DTRS 10

# A Discursive Approach to Understanding Dependencies between Design Integration Actions

**Ömer Akın,** Professor of Architecture
Carnegie Mellon University

**Olaitan Awomolo**
Carnegie Mellon University

DTRS 10

# Background

DTRS 2: Radcliffe

**Non-Numerical Unstructured Data Indexing Searching and Theorizing (NUD.IST)**

DTRS 4: Suwa et al

**Dissecting protocols into types of actions**

DTRS 7: McDonnell and Lloyd

**Linguistic Analysis of Design protocols**

Luck

**Ethno Methodology and Conversational Analysis (EMCA)**

Glock

**Design as a social, interactive, interpretive process**

DTRS 10

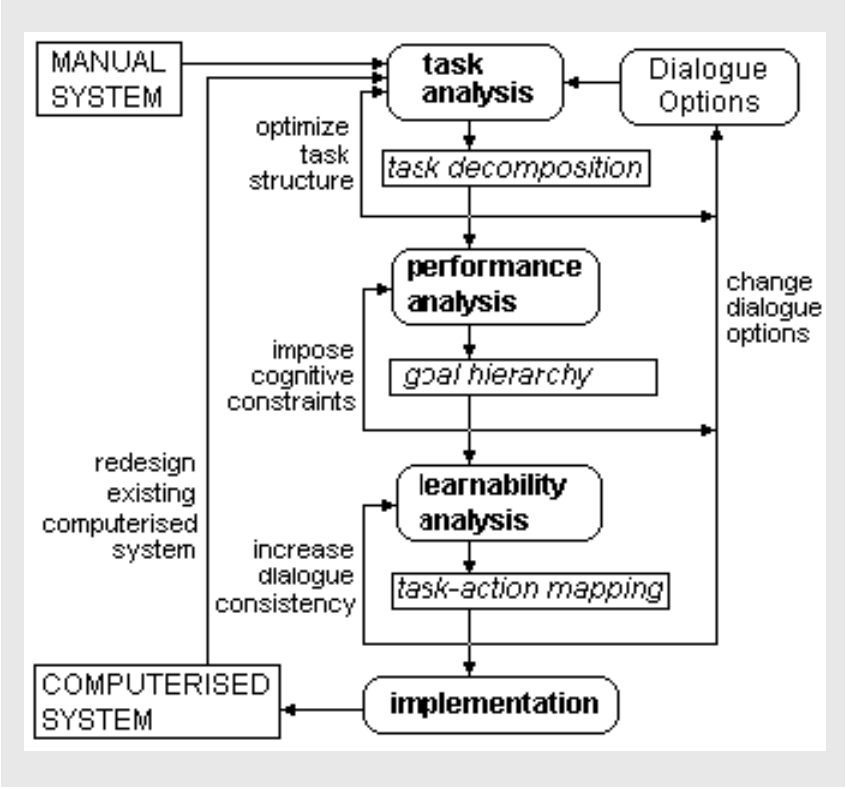
# Background

(Radcliffe, 1996)

1: Design activities are characterized by their discursive space

2. Argumentative activity contributes to the problem solving approach

3. Speech acts are linked to the character of the design step




Source: http://sic.ici.ro/sic1999_2/art05.html

**Hierarchical` Task Analysis**

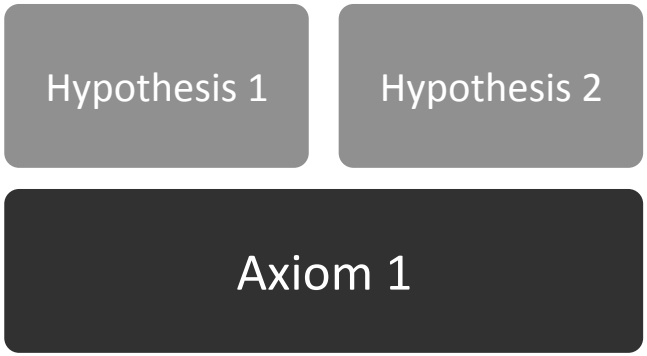
A method of organizing workflow to meet set objectives.

- Identifying the overall goal
- Defining sub-tasks
- Define the conditions guiding tasks

Tasks are represented as a hierarchy of operations organized from the top-down, to meet specified goals.

DTRS 10

# Hypotheses




**[Hypothesis 1]:** Design acts have dependencies when viewed in sequence highlighting moves that are pre- or post-requisites for other moves. This can be verified through statistical analysis of discursive data sequences (Pearl, 2009).

**[Axiom 1]:** Codified as utterances that consist of verb-noun pairings, retains the essence of the discursive representation (Stanton, 2005) mined here from design protocol data. This is all-inclusive of the linguistic representations sufficient to investigate both hypotheses.

**[Hypothesis 2]:** In design, features are decomposed into sub- or subservient features that are developed independently and then synthesized into wholes. This can be shown through episodic analysis of discursive data as was done in two previous studies (Akin, 1996; Akin, 2007).

