Northeastern

Basic Process Improvement Methods in Health Care

Summer Intern Orientation, May 2015

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Healthcare Systems Engineering Institute

CMS Innovation Healthcare Systems Engineering Center

NSF Center for Health Organization Transformation

Northeastern University, Boston MA

www.HSyE.org

Center for Medicare & Medicaid INNOVATION

CHOT Center for Health Organization Transformation

Boston HSyE Extension HSEC

NSF

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Outline

1. The big 3:
   i. Six sigma (Motorola, GE)
   ii. Lean (Toyota production system)
   iii. PDSA (Plan Do Study Act)

2. Others
   i. Theory of constraints
   ii. others

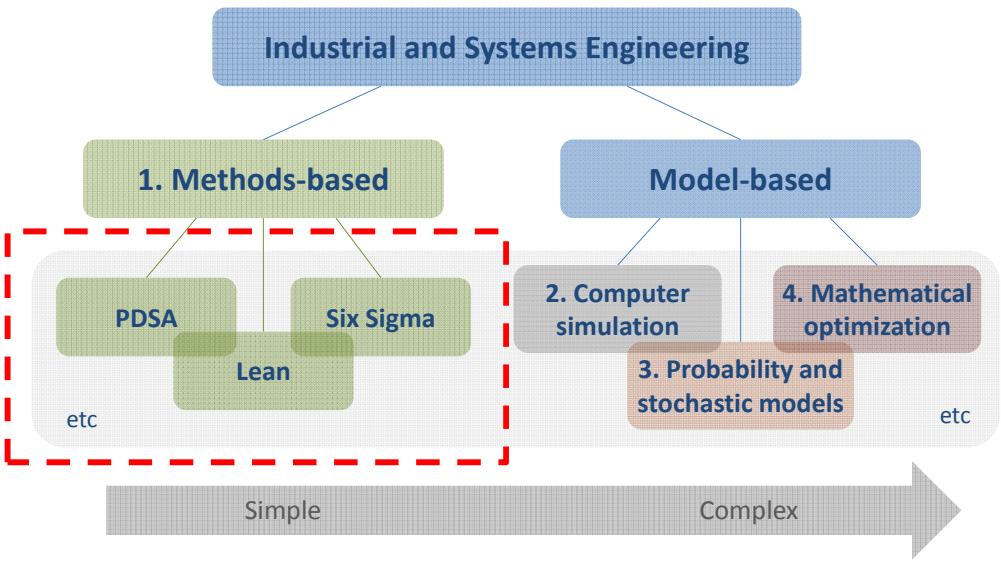
3. Institute for Healthcare Improvement (IHI)
   i. “Model for Improvement”
   ii. Collaborative improvement

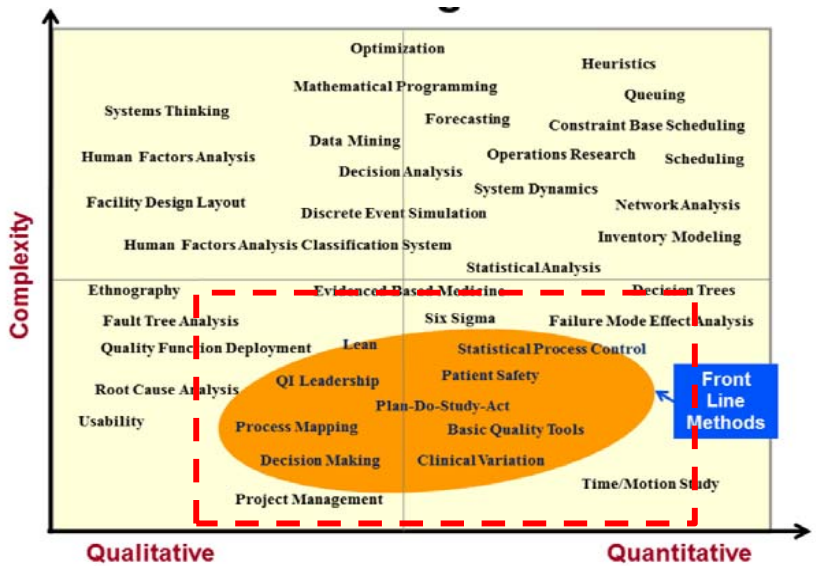
Healthcare Systems Engineering Institute

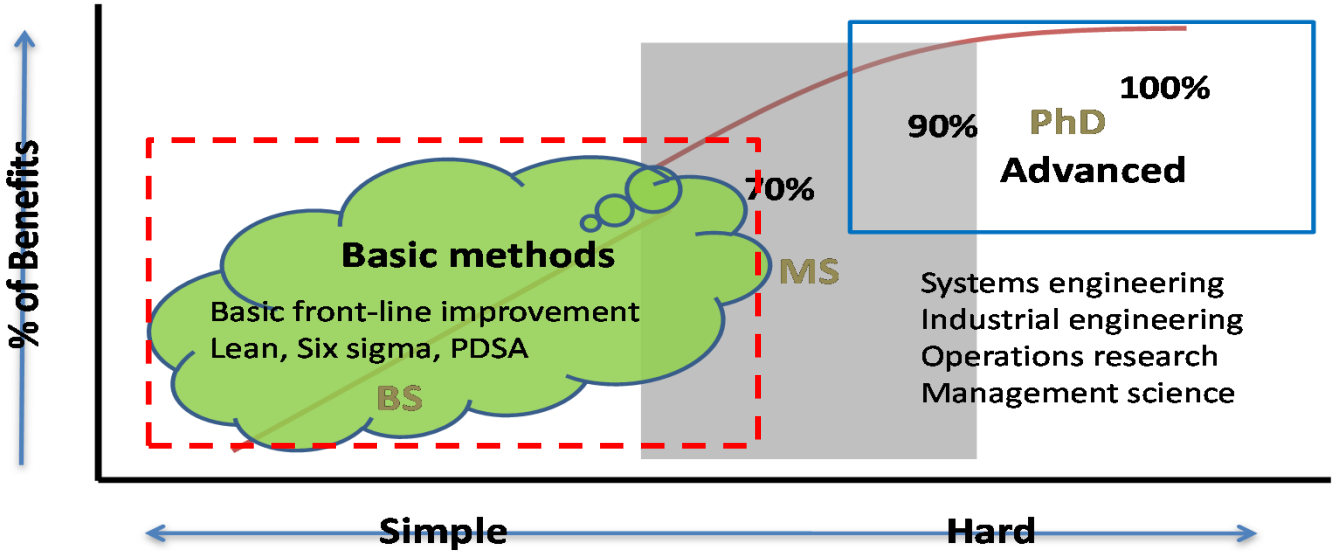
***Mission*: Broad measureable impact on healthcare, nationally, through research, education, and application of industrial and systems engineering**

Partnerships	Project Types	Criteria		Primary Mechanism
	Research – *Discover*	"Developing what we don't know"	1 - 2 years	CHOT – Center for Health Organization Transformation – NSF Research Center
	Applied – *Impact*	"Doing what we know"	3 - 9 months	Center for Medicare & Medicaid INNOVATION – CMS Application Center
	Experiential – *Education*	"Teaching others by doing"	2 - 6 months	• Capstone, Co-ops • Summer Interns

Recall (70-20-10 rule)







1.
Basic Improvement Methods

(70% of it)

Process improvement methods

Variety of approaches

80%+ problems

Slightly different tool kits and approaches

Common concepts:

- **Understand** current process
- **Draw picture** of process logic
- **Use data** (before/after)
- **Test** improvement ideas

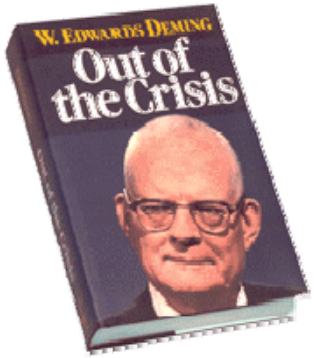
Approach
Total quality mgmt (TQM)
Continuous quality improvement
PDCA / "Model for Improvement"
Six Sigma
Lean **Toyota Production System**

Similar / different focus

Approach	Focus
Total quality mgmt (TQM)	**Management methods** and philosophy for quality improvement
Continuous quality improvement (CQI)	Variety of **tools** to improve processes
Statistical process control (SPC)	Study, detection, and reduction of special and common cause **variability**
PDCA / "Model for Improvement" (IHI)	Framework for **testing** improvement ideas, often rapid cycle & collaborative
Six Sigma	**Variance, defect, & error reduction**. Structured implementation process and tools
Lean / Toyota Production System (TPS)	**Simplification**, flow, waste reduction. Just-in-time "pull", low tech approach
Others (re-engineering, theory of constraints)	(not used much in healthcare)

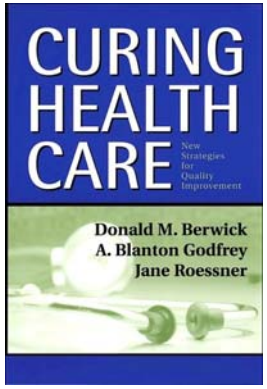
Total quality management (TQM)

TQM overview



- Popularized in U.S. industry in 1970-80's
- "Guru's": Deming, Juran, Feigenbaum, Crosby, …
- Appreciation of the system as a whole
- Focus on **process quality**
- 85% problems due to process (not people)
- Use of statistical methods to understand, monitor, and improve quality
- Adapted into healthcare, 1990's

"Quality is Job 1"



Common approach & philosophy

- Management's job is to create a system to improve quality and remove barriers to improvement
- There is no quick fix, no instant pudding, no magic bullet - continuous improvement of process required
- Long-term focus on continuous never-ending often incremental improvements
- Employee involvement in QI as valuable resource
- Engagement of front-line workers in improvement as key process experts (quality improvement circles)
- Use of data and statistical methods to improve quality, <u>not</u> to measure/reward/punish workers
- Study of variation (natural vs. special cause) (SPC)

W. EDWARDS DEMING:
A THEORY FOR MANAGEMENT

Transformation through application of the fourteen points

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs.

