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Visualising professional vision interactions in design reviews

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ABSTRACT

A visual notation called the interaction dynamics notation was used for analysing the moment-to-moment interpersonal interactions in design reviews. The expressions of professional vision (PV) – a system of seeing and interpreting that characterises a professional group – are identified in these design review interactions. The analysis showed that students’ participation was important to the articulation of PV in design reviews. Specifically, there were four interaction patterns – question-asking, supportive behaviour, building-on behaviour and humour that were associated with nine types of PV expressions in design review interactions. These interaction patterns are examined in the context of existing literature on design reviews. The implication of using the visual representation of review interactions as an educational tool is explored.

ARTICLE HISTORY

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KEYWORDS

interaction; visualisation; professional vision; design review

1. Introduction

Designing is a social activity. The practice of design across its many disciplines – engineering, architecture, product design, etc. – does not occur merely in the cognitive consciousness of a lone designer. It is situated in the physical and social context of a design studio, a design firm or a product development group. The interactions a designer has with her team members, customers, supervisors, and manufacturers or contractors contribute to a large extent to the professional practice of design. In design education as well, hands-on studio based education in architecture or product design, and team based projects in engineering, enable learning through interactions with instructors, peers, and professionals.

Design researchers have recognised this social aspect of designing, and have conducted a number of studies to understand and measure designing in teams. These include studies measuring individual aspects of communication such as the role of gestures (Tang 1991), questions (Eris 2002) or emotions (Jung and Leifer 2011) in team designing; studies of design activities such as concept generation (van der Lught 2003), sketching (Verstijnen et al. 1998) or prototyping in teams (Schrage 1993); studies commenting on the overall nature of thinking and doing in design teams (Valkenburg 2000; Stempflie and Badke-Schaub 2002); and studies on team composition (Kim and Byung 2003; Kress 2012) individual and team
comparison (Goldschmidt 1995) and documentation of globally distributed design teams (Larsson 2003). In most of these studies, the team provides a context for tracking a key parameter being studied such as questions or gestures or concepts, but the moment-to-moment interpersonal responding between team members in and of itself has rarely been a focus of analysis. In this paper, we use a focus on moment-to-moment interpersonal responding to study design reviews in an educational setting, through the use of a visual representation called the interaction dynamics notation (IDN) that facilitates moment-to-moment analysis of design interactions. Our objective is to study design review as an interactional phenomenon by characterising patterns of interpersonal interactions that are meaningful to design reviews.

The purpose of a design review in a design education setting is primarily to enable students to directly engage with experts and get feedback on the students’ design artefacts and design process. Reviews provide a unique setting in time where a student’s evolving understanding of design, and an expert’s professional vision (PV) intersect through interactions focused on a design artefact. It is these interactions that are of interest to us in this paper.

Prior research in design education underscores the importance of a design review interactions. Schön (1983) presented his influential paradigm of design as a process of reflection-in-action through the example of a design review interaction between a student and a studio master. Goldschmidt, Hochman, and Dafni (2010) have evaluated the design crit (critique) and the teacher–student interactions they engender as a key element of design pedagogy. In this paper, we delve deeper into moment-to-moment interpersonal interactions that occur in a design review to investigate interactions that characterise the display of PV. The following sections describe the moment-to-moment perspective on interpersonal interaction and the concept of PV in greater detail.

2. IDN – a moment-to-moment perspective on interpersonal interactions

We define an interaction as reciprocal action. For a team engaged in a design activity, the sequence of actions and responses both verbal and non-verbal between individuals working on the design project constitutes a design interaction. The reflective conversation that Schön (1983) mentions going on between a designer and the sketching or prototyping media is also a design interaction. However, in this paper, we are focusing mainly on the social aspect of designing and design interaction refers to the reciprocal conversation between individuals in a design team. In order to capture this ephemeral reciprocity of interaction, we needed a method that would facilitate an analysis of moment-to-moment interpersonal responding. We needed a method to capture not what a designer said or intended to say, but rather how his speech or action influenced the subsequent response in the ongoing interaction.

Researchers have used conversation analysis in the past to study design interactions (Matthews 2009). Conversation analysis does offer a way to relate one-talk turn to another through descriptive explanation, but it retains the text as-is without signifying the meaning of one-talk turn in terms of the subsequent response to it. Thus, it does not directly capture the reciprocity of interaction. Hence, we turned to cognitive semiotics, the study of how meaning is signified through language, in order to capture the reciprocity of design interaction.