DTRS 10

# Method: Data Selection

| Folder: 1-Partner Debrief #1 | Folder: 2-Brainstorm Review | Folder: 3-Partner Debrief #2 | Folder: 4-Advisor Debrief #1 | Folder: 5-Advisor Debrief #2 | Folder: 6-Partner Review | Folder: 7-Advisor Debrief #3 | Folder: 8-Final Review |
|---|---|---|---|---|---|---|---|
| 1-SL-PartnerDebrief1.mp4 (40 min)<br><br>1-SL-PartnerDebrief1.doc | 2-SL-BrainstormRev.mp4 (60 min)<br><br>2-SL-BrainstormRev.doc | 3-SL-PartnerDebrief2.mp4 (30 min)<br><br>3-SL-PartnerDebrief2.doc | 4-SL-AdvDebrief1.mp4 (11 min)<br><br>4-SL-AdvDebrief1.doc | 5-SL-AdvDebrief2.mp4 (11 min)<br><br>5-SL-AdvDebrief2.doc | 6-SL-PartnerReview.mp4 (19 min)<br><br>6-SL-PartnerReview.doc<br><br>6-SL-PartnerReview-slides.pdf | 7-SL-AdvDebreif3.mp4 (8 min)<br><br>7-SL-AdvDebreif3.doc | 8-SL-FinalReview.mp4 (45 min)<br><br>8-SL-FinalReview.doc<br><br>8-SL-FinalReview-slides.pdf |

DTRS 10

# Method: Data Selection

| Folder: 1-Partner Debrief #1 | Folder: 2-Brainstorm Review | Folder: 3-Partner Debrief #2 |
|---|---|---|
| 1-SL-PartnerDebrief1.mp4 (40 min)<br><br>1-SL-PartnerDebrief1.doc | 2-SL-BrainstormRev.mp4 (60 min)<br><br>2-SL-BrainstormRev.doc | 3-SL-PartnerDebrief2.mp4 (30 min)<br><br>3-SL-PartnerDebrief2.doc |

**Requirement Specification**

Describe design components and identify prescriptive requirements

- Treehouse
- Zip Line
- Ramp

**Preliminary Design**

Define the design concept and state feasible design alternatives

- Character
- Experience
- Features

**Design Development**

Specify design details and select materials.

- Safety
- Dimensions
- Mechanics
- Security/ Access

DTRS 10

# Method: Analysis

**Stages of Analysis**

1. Codification
2. Macro Level Analysis
3. Midi Level Analysis
4. Micro Level Analysis

DTRS 10

# Method: Codification

"So I just kind of had like a little extra area like where like the ramp does branch off and it's like a separate deck. And so like if people do like just like wanna go up there just to stand on it, they're not like blocking traffic, like with their _____ even if it is like an extra-wide ramp. So that was just one idea…."

**Utterances**:
Phrases or sentences that contain a specific idea.

**Utterance segments**:
Utterances assigned a verb-noun pairing according to the taxonomy.

| NOUN CLASSES | |
|---|---|
| **do - Design Objects** | |
| do1: | Ramp objects |
| do2: | Deck objects |
| do3: | Treehouse objects |
| do4: | Sensory/activity objects |
| do5: | Water feature objects |
| **VERB CLASSES`** | |
| I: | Introduce – make a general declaration |
| Q: | Question – pose a question |
| A: | Answer – respond to a Q |
| C: | Confirm – affirm the correctness of |
| E: | Elaborate – add new information |
| D: | Disqualify or delete information |
| M: | Modify information |

**Nouns (design Objects):**
Tokens that define a task to be performed

**Verbs:**
Tokens that describe an action performed on a task

DTRS 10

# Method: Codification

| Rules of Episode Definition |
| --- |
| 1. An episode must have a major noun-class [more than 50% among all noun-classes it contains]. |
| 2. An episode must start with an instance of the major noun-class |
| 3. An episode cannot contain a minor noun-class more numerous than 50% of the major noun-class. |
| 4. An episode cannot end with a sequence of noun-class instances that constitute a new episode. |
| 5. A sequence of noun-class instance consists of two or more consecutive ones in the same class. |