2. Adopt a new philosophy. We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.

3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.

4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.

5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.

6. Institute training on the job.

7. Institute leadership (see point 12). The aim of leadership should be to help people and machines and gadgets to do a better job. Leadership of management is in need of overhaul, as well as leadership of production workers.

8. Drive out fear, so that everyone may work effectively for the company.

9. Break down barriers between departments. People in research, design, sales and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.

10. Eliminate slogans, exhortations and targets for the work force asking for zero defects and new levels of productivity.

11a. Eliminate work standards (quotas) on the factory floor. Substitute leadership.

b. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.

12a. Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.

b. Remove barriers that rob people in management and in engineering of their right to pride of workmanship. This means, inter alia, abolishment of the annual or merit rating and of management by objective, management by the numbers.

13. Institute a vigorous program of education and self-improvement.

14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

Diseases that stand in the way of the transformation

1. Lack of constancy of purpose to plan product and service that will have a market and keep the company in business and provide jobs.

2. Emphasis on short-term profits: short term thinking (just the opposite from constancy of purpose to stay in business), fed by fear of unfriendly takeover, and by push from bankers and owners, for dividends.

3. Personal review system, or evaluation of performance, merit rating, annual review, or annual appraisal, by whatever name, for people in management, the effects of which are devastating. Management by objective, on a go, no-go basis, without a method for accomplishment of the objective, is the same thing by another name. Management by fear would still be better.

4. Mobility of management: job hopping.

5. Use of visible figures only for management, with little or no consideration of figures that are unknown or unknowable.

6. Excessive medical costs.

7. Excessive costs of warranty, fueled by lawyers that work contingency fees.

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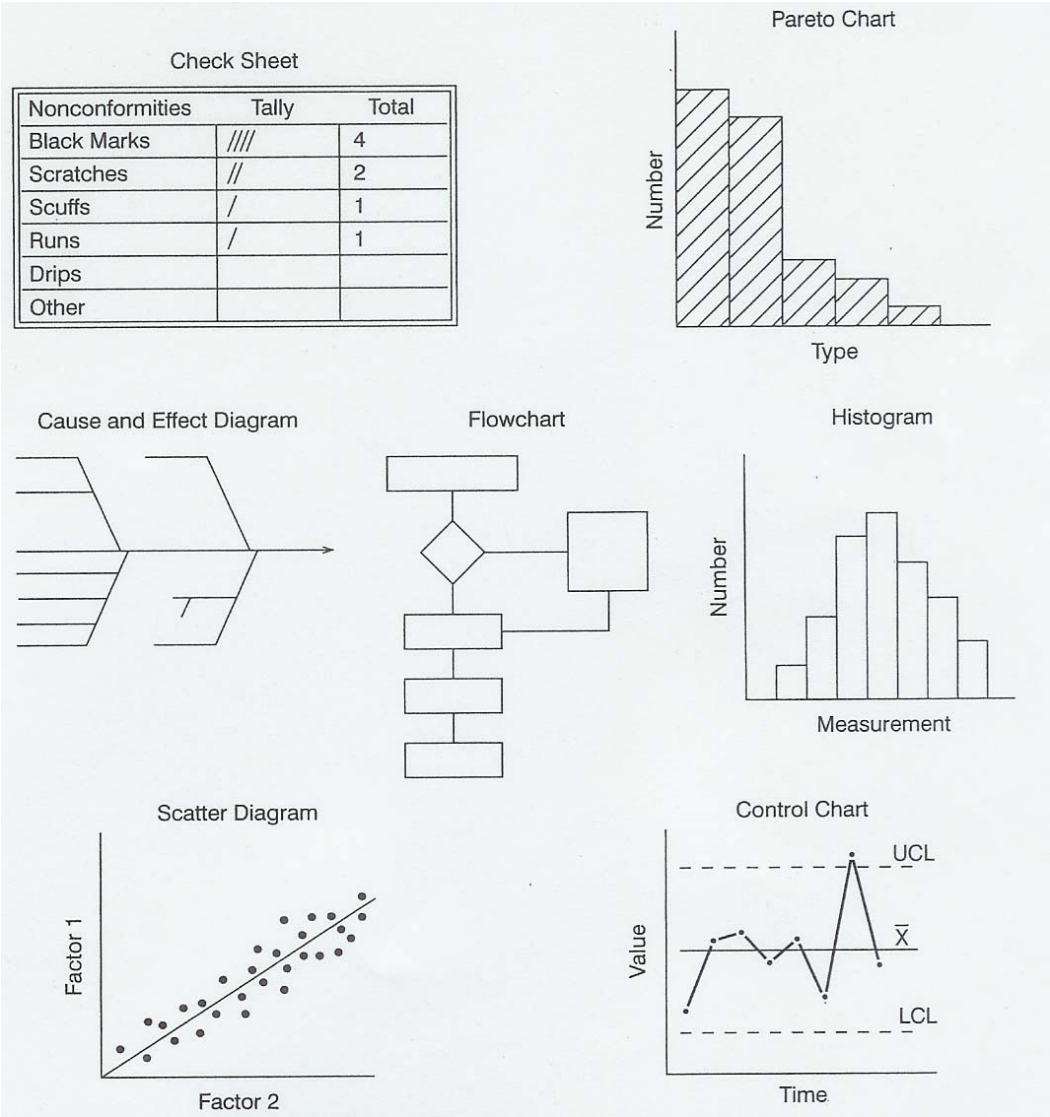
Continuous quality improvement (CQI)

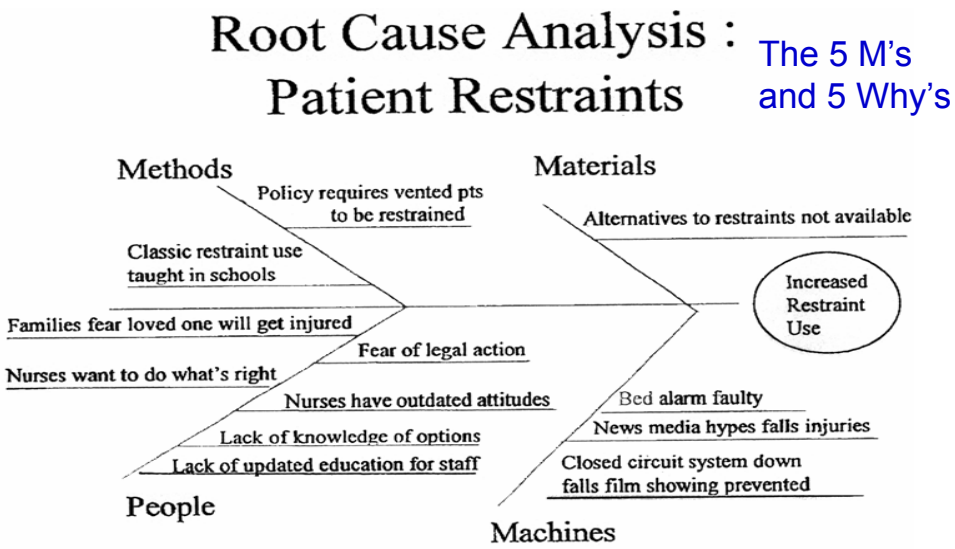
Common QI/6σ tools

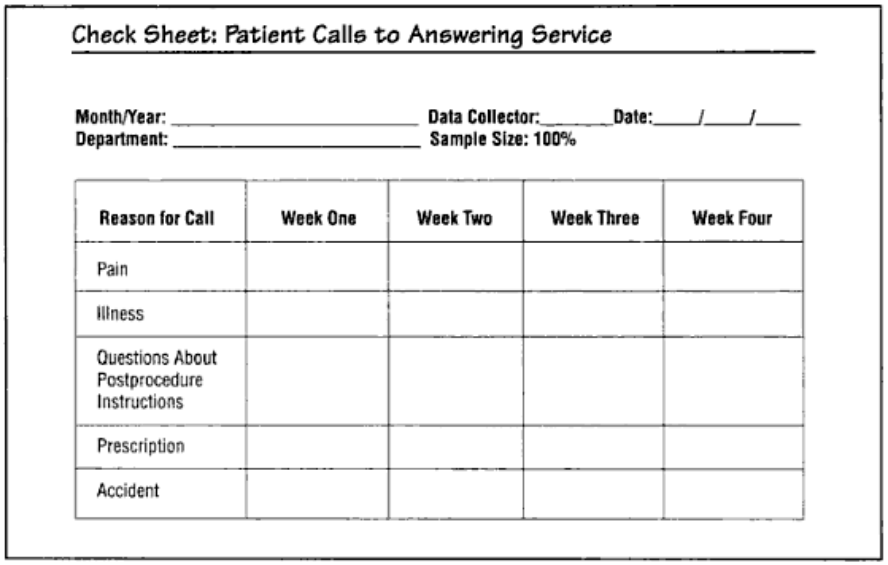
“Basic 7 Tools”

