Seeking Perfection in Healthcare: Applying the Toyota Production System to Medicine

“Leading the Revolution”
Association for Manufacturing Excellence

J. Michael Rona
Christina Saint Martin
Virginia Mason Medical Center
“If you are dreaming about it... you can do it.”

Chihiro Nakao, Chairman and CEO
Shingijutsu International

November 4, 2003
Leading the Revolution

Virginia Mason Medical Center is trying to create a better product. Perhaps when the industry looks back, we will be looked upon as one system that helped “Lead the Revolution”

“Leading the Revolution”
- Customer First
- Zero Defects
- A New Management Paradigm
Virginia Mason Medical Center Strategic Plan

- **Vision:** to be the Quality Leader
- **Mission:** to improve the health and well-being of the patients we serve
- **Values:** Teamwork, Integrity, Excellence, Service

**Strategies:**
- **People:** We will recruit and retain the best physicians and staff
- **Quality:** We will relentlessly pursue the highest quality outcomes of care
- **Service:** We will unequivocally insist on extraordinary patient service
- **Innovation:** We will promote a culture of innovation

**Program Priorities:** Cancer and Cardiovascular Services

**Foundational Elements:**
- Strong Economics
- Responsible Governance
- Integrated Information Systems
- Research and Education
- Virginia Mason Foundation

**Virginia Mason Production System**
An Embarrassingly Poor Product

- The lead story is titled “The Biggest Mistake of Their Lives” and chronicles four survivors of medical errors.
- The article goes on to say that in 2003, as many as 98,000 people in the United States will die as a result of medical errors.
- “System of Secrecy Potentially Puts Patients at Risk” Seattle Post Intelligencer, November 25, 2003
The Bitter Bottom Line of Medical Errors

Kidney transplant on the wrong side (U.C.L.A.)

Unnecessary radical jaw surgery

Surgical sponge and gauze left in a breast

Surgical tool left in stomach

Virginia Mason Medical Center
November 23, 2004

Investigators: Medical mistake kills Everett woman

Hospital error caused death
Hospital Complications Exceed $9 Billion
(Study based on data from 994 hospitals in 2000.)

Excess charges, Left scale
Excess length of stay, right scale

Excess charges

Excess length of stay

<table>
<thead>
<tr>
<th>Condition</th>
<th># Patients affected annually</th>
<th>Mortality rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedsores</td>
<td>41,440</td>
<td>7.23%</td>
</tr>
<tr>
<td>Accidental Puncture</td>
<td>11,810</td>
<td>2.16%</td>
</tr>
<tr>
<td>Infection Caused by Medical Care</td>
<td>11,449</td>
<td>4.31%</td>
</tr>
<tr>
<td>Bloodstream Infections</td>
<td>2,592</td>
<td>21.92%</td>
</tr>
<tr>
<td>Wound Reopening</td>
<td>843</td>
<td>9.63%</td>
</tr>
<tr>
<td>Foreign Object Left Inside Body</td>
<td>536</td>
<td>2.14%</td>
</tr>
</tbody>
</table>
“Costs Continue to Rise”

Source: Mercer National Survey of Employer-Sponsored Health Plans 2004
Why Zero Defects is the Only Acceptable Standard

- At 99.9% quality levels, here is what happens:
  - 22,000 checks are deducted from the wrong bank accounts every day
  - 16,000 pieces of mail are lost by the Postal Service every hour
  - 2,000 unsafe airplane landings are made every day
  - 500 incorrect surgeries are completed every week
Seeing with our Hands…
Japan 2002
What We Learned

Air conditioners, cars, looms, airplanes and forklifts...

What do any of these products have to do with health care?

- Health care, too, is full of production processes
- These Japanese products, like our services, involve the concepts of quality, safety, customer satisfaction, staff satisfaction and cost effectiveness
- The completion of a product involves thousands of processes—many of them very complex
- Many products, if they fail, can cause fatality
- They are in many ways, just like us
Production processes have much in common with admitting a patient, having a clinic visit, going to surgery or a procedure and sending out a bill.

To have smooth, high quality continuous flow of our patients is delightful when it happens.

Our vision is that this would happen always for our patients.

