## Construction Change Order Analysis

**CPS 533C Analysis Project**

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### Definitions of Formalisms (1)

- **Dimension Type dimensions**:
  - **Measure Type dimensions**
  - **Values of Measure type dimension**
  - **Statistics Values of Measure type dimension**
  - **Called “Quantity Measurement”!!**

### Definitions of Formalisms (2)

- **Definition of “Profit”**: 1 to many
- **Values of Measure type dimension “Sales” for Dimension type dimension “sales number”**

### Definitions of Formalisms (3)

- **Definition of “Color” to “Profit”**: 1 to many

### Current Practice of Using Construction Data

**Use Excel or Access to store abstract data**
- **Visualization is only focused on physical data and important abstract data like cost, resource, and schedule**
- **Seldom are full spectrum of construction data analyzed**
- **Excel charts used for rare presentation situation**
- **Too challenging when trying to analyze more data using Excel—ad hoc manner, time consuming. Graphing rather than analyzing**

### Key Criteria of Visualization Tools Selection

- **Alleviate the burden of retrieving and visualizing abstract data**
- **Shorten the time of comprehending the meaning of data represented by visual encodings**
- **Link between visualization of abstract data and physical data**
- **Comprehensive, Robust and Easy to Use. Not necessarily the best.**

### Key Criteria of Visualization

- **Targeted**
  - **Query Data Faster**
  - **Query by slider (Tableau)**
  - **Query by Data Dimensions (Tableau and Advisor)**
  - **Query by Brush (Advisor)**
  - **Generate Visualization Faster**
  - **Automated Graph Generation (Tableau)**
  - **More effective Visualization**
  - **Built-in Visual Encoding Formalism based on Psychology Ground (Tableau and Advisor)**
  - **Link Between Abstract and Physical Data**
  - **Coordinated Multiple View (Tableau and Advisor; Not implement exactly yet, but have extension potential)**

### Tools Selected

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  - **Query Data Faster**
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### Scenario Formalisms (why)

- **Scenario Formalisms bridge the gap for domain experts so that they can systematically and mechanically use tools thereby focusing on “reading information”**

### Scenario Formalisms (what)

- **Find quantity distributions along any Dimension type dimension**
- **Compare quantity distributions along the same Dimension type dimension (Correlations Finding)**
- **Compare trend and occurrence of time dependent data**
- **Association between Data of Different Dimensions**

### Nature of Construction Data (1)

- **Link to Physical Data in Abstract Data**
  - **Categorize Physical Data by types**
  - **Memorandums from Sub-trade vs Client**
  - **Drawings of Interior Components vs Structure Components**
  - **Categorize Physical Data by contents**
  - **Two pictures the site conditions are Good vs Bad**
  - **Problems encountered described in daily site report includes Bad Weather, Equipment Down, etc. Lots of physical data can be transformed into categorical abstract data!**

### Nature of Construction Data (2)

- **Digitized Format**
  - **Format for Abstract Data**
  - **Database or spreadsheet of workbooks and logs**
  - **Format for Physical Data**
  - **Collections of digital video and picture**
  - **Collection of electronically stored text documents (contracts, memorandum, e-mail, meeting minutes)**
  - **Collection of electronic product drawings (2D Cad, 3D Cad)**

### Nature of Construction Data (3)

- **Why Are the Criteria?**
  - **Multidimensional data means you need to understand them from “multi-perspectives”**
  - **Images conveying information from “multi-perspectives” just too many**
  - **The iterative process of retrieving data—visualizing data—observing visualization->retrieving data is sheer tedious**
  - **Visualization of physical data help validate users’ semantic perception of it’s abstract form**

### Nature of Construction Data (4)

- **Construction data can be transformed to totally abstract data for the purpose of analysis**
- **In the abstract data form, they are multidimensional!**

### Problems of Using Construction Data

- **Hybrid of physical and abstract data**
  - **Difficult to link, model, and organize**
  - **Costly to link, model, and organize**
  - **Try to model, but lack of medium to interpret and see the benefit**
  - **Vicious cycle between model and interpret data**

### Nature of Construction Data (1)

- **Original Format**
  - **Filled out preprinted forms, workbooks, and logs**
  - **Plain text documents like contracts, memorandum, e-mail, meeting minutes**
  - **Pictorial documents like drawings, pictures, and videos**