- Check sheets
- Pareto charts
- Cause-and-effect “fishbone” diagrams
- Process flow charts
- Histograms
- Scatter diagrams
- Run and control charts



Examples

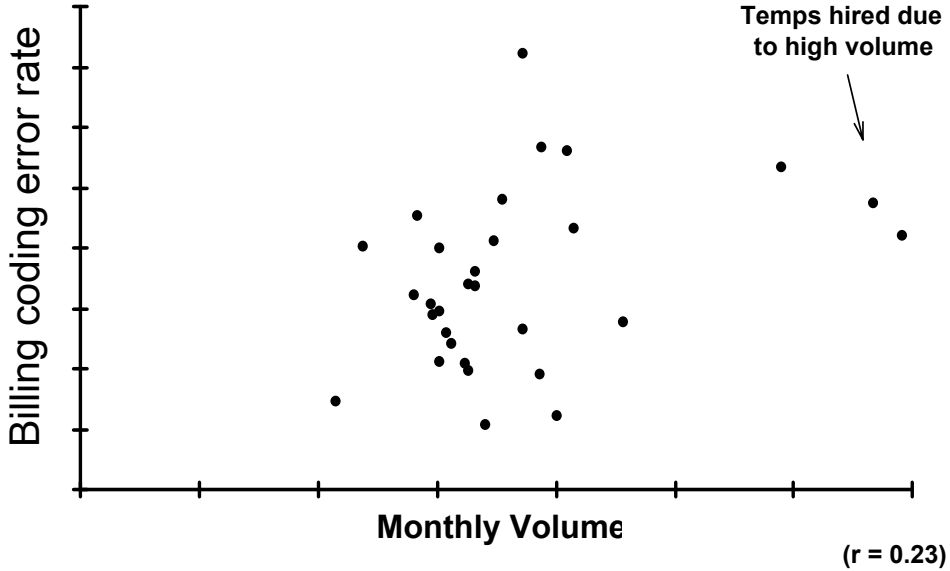


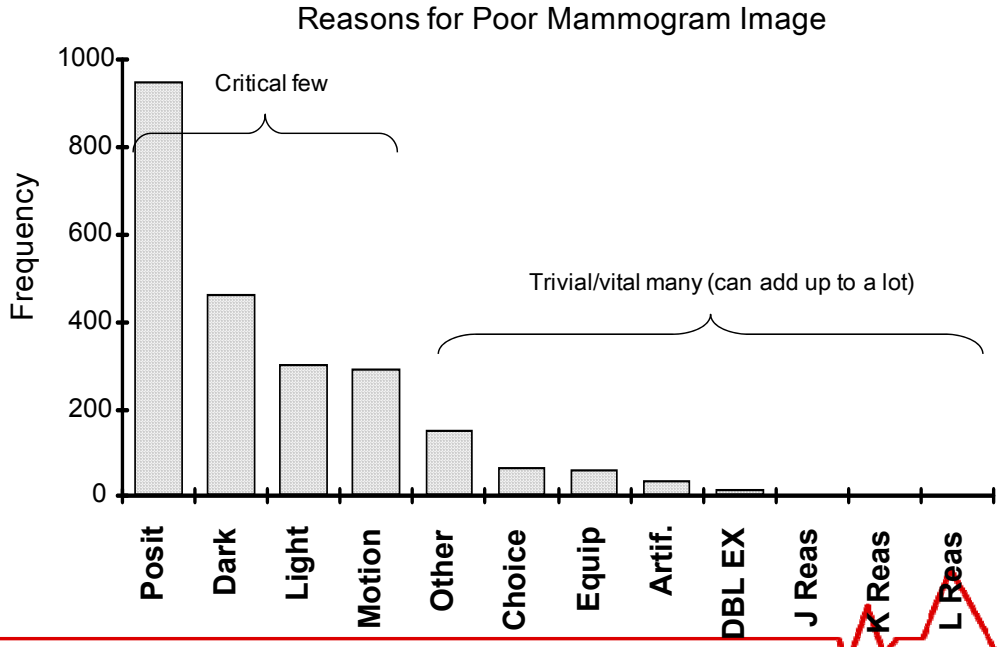


Check Sheet: Patient Calls to Answering Service

Month/Year: _____ Data Collector: _____ Date: ____/____/____
Department: _____ Sample Size: 100%

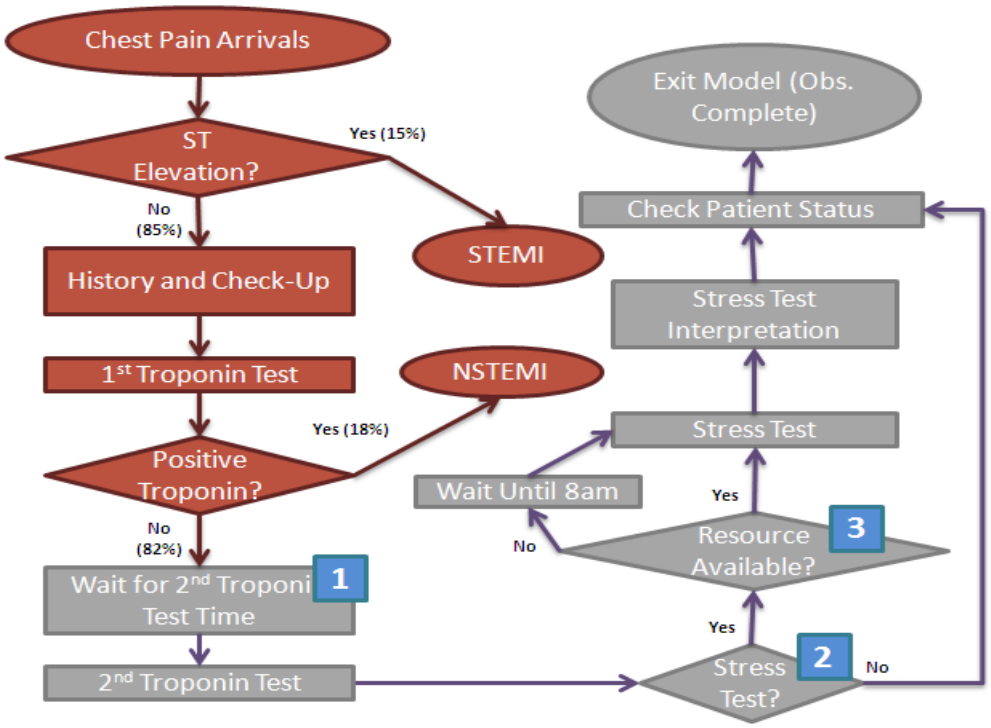
Reason for Call	Week One	Week Two	Week Three	Week Four
Pain				
Illness				
Questions About Postprocedure Instructions				
Prescription				
Accident				