**Episode:**
A clustering of noun classes, usually with a dominant noun class

DTRS 10

# Method: Codification

| | | |
|---|---|---|
| *[0:00:00]* | | |
| *J1:* | ...– to sketch, so, so we don't pick it now.<br>...We will pick it after we do the second sketch.<br>...So now, we just roughly see what the others, ah, group member thinks, and get some inspiration and get more sketches and find out what problem we may face.<br>...For example, some ideas may be too overly realistic. We may trim it down probably. But now just introduce our ideas first, and see what everyone thinks.<br>...So probably we start from the ramp and accessibility.<br>So who draw the first one, and you just go ahead and explain the idea. Which one is – you draw that one, the _____? | Co(i.3)<br>I(i.3)<br>E(i.3)<br>I(r.15)<br>Q(i.1) |
| *C1:* | Yeah. Um, I can't really see it. So I guess – | A(i.3) |
| *J1:* | Probably everyone _____ together and we'll all kind of gather around – | Co(i.3) |
| *[0:01:00]* | | |
| | because it's pretty small images. | E(i.3) |
| *F1:* | _____ chair. | |
| *F2:* | Is that yours? | Q(i.7) |
| *F1:* | It's okay. *[Laughs]* | A(i.7) |
| *C1:* | So, I guess that first idea was kind of like, ah, I was thinking of, of a ramp when we talked about, um, like using it kind of like as ___ ___points.<br>So I just kind of had like a little extra area like where like the ramp does branch off and it's like a separate deck. And so like if people do like just like wanna go up there just to stand on it, they're not like blocking traffic, like with their _____ even if it is like an extra-wide ramp. So that was just one idea. | E(r.15)<br>I(o.4) |
| *J1:* | So keep on going. Just who draw the next, just talk about that. | Co(i.3) |
| *C1:* | Ah, that was me, too. I just like, ah, it was like the bottom floor of like the tree house, I kind of like just like imagined like a trap door that you could open.<br>And there could be like a ladder that's just like hanging on the ceiling, like kind of like you would in like a garage. And then like if you did need – | I(r.1)<br>E(r.1) |
| *[0:02:00]* | | |
| | like a fun way to get, ah, down, you could just have like the ladder be placed in the trap door.<br>And like I also had like something kind of along that note, like where the trap door could also like double as like a pulley system, so like it would have like a hook, but like a pulley and kids could like have fun like using like, like a bucket with like the pulley, like how we did when we were at camp. So – | E(r.1)<br>I(r.13) |
| *J1:* | Um, when she was talking with, ah, if other have some suggestion or how to improve this idea, you can just speak it out and she will do another sketches about that if you think it's good. So just ___ . | Co(i.3) |
| *N1:* | Um, so this is basically I – like, the ramp would kind of be the nature trail, um, since they don't really get to go on a lot of nature trails, um, just kind of making it like kind of more long and windey, and like really incorporating the different trees.<br>Um, so just making that like the ramp part of the experience going up. | I(o.4)<br>E(o.4) |
| *E1:* | I think it would be cool. I heard, ah, Tim kinda talking about like ways to keep them from going off it. | C(o.4) |
| *[0:03:00]* | | |
| | Um, maybe like incorporate into the pathway some like nature elements,<br>so maybe like instead of having like a wooden ledge come up, maybe the base is kind of rock-like, kinda like a gravel path, so adding like those on the side and those are the bumpers that prevent them from going, going off.<br>So it actually looks like a trail 'cause that's a pretty cool idea. | L(s.3)<br>E(o.4)<br>C(o.4) |
| *N1:* | Um, the next one was mine, and it's just basically like to have on the ramp, some kind of like optional wheelchair pull that just like hooks on the back of their wheelchair and it pulls up. Like it, it doesn't have to be automated. It can be like completely mechanical so you can _____ the other end or – | I(o.4)<br>L(r.20) |
| *C1:* | _____ the next one is mine. It's really self-explanatory, just like a super wide ramp.<br>And like I kind of put like the traffic lines on there kind of like just to like so they would stay on their side kind of. It's kinda like them driving. So I just thought that was kinda fun. | I(o.4)<br>E(o.4) |
| *J1:* | Is then the other like protection for these ramps? | Q(r.13) |
| *C1:* | Yeah. Like, like, there would be like a railing. Like I just like couldn't really draw it very well. Like I kind of | A(r.13) |

**Utterance**

**Utterance Segment**

**Verb-Noun Pairing**

**Episode**

DTRS 10

# Method: Codification

**Noun Class: Design Objects**

| NOUN CLASSES | |
|---|---|
| **do - Design Objects** | |
| do1: | Ramp objects |
| do2: | Deck objects |
| do3: | Treehouse objects |
| do4: | Sensory/activity objects |
| do5: | Water feature objects |
| **gp - General-Performance Requirement** | |
| gp1: | Safety requirements |
| gp2: | Nature experience requirements |
| gp3: | Activity requirements |
| gp4: | Cost |
| gp5: | Character of camp champ |
| **go - General-Object Requirement** | |
| go1: | Dimension requirements |
| go2: | Camper requirements |
| go3: | Electricity requirements |
| **i - Information or Statement** | |
| i1: | Introduce design team |
| i2: | Camp information: Camp operations |
| i3: | Process/meeting information |
| i4: | Precedent information |
| i6: | Mechanics of the requirements |
| I7: | Mechanics of the design |
| **ro – Requirement Options** | |
| ro2: | Zip line options |
| ro4: | Ramp options |
| ro5: | Activity options |
| **NOUN CLASSES – continued on the right** | |

| s – Physical Environment | |
|---|---|
| s1: | Site description |
| s2: | Site protection: tree protection |
| s3: | Site characteristics: features on site |
| **so - Specific-Object Requirement** | |
| so1 | Treehouse requirements |
| so2: | Zip line requirements |
| so3: | Ramp requirements |
| so4: | Wheelchair requirements |
| so5: | Observation deck |
| so6: | Water: waterslide, hot tub |
| so7: | Tire swing |
| so8: | Fire-ring, fireplace |
| so9: | Skylights |
| **sp - Specific Performance Requirement** | |
| sp1: | Protection requirements |
| sp2: | Security/ Access requirements |
| sp3: | Structural requirements s-performance |
| **u- People within facility excluding design team** | |
| u1: | Users-kids |
| u2: | Users-staff |
| u3: | User-activity |

| VERB CLASSES` | |
|---|---|
| I: | Introduce – make a general declaration |
| Q: | Question – pose a question |
| A: | Answer – respond to a Q |
| C: | Confirm – affirm the correctness of |
| E: | Elaborate – add new information |
| D: | Disqualify or delete information |
| M: | Modify information |

**Verb Classes**

DTRS 10

# Method: Codification

| Data Coders | 1. V and N match | 2. V X-or N match | 3. Any match [1+2] | 4. No-match | 5. Total |
|---|---|---|---|---|---|
| **3/15/2014 Comparison** | | | | | |
| Omer | 17 | 45 | 62 | 148 | 210 |
| Olaitan | 17 | 45 | 62 | 21 | 83 |
| % [Omer vs. Olaitan] | %21 vs. %8 | %54 vs. %21 | %75 vs. %30 | %25 vs. % 70 | |
| | | | | | |
| **3/25/2014 Comparison** | | | | | |
| Omer | 44 | 90 | 134 | 77 | 211 |
| Olaitan | 44 | 90 | 134 | 52 | 186 |
| % [Omer vs. Olaitan] | %21 vs %24 | %43 vs %48 | %64 vs. %72 | %36 vs %28 | |
| | | | | | |
| **3/31/2014 Comparison** | | | | | |
| Omer | 65 | 100 | 165 | 46 | 211 |
| Olaitan | 65 | 100 | 165 | 90 | 255 |
| % [Omer vs. Olaitan] | %31 vs %25 | %47 vs %39 | %78 vs. %65 | %22 vs %35 | |

*Differences in percentages due to inconsistencies in coding utterance segments and errors in the use of codes.