The domain of cognitive semiotics employs a notation called as the Force Dynamics Notation (Talmy 1988) that visualised the meaning conveyed by phrases such as ‘she let
him down’ (see Brandt 2004, 42). The Force Dynamics Notation visualises the meaning in a phrase as a narrative plot with actors experiencing forces e.g. ’letting down’ that affect their narrative journey. We adapted this notation for design interactions in the form of the IDN. This notation captures the meaning conveyed in a speaker turn – verbal or non-verbal – in terms of the force it has on the subsequent response. For example, a designer ‘A’ is said to have asked a question, not because of the intonation in his tone, or his inferred intention, but because a team member ‘B’ responded to A’s expression as if answering a question. If there is no response to A, her turn is not coded as a question. Just as narrative forces shape an unfolding plot, the forces of individuals receiving and interpreting an expression shape the unfolding interaction. This captures the reciprocity of interaction and the response-to-response visualisation retains the moment-to-moment aspect of the design interaction. Another reason for selecting a visual notation method was the affordance that visualisation lends to manual analysis and comprehension (Larkin and Simon 1987). The categories of response visualisation were derived from improvisation principles since theatrical improvisation as a discipline focuses on the design of in-the-moment interpersonal interactions (Johnstone 1981). The development of the notation is described in detail in Sonalkar, Mabogunje, and Leifer (2013). The IDN has been used in the past to identify interaction patterns associated with transitions between concept space and knowledge space as per C-K Theory (Hatchuel and Weil 2003) during concept generation interactions in student design teams (Sonalkar 2012). Recently, the notation was used to detect interpersonal interaction patterns correlated with novelty and utility of concepts generated during concept generation sessions of seven design teams (Sonalkar et al. 2015). We give a brief description of the notation below.

The IDN consists of 12 symbols that are used to create a descriptive visual model of the interaction. Figure 1 shows IDN of a brief design conversation. Table 1 gives a detailed explanation of each symbol used in the visual notation.

The IDN models design interactions in the context of a design activity such as concept generation, framing of user need, design reviews or planning of user tests. The relevant parameters that we want to analyse being developed through such design interactions can be highlighted in the IDN output. For example, in concept generation activity, the ideation responses can be highlighted to map out how concepts are co-created through interpersonal interactions. In this paper, we use IDN to characterise design review interactions that involve displays of PV from the review participants.

3. PV in the context of design reviews

Goodwin (1994) coined the phrase PV to describe a system of seeing and interpreting which is specific to professional groups and which applies to events in domains of interest to those groups. For example, when a professional structural engineer looks at a free-body diagram, he sees specific elements and understands phenomenon that are hidden to an equally competent biochemist looking at the same diagram. The engineer and the biochemist belong to different professional groups and their training involves the development of a way of seeing events that is distinct to each group.

Goodwin argues that PV is not just a mental process, it is deployed through complex situated practices in a relevant setting. Thus, PV relates to a number of constructs relevant to being a professional. These constructs include purpose, values, context and professional identity. For example, for our structural engineer, the PV activated by the perceptual
examination of a free-body diagram could relate to the context of a design review of a bridge support at a site of construction; the purpose of ensuring that proper loading has been considered during designing and appropriate structural specifications have been made; the values of safety, reliability and cost-effectiveness; and the professional identity of an accredited structural engineer. These influence the PV of the engineer and how it is manifest as his expertise.

In the design disciplines, Lymer (2009) used conversation analysis of video data from architectural critiques to demonstrate how PV is manifest through a set of disciplined visual practices and gestural interactions with the spatial artefacts being critiqued. Lymer, like Goodwin, emphasises that PV is not just a mental process, but rather it is situated in the context of practice with gestures, speech and visual artefacts enabling practitioners to manifest their PV. While there is not much research besides Lymer’s study, on the development of PV in design disciplines, there are a few concepts in literature that come close to what Goodwin refers to as PV. Schon and Wiggins (1992) describe different kinds of seeing and their functions in designing in their study of conversations between a student architect and a studio master. They explain that designers when examining a sketch, see not just the literal marks on paper, but also develop a way of seeing what these marks entail in terms of intended and unintended consequences resulting out of their design moves. In the example they describe, the student ‘Petra’ develops a judgement about her sketched classroom units as being ‘too small in scale’, and redraws them to be ‘more significant in layout’. Schön and Wiggins recognise that while these appreciative judgments of quality may be subjective in nature, there maybe ‘a large area of overlap in appreciations – sufficient, even, to allow us to say that these individuals share a common appreciative system. From such an observation we might infer the existence of a particular design community’ (Schon and Wiggins 1992, 139). This ‘common appreciative system’ can be considered synonymous with Goodwin’s concept of PV in that it alludes to a system of seeing and interpreting events that is specific to design professionals.

Another concept in design that comes close to PV is framing. Dorst (2011) defines framing as the creation of a novel standpoint from which a problematic situation can be

![Figure 1. A conversation between three designers A, B and C is visualised using IDN. The visualisation is read from left to right with the symbols indicating how the ideas being discussed were moved forward, blocked or supported.](image-url)
Table 1. Detailed explanation of each symbol used in the visual notation.