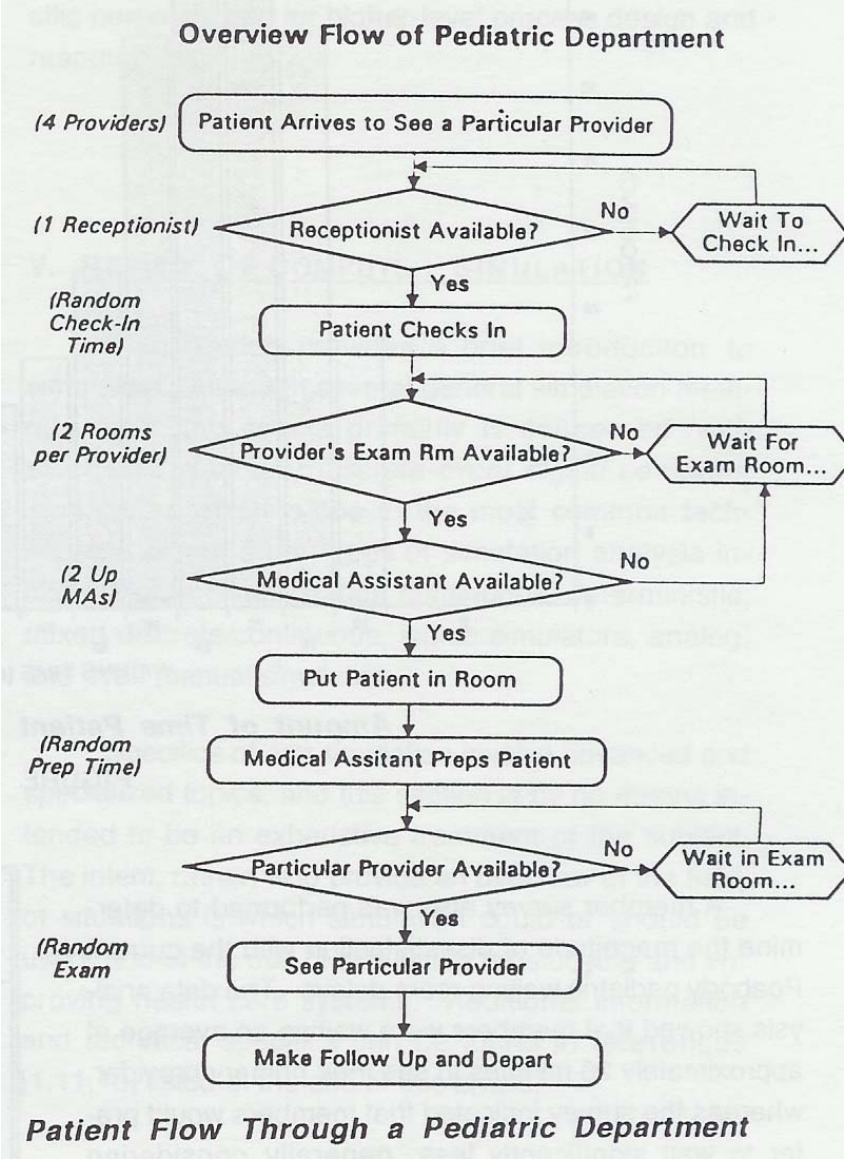




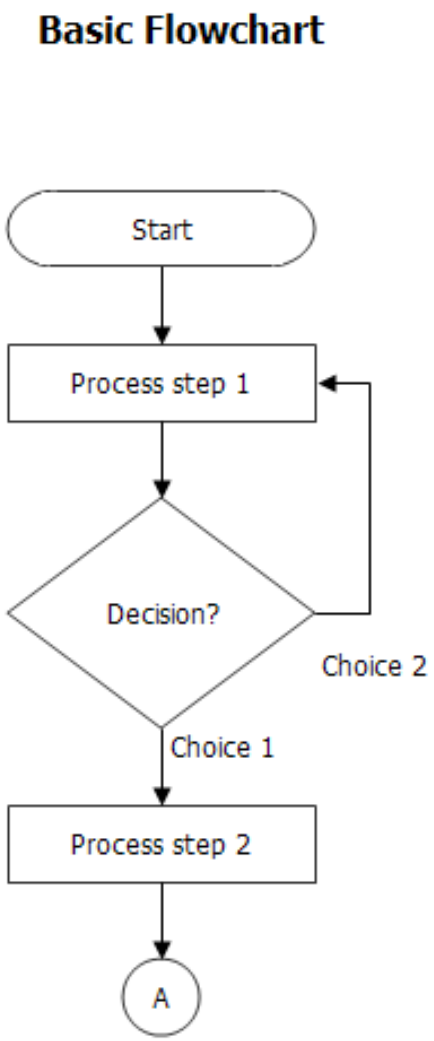
Process flow examples

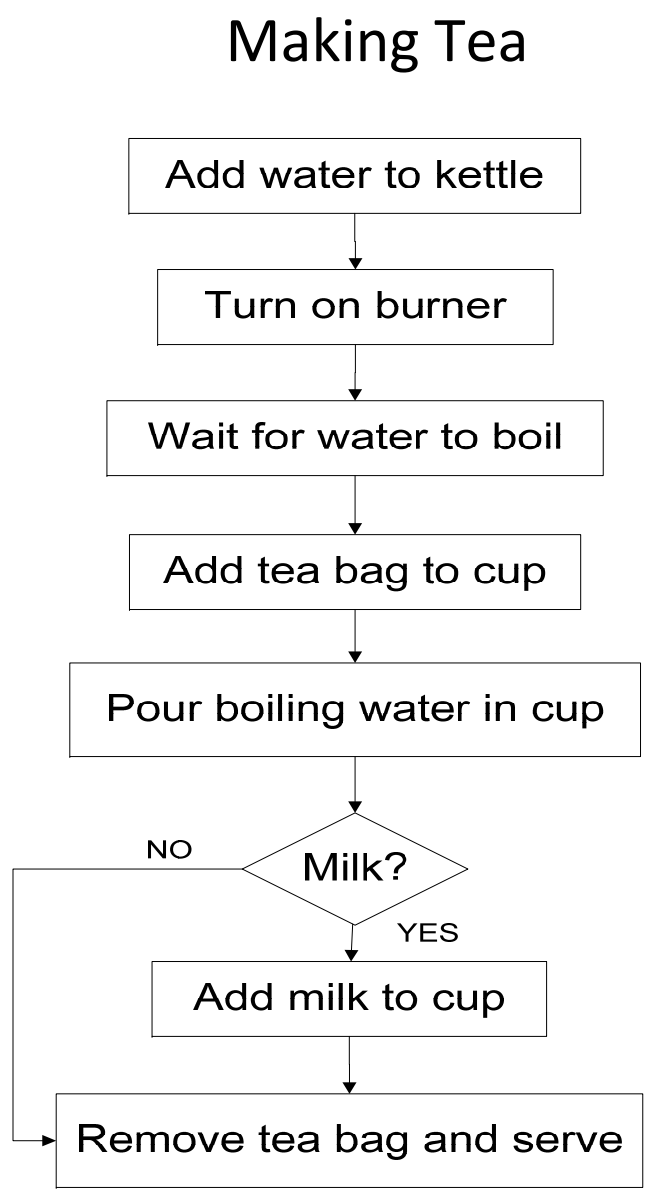
- Graphical depiction of process logic
- Several common formats (none “right” or “wrong”)
- Useful to understand how process could be improved
- Shared consensus and standardization



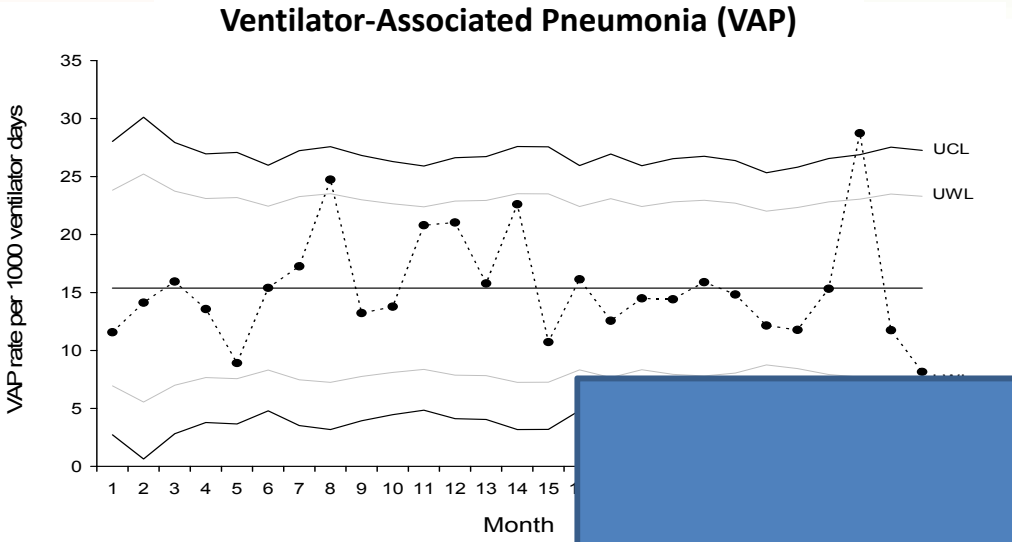


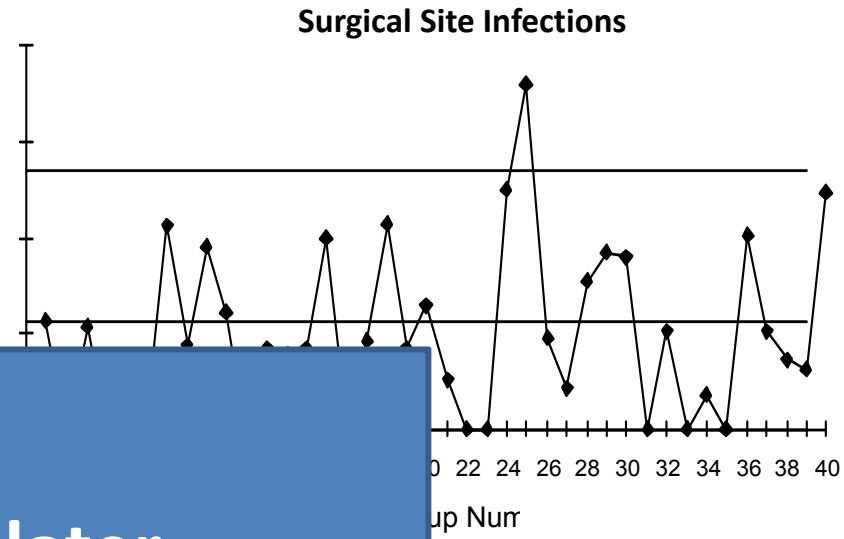
How do you make tea?



