Six-Sigma in Asia

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The Pennsylvania State University
The Unexpected Happens —Be Prepared

Thatcher’s Law

Develop a standard procedure/process when unexpected happens!
Question posed to two groups of PhD students

A small shop is opening to serve a local market with specialty film products. They expect to employ one shift of between 10 and, if they are successful, 25 manufacturing employees. At the moment they are in the early planning stages. They know the machines they wish to use and have leased a facility. They are wondering how to organize the work.

How could you help them?

Source: Parker and Wall, 1998

Finding

- Two groups,
- In the same situation,
- Trying to increase productivity,
- Try to answer the same question,
- In completely different ways.

How are HR and OR different?
Different Models – HR

1. Organizational Context
2. Group Design
3. Process Criteria of Effectiveness
4. Group Effectiveness
5. Group Synergy

Material Resources

Hackman, 1984

Different Models: OR

minimize \[ z = \sum_{i \in F} \sum_{j=(n_{min}+1)}^{n_{max}} c_{ij} x_{ij}, \] (3)

subject to:

\[ \sum_{j=1}^{n} x_{ij} = 1 \quad \forall \ i \in I, \] (4)

\[ \sum_{i=1}^{m} t_{ij} \leq T \quad \forall \ j \in J, \] (5)

\[ x_{kj} \leq \sum_{i=1}^{k} x_{ij} \quad \forall \ k \in J \text{ and } \forall \ i \in I \text{ and } \forall \ h \in P(i), \] (6)

\[ x_{ij} = 0, 1 \quad \forall \ i \in I \text{ and } \forall \ j \in J. \] (7)

Baybars, 1986
Different People

OR people prefer good answers. They are uncomfortable with the ambiguity of HR/OB models. They have little patience with solutions that do not lead to predictable outcomes. They want to be ‘Right’.

HR/OB people prefer good questions. They are uncomfortable with the inherent limitations of mathematical assumptions. They have little patience for solutions to situations that never exist. They want to be ‘Real’.

Asia: What do you know?
**What Do You Know About Asia?**

- **Northern Asia (1)**
  - Russian

- **South-Central Asia (14)**
  - Afghanistan, Bangladesh, Bhutan, India, Iran, Kazakhstan, Kyrgyzstan, Maldives, Nepal, Pakistan, Sri Lanka, Tajikistan, Turkmenistan, Uzbekistan

- **South-East Asia (11)**
  - Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet

- **Western Asia and Middle East (18)**
  - Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen

- **Eastern Asia (?)**
  - China, Hong Kong*, Macau*, Japan, Korea, Taiwan

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**Asia: Year 2004**

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<td></td>
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<td>(30%)</td>
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<td><strong>Population (in Million)</strong></td>
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<td></td>
<td></td>
<td>(4.5%)</td>
<td>(60.6%)</td>
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<td><strong>GDP (in Billion US$)</strong></td>
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<td>11,734.3</td>
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<tr>
<td></td>
<td></td>
<td>(28.7%)</td>
<td></td>
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<td><strong>Per Capita GDP (US$)</strong></td>
<td>6,393</td>
<td>39,959</td>
<td></td>
</tr>
</tbody>
</table>
Son:  
“Daddy, where does baby come from?”

Father:  
“China, mostly.”

Asia—More

- Most areas are very religious (especially Buddhist and Islamism)
- Weak Economics in the past—this was significantly changing in the past 10 years.
What do you know about Asia:
Recent Major Economics/Industry?

- One Sun—Japan
- Four (4) Tigers
  - Hong Kong
  - Korea
  - Singapore
  - Taiwan
- One Dragon—China
- One Elephant—India
- Others

Year 2004

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<td>1649.4 (4%)</td>
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<td>6393</td>
<td>39959</td>
<td>35902</td>
<td>1273</td>
<td>637</td>
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</tbody>
</table>
An Update remark

As of May 2006

- China is the 2\textsuperscript{nd} largest oil customer in the world
- India is the 6\textsuperscript{th}!!!