DTRS 10

# Analysis: Macro Level

**Objective:**

Determine that our coded data represents the distinctions in the three protocols

**Methods:**

Descriptive Statistics

Frequency Analysis

**Expected results:**

Dominant coding showing

[P-1] – requirement specification

[P-2] – preliminary design

[P-3] – design development

DTRS 10

# Analysis: Macro Level

## Verb Classes

| Verbs | Protocol | Count | Episodes per Protocol | Mean: Verb per protocol |
|---|---|---|---|---|
| I | 1 | 73 | 27 | 2.7 |
| | 2 | 297 | 142 | 2.09 |
| | 3 | 105 | 70 | 1.5 |
| E | 1 | 54 | 27 | 2 |
| | 2 | 27 | 142 | 1.6 |
| | 3 | 131 | 70 | 1.87 |
| Q | 1 | 36 | 27 | 1.33 |
| | 2 | 36 | 142 | 0.25 |
| | 3 | 43 | 70 | 0.61 |
| A | 1 | 32 | 27 | 1.19 |
| | 2 | 24 | 142 | 0.17 |
| | 3 | 35 | 70 | 0.5 |
| C | 1 | 27 | 27 | 1 |
| | 2 | 155 | 142 | 1.09 |
| | 3 | 129 | 70 | 1.84 |
| D | 1 | 1 | 27 | 0.04 |
| | 2 | 5 | 142 | 0.04 |
| | 3 | 5 | 70 | 0.07 |

## Noun Classes

| Noun Class | Protocol | Count | Episodes per Protocol | Mean: NC per episode |
|---|---|---|---|---|
| i | 1 | 45 | 27 | 1.67 |
| | 2 | 241 | 142 | 1.7 |
| | 3 | 125 | 70 | 1.79 |
| so | 1 | 92 | 27 | 3.41 |
| | 2 | 24 | 142 | 0.17 |
| | 3 | 45 | 70 | 0.64 |
| gp | 1 | 15 | 27 | 0.56 |
| | 2 | 130 | 142 | 0.92 |
| | 3 | 62 | 70 | 0.89 |
| go | 1 | 21 | 27 | 0.78 |
| | 2 | 11 | 142 | 0.08 |
| | 3 | 6 | 70 | 0.09 |
| sp | 1 | 6 | 27 | 0.22 |
| | 2 | 13 | 142 | 0.09 |
| | 3 | 52 | 70 | 0.74 |
| u | 1 | 32 | 27 | 1.19 |
| | 2 | 23 | 142 | 0.16 |
| | 3 | 29 | 70 | 0.41 |
| s | 1 | 13 | 27 | 0.48 |
| | 2 | 12 | 142 | 0.08 |
| | 3 | 0 | 70 | 0 |
| ro | 1 | 3 | 27 | 0.11 |
| | 2 | 0 | 142 | 0 |
| | 3 | 0 | 70 | 0 |
| do | 1 | 0 | 27 | 0 |
| | 2 | 289 | 142 | 2.04 |
| | 3 | 130 | 70 | 1.86 |

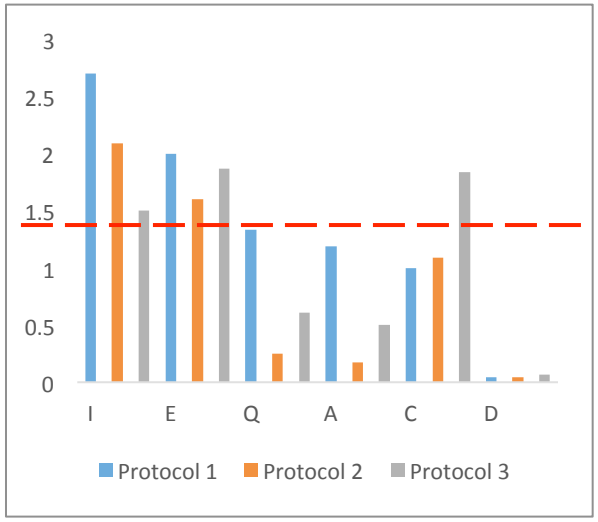
**Descriptive Statistics**

To indicate the distribution of noun and verb classes in the protocols.

