Simplified Six Sigma: Four Easy-to-Use Tools for Fast, Impressive Results in Your Laboratory

SprickStegall
AND ASSOCIATES LLC

Presented by M. Susan Stegall
Certified Management Consultant
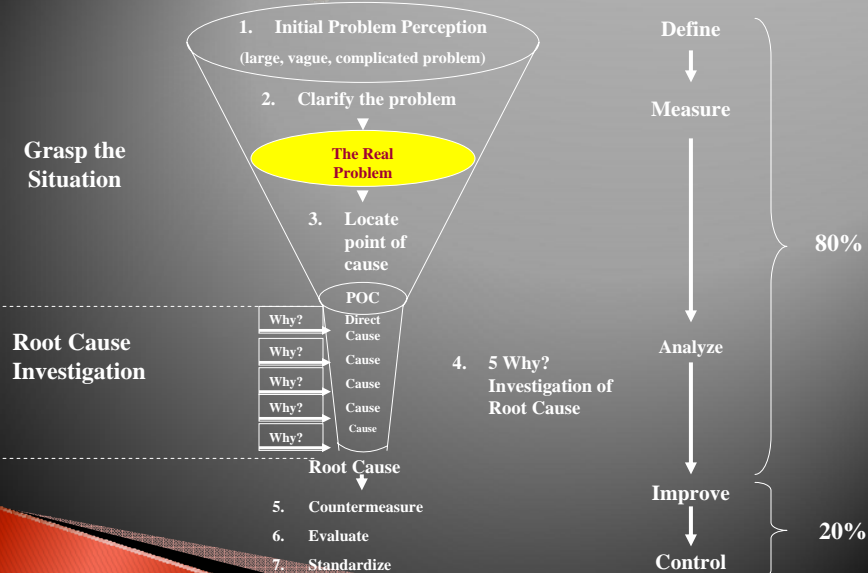Lean Certified, Six Sigma Black Belt Trained

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Introduction

▸ The Four Tools—
1. IPO (Inputs, Process, Outputs);
2. Process Mapping;
3. Cause and Effects Matrix; and
4. Failure Mode Effects Analysis (FMEA)

▸ Benefit of today's session: Use these four Six Sigma tools to drive an entire DMAIC process improvement project.

▸ My Expertise: Certificates of Completion—Green and Black Belt of Six Sigma Methodology from SixSigma.us / Lean Certified by University of Michigan.
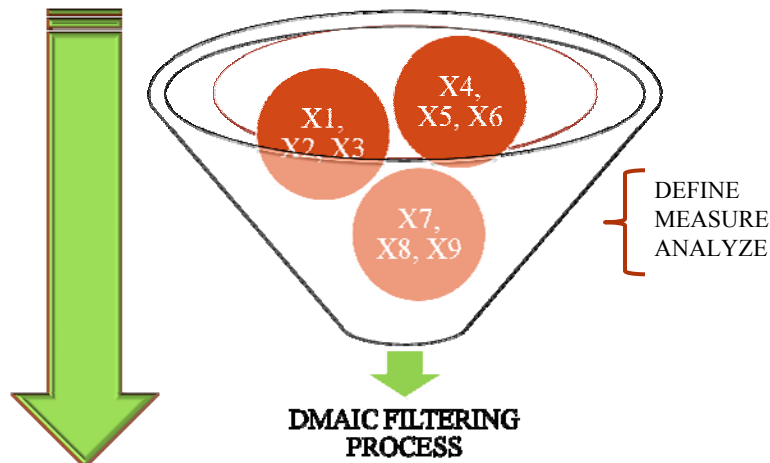
Introduction (cont.)