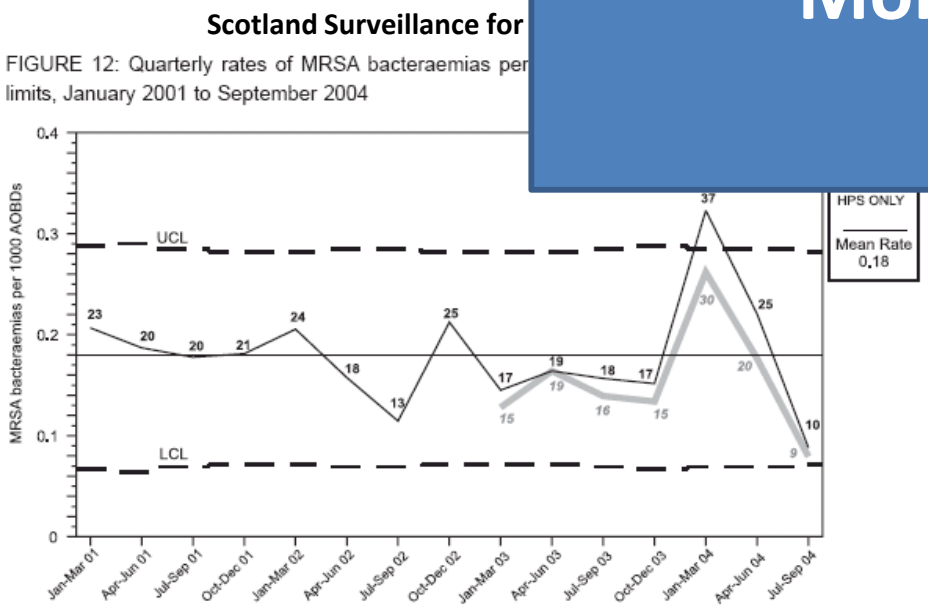


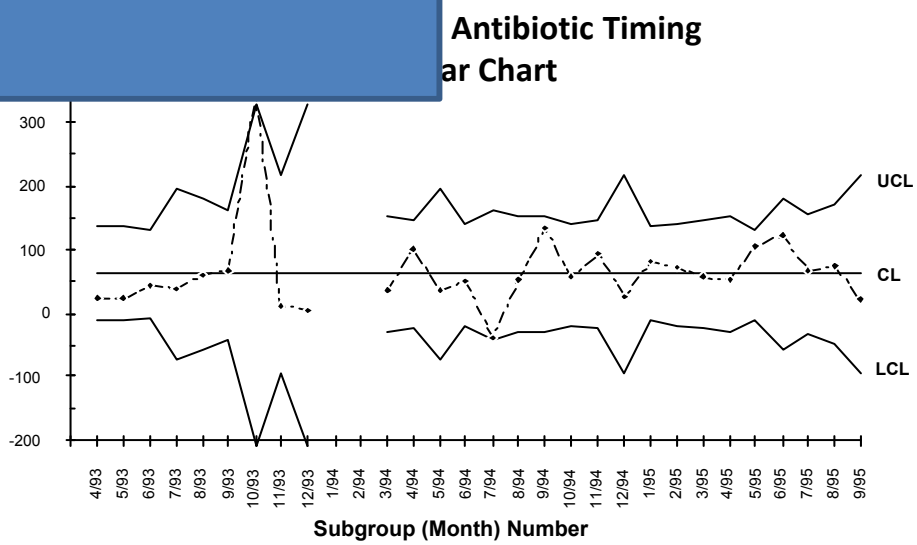
Quality control chart examples





More later



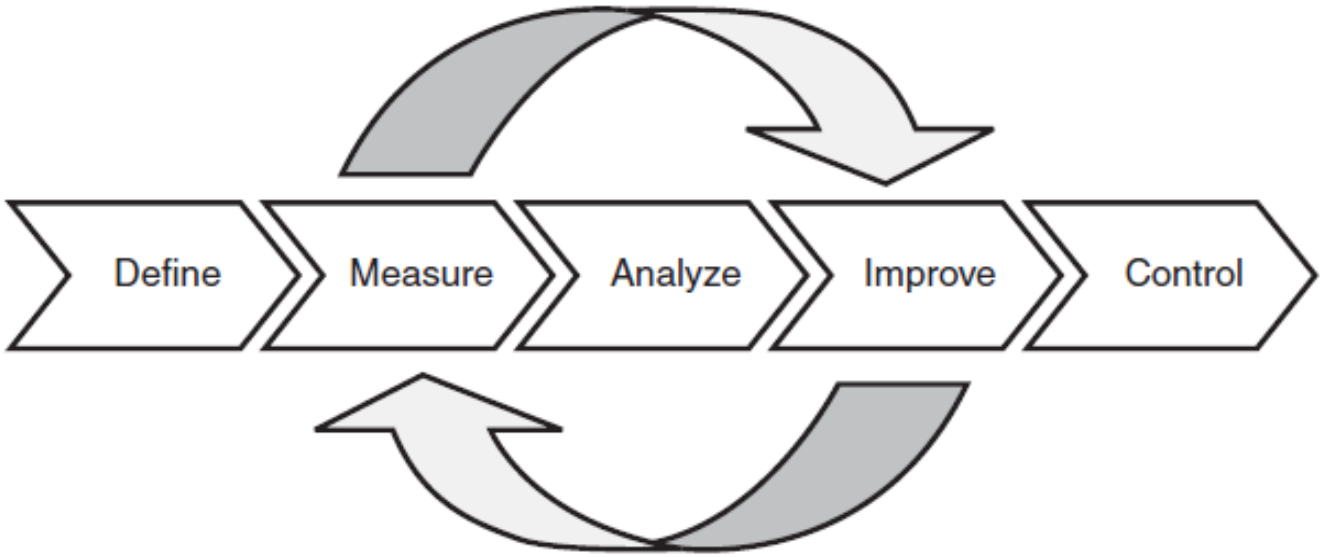


Six sigma

(a CQI implementation approach)

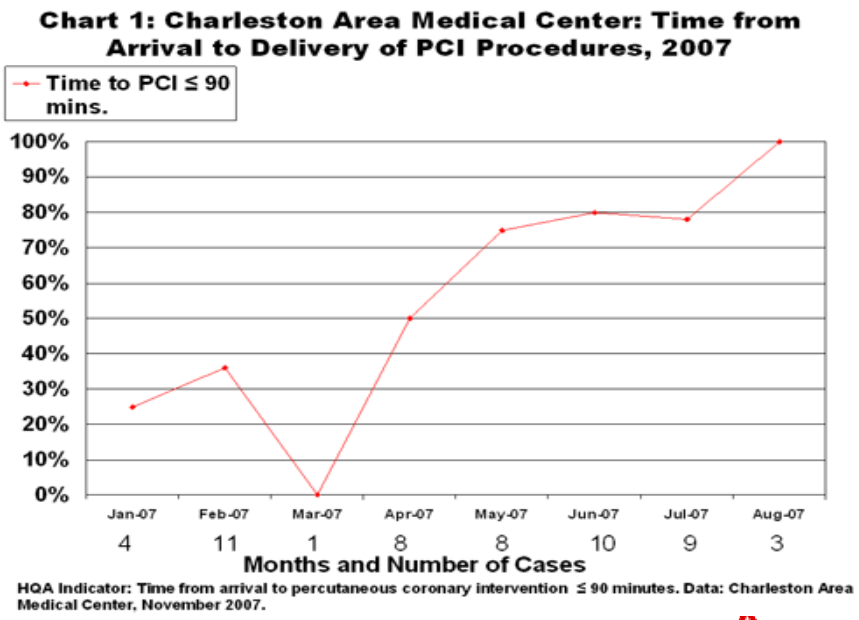
"Six Sigma" DMAIC basics

- Focus: Quality improvement
- Structured approaches, integrated measuring
  - **DMAIC: Improve existing process**
  - DFSS: Design for Six Sigma
  - DMADV: Define, Measure, Analyze, Design Verify



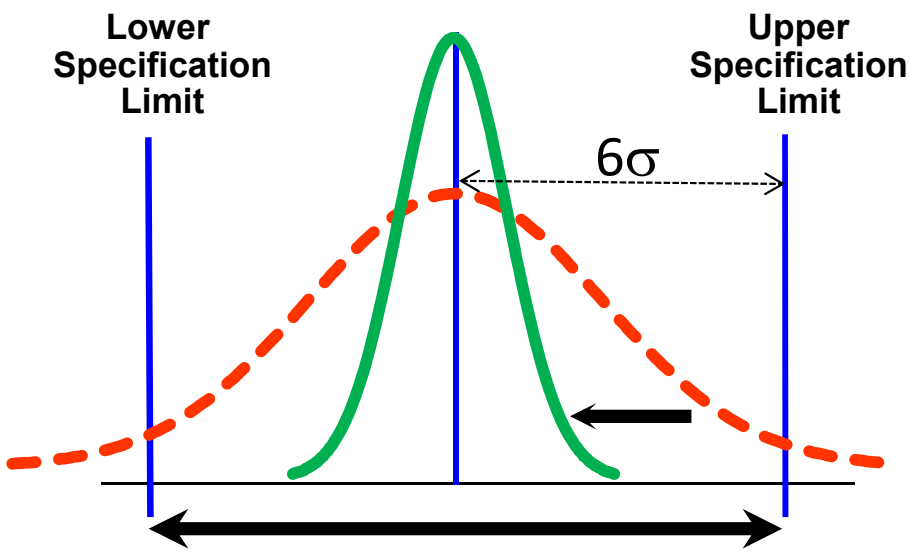
DMAIC example

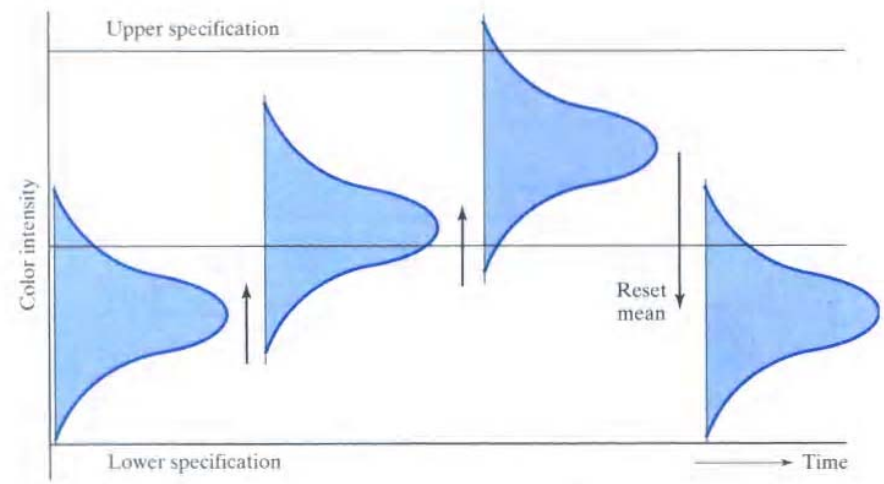
- Define: Process maps for EBM delivery (AMI, SSI, CHF)
- Measure: Baseline element and composite measures
- Analyze: Weekly review of 10 random patient charts by change agents and case coordinators. Root cause analysis
- Improve: Staff education, order sets, Protocols, check lists
- Control: Standardize processes Compliance monitoring