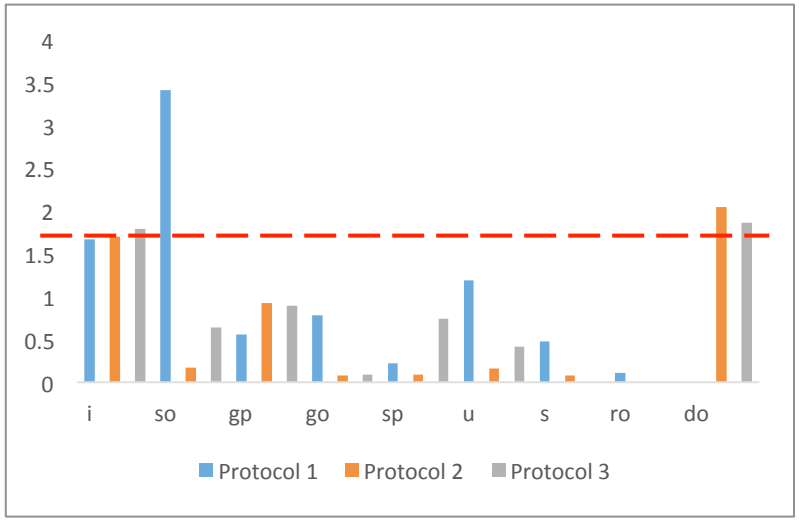
DTRS 10

# Analysis: Macro Level

**Verb Classes**




**Noun Classes**




**Results: Verification of Codification**

| Protocol | Dominant Verb Class | Dominant Noun Class |
|---|---|---|
| P-1 | [I] introduce | [so] specific object requirement |
| P-2 | [I] introduce | [do] design object |
| P-3 | [E] explain<br>[C] confirm | [do] design object |

**Frequency Analysis**

To identify the dominant noun and verb class per protocol

DTRS 10

# Analysis: Midi Level

**Objective:**

Identify the extent of similarity or difference between protocols

Determine episodes to study in the micro level analysis

**Methods:**

Analysis of Variance

Multiple Comparison (Tukey Post hoc Test)

Frequency Analysis

**Expected results:**

Results should show statistically significant difference

between protocols for the dominant noun classes

DTRS 10

# Analysis: Midi Level

## Noun Classes

| | | Sum of Squares | df | Mean Square | F | Signifi-cance |
|---|---|---|---|---|---|---|
| i | Between Protocols | .453 | 2 | .226 | .012 | .989 |
| | Within Protocols | 4637.765 | 236 | 19.652 | | |
| | Total | 4638.218 | 238 | | | |
| so | Between Protocols | 238.010 | 2 | 119.005 | 21.172 | .000 |
| | Within Protocols | 1326.534 | 236 | 5.621 | | |
| | Total | 1564.544 | 238 | | | |
| gp | Between Protocols | 2.977 | 2 | 1.489 | .357 | .700 |
| | Within Protocols | 984.738 | 236 | 4.173 | | |
| | Total | 987.715 | 238 | | | |
| go | Between Protocols | 11.658 | 2 | 5.829 | 4.943 | .008 |
| | Within Protocols | 278.300 | 236 | 1.179 | | |
| | Total | 289.958 | 238 | | | |
| sp | Between Protocols | 20.060 | 2 | 10.030 | 3.894 | .022 |
| | Within Protocols | 607.848 | 236 | 2.576 | | |
| | Total | 627.908 | 238 | | | |
| u | Between Protocols | 24.143 | 2 | 12.071 | 6.109 | .003 |
| | Within Protocols | 466.334 | 236 | 1.976 | | |
| | Total | 490.477 | 238 | | | |
| s | Between Protocols | 4.658 | 2 | 2.329 | 6.126 | .003 |
| | Within Protocols | 89.727 | 236 | .380 | | |
| | Total | 94.385 | 238 | | | |
| ro | Between Protocols | .296 | 2 | .148 | 4.026 | .019 |
| | Within Protocols | 8.667 | 236 | .037 | | |
| | Total | 8.962 | 238 | | | |
| do | Between Protocols | 95.040 | 2 | 47.520 | 2.877 | .058 |
| | Within Protocols | 3897.395 | 236 | 16.514 | | |
| | Tota | 3992.435 | 238 | | | |

| Noun-class | Significance between protocols | | | |
|---|---|---|---|---|
| i | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0.999 | 0.992 |
| | 2 | 0.999 | 1 | 0.99 |
| | 3 | 0.992 | 0.99 | 1 |
| so | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0 | 0 |
| | 2 | 0 | 1 | 0.359 |
| | 3 | 0 | 0.359 | 1 |
| gp | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0.679 | 0.756 |
| | 2 | 0.679 | 1 | 0.995 |
| | 3 | 0.756 | 0.995 | 1 |
| go | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0.007 | 0.015 |
| | 2 | 0.007 | 1 | 0.999 |
| | 3 | 0.015 | 0.999 | 1 |
| sp | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0.92 | 0.326 |
| | 2 | 0.92 | 1 | 0.016 |
| | 3 | 0.326 | 0.016 | 1 |
| u | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0.002 | 0.437 |
| | 2 | 0.002 | 1 | 0.043 |
| | 3 | 0.437 | 0.043 | 1 |
| s | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0.007 | 0.002 |
| | 2 | 0.007 | 1 | 0.617 |
| | 3 | 0.002 | 0.617 | 1 |
| ro | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0.017 | 0.03 |
| | 2 | 0.017 | 1 | 1.00 |
| | 3 | 0.03 | 1.00 | 1 |
| do | Protocols | 1 | 2 | 3 |
| | 1 | 1 | 0.047 | 0.11 |
| | 2 | 0.047 | 1 | 0.952 |
| | 3 | 0.11 | 0.952 | 1 |

**ANOVA**

To determine differences between protocols for noun classes

**Multiple Comparison**

To provide more information on the differences between protocols for noun classes

