Piloting a Hybrid Requirements Engineering Process for Translating Qualitative Information into Quantitative Performance Measures

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Today's Talk

The problem

An overview of our solution

- A little more about Voice of the Customer

- A little more about collaborative processes & tools

- A little more about text analysis

The work thus far

What's next?

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The Problem: A Requirements Crisis?

It's *not* a crisis when the issues have been endemic for many decades...

- Multiple Stakeholders • Stovepiped, organizational boundaries

- Conflicting goals & objectives • Poorly articulated needs

- Unstated requirements • Insufficient V&V criteria throughout the life cycle

Exacerbated by:

- Unprecedented, complex systems • Systems of Systems

- Long-lived systems with changing user needs & system requirements

Similar Issues in Commercial Settings

Clients <u>want to grow</u> their business, not just cut costs!

Business growth is highly correlated with delighted customers!

Delighted customers result from meeting stated <u>and</u> unstated needs!

Analyzing unstated needs leads to a rich source of <u>innovative ideas</u> that spawn customer delighters!

Scope creep is reduced because we capture the full set of client requirements!

A richer set of quality and performance attributes are identified to drive both architecture and product line definition!

So, how do we identify the unstated needs leading to customer delighters???

What is the Solution?

We can do this successfully by conducting:

- Structured interviews of customers and users with subtle modifications to existing interview techniques

- KJ workshops to develop themes and innovative observations within and between themes

- Kano analysis to confirm requirements as customer delighters" *vs* "satisfiers" *vs* "must-be's"

- Using semi-automated, state-of-the-art text analysis tools and collaborative methods to scale up the above methods for distributed geographic participation by many more people

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The Detailed Method

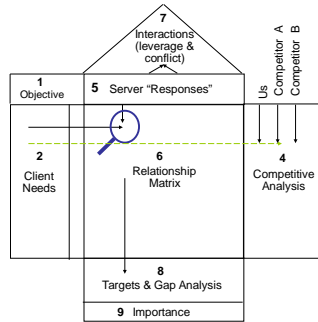**Step 1**: Evaluate existing knowledge of stated needs and requirements

Step 2: Design the open-ended, probing questions to be used in KJ interviews

Step 3: Conduct KJ interviews collecting all possible context information

Step 4: Analyze raw output of interviews to form context need / activity statements

Step 8: Use AHP weighting and QFD matrix to determine quality and performance measures of delighters

Step 7: Conduct Kano analysis to determine must-be's vs satisfiers vs delighters

Step 6: Identify Unstated Needs and subsequent Innovative Requirements

Step 5: Conduct the KJ Workshop including specialized affinity exercise

Scaled Up Step 1

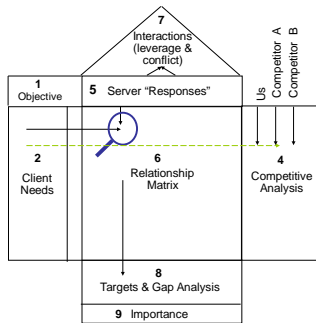**Step 1**: Evaluate existing knowledge of stated needs and requirements

Semi-automated text analysis can scan existing documentation and produce themes and concepts to enrich the design of the interviewing questions.

...onduct ...ws ...all ...ontext ...n

Step 4: Analyze raw output of interviews to form context need / activity statements

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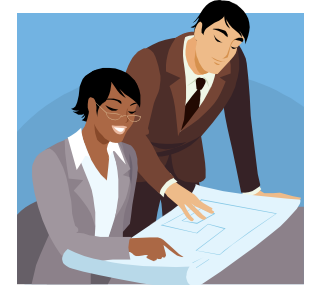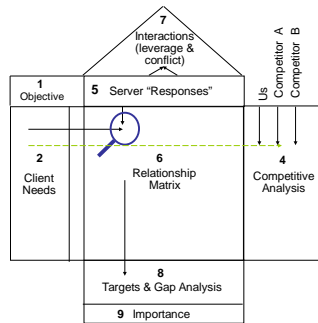
Scaled Up Step 3

Virtual group collaboration tools and environments enable interviewing across physical and time boundaries!

Step 3: Conduct KJ interviews collecting all possible context information

Step 4: Analyze raw output of interviews to form context need / activity statements

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7 Interactions (leverage & conflict)

1 Objective

5 Server "Responses"

Us

Competitor A

Competitor B

2 Client Needs

6 Relationship Matrix

4 Competitive Analysis

8 Targets & Gap Analysis

9 Importance

Scaled Up Step 4

Step 1: Evaluate existing knowledge of stated needs and requirements

Step 2: the ope probing to be us interview

Semi-automated text analysis of responses at the individual question level and across questions, provides efficient inputs to the KJ workshop!