We are more convinced than ever that the principles and tools of the Toyota Production System may well become those of the Virginia Mason Production System, the system of management behind the achievement of becoming the Quality Leader.
The Plan

The plan for translating what we learned into reality at Virginia Mason has seven areas of focus:

1. “Patient First” as the driver for all that we do
2. *The Virginia Mason Production System* will be our our brand of the Toyota Production System
3. The creation of an environment in which our people feel safe and free to engage in improvement - The adoption of a “No Layoff Policy”
The Plan

5. Encouragement of innovation
6. Creating a prosperous economic organization by primarily eliminating waste
7. Accountable Leadership
VMPS at Virginia Mason

We adopted the Toyota Production System philosophies and practices and applied them to healthcare because this industry and we were so lacking in an effective management approach that resulted in:

- Customer first
- Highest quality
- Obsession with safety
- Highest staff satisfaction
- A successful economic enterprise
- Becoming the Quality Leader
The Impact of Lean

- ½ the human effort
- ½ the space
- ½ the equipment
- ½ the inventory
- ½ the investment
- ½ the engineering hours
- ½ the new product development time
## Validated Industry Averages

<table>
<thead>
<tr>
<th>Category</th>
<th>Average Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Labor/Productivity Improved</td>
<td>45-75%</td>
</tr>
<tr>
<td>Cost Reduced</td>
<td>25-55%</td>
</tr>
<tr>
<td>Throughput/flow Increased</td>
<td>60-90%</td>
</tr>
<tr>
<td>Quality (Defects/Scrap) Reduced</td>
<td>50-90%</td>
</tr>
<tr>
<td>Inventory Reduced</td>
<td>60-90%</td>
</tr>
<tr>
<td>Space Reduced</td>
<td>35-50%</td>
</tr>
<tr>
<td>Lead Time Reduced</td>
<td>50-90%</td>
</tr>
</tbody>
</table>

Summarized results, subsequent to a 5-year evaluation, from numerous companies (over 15 aerospace-related). Companies ranged from 1 to >7 years in lean principles application/execution.
## Measuring our results

**Target Progress Report – RPIW’s**

<table>
<thead>
<tr>
<th>Metric (units of measurement)</th>
<th>Baseline</th>
<th>Target</th>
<th>Results at 90-days</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Space</strong> (square feet)</td>
<td>53,964 sq ft</td>
<td>31,211 sq ft</td>
<td>41,369 sq ft</td>
<td>24% Reduction</td>
</tr>
<tr>
<td><strong>Inventory</strong> (dollars)</td>
<td>$709,731</td>
<td>$135,529</td>
<td>$350,480</td>
<td>51% Reduction</td>
</tr>
<tr>
<td><strong>Staff Walking Distance</strong> (feet)</td>
<td>451,822 ft</td>
<td>240,314 ft</td>
<td>301,572 ft</td>
<td>38% Reduction</td>
</tr>
<tr>
<td><strong>Parts Travel Distance</strong> (feet)</td>
<td>436,566 ft</td>
<td>169,971 ft</td>
<td>114,775 ft</td>
<td>77% Reduction</td>
</tr>
<tr>
<td><strong>Lead Time</strong> (minutes)</td>
<td>1,926,719 min</td>
<td>907,610 min</td>
<td>914,751 min</td>
<td>53% Reduction</td>
</tr>
<tr>
<td><strong>Work In Process (WIP)</strong> (units)</td>
<td>640,993 units</td>
<td>320,495 units</td>
<td>247,134 units</td>
<td>62% Reduction</td>
</tr>
<tr>
<td><strong>Standard Work In Process (SWIP)</strong></td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Quality (defects)(%)</strong></td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>47% Reduction</td>
</tr>
<tr>
<td><strong>Productivity Gain</strong> (minutes/FTE)</td>
<td>228.87 FTE</td>
<td>137.71 FTE</td>
<td>151.98 FTE</td>
<td>44% Gain</td>
</tr>
<tr>
<td><strong>Environmental, Health &amp; Safety (EHS)</strong></td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>Organizational Level 3</td>
</tr>
<tr>
<td><strong>Set-up Reduction</strong> (minutes)</td>
<td>572,203 min</td>
<td>190,092 min</td>
<td>101,882 min</td>
<td>83% Reduction</td>
</tr>
</tbody>
</table>

**REMARKS:** Other Cash Savings: Saved $57M (budgeted) in Capital Expenditures by using 3P efforts in Dermatology, Cancer Center, Hyperbaric $200K savings in 30 days by applying tools of VMPS to open positions, use of overtime and temporary labor in overhead areas.