DTRS 10

# Analysis: Midi Level

**Results: Differences between Protocols**

| ANOVA | Verb Class | Noun Cass |
|---|---|---|
| No significant difference >0.05 (All Protocols) | [I] introduce<br>[E] explain<br>[C] confirm<br>[D] disqualify | [i] information<br>[do] design objects<br>[gp] general performance requirement |
| Significant difference <0.05 (All Protocols) | [Q] question<br>[A] answer | [go] general object requirement<br>[sp] specific performance requirement<br>[so] specific object requirement<br>[u] users<br>[ro] requirement options |

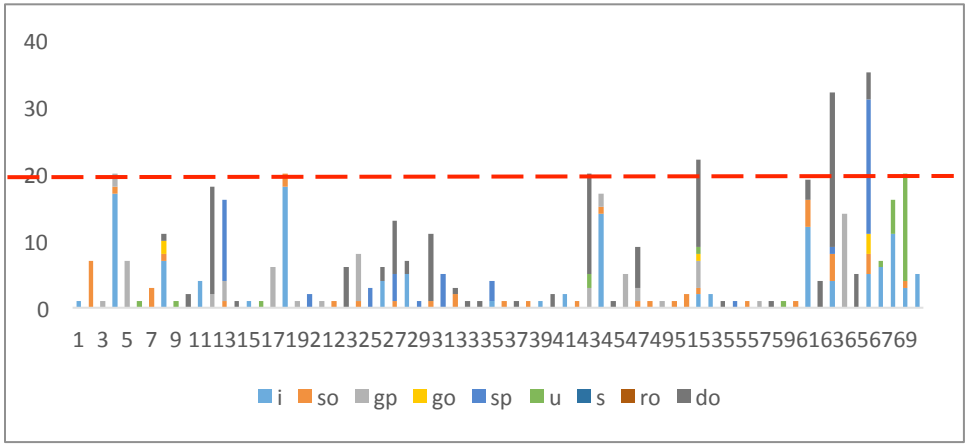
**ANOVA**
To determine differences between protocols for noun classes

**Multiple Comparison**
To provide more information on the differences between protocols for noun classes

DTRS 10

# Analysis: Midi Level

**Graphs showing frequency of noun classes per episode**




**Protocol 3**

**Results: Episode Analysis**

| Protocol | Episodes selected |
|---|---|
| P-1 | Episode 5, Episode 23, Episode 33, Episode 55, Episode 57 |
| P-2 | Episode 54, Episode 92, Episode 100, Episode 113, Episode 154 |
| P-3 | Episode 52, Episode 61, Episode 63, Episode 66, Episode 69 |

**Frequency Analysis**
To identify the dominant episodes per protocol

DTRS 10

# Analysis: Micro Level

**Objective:**

Determine dependencies between dominant noun class and supporting noun classes within an episode

Identify integration of noun classes

**Methods:**

Frequency Analysis

Multivariate Regression

Correlation Comparison (Pearson Coefficient)

Integration analysis

**Expected results:**

[Hypothesis 1]: Significant dependence between noun classes

[Hypothesis 2]: Pattern of solution integration

DTRS 10

# Analysis: Micro Level

**Dominant noun class**

| Episode Analysis | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *P-1: EPISODE 5* | | | *P-1: EPISODE 23* | | | *P-1: EPISODE 33* | | | *P-1: EPISODE 55* | | | *P-1: EPISODE 57* | | |
| **A4** | **f** | **%** | **A23** | **f** | **%** | **A33** | **f** | **%** | **A55** | **f** | **%** | **A57** | **f** | **%** |
| ji | 2 | 12.5 | s | 1 | 8 | u | 2 | 12.5 | gp | 1 | 3 | u | 2 | 6 |
| so | 10 | 62.5 | sp | 1 | 8 | ji | 13 | 81.25 | ro | 3 | 9 | go | 1 | 3 |
| gp | 3 | 18.75 | so | 9 | 76 | sp | 1 | 6.25 | so | 19 | 70 | so | 26 | 73 |
| u | 1 | 6.25 | u | 1 | 8 | **Σ** | **16** | **100** | ji | 3 | 9 | 1 | 4 | 12 |
| **Σ** | **16** | **100** | **Σ** | **12** | **100** | | | | go | 3 | 9 | gp | 2 | 6 |
| | | | | | | | | | **Σ** | **29** | **100** | **Σ** | **35** | **100** |