DMAIC METHODOLOGY

DEFINE

MEASURE

ANALYZE **IMPROVE** **CONTROL**

Lean Six Sigma—a Visual

1. **Initial Problem Perception**
   (large, vague, complicated problem)

2. **Clarify the problem**

The Real Problem

Grasp the Situation

3. **Locate point of cause**

POC

Root Cause Investigation

Why? — Direct Cause
Why? — Cause
Why? — Cause
Why? — Cause
Why? — Cause

4. **5 Why? Investigation of Root Cause**

Root Cause

5. Countermeasure
6. Evaluate
7. Standardize

Define
↓
Measure

80%

Analyze

Improve

20%

Control

DMAIC Methodology—Filtering to Find Root Cause Variables

Comparison of Lean Problem Solving and DMAIC

Lean Problem Solving	Six Sigma Problem Solving
Go and See	Collect Data
Management by Fact	Validated Data
Visual Data Displays	Statistical Analysis
Shop Floor Driven	Expert Driven
Daily Kaizen	Project Focus
Value Stream Focus	Process Focus
Bias for Action (learn by doing)	Bias for Analysis (predict and control)

Introduction (cont.)

- Define
  - "A Problem Well Stated is a Problem Half Solved."
    $Y = X1, X2, X3, X4, X5, X6$

    John Dewey

  - "An undefined problem has an infinite number of solutions."

    Robert A. Humphrey

  - Criteria for Good Six Sigma Projects
    - Driven by customer specifications
    - Clearly linked to business priorities
    - Of major importance to your organization
    - Reasonable in scope—achievable in 4 to 6 months
    - Measurable quantitatively for success
    - Visibly important to your organization
    - Supported and approved by management

Session Outline

- Tool 1: IPO—a measurement tool
  - A high-level graphical illustration of the process
- Tool 2: Detailed Process Map—a measurement tool
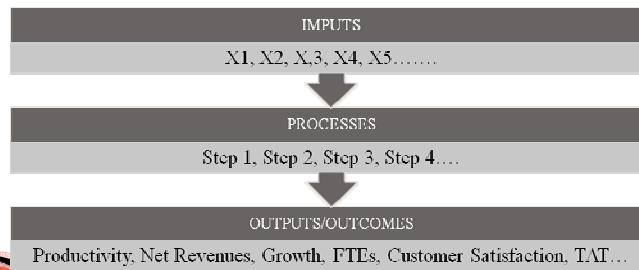 - Define each process step with inputs (controllable and uncontrollable) and outputs clearly defined
- Tool 3: Cause and Effect Matrix—a measurement tool
  - Derived from your high-level and detailed process map
- Tool 4: FMEA—an analysis, improvement and control tool

Tool 1: IPO Diagram— Objectives

▸ Attendees learn to list, rapidly, a broad range of possible variables that may be causing an opportunity or a problem for their companies.

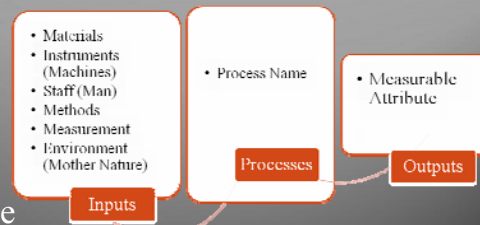▸ Attendees learn to state the problem or opportunity as a measurable outcome—your big "Y"

IMPUTS
X1, X2, X,3, X4, X5…….

PROCESSES
Step 1, Step 2, Step 3, Step 4….

OUTPUTS/OUTCOMES
Productivity, Net Revenues, Growth, FTEs, Customer Satisfaction, TAT…

Tool 1: IPO Diagram

▸ Goal is to get a 50,000 ft. view of the process first.

▸ Identify the process in the middle box in simple terms

▸ Identify the Customer Requirements in the Output box

▸ Identify the external inputs required to make the product or service (the 6 M's)

- Materials
- Instruments (Machines)
- Staff (Man)
- Methods
- Measurement
- Environment (Mother Nature)

Inputs

- Process Name

Processes

- Measurable Attribute

Outputs

Case Study Number 1: Morning TAT

▸ Case study 1: You work in an acute care hospital laboratory. Your service promise to nurses and physicians is that you will have all morning run results on the patients' charts by 7:00 AM each morning.