### Key Visualization Techniques Targeted

- **Query Data Faster**
  - **Query by slider (Tableau)**
  - **Query by Data Dimensions (Tableau and Advisor)**
  - **Query by Brush (Advisor)**
- **Generate Visualization Faster**
  - **Automotive of Graph Generation**
  - **More effective Visualization**
  - **Built-in Visual Encoding Formalism based on Psychology Ground (Tableau and Advisor)**
- **Link Between Abstract and Physical Data**
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### Definitions of Formalisms (1)

- **Quantity Distribution of Data along Dimension Type Dimension**
  - The distribution of Quantity Measurements along a Dimension type dimension

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**Note:**

- **Called “Quantity Measurement”!!**

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**Note:**

- **‘Color’ to ‘Profit’ : 1 to many**

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**Note:**

- **‘Number’ to ‘sales’ : 1 to 1**

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**Note:**

- **Called “Quantity Measurement”!!**
**Scenario Formalism + Visualization Tools**

**Visualization Tools**

- **Scenario Formalism:**
  - Compare quantity distributions along any Dimension type dimension
  - Find in the whole dataset
  - Find in the subset of data

- **Key Techniques:**
  - Query by dimensions, Visualization Automation, Visual Encoding Formalism

**Dataset of Change Order Domain**

**Quantity Distributions of the subset of dataset along with different Dimension type dimensions**

**Association Between Data of Different Dimensions**

- Similar to finding quantity distribution (first type of scenario formalism)
- But quantity is not our concern now.
- Find "which data has something to do with what data".

**Quantity Distributions of the whole dataset along with different Dimension type dimensions**

**Scenario Formalism + Visualization Tools (1.1)**

- **Scenario Formalism:**
  - Find quantity distribution
- **Tool:**
  - Adivzor (better in gaining overview)
- **Key Techniques:**
  - Query by dimensions, query by brush, linked data views, visual encoding formalism

**Scenario Formalism + Visualization Tools (1.2)**

- **Information Extracted:**
  - 9–12 information pertinent to change order obtained
  - Example Information: Interior construction and service construction encounter more change orders than other components of the building
- **Time Spent on Retrieving and Visualizing:**
  - Less than 5 minutes (excluding one time overhead of setting environment)

**Quantity Distributions of the subset of dataset along with different Dimension type dimensions**

**First type of quantity distribution comparison**

- Drag Measure type dimension of "projected cost", "approved cost", and "record count" to Column Shelf, instruct the system to total these three dimensions, and drag the Dimension type dimension "reason of change" to Row Shelf.

- Drag Dimension type dimension "sub-trade" and Measure type dimension "trade change order cost" to Column Shelf and Row Shelf respectively. Also we instruct the system to do total on "trade change order cost".

- Replace the Dimension type dimension "reason of change" on the Row Shelf by "issued date". Also add another Measure type dimension "difference between projected and approved cost" (same data, along same Dimension dimension, different quantity measurement).

- Filter the subset of data whose location is "main floor".

- Create 7 bar charts to see quantity distributions of 7 dimensions

- Drag from Dimension type dimension "sub-trade" and Measure type dimension "projected cost", "approved cost", and "record count" to Column Shelf, instruct the system to total these three dimensions, and drag the Dimension type dimension "reason of change" to Row Shelf.

- Compare Trend and Occurrence of Time Dependent Data

- Create 7 bar charts to see quantity distributions of 7 dimensions

- Filter to the subset of data whose location is "main floor".
Switch to already generated Heatmap chart that visualizes data of "reason of change" and "initiated documents". All related data values are highlighted.

Scenario Formalism + Visualization Tools (3.2)
- **Information Extracted:**
  - 2 information pertinent to change order obtained
  - Example Info.: There are two periods of time when the change orders involve almost all locations of the building. During those two time periods, one sharply increase of projected cost is observed!
- **Time Spent on Retrieving and Visualizing:** Less Than 2 minutes (excluding one time overhead of setting environment)

Switch to already generated Multiscape chart that visualizes related data of combinations of two dimensions (time and space).

Scenario Formalism + Visualization Tools (4.2)
- **Information Extracted:**
  - 5 information pertinent to change order obtained
  - Example Info.: Of those change orders that the client strongly disagree with, we find the coincidental time and space in which those change orders occur
- **Time Spent on Retrieving and Visualizing:** Less Than 3 minutes (excluding one time overhead of setting environment)

Conclusion
- **Difficult to say which still images better (infovis technology generated vs Excel or even hand made)**
- Big improvement made mostly by technology of interaction
- We specifically value "linked data view" most:
  - It help link data and give overview of data
  - It give flexibility of graphing (no need to consolidate nb into a 20 or 30)
  - It bridge the infovis with scientific visualization, which is major focus of engineering field
- **Scenario Formalism further enhance improvement**