\begin{table}
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
 & World & USA & Taiwan & Hong Kong & Singapore & Korea \\
\hline
Area (1000 Km\textsuperscript{2}) & 147800 & 9372.61 & 36.18 & 1.09 & 0.65 & 99.26 \\
\hline
Population (in Million) & 6389.3 & 293.03 & 22.6 & 6.92 & 4.2 & 48.2 \\
\hline
Population Density (per Km\textsuperscript{2}) & 43 & 31 & 625 & 6,337 & 6,461 & 486 \\
\hline
GDP (in Billion USS) & 40887.8 & 11734.3 & 322.2 & 165.7 & 106.8 & 680.1 \\
\hline
Per Capita GDP* (USS) & 6,393 & 39,959 & 14,271 & 24,082 & 25,191 & 14,144 \\
\hline
\end{tabular}
\end{table}

* cf. Japan ($35,902); China ($1,273) and India ($637).
Cultures
(J of Cross-Cultural Psychology 2004)

- Cross-cultural comparisons of personality traits
- Data: 28,000 respondents to 240 item questionnaire
  - Summarized in 30 traits, called facets
  - A profile of facets for each of 36 cultures
- Nearby cultures often have similar profiles

For Each Country

- When did six sigma come to your nation, and when did it become popular? and how? and why?
- What type of companies use Six Sigma in your nation? what are the leading users?
- How would academia fit into this six sigma program, if there is? what are the leading academia (University) programs?
- How would six sigma compare with other Quality programs (such as, TQM, Taguchi Method etc).
- What do you see about the future of six sigma in your nation?
- Any other general observations and comments?
What is Six Sigma?

Key Components

- Process
  - Known vs Unknown

- Tool/Methodology
  - Known vs Unknown

- Execution
Process Mining

- Process: A standard procedure

- How to Wash your hands?
  - Five Steps Approach

- When your company faces problems, is there any formal procedure to follow?

正確洗手五步驟

1. 脫下手中飾物，手沾濕
2. 取清潔劑搓洗指尖、指縫、手心、手臂，至少20秒
3. 在流動的自來水下，沖淨雙手。
4. 捧水沖洗水龍頭。
5. 用乾淨的紙巾擦乾雙手，以用過的擦手紙關緊水龍頭。
Procedure

1) Define your goal as clear as possible
2) Use SPC technique (historical data) to understand the process
3) Identify controllable / uncontrollable factors
4) Use DOE technique to find the “optimal” setting for potential improvements
5) Run confirmation experiments

Define ➔ Measure ➔ Analysis ➔ Improve ➔ Control

Six Sigma’s DMAIC Method

- **Define**: Select problem and perform cost-benefit analysis
- **Measure**: Translate the problem into a measurable form, gather data and assess the current situation
- **Analysis**: Identify influence factors and causes that determine the critical to quality (CTQ) characteristic’s behavior
- **Improve**: Design and implement modifications to the performance of the CTQs.
- **Control**: Adjust the process management and control system to ensure improvements are sustainable
Define

Improve

Control

Measure

Analyze

**Six Sigma Project Process**

- Rigorous, data-driven and customer-focused methodology

**Seven Core Principles of Six Sigma Methods**

- Improvement actions are based on causal modeling
- Inquiry alternates between discovery and justification
- Problems are defined in precise operational terms
- Problems are quantified if possible
- A data based diagnosis precedes attempts at solving the problem
- Idea generation is daring and imaginative
- Hypotheses must be tested against empirical data.
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Sakura and Samurai

Six-Sigma in Japan

- Popular since 1997
  - Economical Depress in 1990’s, eager to learn USA approaches
- Companies Adapted $6\sigma$:
  - Kodak; Sony; Shimano; Toshiba; GE-Yokokawa.
  - Anti-$6\sigma$: Toyota; Nissan.
- Academic Fit
  - Not much.
- Compared to Other Quality Programs
  - TQM remains dominated
- Other Remarks
  - Six Sigma in Japan is not as popular as other areas.
Japanese TQM and Six Sigma: aim

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<tr>
<th><strong>Japanese TQM</strong></th>
<th><strong>American Six Sigma</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>“CUSTOMER FIRST” has been recognized an important concept in the long history of TQM.</td>
<td>Michel Harry's remarks on a conference. “TQM would be effective approach if stockholders could wait a long time, however recent stockholders are eager to obtain financial immediately” (Magire{1999}).</td>
</tr>
<tr>
<td>Customer satisfaction at high level</td>
<td>Profit</td>
</tr>
<tr>
<td>High level customer satisfaction brings profit.</td>
<td>To obtain profits, pursuing customer satisfaction and cost reduction</td>
</tr>
<tr>
<td>Customer satisfaction at high level</td>
<td>Profit at high level</td>
</tr>
<tr>
<td>Deployment of customer requirements thoroughly and precisely</td>
<td>Separated from the regular organization that has an advantage for drastic change</td>
</tr>
<tr>
<td>Keywords: thoroughly and precisely Management by Policy, Quality Function Deployment (QFD) Daily management Japanese TQM has few specialized tools for cost reduction.</td>
<td>Project selection is a key to obtain profits. All projects are selected in terms of profits to aim profit, where pursuing high-level customer satisfaction is an option to attain the financial success. One of the key issues to attain success is project based activity that is separated from the daily works.</td>
</tr>
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Organizational structure of Japanese TQM and Six Sigma