▸ The laboratory staff is only meeting this service promise 50% of the time.

▸ Administration wants an improved physician satisfaction score and has specifically requested that the laboratory improve their TAT performance.

Case Study Number 1: Morning TAT (Cont:)

▸ Your team's job is to solve this problem following the DMAIC Six Sigma process.

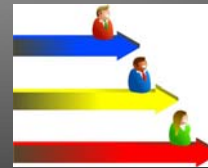▸ Your first step is to develop your team's IPO

IPO DIAGRAM

Time allowed is 15 minutes

Case Study Number 2: Monthly Sales Revenue Is Not Consistent

- Your hospital-based laboratory outreach program was launched, successfully, three years ago.
- Finance expects that the program will show a positive contribution margin this year (Year 4).

You are three months into the calendar year, and your sales team is not meeting the expected monthly net revenues consistently—January was on track but February and March results are dismal.

Case Study Number 2: Monthly Sales Revenue Is Not Consistent (Cont:)

- Your CFO has asked you to improve the net revenue line by the next quarterly review scheduled for June.
- Your team's job is to solve this problem following the DMAIC Six Sigma process.
- Your first step is to develop your team's IPO

IPO DIAGRAM

Time allowed is 15 minutes

Tool 1: Work Teams Develop Their IPOs

- Develop your team's IPO
- Draw it on the flip chart
- Present the IPO as you are called to the front of the room

- Questions, Observations

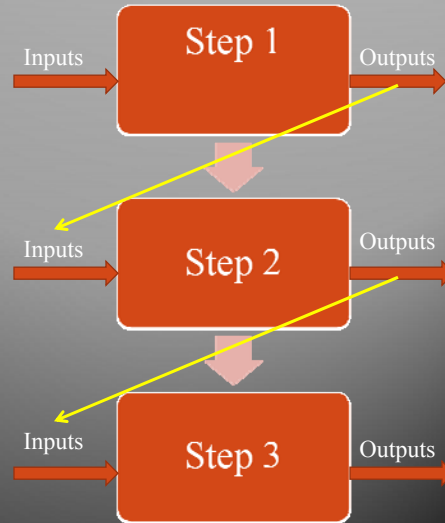## Tool 2: Process Mapping Objectives

- Learn to think about a process in a step-wise fashion—what happens first, second, third, etc
- Learn to identify the inputs required for each step and to classify the inputs as controllable vs. uncontrollable.
- Learn to identify the outputs from each process step as a measurable attribute.
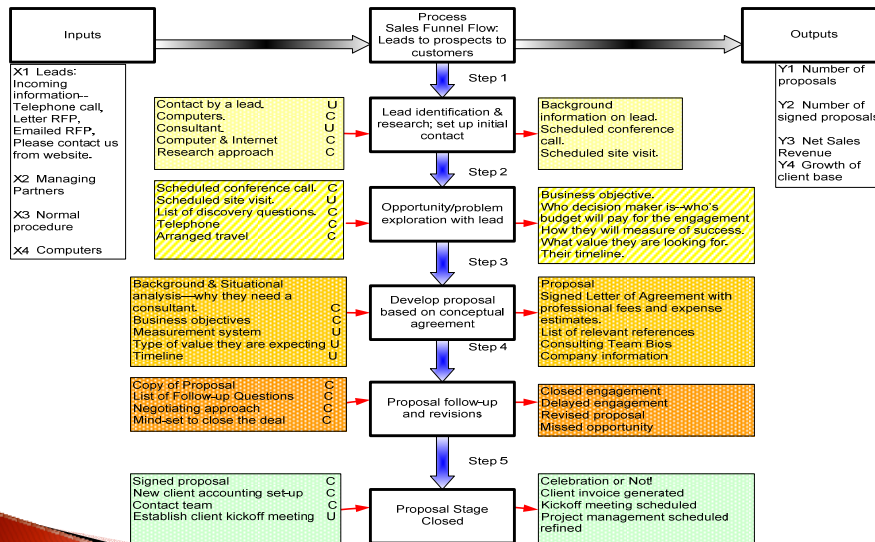
INPUTS → PROCESS STEP → OUTPUTS