Step 4: Analyze raw output of interviews to form context need / activity statements

Step 8: Use AHP weighting and QFD matrix to determine quality and performance measures of delighters

Step 7: Conduct Kano analysis to determine must-be's vs satisfiers vs delighters

Step 6: Identify Unstated Needs and subsequent Innovative Requirements

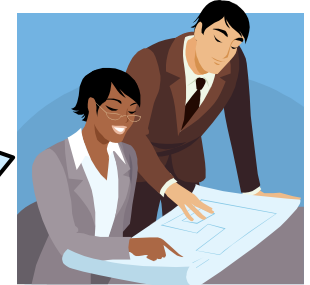**Step 5**: Conduct the KJ Workshop including specialized affinity exercise

Scaled Up Step 5

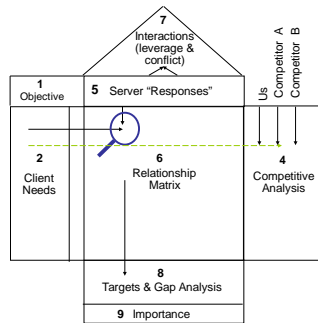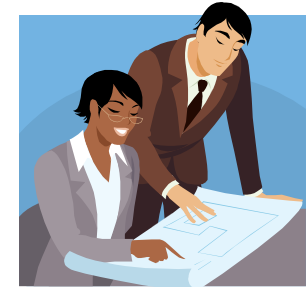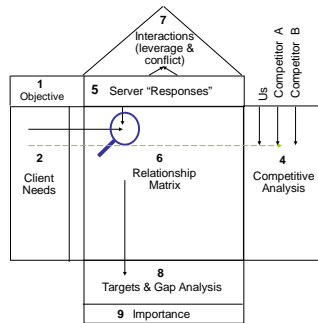**Step 1**: Evaluate existing knowledge of stated needs and requirements

Step [obscured] the o[bscured] probi[ng] to be [obscured] interv[iew]

Virtual group collaboration tools and environments enable almost limitless workshop participation across physical and time boundaries!

Step 4: Analyze raw output of interviews to form context need / activity statements

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Scaled Up Step 6

Step 1: Evaluate existing knowledge of stated needs and requirements

Step the op probir to be interv

Semi-automated text analysis enables thematic conclusions from the expected voluminous output of the virtual KJ workshop

Step 4: Analyze raw output of interviews to form context need / activity statements

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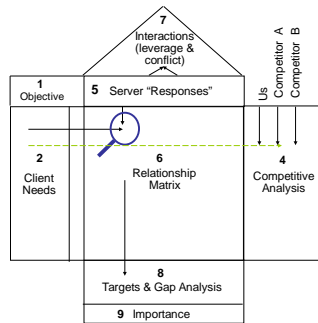
Step 8: Use AHP weighting and QFD matrix to determine quality and performance measures of delighters

Scaled Up Step 7

Virtual group tools and environments enable unlimited Kano survey participation!

Semi-automated text analysis enables synthesis of text explanations which can accompany responses to the Kano survey!
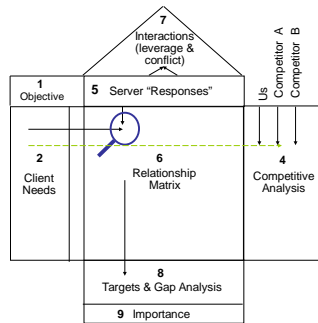
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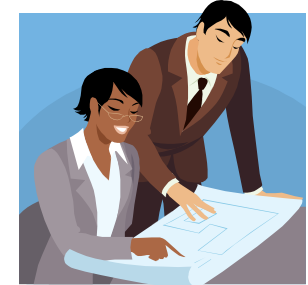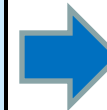
Scaled Up Step 8

Virtual group tools and environments enable unlimited, but efficient participation in a tightly controlled Quality Function Deployment (QFD) exercise to translate priorities of the new customer delighters into priorities of implementation quality/performance measures!

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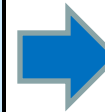
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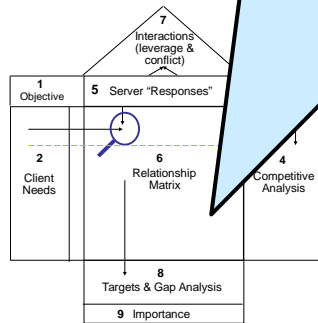
More about VoC: KJ Analysis

Method for Collaborative Processing of Language Data

- Named for Kawakita Jiro, a Japanese anthropologist
- Method for transmuting **tacit** knowledge into **explicit** and more & more objective statements

Structured interviews

- Broad, open ended questions, with probes as necessary
  - Clarification asking for examples, asking "how" and "why"
- Focused on positive & negative experience, **not** solution space