<table>
<thead>
<tr>
<th>Symbols</th>
<th>Name</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>→</td>
<td>Move</td>
<td>'Move' indicates that a participant has made an expression that moves the interaction forward in a given direction. This can be a verbal expression or a non-verbal gesture that leads to some sort of a response. Expressions that do not elicit a response are not modelled.</td>
<td>A: I need to buy Legos (at) home. Think about how therapeutic it would be</td>
</tr>
<tr>
<td>?</td>
<td>Question</td>
<td>A question indicates an expression that elicits a move. A question projects onto the next response and constrains the content of that response because the next response answers the question. Non-verbal facial expressions can be coded as questions, if they elicit an answer from other participants.</td>
<td>A: Where should we start?</td>
</tr>
<tr>
<td>⬤ ......</td>
<td>Silence</td>
<td>Silence is a state in the conversation when none of the participants speak as they are engaged in other individual level activities. Silence has been included in the notation because a number of design conversations are an interplay of both group conversation and individual activity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Block</td>
<td>Block indicates an obstruction to the content of the previous move. This is recognised by the response to a potential block, which denotes whether any resistance is being felt by the participants.</td>
<td>B: Maybe have something which looks like a computer but you can just type your name or do a simple math, a calculator in the shape of a computer kind of C: Er, but I don't know, I mean, considering the age segment we are targeting 3 to 7 years</td>
</tr>
<tr>
<td></td>
<td>Support</td>
<td>Support indicates that the speaker understands and/or agrees with the previous move. Support can also be given non-verbally through head-nods and mimicry of gestures.</td>
<td>C: Safe and entertaining (bending forward to write). B: Safe and entertaining, yes</td>
</tr>
<tr>
<td>⬤ ......</td>
<td>Support for block</td>
<td>Support-for-block indicates an acceptance of a block by another person. It is same as support, but is visualised differently to account for the visual logic implicit in the notation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overcoming</td>
<td>Overcoming a block indicates that though a block was placed in front of a move, a speaker was able to overcome the block and persist on course of the original move.</td>
<td>C: Er, but I don't know, I mean, considering the age segment we are targeting 3 to 7 years B: So 7 years they go to school, they would learn A, B, C right?</td>
</tr>
<tr>
<td></td>
<td>Deflection</td>
<td>When a speaker blocks a previous speaker’s move, that speaker or another can deflect the block with a move that presents an alternative direction for the interaction.</td>
<td>B: So when you say we need to divide the age-group, but you cannot have like 3, 4, 5 A: No, no of course not, but I mean you might have a few different (concepts)</td>
</tr>
<tr>
<td></td>
<td>Interruption</td>
<td>An interruption is indicative of a speaker being interrupted by another speaker.</td>
<td>B: Should we start generating some concepts now? A: Yeah (interrupted by X) X: 10 min are gone</td>
</tr>
<tr>
<td>⬤ ......</td>
<td>Yes and</td>
<td>A move is considered to be a 'Yes and' to the previous move if it accepts the content of the previous move and adds on to it.</td>
<td>A: What about... if we made a toy that incorporates girls and boys. Its like a house that has a car with it kind of like enables the guys to play with the girls? C: I think that's a good point to have some sort of an educational point in it</td>
</tr>
<tr>
<td>⬤ ......</td>
<td>Deviation</td>
<td>Deviation indicates a move that changes the direction of the conversation from the one implied by the previous moves.</td>
<td>C: But we need to remember it C: This is not the buildable room (deviating from previous topic)</td>
</tr>
<tr>
<td>A, B</td>
<td>Humour</td>
<td>Humour indicates instances of shared laughter in teams.</td>
<td>A: I don't know I probably would have swallowed but (All of them laugh)</td>
</tr>
</tbody>
</table>
tackled. A frame is a perceptual configuration of an emergent situation that is created to arrive at specific solutions. A designer can adopt a frame and then discard it, as the situation changes to adopt a new frame. This framing and reframing (Schön 1983) is a critical aspect of design thinking. PV relates to framing in the following way. PV for a designer defines what perceptual aspects to pay attention to when formulating a frame. If the frame is a perceptual configuration of an emerging situation, PV for a designer is the identification of what elements to attend to that can be formulated into specific frames. PV is acquired through disciplinary training and remains consistent throughout a professional community, while frames can change from moment-to-moment and person-to-person.

4. Research questions guiding the application of IDN to design reviews

We propose that a design review provides a relevant setting for the deployment of PV distinct to the design profession. In a design review, an expert designer is faced with a complex perceptual field of the design artefact and social interaction with the student designer or design teams. Based on his expertise, the expert ‘sees’ information relevant to his expertise that collectively comprises his PV. The interaction with the student designers provides a setting for this PV to be displayed to students, which contributes to the development of their own PV. Looking at the expression of PV in design reviews from a design interaction perspective, we ask the following question.

*What interaction patterns are characteristic to the display of PV in design reviews?*

We investigate this question by applying IDN to a video data-set of design review interactions, highlighting the occurrences of PV expressions and identifying interaction patterns associated with such PV occurrences.