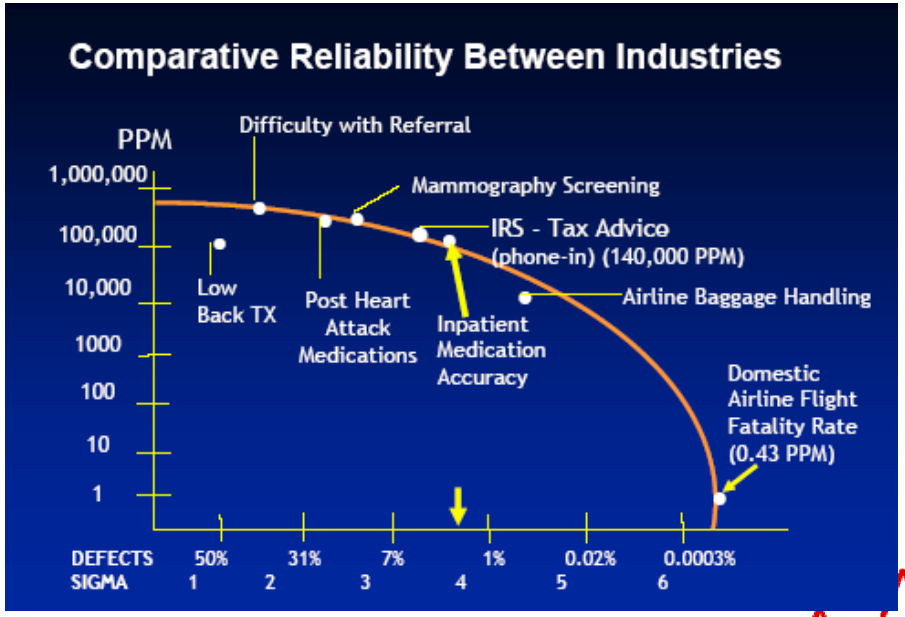
http://www.commonwealthfund.org/Content/Innovations/Case-Studies/2007/Nov/Case-Study--Improving-Performance-at-Charleston-Area-Medical-Center.aspx

Why Six Sigma?





Sigma	Defects per million	Yield
1	690,000	30.9%
2	308,000	62.9%
3	66,800	93.3%
4	6,210	99.4%
5	230	99.98%
6	3.4	99.9997%
7	0.019	99.99998%



‘Lean’

Toyota production system (TPS)

 © 2012

Lean primer

- Focus: Flow, simplification, reduce waste
- Idea: Simpler processes work better, less error, lower cost, higher safety

Lean Tools

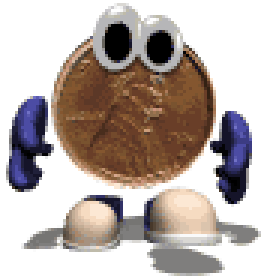
- Value stream mapping
- 5S (sort, simplify, standardize…)
- Non-value added time
- Single piece flow
- Quick changeover (SMED)
- Waste elimination
- Error proofing
- Visual controls

7 Types of Waste

- Transportation
- Motion
- Waiting
- Inventory
- Over-production
- Over-processing
- Defects
- (Variation)

Examples of non-value added activities

Approving



Walking

Batching

Searching

Waiting

“5 S”

Sort
Standardize
Simplify
Set in order
Sustain
(Safety)

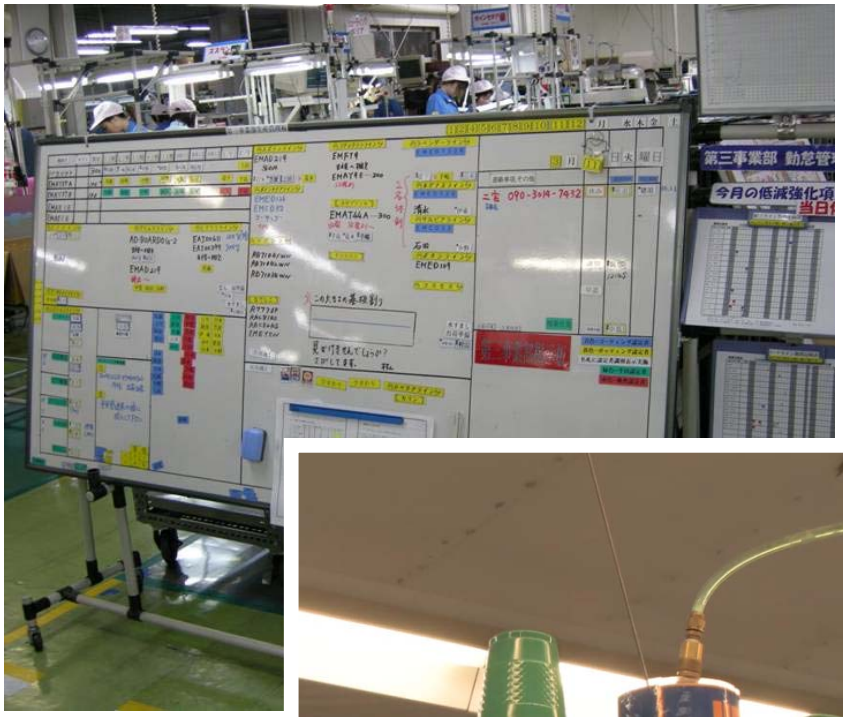
Seiri
Seiton
Seiso
Seiketsu
shitsuke

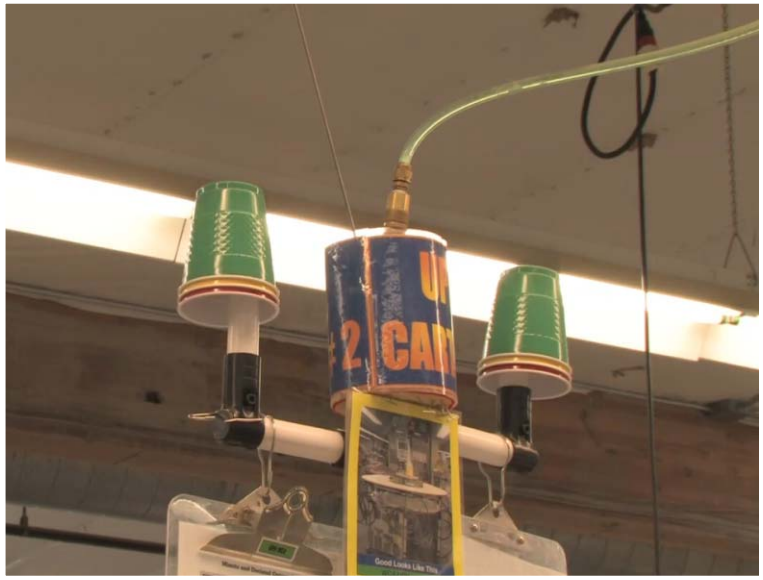
Healthcare examples

"5S"

