The New Economics of Variation

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W. Edwards Deming Institute Conference, October 13-14, 2007 Purdue University, West Lafayette, Indiana, USA The aim of this session is to offer insights on how W. Edwards Deming's "new economics" has integrated the thinking of two pioneers in the field of variation management – Walter Shewhart and Genichi Taguchi.

In doing so, this presentation will contrast these systemic views of variation management with those of the prevailing style of management, in both cases offering reflections on the decisions made in quality improvement efforts under guidance from the "old" and "new " economics.

W. Edwards Deming



Walter Shewhart



Genichi Taguchi



Agenda

- Aim
- Questions
- Taguchi Methods at Rocketdyne
- Present State
- Future State
- Part Quality vs. Relationship Quality

Questions

Q: Alligator Management

What is the leading use of alligator skin the world today?

Q: Tire Management

Who makes the best automobile tires in the world today?

Q: Time Management

How much time is spent discussing *parts* which are good and arrive on time?

Q: Straw Management





Q: Circle Management

Which 2 of these 3 circles are closest to having the same diameter?



Q: Wood Management

Given a piece of wood that will be cut into 2 pieces....



how many lines will be drawn across the top face before the cut is made ?

Q: Wood Management



Q: Wood Management



Q: Circle Management

Which 2 of these 3 circles are closest to having the same diameter?



Decisions Decisions

Which 2 of these 3 circles are closest to having the same diameter?



Taguchi Methods at Rocketdyne



Dr. Taguchi's first visit to Canoga Park – May 1994. While here he met with 6 application teams, including manufacturing engineers on the Space Shuttle Main Engine.

Taguchi Methods – History in Canoga Park

- Management briefings provided by American Supplier Institute (ASI) in 1989
- "Introductory" training (36-42 hours) by ASI began in 1989
- Internal expert hired in 1990
- In-house "Introductory" seminars through the TQM Office began in 1991
 - 800+ graduates to date

Taguchi Methods – History in Canoga Park

- First visit by Dr. Taguchi in May 1994
 - Dr. Taguchi reviewed applications with 6 teams
- Second visit by Dr. Taguchi in November 1994
 - Dr. Taguchi reviewed applications with 4 teams
 - Meetings arranged with Dr. Taguchi and executives to review application strategies for R&D
- Third visit by Dr. Taguchi in May 1996
 - Dr. Taguchi and Professor Yuin Wu reviewed RS-68 combustion design activities

Taguchi Methods – Deployment (1900 – 1993)

- First application (1990) National Launch System - turbo-machinery design
- First process application (1990) etching process problem solving study
- First "advanced" application (1993) silver plating problem solving study

Taguchi Methods – Directions (1994 – 2007)

- Focus of implementation on problems, repairs, and rework was examined for clues of how to expand applications to "proactive use"
- Links established between Taguchi Methods and the management theory of Dr. Deming
- Using Deming's ideas, broader implications of the thinking of Dr. Taguchi have been re-examined
- Transformational thinking efforts began in 1993

Taguchi Methods – Directions (1994 – 2007)

- Curriculum of "thinking" courses established in 1995 – "A Thinking Roadmap"
- Taguchi Methods seminar expanded into 2 40hour seminars as part of "A Thinking Roadmap"
- Thinking transformation efforts focus on a need to
 - "manage variation", not "reduce variation"
 - "manage costs", not "reduce costs"
 - "manage resources", not "reduce resources"
 - "continuous investment", not "continuous improvement"

Taguchi Methods – Lessons Learned

- **1. Variation Management**
- 2. Quality Loss Function
- 3. Parameter (Robust) Design
- 4. Tertiary Design

Variation Management

Background: Consider the following two processes and the specification limits and target provided.



Decisions Decisions

Given the following 5 criteria, which is the preferred process – 1 or 2?

- Equal purchase prices
 Equal delivery schedules
 Zero defects are guarantee from both processes
 Distributions will never change shape and/or location
- 5 The "team" selected the "target" value, which is preferred, plus the tolerances

target



Relationship Quality

"Quality is the minimum of loss imparted to the Society by a product *after* its shipment to a customer"

Source: Introduction to Quality Engineering, G. Taguchi, 1983

Examples of Variation Management



Taguchi Methods – Stages of Design

- 1. Concept Selection define the product or process technology
- 2. Parameter Design given levels of input (process or product) variation and average, define the "best" value for each input average (the "target")
- 3. Tertiary Design given levels of input (process or product) variation and a preferred average for each, define the "best" variation level for each input

 Concept Selection – identify the product or process inputs and outputs

Inputs



 Concept Selection – sort the inputs into Control Factors and Noise Factors



2. Parameter Design – exploit non-linearity to define the "target" value for Control Factor



3. Tertiary Design – fine-tune process variation for each Control Factor



Time Management (US vs. Japan)

- **1. Concept Selection** 70 % vs. 40%
- **2.** Parameter Design 2% vs. 30%
- **3. Tertiary Design** 28% vs. 20%

Present State (The Old Economics of Part Quality)

Part Quality

- "Zero defects is another way of saying 'do it right the first time'"
- Quality is defined as conformance to requirements

Source: Let's Talk Quality, P. Crosby, 1989

The "Absolutes" of *Part* Quality

- Quality is defined as conformance to requirements, not as 'goodness' nor 'elegance'.
- The system for causing quality is prevention, not appraisal.
- The performance standard must be Zero Defects, not 'that's close enough'.
- The measurement of quality is the Price of Non-conformance, not indices.

Source: Quality is Free, Philip Crosby, 1979

Good Parts vs. Bad Parts



Hole Diameter, inches

Present State

- Driving Change
- Reliance on Reforming
- Reducing Variation, Cost, Waste, Inventory, etc
- Talk about "Working Together"
- Striving for "Zero Defects" and "Zero Waste"
- Continuous Improvement
- Using Metrics for Alignment*

*without a thinking transformation

Future State (The New Economics of *Relationship* Quality)





Perception & Thinking

"How the world we perceive works depends on how we think.

The world we perceive is a world we bring forth through our thinking."

H. Thomas Johnson

Source: Profit Beyond Measure, H. Thomas Johnson, 1999

Future State

- Leading Transformation
- Use of Reformation and Transformation
- Resource & Relationship Management (Striving for Balance)
- Thinking & Learning Together Then Working Together
- Continuous Investment
- Using Thinking for Alignment
 - InThinking and Enterprise Thinking

Part Quality vs. Relationship Quality

Better Value

Consider a brazing process for SSME nozzle joining



Better Value – Tube in Hole -*Next* Assembly

Traditional Approach



Better Value – Tube in Hole -*Next* Assembly

- Traditional Approach
- Ream/ rework holes
- Braze flow thru holes
- Crack welds
- Add grind operation
- Add etch operation
- Add "better" etch operation



Better Value – Drilled Hole Data



Better Value – Drilled Hole Data Post Taguchi Experiment

MACHINING RESULTS FOR 1080 HOLES - "BEFORE" & "AFTER"



Better Value – Tube in Hole -Next Assembly

- Traditional Approach
- Ream/ rework holes
- Braze flow thru holes
- Crack wolds
- Add grind operation
- Add etch operation
- Add better etch operation



- Better Approach
- Improve hole drilling
 - To target
 - Better distribution
- Successful first-cycle braze
- No excess braze



Relationship Quality – The New Economics

"The Taguchi Loss Function is a better view of the world."

W. Edwards Deming

Source: Out of the Crisis, W. Edwards Deming, 1986

Dr. Taguchi at 80 in 2004