5. Analysing PV in design reviews using IDN

The following process was adopted to analyse design reviews using IDN and identifying PV expression in the IDN data.

1. A corpus of design review videos was selected.
2. The videos were coded using software called IDN Tool to develop a visual representation.
3. PV expressions were identified in the design review data using the transcripts of the design review videos.
4. The PV expressions were then overlaid on the IDN representation using the IDN Tool.
5. The topical segments containing PV expressions in the IDN data were identified as episodes of PV interactions.
6. The visual representation of IDN data with PV expressions and PV interactions was then analysed manually to detect interaction patterns associated with PV interactions.

The following sections explain each of the process steps in greater detail.
5.1. Selecting a corpus of design reviews

The first step in investigating the research questions mentioned above was the identification of a suitable corpus of design review data. We chose the video data of design reviews distributed through the 10th Design Thinking Research Symposium (Adams 2015). The data-set included design review from a number of different disciplines – industrial design (undergraduate and graduate), mechanical engineering, entrepreneurship, service learning and choreography. The design reviewers varied in their format and included community reviews (service learning), formal presentations (entrepreneurship), group reviews (industrial design graduate, mechanical engineering, choreography) and one-on-one reviews (industrial design undergraduate). Since, the focus of our research was on the articulation of PV through design review interactions we narrowed down our selection to service learning, mechanical engineering, choreography and industrial design graduate datasets. Out of these, the industrial design graduate ‘ID-G’ data-set was chosen since it afforded a greater number of design reviews per student in the data-set, and the artefacts were well documented. Also, unlike service learning or choreography, we as researchers were familiar with the discipline of industrial design. This was essential because familiarity with the discipline of the design review is a prerequisite for the analysis of PV.

The ‘ID-G’ data-set consisted of video and transcripts of four different design reviews – dsearch (design user-research) review, concept review, client review and concept reduction review – for six graduate students. All reviews, except the client review had peer participation along with one design instructor. The client reviews consisted of the student designers speaking to two client representatives on phone. All reviews involved conversations focused on an artefact – a report in case of the dsearch review, or concept sketches for rest of the reviews. The data-set also contained PDF copies of the artefacts that were being reviewed. This helped a great deal in understanding the review conversation. One drawback of the data-set was that from the sequence of reviews provided, each student had data missing for at least one of the reviews. Only three of the six graduate students – Eva, Mylie and Sydney (names changed to protect identity) had data available for the initial dsearch review, the concept review and subsequent client review. Hence, the design review data of these three students was selected for further analysis. This amounted to a total of eight design review sessions.

5.2. Coding the video data with IDN

A software tool called the IDN Tool was developed to facilitate the coding of video data to a visual IDN output. IDN has been used successfully in the past to analyse concept generation interactions in design teams (Sonalkar 2012). The construct validity of IDN has been established with concepts from design research and conversation analysis. The reliability of notation has also been established with multiple analysts using the notation, which led to a refinement of notation application rules. The refined rules were used by one of the authors to apply IDN to video data of dsearch, concept and client reviews using the IDN Tool. Figure 2 shows the IDN Tool interface. The video to be coded was imported into the tool, the speakers were assigned specific acronyms – A, B, C etc., and then each speaker participation was assigned an IDN symbol using the IDN coding scheme. The reliability
of IDN coding was not re-evaluated for this design review data-set. The IDN Tool gave a visual representation output of the design review interactions.

### 5.3. Developing a coding scheme for PV

Goodwin described PV as ways of seeing and organising events that are specific to distinct professional groups. Initial viewings of the video data combined with past research that points to the role of media in PV (Lymer 2009), led us to realise that speaker utterances that referred to the design artefact were critical to recognising expressions of PV. These were generally accompanied by handling of the design artefact or gesturing towards the design artefact. We found that though PV expressions contained gestures and handling of the artefact, they could be reliably identified in the transcript data by highlighting responses from an expert or peer reviewer that commented on the artefact or the design concept being reviewed in terms of appreciation, critique or recommendations for change. We noticed that at times clarifying questions were asked regarding the artefact or the design concept. We did not denote such clarifying questions as PV since they indicated that the reviewer was seeking further information and not making a professional judgement that could be included as his PV. Figure 3 shows an excerpt from the coded transcript.

In order to comment on the nature of PV, a coding scheme was developed by studying the instances of PV responses highlighted in the transcripts. PV responses were observed to involve the reviewers appreciating a student’s work, critiquing an artefact, calling out the significance of certain aspects of designing and giving encouragement. The appreciation and critique responses pertained to the communication of a concept through sketching or annotating, the concept itself, or the design process followed by a student. Accordingly, a coding scheme consisting of nine categories was developed and used to categorise the PV responses observed in the data. The coding scheme was further mapped to Schön and Wiggin's framework of PV expressions. See Table 2.