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<tr>
<th>Item</th>
<th>Japanese TQM</th>
<th>Six Sigma</th>
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<tr>
<td><strong>Aim</strong></td>
<td>Primal aim is to attain high-level quality. Profits are brought by high-level quality</td>
<td>Primal aim is to obtain profit. Attaining high-level quality is an approach to obtain profits.</td>
</tr>
<tr>
<td><strong>Cost reduction</strong></td>
<td>Not first priority. Sometimes it is tackled by general tools of quality improvement</td>
<td>Basically, the major issue is cost reduction, that is a typical subject of Black Belt projects.</td>
</tr>
<tr>
<td><strong>Organization structure</strong></td>
<td>Based on the daily routine works.</td>
<td>Standardized structure of organization has been prepared.</td>
</tr>
<tr>
<td><strong>Driving force</strong></td>
<td>Management by policy, Daily management, cross functional management, Quality circles</td>
<td>Aligned structure: Champion, Master Black Belt, Black Belt, Green Belt.</td>
</tr>
<tr>
<td><strong>Guidelines for improvements</strong></td>
<td>Problem solving QC story, Task achieving QC story</td>
<td>DMAIC (Define, Measure, Analyze, Improve and Control), Design for Six Sigma</td>
</tr>
<tr>
<td><strong>Concepts</strong></td>
<td>Importance of commitment by top management, Process approach, Customer first</td>
<td></td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>Better to align the existing quality system, such as ISO 9001, organizational structure</td>
<td>Easy to implement a drastic change</td>
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## India: Year 2004

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## India: Year 2004

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India ...

- 70% of India’s population lives in rural areas
  - 600,000 Indian villages with 700 million occupants
  - Infrastructural issues undermine seamless connectivity
- Rural literacy rates under 50%
  - Literacy rates are even lower for women
- Sharing is a social good
  - Govt. sponsored kiosks support mediated access

Six-Sigma in India

- Popular since 1997, by 2002 it is very much so!
- ISI training programs since 1998
- Companies Adapted 6σ:
  - GE—Corp; GE—Lighting; GE—Medical; Tata Motors; Samtel Group; Standard Chartered Banks.
- Academic Fit
  - Black Belt (BB) is comparable to MS in Applied Stat.
- Compared to Other Quality Programs
  - Bigger Impact than ever
- Other Remarks
  - Bright future (the next coming years)
### China: Year 2004

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<td>1,273</td>
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Culture Behind Forbidden City

The Largest and The Smallest uniqueness of Forbidden City
Meeting Emperor
Great Walls

Culture behind Great Wall

Invade/Expand Your Territory vs Protect Your Own Land
1911—Republic of China

World War II
(1941—1949)

Cultural Revolution
(1966—1976)

Olympic 2008 at Beijing
Six-Sigma in China

- Popular since 2000
- Companies Adapted $6\sigma$:
  - GE Global; most manufacturing and some financial companies.
- Academic Fit
  - Only about short courses on methodologies
- Compared to Other Quality Programs
  - Taguchi Method was very popular, and some TQM.
- Other Remarks
  - More on Lean and Innovations.

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Taiwan: Year 2004

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### Six-Sigma in Taiwan

![Six-Sigma Diagram](image)

- Define
- Measure
- Improve
- Control
- Analysis

5α 執行步骤 (DMAIC)
Six-Sigma in Taiwan

- Introduced in 1997; Popular since 2002
- Lin’s Short Course in 2002
- Companies Adapted 6σ:
  - ASUS; MITAC; Ford
  - 東元電機、大同公司、台鹽實業、實華電子、今台電子、大東紡織、功學社.
- Academic Fit
  - Not much
- Compared to Other Quality Programs
  - See next Table
- Other Remarks
  - A bright future—although most manufacturers have been moved to China