Visual controls

Toyota





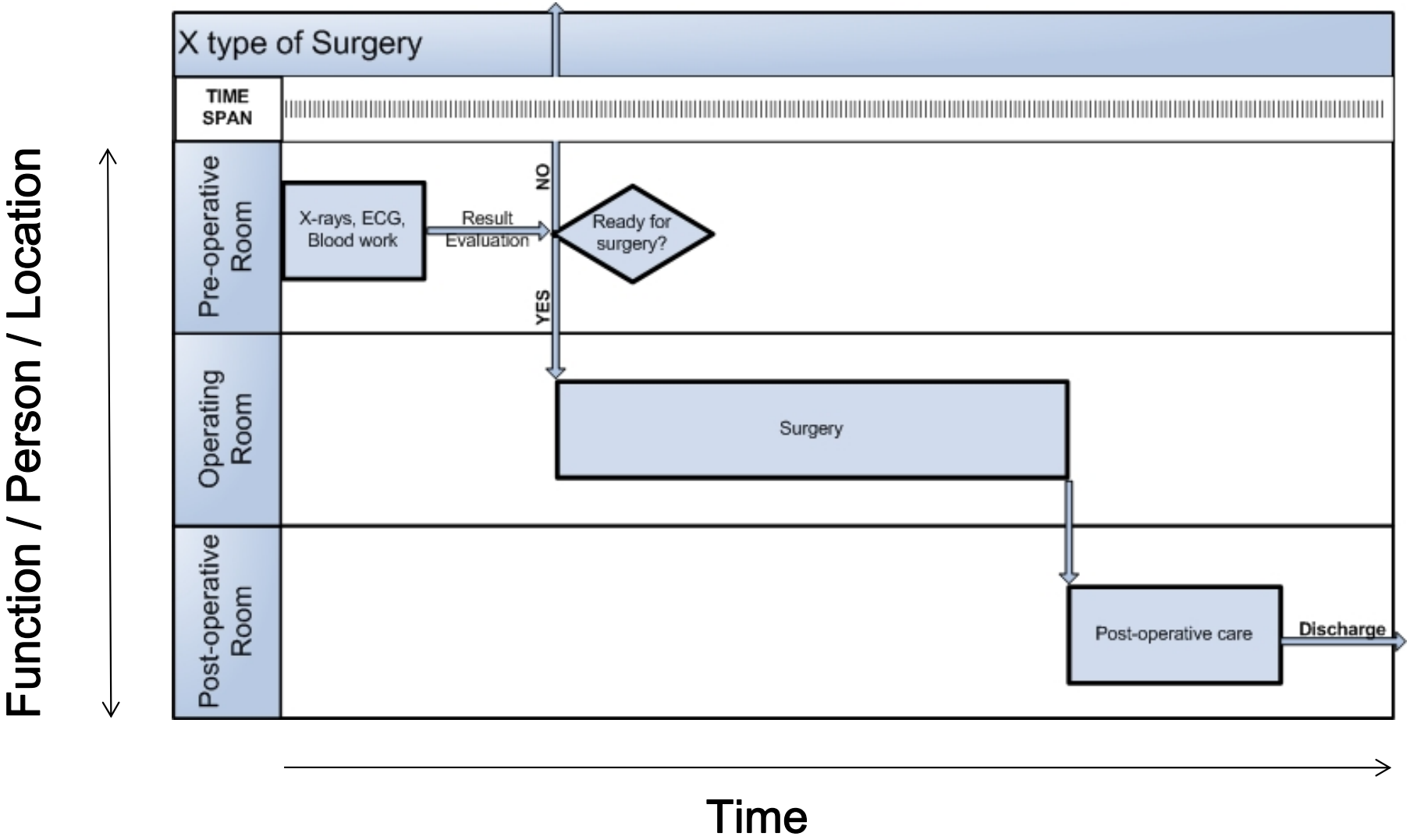
3 Cup System

Wristbands

Barb Averyt, program director of patient safety at Arizona Hospital and Healthcare Association

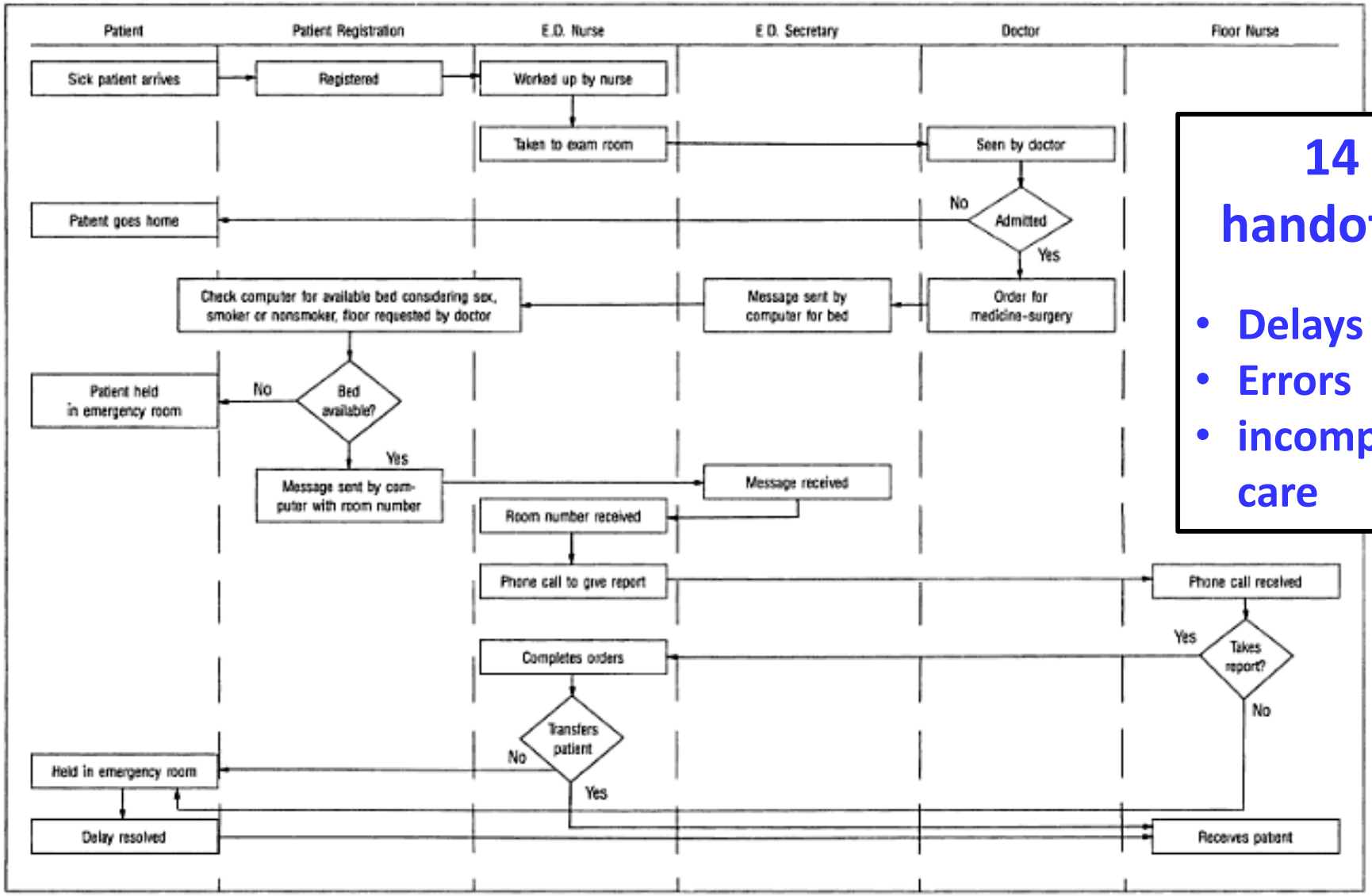
Cross functional maps
(aka 'swimming lane' charts)

Sequential Scheduling Example



Swimming lane example

Figure 11-5. Flowchart of Admission from Emergency Department to Surgical Bed



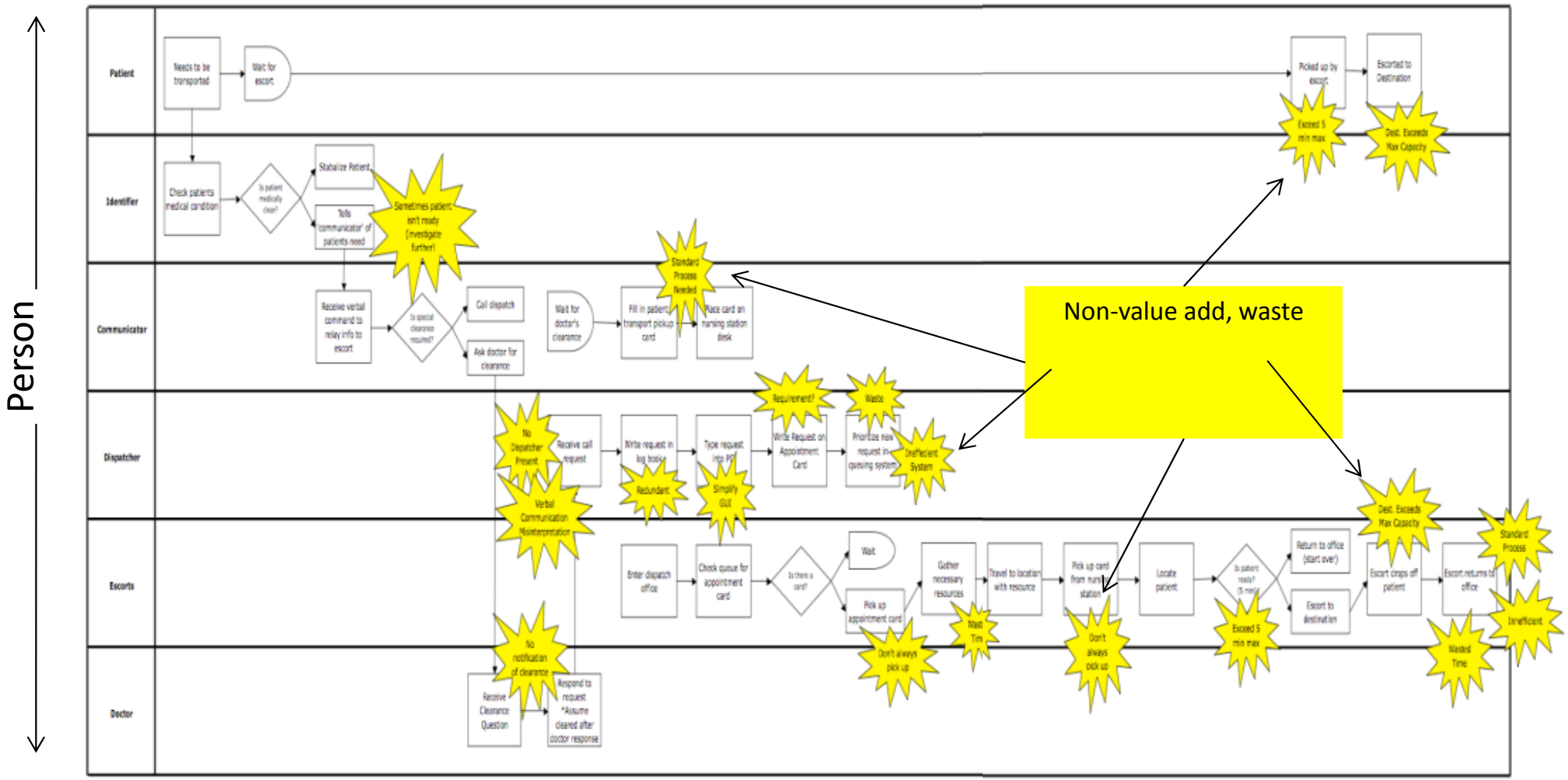
Reprinted, with permission, from Holston Valley Hospital and Medical Center, Kingsport, TN, 1990.