![Figure 2. The IDN Tool interface used for creating a visual representation of design review interactions using the IDN.](image)
The ‘appreciate process/technique’ and ‘critique process/technique’ categories and the ‘encourage’ category did not have direct one-to-one mapping with the ways of seeing as described by Schön and Wiggins. Their research focused on the artefact and the concept as it was being created through the artefact. In the design reviews in this data-set, the focus on concept and the artefact is predominant. However, at times the experts comment on the process or technique shown by the student in preparing the artefact. For example, on one occasion the expert, Simon encouraged his students to ‘go wild and crazy’ in their ideations. These aspects of PV that deal with the design process were not captured in Schön and Wiggin’s work.

5.4. Overlaying PV on the notation data

Once the expressions relevant to PV were identified, they were superimposed on the IDN visualisation using the IDN Tool to create a representation that included both interaction information and PV response information. Figure 4 shows an example outcome of IDN coding with the PV responses highlighted.

5.5. Identification of specific episodes of interaction that corresponded to articulation of PV

When analysing the video data using IDN and then using transcripts to identify expressions of PV, we realised that these expressions, though seemingly isolated occurred within interaction segments that had topical continuity. We identified such topically continuous interaction segments that involved expressions of PV, as episodes of PV interaction. These episodes were a time-bound set of speaker turns and not single speaker expressions. Figure 5 shows the same visual representation as Figure 4, but now with the specific episodes of PV interaction highlighted.

*Figure 3.* Except from Eva’s concept review. The highlighted parts are expressions that indicate PV.
5.6. Analysing the visual representation of design review interactions

Once the visual representation showing individual expressions of PV in the context of ongoing episodes of PV, was complete, we printed such visualisation of all the design reviews and laid them on a table for analysis of patterns. Subsequently, we conducted a quantitative analysis of the occurrence of IDN symbols in design review interactions. The observations from the analysis are described below.

### Table 2. Categories of PV responses.

<table>
<thead>
<tr>
<th>Nature of PV response</th>
<th>Example</th>
<th>Mapping to Schön &amp; Wiggins’s classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Appreciate communication</td>
<td>Simon: But they are beautiful drawings, really nicely done. Love the vignette and the way these two drawings are tied together with that vignette. It does a really nice job of showing that. (Sydney concept review, 02:09 min)</td>
<td>Literal visual apprehension</td>
</tr>
<tr>
<td>2 Appreciate process/technique</td>
<td>Chuck: Yeah, no, I, I definitely appreciate the can. I mean, always push stuff out like that ‘cause you never know. You might not have gotten to the last concept if you didn’t get to that one so. (Eva client review, 11:33 min)</td>
<td>NA</td>
</tr>
<tr>
<td>3 Appreciate concept</td>
<td>Peter: I mean, that’s something different that at least I haven’t seen. Again, you might wanna look out there. Just Google search or patent search foldable hangers you might see there. I think there’s a lot of people that could benefit from something like this and it seems so simple and elegant a solution. (Sydney client review, 02:17 min)</td>
<td>Appreciative judgement</td>
</tr>
<tr>
<td>4 Critique communication</td>
<td>Simon: Now, I read it as a stylised tree, right, and it’s actually a product that looks like a tree. Not a stylised tree. Um, to make it look more product like, what can she do? What can she do to make it more product-like? (Mylie concept review, 3:22 min)</td>
<td>Literal visual apprehension</td>
</tr>
<tr>
<td>5 Critique process/technique</td>
<td>Simon: Okay, translating them into – is it – I think sometimes more is not better so maybe if you can … (DM dsearch review, 23:00 min)</td>
<td>NA</td>
</tr>
<tr>
<td>6 Critique concept</td>
<td>Chuck: So, but, ya’know, with us, it’s like you don’t want your gym clothes to smell like my wife’s dress, ya’know, cocktail dress. So is this a thing that you kind of – I, I don’t know. I’m just kind of thinking. (Mylie client review, 10:34 min)</td>
<td>Appreciative judgement</td>
</tr>
<tr>
<td>7 Highlight significance</td>
<td>Simon: And this is sort of grey. It’s that – and so a storage system that deals with that sort of transition between maybe every third time I need to wash it. Has it got there yet and how does it progress from one to the other? That’s an opportunity. (SE dsearch review, 06:04 min)</td>
<td>Appreciative judgement</td>
</tr>
<tr>
<td>8 Suggest alternatives</td>
<td>Simon: But you could create anti – you want things to just like freely tumble around? Um, you could use like a – like a rotational moulding where it is constantly tumbling randomly and so things are always just tumbling around as a way to clean it. Um. You could also use anti-gravity magic rays. Um, we’re allowed to propose that. (Eva concept review, 03:01 min)</td>
<td>Appreciative judgement</td>
</tr>
<tr>
<td>9 Encourage</td>
<td>Simon: So it gives us this great diversity of things we can explore. Um, I think they really want us to scare them with crazy, wild ideas, so don’t be afraid to let yourself go wild and crazy in your ideations, okay. (DM dsearch review, 29:00 min)</td>
<td>NA</td>
</tr>
</tbody>
</table>
6. Observations

6.1. Students played an active role in sustaining PV interactions in design reviews

We observed that PV expressions did not occur in isolation. An instance of PV expression could be placed within an interaction episode that referred to a particular topic, and had a clear beginning and an end. There were a total of 38 episodes of PV interactions in the eight design reviews analysed in this study. In addition, there were two PV monologues in which there was no interaction visible between the reviewer and the student. In the 38 episodes of PV interaction, the students played an active role in engaging with the reviewer and in drawing out his PV through the interaction. The following two examples illustrate the role of student and reviewer in PV interactions.