Workshop

- Affinity grouping of concise statements derived from interviews
- Use of those ubiquitous "yellow stickies," rearranged by workshop participants

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More about VoC: The Kano Model (for a given requirement)
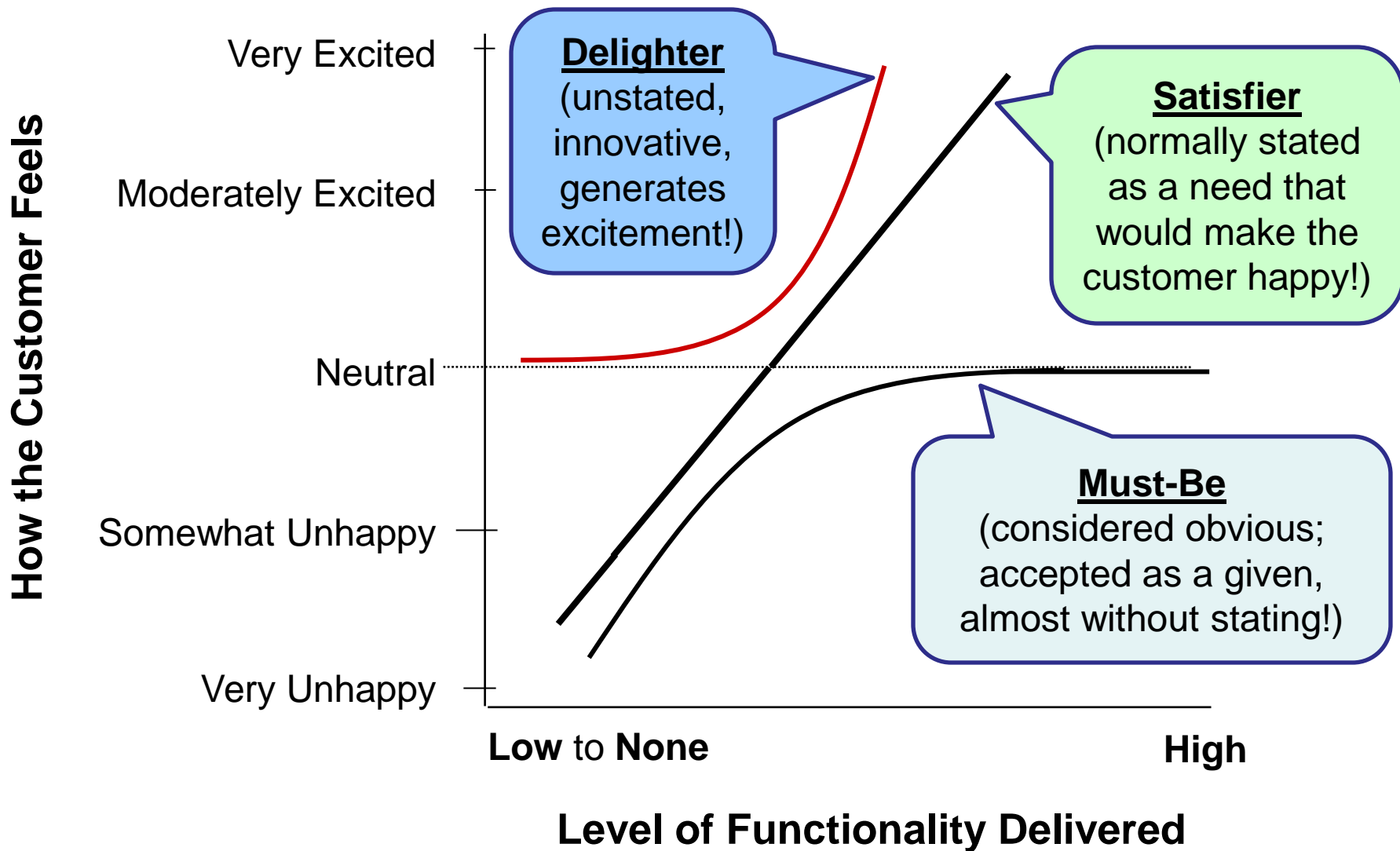
The Kano model was developed by Professor Noriaki Kano in the 1980s.

More about VoC: Business Results

Enabled Motorola to identify customer delighters for a new cell phone product, thereby transforming a negative customer relationship into a very positive one

- A product line that wouldn't otherwise have happened
- With substantial payoff for the company

Enabled LL Bean, as one of the first US companies using this method, to identify customer delighters which revitalized several product lines

Enabled the identification of customer delighters related to the operation of internal process improvement & quality teams

- KJ run with senior management at Motorola
- Focusing on what executives needed from EPG & quality team

Provided compelling experiences in both the product and service space

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More about VoC: Limitations

Insuring Consistency & Completeness

- A problem, particularly for KJ
  - Which to date has been applied in small, face-to-face & one-day workshops

- Similar issues with other VoC methods

Worry is that results might be quite different if different participants were assembled on a different day.