(a) Number includes minutes of work eliminated from multiple operators converted to FTE equivalents.
A reduction of 34 miles!!

A reduction of 70 miles!!

A reduction of 702 Days!!

<table>
<thead>
<tr>
<th>Metric</th>
<th>Before (units)</th>
<th>After (units)</th>
<th>Change</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space (square feet)</td>
<td>55,964 sq ft</td>
<td>52,630 sq ft</td>
<td>3,334 sq ft</td>
<td>24% Reduction</td>
</tr>
<tr>
<td>Inventory (dollars)</td>
<td>$707,500</td>
<td>$135,820</td>
<td>$521,680</td>
<td>51% Reduction</td>
</tr>
<tr>
<td>Staff Walking Distance (feet)</td>
<td>481,822</td>
<td>240,314</td>
<td>241,508 feet</td>
<td>38% Reduction</td>
</tr>
<tr>
<td>Parts Travel Distance (feet)</td>
<td>486,680</td>
<td>169,079</td>
<td>317,601 feet</td>
<td>77% Reduction</td>
</tr>
<tr>
<td>Lead Time (minutes)</td>
<td>1,926,719 min</td>
<td>907,610 min</td>
<td>1,019,109 min</td>
<td>53% Reduction</td>
</tr>
<tr>
<td>Work In Process (WIP) (units)</td>
<td>110,873 units</td>
<td>320,495 units</td>
<td>109,622 units</td>
<td>62% Reduction</td>
</tr>
<tr>
<td>Standard Work In Process (SWIP)</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality (defects) (%)</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Productivity Gain (minutes/FTE)</td>
<td>228.87 FTE</td>
<td>137.71 FTE</td>
<td>91.16 FTE</td>
<td>44% Gain</td>
</tr>
<tr>
<td>Environmental, Health &amp; Safety (5S)</td>
<td>---</td>
<td>---</td>
<td>Organizational Level 3</td>
<td></td>
</tr>
<tr>
<td>Set-up Reduction (minutes)</td>
<td>572,203 min</td>
<td>190,992 min</td>
<td>381,211 min</td>
<td>83% Reduction</td>
</tr>
</tbody>
</table>

**Remarks:** Other Cash Savings:
Saved $5-TM (budgeted) in Capital Expenditures by using 3P efforts in Dermatology, Cancer Center, Hyperbaric $200K savings in 30 days by applying tools of VMPS to open positions, use of overtime and temporary labor in overhead areas.

(a) Number includes minutes of work eliminated from multiple operators converted to FTE equivalents.
Stopping the Line™

Virginia Mason’s Patient Safety Alert System™
Stopping the line
Stopping the Line™
Intervention Concepts

- Safety hazards are **process** defects
- Process defects are **least** harmful and **easiest** to fix **at the time** they arise
- Process defects are **more** harmful and **harder** to fix as they go downstream
Stopping the Line™ Concepts and System

- *Everyone* is an inspector
- *Everyone* can stop defects
- If the process cannot be stopped from making defects, *the process must stop*

- Leadership from the top
- “Drop and run” commitment
- 24/7 policy, procedure, staffing
- Legal & reporting safeguards
Case 1: Numbers and Abbreviations

Planning - OK to return to Pacific

☐ Anticipate D/C in 48 hrs - Use D/C Planning Protocol

ANOTHER BRAND OF DRUG IDENTICAL IN FORM AND CONTENT MAY BE DISPENSED UNLESS CHECKED

DATE

TIME

Regression BWU?

3) MSW - D/C planning
4) AM labs: BMR
5) Atorvastatin 25 mg PO QD

☐ Anticipate D/C in 48 hrs - Use D/C Planning Protocol
Case Study 9: Mixing of Medications

1) A patient presented to Dermatology Clinic for removal of a pigmented lesion.

