than would be given by simply stating ‘thin walled aluminium tube fractures easily in the cold’. The participants in the conversation are shifted to Denver and the ski pole fracture is highlighted in the context of skiing. There is no need to describe the wall thickness or pole length to anyone familiar with ski poles and skiing (although the temperature is open for debate).

**Transcript 7**

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K steel painting isn't that expensive is it
2 J no but the only the only thing I know that's wrong with aluminum is if you've ever skied I had my ski poles fracture on me in really cold temperatures and er I was skiing in Denver one time and my ski pole bent in half and not only did it bend in half it broke when it bent.
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Without even telling a complete story, selective interpretation and reframing of past design experiences or even of the problem statement (see Transcript 3), and creation of scenarios play an important role in developing, representing and communicating partial design alternatives.

5 Conclusion

The content of the evolving design depends heavily upon negotiation strategies and other more subtle and ubiquitous social processes that shape design work. Minneman has also demonstrated that design emerges from social interaction. Team members’ orientation to a solution or process is demonstrated by levels of commitment in utterances (and gestures). Depending on their level of commitment and other team members’ alignment they adopt appropriate strategies of persuasion. They carefully moderate their commitment to their ideas to remain amenable to negotiation. They appeal to common sense, design theories, standard practices, expert practices, user preference and demonstrations with physical hardware in order to persuade.

Many solution proposals and interpretations of requirements clearly arise from designers’ interacting with available hardware. They also emerge as part of the ongoing activity. We have focused on the designers as actors that interpret the hardware, examining how their utterances steer the activity. A compelling analysis would also result from examining how hardware acts as a negotiator to steer the activity.

The design progresses as the group focuses and transitions from topic to topic. Still there is evidence that team members are continuously engaged in monitoring multiple issues at multiple levels of attention. Transitions occur when:

- team members seek to shift the debate to another topic
- team members seek to change the process
- prompted by related topics
- topics lose steam
...processes lose steam
...team members stop to seek information.

We conjecture that the collaboration is successful because the group is well balanced in their roles and manages their negotiation well. Kerry seeks to pin down solution alternatives, John seeks to preserve ambiguity and characterize the ongoing process, and Ivan keeps the solution progress on track and acts as an arbitrator between John and Kerry.

This is a story of one group of designers that we have used to illustrate strategies of design collaboration. There are surely many other methods and interpretations. However, the tape provides a valuable means of introspection and reflection for the design student. Watching, discussing and reflecting upon such tapes provides a means for design students to become aware of the variety of productive and counterproductive strategies and processes available to them. The tape makes these processes available and identifiable. With this awareness it becomes easier to identify when oneself or members of one's own team are following counterproductive strategies. Videotapes offer the opportunity of process examples with the context necessary for the student to gain a fuller appreciation of strategies that work well in design.

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References

ANALYSING DESIGN ACTIVITY

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Design encompasses some of the highest cognitive abilities of human beings, including creativity, synthesis and problem solving. A substantial and varied range of research methods has been developed and adopted for the analysis of design activity, but until now it has been difficult to compare the work of different researchers using different methods.

This book contains the results of an international workshop held in Delft, The Netherlands, which focused on one particular research method, that of protocol analysis. Researchers from seventeen different leading centres around the world were invited to analyse the same video recordings of designers working on an engineering product design.

The 20 chapters in this book are the records of that workshop, providing rich insights into the design process and an overview of accumulated knowledge on design from these researchers. There is also a discussion of the properties and limitations of protocol analysis as a research technique for analysing design activity.

The book is a substantial contribution to developing understanding of the nature of design activity, and is of value to researchers, teachers and practitioners of design.