**Frequency Analysis**
To identify the dominant noun class per episode

DTRS 10

# Analysis: Micro Level

| Protocol-1: Requirement Specification | | | | | |
|---|---|---|---|---|---|
| Episode | Dependent Variable [major noun-class] | Independent Variable [minor noun-classes] | R | R. sq | Adjusted R.sq |
| 4 | so | u, gp, i | 0.893 | 0.798 | 0.646 |
| 23 | so | u, sp, s | 0.933 | 0.871 | 0.677 |
| 33 | i | sp, u | 0.919 | 0.844 | 0.687 |
| 55 | so | go, gp, i, ro | 0.696 | 0.484 | 0.255 |
| 57 | so | gp, go, u, i | 0.727 | 0.529 | 0.214 |
| **Protocol-2: Preliminary Design** | | | | | |
| Episode | Dependent Variable [major noun-class] | Independent Variable [minor noun-classes] | R | R. sq | Adjusted R.sq |
| 54 | do | i, u, go, s, gp | 0.778 | 0.605 | 0.506 |
| 92 | do | i, gp | 0.682 | 0.465 | 0.376 |
| 100 | i | do, u, gp | 0.636 | 0.405 | -0.042 |
| 113 | do | so, gp, i | 0.657 | 0.432 | 0.006 |
| 154 | do | i, s, u, gp, sp, so | 0.822 | 0.676 | 0.432 |
| **Protocol-3: Design Development** | | | | | |
| Episode | Dependent Variable [major noun-class] | Independent Variable [minor noun-classes] | R | R. sq | Adjusted R.sq |
| 52 | do | u, so, go, i, gp | 0.715 | 0.512 | -0.098 |
| 61 | i | do, so | 0.703 | 0.494 | 0.292 |
| 63 | do | so, i, sp | 0.801 | 0.642 | 0.489 |
| 66 | sp | go, so, do, i | 0.537 | 0.288 | -0.067 |
| 69 | u | so, i | 0.73 | 0.532 | 0.298 |

**Protocol 1**

**Protocol 2**

**Protocol 3**

**Multivariate Regression**

To determine dependencies between major the dominant noun class and supporting noun classes

DTRS 10

# Analysis: Micro Level

## Protocol 1

| Episode | Dominant Noun Class | Supporting Noun Class | Correlation Coefficient |
|---|---|---|---|
| 4 | so | u | -0.276 |
| | | gp | -0.393 |
| | | i | -0.421 |
| 23 | so | u | -0.417 |
| | | sp | -0.417 |
| | | s | -0.417 |
| 33 | i | sp | -0.375 |
| | | u | -0.612 |
| 55 | so | go | -0.334 |
| | | gp | -0.177 |
| | | i | -0.245 |
| | | ro | -0.245 |
| 57 | so | gp | -0.337 |
| | | go | -0.226 |
| | | u | -0.226 |
| | | i | -0.295 |

## Protocol 2

| Episode | Dominant Noun Class | Supporting Noun Class | Correlation Coefficient |
|---|---|---|---|
| 54 | do | i | -0.345 |
| | | u | -0.141 |
| | | go | -0.141 |
| | | s | -0.193 |
| | | gp | -0.364 |
| 92 | do | i | -0.378 |
| | | gp | -0.407 |
| 100 | i | do | -0.253 |
| | | u | -0.253 |
| | | gp | -0.36 |
| 113 | do | so | -0.29 |
| | | gp | -0.351 |
| | | i | -0.29 |
| 154 | do | i | -0.292 |
| | | s | -0.211 |
| | | u | -0.211 |
| | | gp | -0.211 |
| | | sp | -0.211 |
| | | so | -0.31 |

## Protocol 3

| Episode | Dominant Noun Class | Supporting Noun Class | Correlation Coefficient |
|---|---|---|---|
| 52 | do | u | -0.171 |
| | | so | -0.171 |
| | | go | -0.171 |
| | | i | -0.241 |
| | | gp | -0.241 |
| 61 | i | do | -0.466 |
| | | so | -0.32 |
| 63 | do | so | -0.533 |
| | | i | -0.231 |
| | | sp | -0.231 |
| 66 | sp | go | -0.14 |
| | | so | -0.14 |
| | | do | -0.181 |
| | | i | -0.298 |
| 69 | u | so | -0.365 |
| | | i | -0.526 |

**Pearson Correlation**

To determine the extent of the dependencies between major the dominant noun class and supporting noun classes

DTRS 10

# Analysis: Micro Level

**Results: Dependency**

| Episode | Dominant Noun Class | Highest supporting noun class |
|---|---|---|
| 4 | [so] | [i] |
| 23 | [so] | [u], [sp], [s] |
| 33 | [i] | [u] |
| 55 | [so] | [go] |
| 57 | [so] | [go] |

**Protocol 1**

| Episode | Dominant Noun Class | Highest supporting noun class |
|---|---|---|
| 54 | [do] | [gp] |
| 92 | [do] | [gp] |
| 100 | [i] | [gp] |
| 113 | [do] | [gp] |
| 154 | [do] | [so] |

**Protocol 2**

| Episode | Dominant Noun Class | Highest supporting noun class |
|---|---|---|
| 52 | [do] | [i], [gp] |
| 61 | [i] | [do] |
| 63 | [do] | [so] |
| 66 | [sp] | [i] |
| 69 | [u] | [i] |