2) A medical assistant prepared two 5 ml syringes containing an intended mixture of:
   - 4.5 ml 1% lidocaine with epinephrine
   - 0.5 ml 8.4% sodium bicarbonate.

3) The physician injected the contents of the first 5 ml syringe into the skin. The patient immediately reported unusual discomfort and a lack of numbness in the area of injection.
Case Study: Incident 9
Mixing of Medications

4) The physician suspected that the quantities of lidocaine and bicarbonate had been reversed when the solution was mixed. The procedure was aborted. The patient was informed of the suspected error. Pharmacy was called for advice.

5) The patient’s was observed in the clinic for 1 hour and then released to home with continuing follow-up.
Notification

- Patient Safety Alert Initiated
  Physician, Dermatology

- Leadership Notified
  CEO, President, Sr. Vice President, Vice President Quality and Compliance, Chief of Medicine, Administrative Director
Patient Safety Alert
Case 9 – Day 1

Stopping the Line

- The “line was stopped” for the current process of injectable medication mixing involvement of medical assistants

- A “buddy” system was immediately initiated to verify appropriate mixing of injectable medications

- An evaluation team was selected
Issues Identified

- High variation in practice
- No standard process for mixing and administration of injectable medications
- High variation in process to assure that medical assistants have appropriate competency and certification for mixing injectable medications
Patient Safety Alert™
Case 9 – Days 2-12

Improvements

- Developed standard process for an acceptable method of mixing injectable medication

- Developed standard process for assuring that medical assistants have appropriate competency and certification for mixing injectable medication
Cumulative Declared PSA’s

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>18</td>
</tr>
<tr>
<td>2003</td>
<td>143</td>
</tr>
<tr>
<td>2004</td>
<td>347</td>
</tr>
<tr>
<td>Mar-05</td>
<td>443</td>
</tr>
</tbody>
</table>
Distribution of Declared PSA's

- Facilities & Equipment: 56%
- Diagnosis & Treatment: 13%
- Medication Errors: 15%
- Professional Conduct: 8%
- Systems: 56%

as of 3/31/05
Average PSA’s per Month

Number

2002 2003 2004 2005

4 10 17 32

as of 3/31/05
Days to Completion of PSA as of 3/31/05

- 2002: 18
- 2003: 13
- 2004: 14
- 2005: 11
### Offline During Investigation

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>6</td>
<td>5</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Equip/Process</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>2</td>
</tr>
</tbody>
</table>

*as of 3/31/05*
Virginia Mason Results

- The Cost of Error
- Mistake Proofing and Improvement
- FTE Trends
- Learnings from Production Preparation Process (3P)
- Cost Avoidance and Savings
- RPIW Roll Up
The Cost of Error

Ventilator Acquired Pneumonia

- 2002 Cases: 34  
  Est. Deaths: 5
- 2002 Cost: $500,000

Professional Liability Expense

- Claims Paid \(^2\): $4.6 Million
- Claims Paid \(^3\): $4.5 Million

\(^2\) 1999 - 2003 Average  
\(^3\) Projected 2004
Mistake Proofing
Ventilator Acquired Pneumonia

- Cases in 2002: 34
- Cost in 2002: $500,000
- Cases in 2005: 1
- Cost in 2005: $15,000

- Est. Deaths: 5
- Est. Deaths: 0

* Projected 2005
# Staffing Trends

## Full Time Equivalents

<table>
<thead>
<tr>
<th>Year</th>
<th>FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>2890</td>
</tr>
<tr>
<td>1997</td>
<td>3264 ▲</td>
</tr>
<tr>
<td>1998</td>
<td>3467 ▲</td>
</tr>
<tr>
<td>1999</td>
<td>3528 ▲</td>
</tr>
<tr>
<td>2000</td>
<td>3612 ▲</td>
</tr>
<tr>
<td>2001</td>
<td>3647 ▲</td>
</tr>
<tr>
<td>2002</td>
<td>3656 ▲</td>
</tr>
<tr>
<td>2003</td>
<td>3581 ▼</td>
</tr>
<tr>
<td>2004</td>
<td>3562 ▼</td>
</tr>
</tbody>
</table>
3P’s: Production, Preparation, Process