Consider the interaction shown below in Figure 6. In this particular interaction, the reviewer Simon starts the episode of interaction with a question pointing at the artefact, which is a concept sketch. The student Mylie responds with her PV. Simon seems surprised and asks further clarifying questions. He then admits that he had a different reading of the sketch and goes on to explain his PV regarding how to indicate shadows in the sketch.

Figure 4. Visual representation of Eva’s client review using IDN with expressions of PV highlighted. The alphabets below the symbols indicate speakers. The number at the start of each row indicates the timestamp in video corresponding to the first symbol in the row.
Figure 5. Three PV interaction sequences are highlighted in the visual representation of Eva’s client review.

Figure 6. A and C indicate the student, Mylie and the expert reviewer, Simon, respectively. The symbols surrounded by the dotted rectangle indicate PV display responses. Excerpt from Mylie’s concept review 6:42 – 7:53 min into the review session.
and what it means for an object to be in 3D vs. in relief. Mylie then agrees. Thus, in this interaction, we observe both the student and the reviewer articulate their individual PVs, and then find a way to come to a mutual understanding guided by clarifying questions that form part of the interaction but not necessarily the PV expressions indicated by the symbols surrounded by dotted rectangle in the figure.

Figure 7 below gives another example of PV interaction, this time between the client representatives reviewing the concept and the student. The above interaction is prompted by the reviewer calling attention to a particular sketch. The reviewer appreciates the sketch and explains how he views it in terms of prior customer feedback. This response constitutes a PV expression since he is able to appreciate the sketch based on his professional experience and see that ‘there is something interesting here’. Mylie, the student contributes to the reviewers expression of PV through a ‘yes and’ response. She mentions the inclusion of freshness filters in the sketch. This response helps sustain the interaction and influences the reviewer to further elaborate on the kind of product the sketch could become. The reviewer imagines a practical scenario, which is also an indication of his PV for the future use of the product. In the remainder interaction, Mylie plays a supportive role acknowledging the experts PV and perhaps encouraging him with her back-channelling behaviour of intermittent ‘yeah’s and ‘mmh-hmm’s.

As the two examples discussed in this section indicate, the students helped sustain the PV interactions by questioning, building on reviewers’ comments, supporting ongoing responses and, at times, contributing their own evolving PV to the discussion.

Figure 7. A and C indicate the student, Mylie and one of the client reviewers, respectively. The symbols surrounded by the dotted rectangle indicate PV display responses. Excerpt from Mylie’s client review 10:02 – 12:20 min into the review session.
6.2. Four out of five IDN behavioural sequences observed in PV interactions

Analysing the visual output of the design review sessions, and correlating them with the underlying principles of IDN, the following five behavioural sequences (Table 3) could be identified as something that IDN is designed to highlight in interpersonal interactions. We counted the instances of each of these behavioural sequences as observed in the episodes of PV interactions (see Figure 8).

The role of question-asking in PV interactions is worth noting. Interaction episodes commonly began with a question, asked either by the student or in most cases by the reviewer. Supportive behaviour was most common after the question-asking in terms of frequency of occurrence. Similar to question-asking, both reviewers and students displayed supportive behaviour. Building-on sequences and humour sequences were also found in PV interactions. Argumentative sequences were notably absent from this data.

Table 3. IDN behavioural sequences.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>IDN notation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question-asking sequence</td>
<td>? A C</td>
<td>Question-asking sequence consists of a question response followed by a move response. Sometimes, it can also be followed by another clarifying question response</td>
</tr>
<tr>
<td>Building-on sequence</td>
<td>C A</td>
<td>Building-on sequence is a combination of a move followed by a ‘yes and’ move. It indicates that participants are collaborating together on content</td>
</tr>
<tr>
<td>Supportive sequence</td>
<td>C A</td>
<td>Supportive sequence includes a move followed by a support response</td>
</tr>
<tr>
<td>Argumentative sequence</td>
<td>B A C</td>
<td>A block response followed by an overcoming response is considered as an argumentative sequence. A block indicated contradiction and disagreement. A block followed by overcoming indicates that in spite of the block, participants are persisting in the original idea being blocked. Thus, it indicated contradiction and disagreement between participants</td>
</tr>
<tr>
<td>Humour sequence</td>
<td>C A B</td>
<td>Humour sequence is a move followed by shared laughter</td>
</tr>
</tbody>
</table>

Figure 8. Question-asking sequences occurred most frequently followed by supportive sequences, building-on sequences and humour. Argumentative sequences were absent from episodes of PV interaction.
6.3. IDN behavioural sequences were associated with specific PV categories

Besides the identification of episodes of PV, we had categorised the PV expressions into nine types (Table 2). We analysed the visual representation to determine whether IDN sequences were more common in some categories of PV interactions than others. Figure 9 shows the different IDN sequences occurring in the PV categories that were identified during analysis.