- Need more confidence that results are complete, repeatable & generalizable

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More about Collaborative Processes & Tools[1]

Collaborative computer support tools exist that can

- Capture & assist in analyzing much more & varied information in textual form than can manual methods alone
- Often in far less time

Tools such as GroupSystems have been used to facilitate requirements development as well as other purposes

- Facilitate requirements development
  — Notably Barry Boehm's Win-Win
- Software inspections (Michiel van Genuchten, Doug Vogel, et al.)
- Agreement on appraisal findings (van Genuchten)
- Strategic discussions planning & tactical decision making by participants on ships at sea

Such tools can allow many more people to be included in VoC activities without having to meet face-to-face

More about Collaborative Processes & Tools$_2$

Several troublesome problems in the manual VoC process can be addressed with collaborative software support

- Manual KJ groups succinct yellow sticky notes into distinct affinity groups
  - It sometimes makes sense to have a single statement map to more than one group to recognize interdependencies
- But KJ statements can be too succinct
  - Such that the intended meaning isn't clear to workshop participants
  - Collaborative tools can selectively hide or display additional information in a graceful, easy to use manner

Collaborative software's increased bandwidth can encourage iterative side conversations among workshop participants helping them:

- Think through & harmonize affinity grouping decisions in much less time
- Edit their judgments before solidifying their positions publicly

Yet collaborative tools *do* depend heavily on the skills of the facilitator

- ***VoC methods can provide the repeatable process discipline***

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More about Text Analysis[1]

Computer assisted text analysis methods & tools have improved greatly over the past decade

- Help analysts identify & interpret recurring concepts, themes & inter-relationships in large, otherwise unwieldy text corpora
- Used with multiple related textual sources analyzed for consistency, contention & lack of coverage

Have been used in software & systems engineering for

- Development & management of software & system requirements (by others as well as us)
- Analyses of system requirement specifications, policy, doctrine
- Problem reports, change requests
- Responses to open ended survey questions
- Reviews of voluminous published research
- Rapid classification of appraisal findings & recommendations from interviews (van Genuchten)

More about Text Analysis$_2$

Many powerful text analysis methods & tools now exist

- For natural language processing, thesaurus building & other semantic aids, in addition to automated content analysis algorithms
- In principal could be used for any text analysis captured electronically or conversion of audio to text

While automation makes the analysis practically & intellectually possible

- But interpretation, semantic analysis & validation must be done iteratively in collaboration with domain experts.

Limitations: Crossing the chasm

- Unfamiliar methods, tools & user interface for most systems & software engineers

Our challenge

- ***Integrate best available language data tools & make them widely accessible & usable in our field***

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Work Thus Far$_1$

Used semi-automated content analysis at a US military maintenance & sustainment organization supporting long-lived systems

- Identified recurring usability issues not recognized previously in case-by-case resolution of problem and change requests
- Opportunities for improvement in scenarios & test cases
- Implications for requirements elicitation & user test

Earlier text analysis of requirements documents, problem reports & associated materials in another military maintenance shop

- Identified recurring integration, modifiability & usability issues

Both done prior to recognition of importance of VoC defined & trainable processes

Work Thus Far$_2$

Battle command for ground & air operations

- Text analysis to seed KJ interviews, workshop & limited Kano

- Text analysis extracted references to quality attributes

- Embedded in:
  - future concept documents • doctrine • capabilities
  - requirements documents • information support plans
  - user functional descriptions • software problem reports

Identified issues with respect to interoperability, usability & fitness for use

- Not considered sufficiently or recognized explicitly
  ... prior to the proactive VoC & text analysis

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What's Next?

Currently negotiating engagements with major commercial & defense contractors

- Focus on requirements development, management, evolution & change

Seeking grant funding with academic colleagues

- At Carnegie Mellon & elsewhere

Please see me if you're interested in joining us

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Thank You for Your Attention!

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Backup Slides

... follow here

Text Analytics & Concept Maps: Leximancer Example

Automated text analysis tools used to identify recurring concepts & clusters of concepts

- Concepts include synonyms based on strongly related co-occurring terms
  - Constituted in automatically generated affinity lists
  - Named by most representative term in affinity list

- Themes are clusters of concepts with similar co-occurrence patterns
  - More strongly related to each other than to concepts in other clusters
  - Named by automatic selection of the concept most strongly related to other concepts in the cluster

Themes are represented graphically as Venn diagrams

- Concept names label dots that are in circles representing themes
- Dots can be linked by lines whose brightness represents frequency of co-occurrence
- Dots can appear in the overlap of two (or more) circles
- Circle size does not always indicate importance since circles can be sparsely populated

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An Estimation Example

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