6σ as compared with Others

<table>
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<tr>
<th>Tool</th>
<th>Process</th>
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<tr>
<td>6 Sigma</td>
<td>Define 功學社、Measure 衡量、Analyze 分析、Improve 改善、Control 管制</td>
</tr>
<tr>
<td>QC Story</td>
<td>潛在問題分析、狀況評估、問題分析、決策分析、潜在問題分析</td>
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<tr>
<td>8D法</td>
<td>狩野紀昭</td>
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<tr>
<td>KT法</td>
<td>1.成立品管圈、2.發覺問題、3.現況分析、4.思考對策、5.選擇最佳方案、6.方策實施、7.效果確認、8.標準化、9.撰寫報告書、10.成果發表</td>
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<td>165.7</td>
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<tr>
<td>Per Capita GDP (US$)</td>
<td>6393</td>
<td>39,959</td>
<td>24,082</td>
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</table>

**Hong Kong**

**USA**

- Area (1000 Km²): 9372.61
- Population (in Million): 293.03
- Population Density (per Km²): 31
- GDP (in Billion US$): 11734.3
- Per Capita GDP (US$): 39,959

**Hong Kong**

- Area (1000 Km²): 1.09
- Population (in Million): 6.92
- Population Density (per Km²): 6337
- GDP (in Billion US$): 165.7
- Per Capita GDP (US$): 24,082
**Six-Sigma in Hong Kong**

- Popular since 2001
- HK Productivity Council (HKPC) in 2000
- Companies Adapted 6σ:
  - AIG (financial) International Bank; ASTEC Electrics (Emerson Group); Nokia; Johnson; Bosch Automation.
- Academic Fit
  - Not much (HKSQ)
- Compared to Other Quality Programs
  - More concrete approach, but not real new!
- Other Remarks
  - Blooming area!
  - Very “scary” certification process.
### (South) Korea: Year 2004

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<th>USA</th>
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Six-Sigma in Korea

- First case reported in 1996
- Very popular since 2002
- Companies Adapted 6\(\sigma\):
  - Samsung SDI; Samsung Electrics; LG Electrics; LG Chemistry; LG Caltex; POSCO.
  - Samsung Life Insurance; KT; Korea Rail; SKT; Kookmin Bank.
- Academic Fit
  - Not much, but many Professional Consulting Companies.
- Compared to Other Quality Programs
  - Not much difference, but more focus on “hand-on” procedure.
- Other Remarks
  - Big Impact to improve the way people think & work.

Singapore: Year 2004

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Singapore—A *Fine City.*

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**General Observations**

- Popularized because of the successfulness from USA.
- Not much on methodology development; more so on culture change.
- There is more IE involvement, than Stat involvement.
- Impact to Statistics (next page)
- Major difficulties (especially in Japan)
  - Six Sigma is viewed as an old wine in a new bottle.
Indonesia ...

- **During the 1990s, Indonesia had an aggressive ICT policy**
  - Created intranet/internet connections btw universities, government labs & other research centers
- **Concern about universal access leads to launch of e-mosque program**
  - Greater mosque density than tele-density; Centrality of mosques in daily life & education process
  - Provides cultural context for computing
  - New government rules & roles

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**Does Six Sigma Work in China?**

What do you know about China?
People vs system (connection vs law)
Different Culture

- Example on the assumption of the front-line workers
  - USA workers
    - Not very Smart
    - Follow the rules well
  - Asia workers
    - Extremely Smart
    - Does not follow the rule much

Impact to Data Sciences

- Visibility of Statistics
  - a powerful tool for problem solving
  - a powerful thinking process
- More jobs for statisticians (more so on statistical applications)
- Not much on scientific research yet (fundamental statistics), as compared to general research
### Quality Assurance

- Crosby’s Zero Defective
- Feigenbaum’s TQM
- Juran’s Trilogy
- Deming’s 14 Points
- Japanese TQM Style
- Quality Circle
- Tagushi Three-Stage Design
- Kaizen
- ISO-9000 Criteria
- Baldridge Criteria
- Six Sigma
- What’s Next??????

### Beyond Six-Sigma, what’s next?

A systematic innovation procedure/process
A scientific (systematic) approach (procedure/process) to problem solving

- Strategy
- Procedure
- Process
- Methodology
- Criteria

Recent News In Beijing-Labor Day

Golden Holiday from May 1st to May 7th

Tourist in all hot sights from domestic cities

Crowds everywhere