The figure refers to seven of these categories that occurred in distinct interaction episodes. The PV categories of ‘encourage’ and ‘suggest alternatives’ occurred alongside the seven categories mentioned above, and hence were not included in the analysis of interaction sequences shown in Figure 9.

Question-asking sequences occur in six of the seven PV categories shown above. Interactions dealing with critique of communication were most common. Question-asking behaviour was the most frequently occurring IDN sequence in these interactions, followed by supportive behaviour, humour and building-on behaviour. Question-asking was also the most frequently occurring IDN sequence in interactions pertaining to critique of concept, and second most frequently occurring IDN sequence in ‘appreciate concept’, ‘highlight significance’ and ‘critique technique’ categories.

The second most noteworthy IDN sequence was supportive behaviour sequence found in ‘critique communication’, ‘appreciate communication’, ‘highlight significance’, ‘appreciate technique’ and ‘appreciate concept’ categories. Supportive behaviour was the only IDN sequence found in appreciate communication category.

Building-on behaviour sequence was found in six of the seven categories. It occurred least frequently of all the IDN sequences in ‘critique communication’ and ‘highlight significance’ interactions, and most frequently in ‘critique technique’ category of PV. It also appeared in ‘appreciate concept’ and ‘critique concept’ categories. Humour was seen in only two PV categories – ‘critique communication’ and ‘appreciate concept’.

These observations indicate that in this data-set, critiquing interactions such as ‘critique communication’ and ‘critique concept’ showed a dominance of question-asking sequences, while appreciative interactions such as ‘appreciate concept’, ‘highlight significance’ and ‘appreciate communication’ showed a dominance of supportive behaviour. Building-on

![Figure 9. IDN sequences occurring in interactions categorised per type of PV expressed.](image-url)
behaviour, which indicates collaboration between participants was seen in ‘appreciate concept’ interactions, but also surprisingly in critiquing interactions dealing with ‘critique communication’, ‘critique technique’ and ‘critique concept’. Similarly, it was interesting to note that humour was more common in critique communication interactions than any other PV category. Argumentative sequences were notably absent.

7. Discussion

In this section we discuss the interaction patterns observed in design review interactions and comment on the implication of visualising these patterns.

7.1. Interaction patterns observed in design reviews

Based on the observations from the study we make two assertions. First, we assert that student participation in interaction with the reviewer is important to effective design reviews. By effective design reviews we imply reviews, which expose students to displays of PV from the reviewer. The observation that a majority of PV interaction episodes (38 out of 40) were dialogues in which the student contributed to the PV interaction evidences this assertion. The notion that PV in design reviews is displayed through social interaction will not come as a surprise in the field of learning science. Lave and Wenger’s (1991) notion of situated learning transcends the concept of learning from an individual mind to a participatory framework. Here, the participatory framework of an interactive design review provides an opportunity for the display of PV that could facilitate student learning. Broudy (1977) when talking about types of knowledge mentions that ‘knowing with’ provides a situational context within which ‘knowing what’ (declarative knowledge) and ‘knowing how’ (procedural knowledge) are situated. The interactions between student and reviewer in a design review provide a ‘knowing with’ context in which the PV of the reviewer is articulated for the purpose of student learning. In the fields of design however, the primary focus in a design review remains on the artefact being reviewed and the interaction between reviewer and student is given peripheral attention. Though there are a few studies, which explicitly call out the role of social interaction in a design review from the perspective of knowledge transfer. Heylighen, Bouwen, and Neuckermans (1999) showed that interactions between teachers and students occurring in a design studio environment permit the transition of concept knowledge. Uluoğlu (2000) identified two types of reviewer–student interactions – coaching interactions dealing with associative knowledge where a student is encouraged to think of a specific solution via examples, analogies and scenarios; and demonstration interactions dealing with reflective knowledge where a solution demonstration is supplemented with reflection on action. In this paper, we go beyond previous studies that specify overall types of interaction, to specifying the moment-to-moment interactional dynamics between reviewer and student through which PV is articulated.