Tool 2: Process Mapping

- Include all value adding and non-value adding process steps
- All process step names are verbs or gerunds
- Write down what comes first, then second, then third…

Inputs	Step 1	Outputs
Inputs	Step 2	Outputs
Inputs	Step 3	Outputs

Sprick, Stegall & Associates, LLC | Six Sigma Project to Drive Company Sales | March through July 2009

| Inputs | | Process Sales Funnel Flow: Leads to prospects to customers | | Outputs |

Inputs

X1 Leads: Incoming information-- Telephone call, Letter RFP, Emailed RFP, Please contact us from website.

X2 Managing Partners

X3 Normal procedure

X4 Computers

Outputs

Y1 Number of proposals

Y2 Number of signed proposals

Y3 Net Sales Revenue
Y4 Growth of client base

Step 1

Contact by a lead.	U
Computers.	C
Consultant.	U
Computer & Internet	C
Research approach	C

→ Lead identification & research; set up initial contact →

Background information on lead.
Scheduled conference call.
Scheduled site visit.

Step 2

Scheduled conference call.	C
Scheduled site visit.	U
List of discovery questions.	C
Telephone	C
Arranged travel	C

→ Opportunity/problem exploration with lead →

Business objective.
Who decision maker is--who's budget will pay for the engagement
How they will measure of success.
What value they are looking for.
Their timeline.

Step 3

Background & Situational analysis—why they need a consultant.	C
Business objectives	C
Measurement system	U
Type of value they are expecting	U
Timeline	U

→ Develop proposal based on conceptual agreement →

Proposal
Signed Letter of Agreement with professional fees and expense estimates.
List of relevant references
Consulting Team Bios
Company information

Step 4

Copy of Proposal	C
List of Follow-up Questions	C
Negotiating approach	C
Mind-set to close the deal	C

→ Proposal follow-up and revisions →

Closed engagement
Delayed engagement
Revised proposal
Missed opportunity

Step 5

Signed proposal	C
New client accounting set-up	C
Contact team	C
Establish client kickoff meeting	U

→ Proposal Stage Closed →

Celebration or Not!
Client invoice generated
Kickoff meeting scheduled
Project management scheduled refined

Tool 2: Process Mapping Exercise

- Case Study 1: Morning TAT
- Steps:
  1. Organize draw list & labels
  2. Perform phlebotomies
  3. Receive specimens and complete pre-processing
  4. Distribute specimens to testing areas
  5. Test specimens
  6. Validate and release results

Time Allowed = 20 minutes

- Case Study 2: Monthly Sales Revenue Is Not Consistent
- Steps:
  1. Evaluate actual net sales as compared to planned
  2. Assess each sales rep's monthly performance
  3. Assess the market conditions and competitor situation
  4. Draw conclusions
  5. Develop Action Plan
  6. Implement Action Plan
  7. Monitor Results

Time Allowed = 20 minutes

# Tool 2: Process Mapping Exercise

Team Presentations

Questions and Observations

Tool 3: Cause and Effects Matrix

- Objectives include:
  - To illustrate how the Cause and Effects Matrix is derived from the Process Maps data.
  - To teach you the steps required to create a Cause & Effects Matrix
  - To link the Cause and Effects Diagram to the Analyze, Improve and Control Phases of the DMAIC process.
 - To ensure you gain some experience creating a Cause and Effects Matrix.
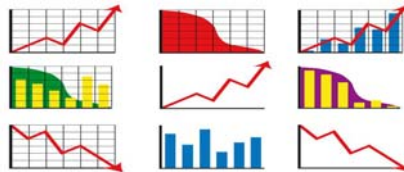
Tool 3: Cause and Effects Matrix