**Protocol 3**

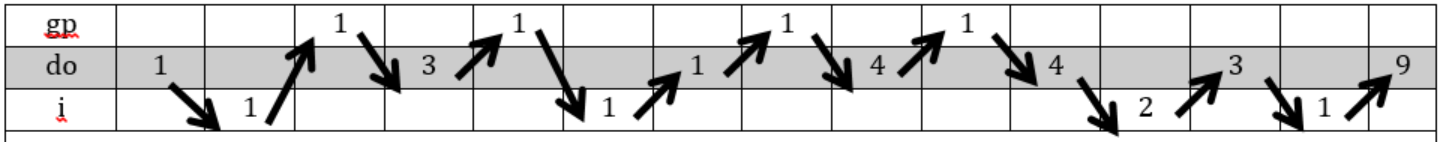
DTRS 10

# Analysis: Micro Level

| Protocol Transcription and Assigned Codes | | | |
|---|---|---|---|
| **Subject** | **Discourse [utterance]** | **Code** | **Noun Tokens** |
| *M1* | Yeah, the main tree house area,<br>and like maybe – like when we were talking with the kids with like the cards, a lot of the things they liked about like that one ship tree house,<br>or like the other one, so they have like a place to – | I(do.3)<br>I(i.4)<br>I(gp.2) | treehouse_objects<br>precedent_information<br>nature_exp_requirements |
| *0:37:00* | *timestamp* | | |
| | go up high if they wanted to and look out.<br>So maybe like having an observation – like an obso- – like an — observation deck like up high or whatever, they could go to. | I(do.2) | deck_objects |
| | Like a crow's nest, but like having it like close in with glass, even on the top so they can see out like all the sides. | E(do.3) | treehouse_objects |
| *N1* | That'd be cool. | C(do.3) | treehouse_objects |
| *M1* | Um, and then my second one is kind of like nature,<br>but like now I kinda feel like it's – I don't know.<br>Just the way I was thinking at the time is having like a retractable roof on like a pulley system from like down below<br>where they can pull the roof open to stargaze at night,<br>but if the window gets bad, they can like undo it more and like flip it back where it was.<br>And then the last one is just having like port hole windows,<br>like at different levels where like everybody at different heights could see out – | I(gp.2)<br>I(i.3)<br>I(do.3)<br>I(gp.2)<br>E(do.3)<br>E(do.3)<br>E(do.3) | nature_exp_requirements<br>process_meeting_info<br>treehouse_objects<br>nature_exp_requirements<br>treehouse_objects<br>treehouse_objects<br>treehouse_objects |
| *N1* | I like that. | C(do.3) | treehouse_objects |
| *M1* | – like different ways. And maybe even like attach them to bird feeders, too, though, so they can have like different specified areas to see just nature up close. | I(gp.2) | nature_exp_requirements |
| *C1* | And you could have those even like outside like you said, but open – | E(do.3) | treehouse_objects |
| *M1* | Yeah. Like they're really neat.<br>They, they come in bird feeders. They make like a nest that like you can just see the inside and it's closed on the outside, so like they're not like nervous about what's going on – | C(do.3)<br>E(do.3) | treehouse_objects<br>treehouse_objects |
| *0:38:00* | *timestamp* | | |
| | outside your window, just see. | E(do.3) | treehouse_objects |
| *J1* | I have – | I(i.3) | process_meeting_info |
| *S1* | Sorry. I, I had some ideas to add onto that like could make _____.<br>And so just flat portholes, you can make them bubble inward, and then you can put a feeder on the inside of the bubble, and then hopefully, the birds would come in and it would be inside of the tree house and – | I(i.3)<br>I(do.3)<br>E(do.3) | process_meeting_info<br>treehouse_objects<br>treehouse_objects |
| *N1* | That's cool. I like that. | C(do.3) | treehouse_objects |
| *J1* | I had two ideas.<br>The first one is like the top is like, ah, dome shape roof, and on top, it's like a one section is ch-, ah, like, actually, the base is totally transparent,<br>and on top of that, has three sections, which is solid.<br>So the roof is rotating to change the transparency of the, the roof. | I(i.3)<br>I(do.3)<br>E(do.3) | process_meeting_info<br>treehouse_objects<br>treehouse_objects |
| *M1* | You mean like an open one? | Q(do.3) | treehouse_objects |
| *J1* | Yeah, like – | A(do.3) | treehouse_objects |
| *M1* | Like you could rotate – | E(do.3) | treehouse_objects |
| *J1* | Changing the rope, opening section of the house. | E(do.3) | treehouse_objects |
| *M1* | Cool. | C(do.3) | treehouse_objects |
| *J1* | And, and also they can block it if they want sunshine to come in.<br>And this one is just for the ramp side here, which can have some like branches cover around – | E(do.3)<br>I(do.1) | treehouse_objects<br>treehouse_objects |

DTRS 10

# Analysis: Micro Level




intermittently the focus of the process going back to: general performance requirement [gp]; and basic information [i] with specific purposes expressed as "a place to go up and look out"; "emulating nature"; "stargazing at night";

**Micro Level Analysis**

Dominated by treehouse objects [do.3] with one or two visits to ramp objects [do.1] and deck objects [do.2]. These reveal a transformation of the design from-to: ship tree house → observation deck →a crow's nest →retractable roof → flip the window back → port-hole windows → bird feeders → view outside your window → flat portholes → make windows bubble inward with feeder →dome shaped roof →with transparent base →rotating roof →open section of the house → regulate sunlight.

DTRS 10

# Summary

- Discursive data enabled us to discover a rich set of analytical techniques that were applicable to syntactic codifications.

- When compared with previous research, discursive syntax provides less ambiguous information than semantics-laden graphic and visual data.

- In the Verb-Noun Analysis (VNA) method we used, the tokens of the taxonomy consist of natural language symbols which was easy to discern allowing us see the dependencies between these symbols without overlaying a network of new symbolic relationships.

- Verb-Classes (actions) were not specific enough to reveal any dependency relations

- Major noun-classes (those that dominate a given episode) were dependent on the minor noun-classes.

- Dependencies provided an understanding of how design objects became anchors for all other noun-classes, particularly in the later stages of the design workflow process.

# Summary

Finally, we observe the following best practices for design in the office or in the studio:

- In design, flow of actions should be anchored around a single, major task/action

- In design, keeping the focus on discursive information is vital, private solo design activities should be discouraged in lieu of team, conversational sessions

- In team design, concurrent and co-located activities by multiple participants increases the chances of multiple design object (physical feature) integration.