Henry Ford once said, "Time waste differs from material waste because there can be no salvage."
Six Sigma can be used in each stage of product development and implementation.
Recall that Six Sigma focuses on reducing process variation.

Material and information flow between process steps.

Value added transformations occur within the process steps.
Why 99% isn’t good enough

<table>
<thead>
<tr>
<th>Example</th>
<th>99% Good (3.8 Sigma)</th>
<th>99.99966% Good (6 Sigma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsafe drinking water per day</td>
<td>14.4 minutes</td>
<td>0.3 seconds</td>
</tr>
<tr>
<td>Electricity power failure per month (30 days)</td>
<td>7.2 hours</td>
<td>8.8 seconds</td>
</tr>
<tr>
<td>Severe turbulence on a 6 hour flight</td>
<td>3.6 minutes</td>
<td>0.1 second</td>
</tr>
<tr>
<td>Impurities in a kg of raw material</td>
<td>10 grams</td>
<td>0.0034 grams</td>
</tr>
<tr>
<td>Losses per $1,000,000 worth of business</td>
<td>$10,000</td>
<td>$3.40</td>
</tr>
<tr>
<td>Worker days lost per 10,000 employees</td>
<td>100 man days</td>
<td>480 minutes</td>
</tr>
</tbody>
</table>
Outline Step 1: DEFINE

Goal
• Define the project’s purpose and scope and get background on the process and customer

Output
• A clear statement of the intended improvement and how it is to be measured
• A high level process map
• A list of what is important to customer
Outline Step 2: MEASURE

**Goal**
- Focus the improvement effort by gathering information on the current situation

**Output**
- Baseline data on current process performance
- Data that pinpoints problem location or occurrence
- A more focused problem statement
Outline Step 3: ANALYZE

**Ask**
- What vital few process and input variables affect CTQ process performance or output measures?

**Goal**
- Develop theories of root causes
- Confirm them with data

**Output**
- A theory that has been tested and confirmed
Outline Step 4: IMPROVE

**Goal**

- Develop, try out, and implement solutions that address root causes

**Output**

- Planned, tested actions that should eliminate or reduce the impact of the identified root causes
Outline Step 5: CONTROL

**Goal**
- Use data to evaluate both the solutions and the plans
- Maintain the gains by standardizing processes
- Outline next steps for on-going improvement including opportunities for replication

**Output**
- Before and After analysis
- Monitoring system
- Completed documentation of results, learning's, and recommendations
Lean Six Sigma in Healthcare

Combining the **Quality** of Six Sigma with the **Process Speed** of Lean to drive improvement and achieve the best competitive position
Door to Balloon RIE
Sample case study: Thrombolysis in Myocardial Infarction (TIMI)

'TIMI Grade Flow' is a scoring system from 0-3 referring to levels of coronary blood flow assessed during percutaneous coronary angioplasty:

- TIMI 0 flow (no perfusion) refers to the absence of any antegrade flow beyond a coronary occlusion.
- TIMI 1 flow (penetration without perfusion) is faint antegrade coronary flow beyond the occlusion, with incomplete filling of the distal coronary bed.
- TIMI 2 flow (partial reperfusion) is delayed or sluggish antegrade flow with complete filling of the distal territory.
- TIMI 3 is normal flow which fills the distal coronary bed completely.
Door-to-balloon time = from the moment a heart attack patient arrives in the ER to when the blocked artery is opened with an angioplasty balloon.
Let’s try to see what the process looks like...is it in control?
Are there any special causes?

![Individual Run Graph]

- Minutes
- UCL - i
- LCL - i
Define: Door to Balloon

*Project goals:*
Achieve Door to TIMI 3 perfusion time of less than 90 minutes for all patients

*Project scope:*
Start – Patient arrival at ED
Stop – Establishment of TIMI 3 Flow
Includes – ST elevated, non-transfered
Excludes – All other cases
Now if we change how we evaluate the process, are we still in control?
And do we have any special causes?
<table>
<thead>
<tr>
<th>Patient</th>
<th>EMS</th>
<th>ED</th>
<th>Cardiology</th>
<th>Cath Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seks medical attention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>patient having MI</td>
<td>Get 12 lead EKG, IV, O2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Call MD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transport patient to ED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Report to RN and MD at arrival</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Additional IV, 15 lead EKG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Start Chart</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Start meds, call IR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Additional meds waiting on IR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>See patient in ED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consent</td>
<td>Informed consent by RN</td>
<td>Cath Lab called</td>
<td>Call confirms call</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RN gets patient ready for transport</td>
<td>cath lab setup</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cath lab calls when ready</td>
<td></td>
<td>Calls ED when ready</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>patient arrives in Cath Lab</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Patient prepped</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IR enters Cath Lab</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cath placed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Imaging done</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Baloon placed</td>
<td></td>
</tr>
</tbody>
</table>
A fishbone diagram can be a good way to explore and document potential causes.
Analyze: Door to Balloon Project

Door to Balloon Time by Day of Week

Day of Week: Fri-Sat-Sun, Mon-Thu

Minutes

Goal 90 minutes

Door to Balloon Time by Time of Day

Time of Day: Midnight-0700, 0700-1600, 1600-Midnight

Minutes

Goal 90 minutes

Door to Balloon Time by Day of Week

Day of Week: Friday-Sunday

Minutes

Goal 90 minutes
The D2B Alliance has developed six strategies to reduce door-to-balloon times:

1. Have attending Interventional Cardiologist always on-site
2. Have ED and Cath Lab staff use real-time data feedback
3. Have ED activate the Cath Lab while the patient is still en route to the hospital
4. Cath Lab team arrive and be ready to start procedure in 20 minutes
5. ER medicine Physician activates the Cath Lab
6. A single call to a central page operator activates the Cath Lab and Interventional Cardiologist
Strategy 2: Have ED and Cath Lab staff use real-time data feedback

• **Benefit**
  - 8.6 minutes faster door-to-balloon time

• **What it will take to implement**
  - Modify Chest pain and Quality records
  - Copy of the completed form to the Cath Lab Director

• **Barriers to implementation**
  - Staff education
  - Compliance
  - Trust and teamwork between all staff
  - Legibility of information on the form
Improve: Door to Balloon

**STEMI Flowchart**

1. Page STEMI Alert over hospital stat line
2. Activate STEMI Alert via ED hot-line
   - If no response from Cath Lab team within 10 minutes, contact Nursing Supervisor and follow backup procedure

   - NSA, Lab, Radiology, EKG, Pastoral Services, and Registration mobilized to ED

   - Cath lab staff returns pages to ED. Mobilize to Cath Lab
     - Team member 1 arrives, turns on equipment, and begins setting up table
     - Team member 2 arrives and goes to ED to assist with patient transport to Cath Lab
     - Team member 3 to Cath Lab to assist with supplies and preparation for patient

   - ED obtains consent and prepares patient for Cath Lab
     - Patient arrives to Cath Lab

   - Perfusonist & Interventionalist report to Cath Lab

   - Record Time

   - Monitor V/S, Adm. O2, ASA, NTG, MSO4, Start 3 IVs (per protocol)

   - Stat EKG to be done within 10 minutes of arrival at ED

   - Notification of AMI from EMS. EKG transmitted to ED

   - Patient arrival in ED. Patient triaged, suspicious for AMI
     - Record Time

   - Record Times

**PERFUSION Goal:** Door to Balloon 90 minutes OR LESS

- Pastoral Svcs/Nursing supv takes family to critical care waiting room
Sustain: Surgery room changeover reduction

Changeover reduction process

1. Observe the Process
   
   Previous Patient | Changeover | Next Patient

2. Measure the time to complete each step
   
   Previous Patient | Changeover | Next Patient

3. Separate ‘Internal’ from ‘External’ activities
   
   Previous Patient | Ext | Internal Changeover | Ext | Next Patient

4. Convert ‘Internal’ steps to ‘External’
   
   Previous Patient | Internal Changeover | Next Patient

5. Reduce the time to carry out ‘Internal’ tasks
   
   Previous Patient | Internal Changeover | Next Patient

6. Continually improve the startup time
Lean Six Sigma Project Examples

Henry Ford once said, "Time waste differs from material waste because there can be no salvage."
What is Lean Six Sigma?
How does it apply in Healthcare?

- Smooth operations
- Ensure patient safety
- Provide quality care
- Effective patient treatment
- Utilized staff and resources

What that leads to:
- Available and prompt care
- Better patient outcomes
- Increased patient satisfaction
- Improved financial viability
- Improved patient throughput
- Improved publicly reported information
- Higher employee involvement and satisfaction
- Reduced LOS
Recall that Six Sigma focuses on reducing process variation.
The Hospital as a System:

All work is a process . . .
this is true of a hospital too!
7 Kinds of waste

**Inventory** - unneeded stock or supplies

**Motion** - movement of staff and information

**Overproduction** - unnecessary tests

**Overprocessing** - filling out extra paperwork

**Transportation** - movement of patients or equipment

**Rework/Correction** - paperwork, med errors

**Waiting** - delays in diagnosis and treatment
CT and 7 Kinds of Waste

**Inventory**
- Set up tray for unneeded procedures
- Expired IR stock
- Wasted contrast

**Motion**
- Transporting patients
- Walking between procedure room and control room
- Getting onto computer

**Overproduction**
- Supplies/tray
- Protocols
- Making contrast and Patient consumption of contrast

**Overprocessing**
- Paperwork
- Films vs. disk
- Multiple systems - RIS, PACS, etc.

**Transportation**
- Patients
- Ordering syringes and having extra boxes to store
- Taking oral contrast to the floor
- IV lock

**Rework/Correction**
- Duplicate work
- Phone calls to communicate with departments or units

**Waiting**
- On Toshiba scanner
- Waiting on ED patients to be ready
- On oral contrast
5S Workplace Organization

Before 5S

S1: Sort (Seiri)

- Needed
- Create Visual Workplace

- S2: Set In Order (Seiton)

- S3: Shine (Seiso)

- S4: Simplify & standardize (Sieketsu)

Remove from Workplace
(Red Tagged)

After 5S

Needed

-S5: Sustain (Shitsuke)

A place for everything and everything in its place
Sort and Set in Order
Shine (Clean)
After - Sustain
Storeroom before & after color coding
Six Sigma in Industry – R&D/Product Design

• Examples of applicability
  • Reduce time to market
  • Reduce rework through linking R&D efforts to customer needs
  • Improving overall performance and quality from start
  • Minimize failures through robust design
  • Improving quality of experiments by providing experimental design and multivariable studies
  • Focus on data-driven design reviews
Six Sigma Applications in Industry-Manufacturing

• Reduce waste
• Optimize inventory
• Reduce rejections in designs
• Improve reliability by identifying and optimizing critical factors