- Filtering of variables continues with the use of this tool.
- The Matrix quantifies and emphasizes the importance of customer requirements—your IPO Outputs—the big "Y".
- The Matrix relates process input variables to your major output variables

Input variables b, c, s have direct and strong affect on your IPO Outputs, i.e. Customer Specifications

Input variables b, c, s
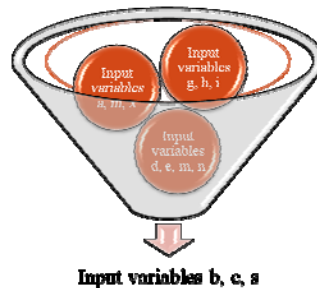
Tool 3: Cause and Effects Matrix

Assign a Customer Importance Rating on the Major Outcomes from your IPO (Scale is 1 = Not Important to 10 = Extremely Important)
- Y1= _____
- Y2 = _____

Relate the impact of each input variable on your Major Outcomes for each Step in your Process Map using correlation scores below.
- Step 1—Input variable 1 = _____ correlation score
- Step 1—Input variable 2 = _____ correlation score
- Step 1—Input variable 3 = _____ correlation score, etc

Correlation scores are as follows for each input variable:

0 = No correlation on the IPO Output

1 = The process input only remotely affects the IPO output

3 = The process input has a moderate affect on the IPO Output

9 = The process input has a direct and strong affect on the IPO Output

The spreadsheet will calculate the matrix for you.
- Input variables with high number results will be the focus of your next step in the DMAIC—the FMEA
- Your flash drive has a sort tab to bring important input variables to the top.

The Cause & Effects Matrix

Morning Run TAT

Cause and Effect Matrix

Rating of Importance to Customer >>

#	Process Step	Process Inputs	Project Y 1–Results on charts by 7 AM	Project Y 2–Physician Satisfaction Scores Improve	Project Y 3:	Project Y 4:	Total
1	Process Step 1	Input 1					0
2	Process Step 1	Input 2					0
3	Process Step 1	Input 3					0
4	Process Step 1	Input 4					0
5	Process Step 1	Input 5					0
6	Process Step 1	Input 6	Ranking Definition for Input Variables : 0 1 3 9				0
7	Process Step 1	Input 7					0
8	Process Step 1	Input 8					0
9	Process Step 2	Input 1					0
10	Process Step 2	Input 2					0
11	Process Step 2	Input 3					0
12	Process Step 2	Input 4					0
13	Process Step 2	Input 5					0
14	Process Step 2	Input 6					0

Project Name: Six Sigma Sales Funnel Process

| | | | | | Rating of Importance to Customer >> | 10 | 7 | 5 | 5 | |

Cause and Effect Matrix

	Process Step	Process Inputs	Project Y 1: Number of Proposals	Project Y 2: Number of Signed Proposals	Project Y 3: Net Sales Revenue	Project Y 4: Growth of Client Base	Total
1	Lead identification & research, set up initial contact	Input 1: Contact by a Lead	9	9	9	9	243
2	Lead identification & research, set up initial contact	Input 2: Access to a computer	3	1	0	0	37
3	Lead identification & research, set up initial contact	Input 3: Consultant availability	3	3	3	3	81
4	Lead identification & research, set up initial contact	Input 4: Access to the internet	3	1	0	1	42
5	Lead identification & research, set up initial contact	Input 5: Research Approach	3	3	0	0	51
6	Process Step 2: Opportunity/problem exploration with lead	Input 1: Scheduled conference call	3	0	0	0	30

Tool 3: Exercise and Tool 3 Wrap-up

▸ Each team develops their Cause and Effects Matrix for one or two steps in their processes.