Our second assertion is that there are specific interaction behaviours associated with the display of PV in a design review. Amongst the four interaction behaviours identified in this study – question-asking, supportive behaviour, building-on and humour – question-asking has emerged as a key interaction behaviour. Questions prompted by the artefact commonly occurred at the beginning of episodes of PV. Reviewers asked
clarifying questions such as the one indicated in Figure 6, to understand certain aspects of the design artefact, which opened up opportunities for further comments. In some cases during client reviews and concept reviews, generative design questions (Eris 2002) sustained an interaction between the reviewer and student in which further elaboration of concepts occurred along with a discussion of possible alternatives. Cardoso, Eris, and Badke-Schaub (2014), who also analysed the graduate students’ design review data-set, mention that the reviews were lacking in deep-reasoning questions. While this observation is supported by our analysis, we find that question-asking in design reviews, even if it was clarifying questions, served as a prompt for initiating an interaction that led the reviewer to display his PV. Hence, question-asking, irrespective of question type, is a key interaction element in PV interactions.

Supportive behaviours indicating verbal or gestural acceptance, and building-on behaviours indicating co-creation of content were the second and third most frequently occurring interaction behaviours after question-asking. Supportive behaviour was found to occur is all PV interaction types except those that critiqued technique or critiqued concept. Since moment-to-moment interpersonal interactions have not been a subject of study in prior research in the context of design review, we do not find interpersonal supportive behaviour discussed in design review literature. We conjecture that supportive behaviour helps sustain a PV interaction by providing subtle encouragement to the participants. The absence of supportive behaviour in critique technique and critique concepts categories of PV is striking. Goldschmidt, Hochman, and Dafni (2010) point out that students like full-fledged designers have a strong sense of possession of their projects and their design concept. Perhaps, the absence of supportive behaviour may indicate students’ resistance to modification suggested by the reviewer when critiquing the concept or technique.

Unlike supportive behaviour, there is past research on building-on behaviour that points to its importance in design concept generation (van der Lugt 2003; Hargadon and Bechky 2006). However this behaviour has not been explicitly studied in the context of design review sessions. Building-on behaviour consisting of ‘yes and’ responses was observed in client reviews as shown in Figure 7, and also in concept reviews. It was observed in critiquing interactions as well as in interactions dealing with appreciation of concept category of PV. The presence of building-on behaviour in association with critique interactions suggests that even when critical feedback was being given, the reviewer and the student were participating in co-creation of the conversational content. This implies a collaborative attitude to reviewing and not an authoritative hand-over of knowledge from reviewer to student. There is some evidence in literature to support this collaborative style of reviewing. Goldschmidt, Hochman, and Dafni (2010) have highlighted a less assertive coaching style as desirable in design review sessions.

The fourth type of interaction behaviour observed in PV interactions was humour. We observed humour to a small extent in appreciate concept category and to a large extent in critique communication category. In the past application of IDN to concept generation (Sonalkar 2012), humour was implicated in sustaining interaction in concept space, as well as in diffusing negativity when contradicting or confronting team members. The presence of humour in the critique communication category could fulfil a purpose similar to diffusing negativity when confronting a person, since critiquing communication style could be taken more personally than critiquing the design concept under review.
7.2. The implication of visualising design review interactions

In this paper, we delved into moment-to-moment interpersonal interactions occurring in a design review and identified key interaction behaviours associated with the articulation of PV. We could have conducted this study using the IDN as a purely categorical coding scheme without the visual representation of interpersonal interactions. However, our choice of generating a visual representation and using it to analyse interpersonal interactions has a key implication for design education. The IDN was intentionally developed as a symbolic notation rather than just a categorical coding scheme in order to facilitate the conversion of moment-to-moment interpersonal interaction into an enduring visual artefact that can be placed alongside concept sketches and drawings in a design studio. The conversion of design interaction into a visual artefact not only affords it greater attention with the same level of accessibility as other forms of media such as design sketches, but it also enables designers to grasp the moment-to-moment dynamics quickly in a visual format. The design review interactions visualised in this study can be used to give feedback to design students about their interaction behaviours in design reviews. Students can realise how their responding influences the display of PV, and going beyond the scope of this study they could also comment on which interactions were critical to their learning experience. The visualisation of design review interactions using IDN with PV display highlighted forms a potential educational tool for improving student’s interactional engagement in design reviews. In this study, we did not get an opportunity to test the use of IDN representations of design review interactions to improve student’s review participation since we were working with pre-recoded video data. In our future work, we expect to report on methods to improve student’s review participation through visual interaction feedback.

8. Conclusion

In this paper, we examined the moment-to-moment interpersonal interactions in design reviews in an educational setting to identify interaction patterns that are associated with displays of PV. The display of PV indicates moments when a reviewer exhibits his ways of seeing and interpreting that are specific to the design profession, and can be considered crucial to the effectiveness of a design review as a learning situation. We identified four interaction behaviours – question-asking, supportive behaviour, building-on behaviour, and humour in the interactions that contribute to the expression of nine types of PV in design reviews. This analysis was conducted by representing review interactions visually using the IDN. This type of visualisation of design review interactions has the potential to be developed into an educational tool for design students to get feedback on their interactions and improve their participation in design reviews.

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References