- Cancer
- Hospital
- Dermatology
- GI
- Hyperbarics
The patient would enter and exit through a peaceful, quiet “museum like” environment. (See center of model) Along the walk, the patient would be provided with education about skin care and the services that VMMC Dermatology provides. Images would be projected up on plasma screens projected through frosted glass. (See sample/photos on the next page) The Concierge (Water Strider) would serve as tour guide through this area, offering the patient information and suggest skin products for purchase. Calming music and aromatherapy will add to the ambiance. “Circles” of Specialty Dermatology care are placed in specific areas. The Moh’s Specialty area, for instance, is located where the patient can enter and exit privately. This model is patterned after the Kitchen Triangle Model where each Specialty Circle would serve 1 provider and 2 MA’s. There are no waiting rooms in this model, expecting one-piece flow to Takt time.
Cost Avoidance

- 1M Capital Savings for Hyperbaric Chamber from 3P
- 1-3M Endoscopy Suites now staying in current location
- 6M Surgery Suites budgeted and planned - now not building
- Hospital 3P
  - Lead Time, Staffing, Space
- Cancer 3P
  - Same amount of space 120 pts per day to 188 pts per day (57% increase)
  - Patient Travel -1600 ft to 375 ft. (76% reduction)
What hasn’t worked

- Lots of activity but not enough traction
  - Safety vs. Waste and Flow
- Scope too big
- Hit the wrong target
- Too many targets
Virginia Mason RPIW Activity

Total

2000 2001 2002 2003 2004 2005 2006
Strategies Revisited:
How do we really get there?

- Infrastructure
- Education
- Focus of RPIW’s/Kaizen Events
- 3P
- Everyday Lean
- Accountability
Improving the Infrastructure: Critical to implementation

- Focused goals aligned with organizational goals
- Explicit measurable targets
- Accountability for implementation and sustained results
- Enhanced leadership structure
- Enhanced “gemba” support
- Improvement never ends and is full-time work
- Goal is 1%-5% of all staff working in KPO’s
Virginia Mason RPIW Activity
VMPS Educational Strategies

- Everyday Lean Idea Campaign – All Staff
- Intro to VMPS (course) – All Staff HES requirement
- Leading 5S – Management leads and teaches staff
- Value Stream Mapping – Management course/All staff in 2006
- Standard Operations – Management course/All Staff in 2006
- Mistake Proofing – Management course/All Staff HES requirement
- Lean Mastery Track – Management course & collaborative
- Workshop Leader Certification – Senior management requirement
- Kaizen Fellowship – Select senior management
- Japan Gemba Kaizen – Management & staff
- 3P Certification
- On Site Gemba’s
Everyday Lean Idea System

Three Ground Rules

Rule #1:
Proposals involve creatively changing the approach to our jobs or work unit to reduce waste and add value for our patients. Kaizen means we continuously improve using lean thinking principles and strategic plan goals to either eliminate an activity, reduce the steps of an activity, or change the activity.

Rule #2:
Proposals are practical to try out on a small scale ourselves or with our coworkers’ help. They can be implemented almost immediately with little or no extra cost.

Rule #3:
If we propose the solution, we help implement it.
To Change Medicine...... Change Your Mind

- Provider First
- Waiting is Good
- Errors are to be Expected
- At-risk Employment
- OTJ Training
- Diffuse Accountability
- Add Resources
- Reduce Cost
- Retrospective Quality Assurance
- Management Oversight
- We Have Time

- Patient First
- Waiting is Bad
- Defect-free Medicine
- Guaranteed Employment
- Explicit Training
- Rigorous Accountability
- No New Resources
- Reduce Waste
- Real-time Quality Assurance
- Management On Site
- We Have No Time
Ongoing Challenges

- Culture Change
- Professional Autonomy
- “People are Not Cars”
- Belief in Zero Defects
- Rigor, Alignment, Execution
- Victimization
- Scarcity v. Abundance
- Leadership Constancy
“It is not by accident that you were chosen to be a leader. It is your destiny.”

Sensei Chihiro Nakao