▸ Calculate the line item results by multiplying the column "Y" value by the Input variable number you have selected, then sum the products, and record the value in the column provided. (Note: Your flash drive version will do the math for you.)

▸ Report the most important input variables during your team's presentation.

Team C&E Matrix Presentations

Morning TAT stability problem:

Outreach Sales revenue problem

Questions, concerns and clarifications?

Tool 4: Learning Objectives for Failure Mode Effects Analysis

▸ FMEA is a Measure, Analyze and Improve Six Sigma Tool.

▸ Session objectives include:
1. Discuss the uses of FMEA
2. Learn to identify sources of risk and potential failures
3. Understand the steps to develop a process FMEA
4. Practice creating a FMEA with our case studies

Tool 4: Failure Mode Effects Analysis--History

▸ 1960—Aerospace industry during Apollo missions
▸ 1974—Navy developed MIL-STD-1629 regarding the use of FMEA
▸ Late 1970's—automotive applications driven by liability costs
▸ Now a TS-16949 Quality System requirement

Tool 4: Failure Mode Effects Analysis

▸ A systemized & structured tool that enables the following:
▸ **Measure** –recognize and evaluate the potential failure of a service or process
▸ **Analyze** the effects of the potential failures
▸ **Improve** the service or process by implementing an action plan designed to reduce the chance of the potential failure

Tool 4: Failure Mode Effects Analysis

Purpose of Process FMEA	FMEA Requirements
‣ Analyze and guide the development of new processes or services, or ‣ Identify deficiencies in existing processes or services, ‣ Establish the priority of contemplated actions, ‣ Identify variables to be considered in a design of experiments and ‣ Set the stage for breakthrough improvements	1. Developed process map (Tool 2) 2. Cause & Effect Matrix (Tool 3) 3. Process knowledge—value adding operator 4. Process technical procedures—current SOPs

Tool 4: Failure Mode Effects Analysis--Beginning Five Steps

‣ Step 1: List the Input Variable with the highest C&E number—Xa, Xb….

‣ Step 2: Brainstorm and list how the input goes wrong—there may be more than one way—list each in bullet format

‣ Step 3: What are the effects on your customer when this input goes wrong? Brainstorm and list them out.

‣ Step 4: What are the causes of the input going wrong? List them out.

‣ Step 5: What controls do you currently have in place to prevent the input from going wrong?

List an input variable with high C&E score

Q1. How does this variable go wrong?

Q2. What are the effects on the customer when this input variable goes wrong

Q3. What are the causes of the input variable going wrong?

Q4. What controls are in place to prevent the input variable from going wrong?

FMEA exercise—allow 15 minutes

Your task: For each important input variable from your C&E Matrix try answering the four questions above.

Worksheet for Class Exercise

Input Variable	How the Input Variable goes wrong	Effects on the customer when the input goes wrong	Severity Number	Causes of the Input variable going wrong	Occ. Number	Controls in place to prevent the Input variable from going wrong	Detection Number	RPN Calculation	

Tool 4: Failure Mode Effects Analysis—Answer the first four questions on page 32.

Worksheet for Class Exercise—Time is 20 minutes

Tool 4: Failure Mode Effects Analysis—Last Five Steps

- Step 6: Create Severity, Occurrence, and Detection rating scales
- Step 7: Assign Severity, Occurrence, and Detection ratings to each cause
- Step 8: Calculate Risk Priority Numbers for each cause

- Step 9: Develop recommended actions to reduce high RPNs
- Step 10: Implement actions and recalculate the RPN to assure improvements occurred.

Tool 4: Failure Mode Effects Analysis—Risk Priority Number (RPN)

SEVERITY ✖ OCCURRENCES ✖ DETECTION = **RPN**

- *Effects*
- Select value from the Severity Scale

- *Causes*
- Select value from the Occurrences Scale

- *Controls*
- Select value from the Detection Scale

Tool 4: Failure Mode Effects Analysis—Severity Scale

- Applies only to the Effect
- Focus is on customer requirements (Note that customer may be external or internal)
- Scale is from 1 to 10
  - 1—not severe
  - 10—very severe

Rating	Severity of Effect
10	Injure a customer or employee
9	Be illegal
8	Render the service unfit for use
7	Cause extreme customer dissatisfaction
6	Result in partial malfunction
5	Cause a loss of performance which is likely to result in a complaint
4	Cause minor performance loss
3	Cause a minor nuisance, but be overcome with no performance loss
2	Be unnoticed and have only a minor affect on performance
1	Be unnoticed and have no affect on performance

Definition of Severity—How Bad!

One of Many Severity Scales

Tool 4: Failure Mode Effects Analysis—Occurrence Scale

- Estimates, based on actual measurements if possible, how often the cause occurs to create the failure mode effect.
- Scale is 1 to 10
  - 1—cause not likely to occur
  - 10—cause and resultant failure mode is inevitable

Rating	Likelihood of Occurrence
10	
9	Very high: Failure is almost inevitable
8	
7	High: Repeated Failures
6	
5	
4	Moderate: Occasional Failures
3	
2	Low: Relatively few Failures
1	Remote: Failure is unlikely

Definition of Occurrence— How Often!

One of Many Occurrences Scales

Tool 4: Failure Mode Effects Analysis—Detection Scale

▸ Predicts how likely it is that "current controls" will detect and/or prevent causes and/or failure modes from happening.

▸ Scale is from 1 to 10
  ◦ 1—likely to detect
  ◦ 10—will never detect

Rating	Ability to Detect
10	Cannot detect
9	Very remote chance of detection
8	Remote chance of detection
7	Very low chance of detection
6	Low chance of detection
5	Moderate chance of detection
4	Moderately high chance of detection
3	High chance of detection
2	Very high chance of detection
1	Almost certain chance of detection

Definition of Detection—How Well!

One of Many Detection Scales

Worksheet for Class Exercise

Input Variable	How the Input Variable goes wrong	Effects on the customer when the input goes wrong	Severity Number	Causes of the Input variable going wrong	Occ. Number	Controls in place to prevent the Input variable from going wrong	Detection Number	RPN Calculation	

Tool 4: Failure Mode Effects Analysis— Calculate a few RPNs

Worksheet for Class Exercise—Time is 15 minutes

Tool 4: Failure Mode Effects Analysis—Improve and Control

- ▸ Develop recommendations
- ▸ Assign a responsible person for implementation
- ▸ Develop fictional future state RPN that shows marked improvement.
- ▸ Prepare for your final presentation—10 minutes

Tool 4: Failure Mode Effects Analysis—Team Presentations (5 Minutes Each)

‣ IPO
‣ Process Map
‣ Cause & Effects Matrix
‣ Completed FMEA

Summary of Workshop

‣ The four tools when used together enable you to actually complete a process improvement initiative in a relatively short period of time.

Quiz

Sev	Occ	Det	RPN	Results	Action
1	1	1	1	Ideal Situation	None
1	1	10	10		
10	1	1	10		
10	1	10	100		
1	10	1	10		
1	10	10	100		
10	10	1	100		
10	10	10	1000	Big Trouble	Emergency action!

Quiz

Sev	Occ	Det	RPN	Results	Action
1	1	1	1	Ideal Situation	None
1	1	10	10	Not a problem	None
10	1	1	10	A failure does not reach the customer	None
10	1	10	100	Failure will reach the customer	Address your controls
1	10	1	10	Frequent failures, detectable, and cost you money	Process improvement
1	10	10	100	Frequent failures, reaches your customer	Improve detection then improve process
10	10	1	100	Frequent failures and major customer impact	Requires immediate process improvement
10	10	10	1000	Big Trouble	Emergency action!

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Thank you for your participation.
Please complete your session evaluations.
It's been my pleasure!