14 handoffs!

- **Delays**
- **Errors**
- **incomplete care**

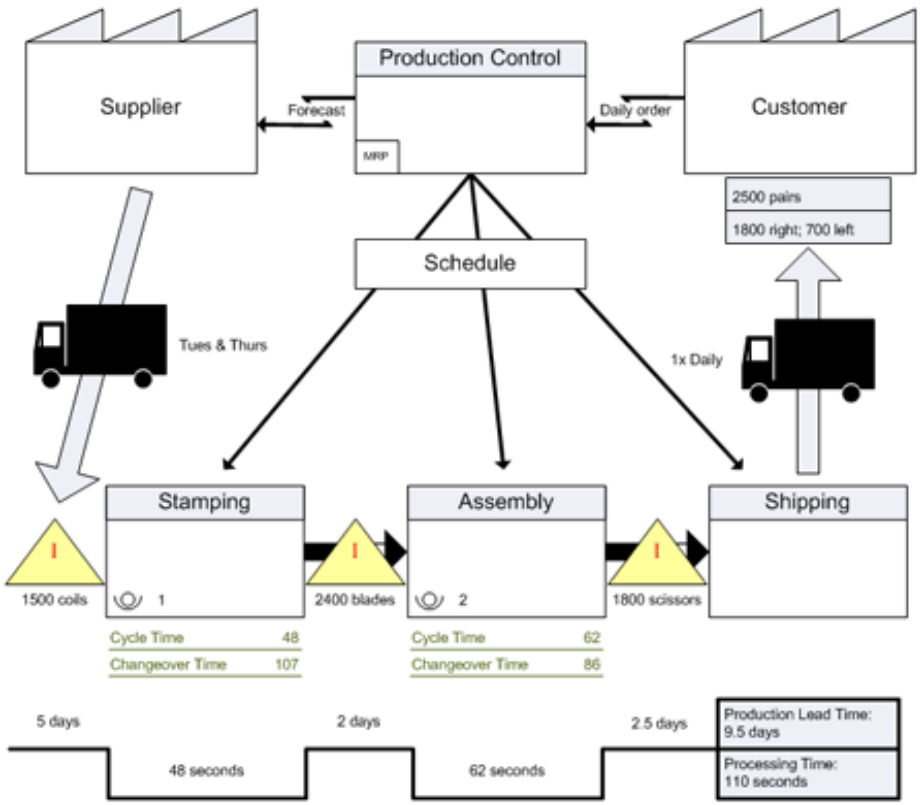
Non-value added work (NVA)

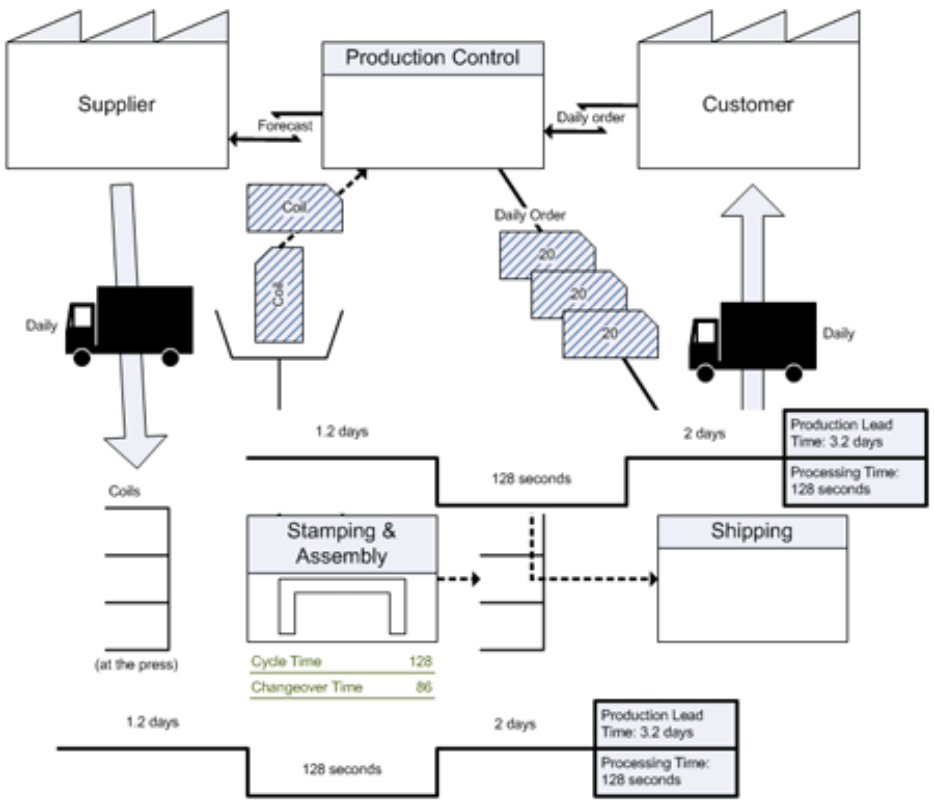
Swimming lane diagram – “current state map”



Value stream maps

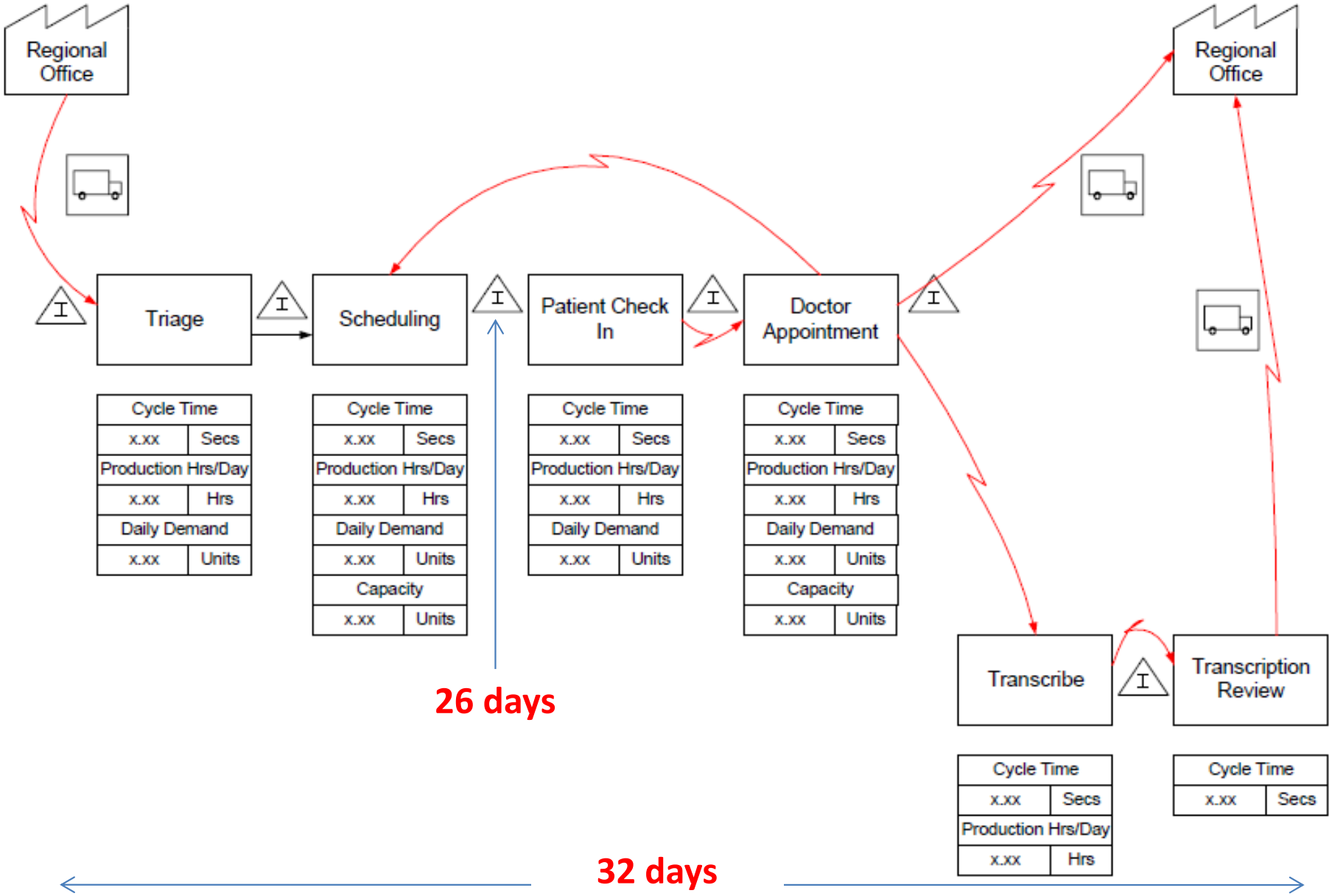
Current State → Future State





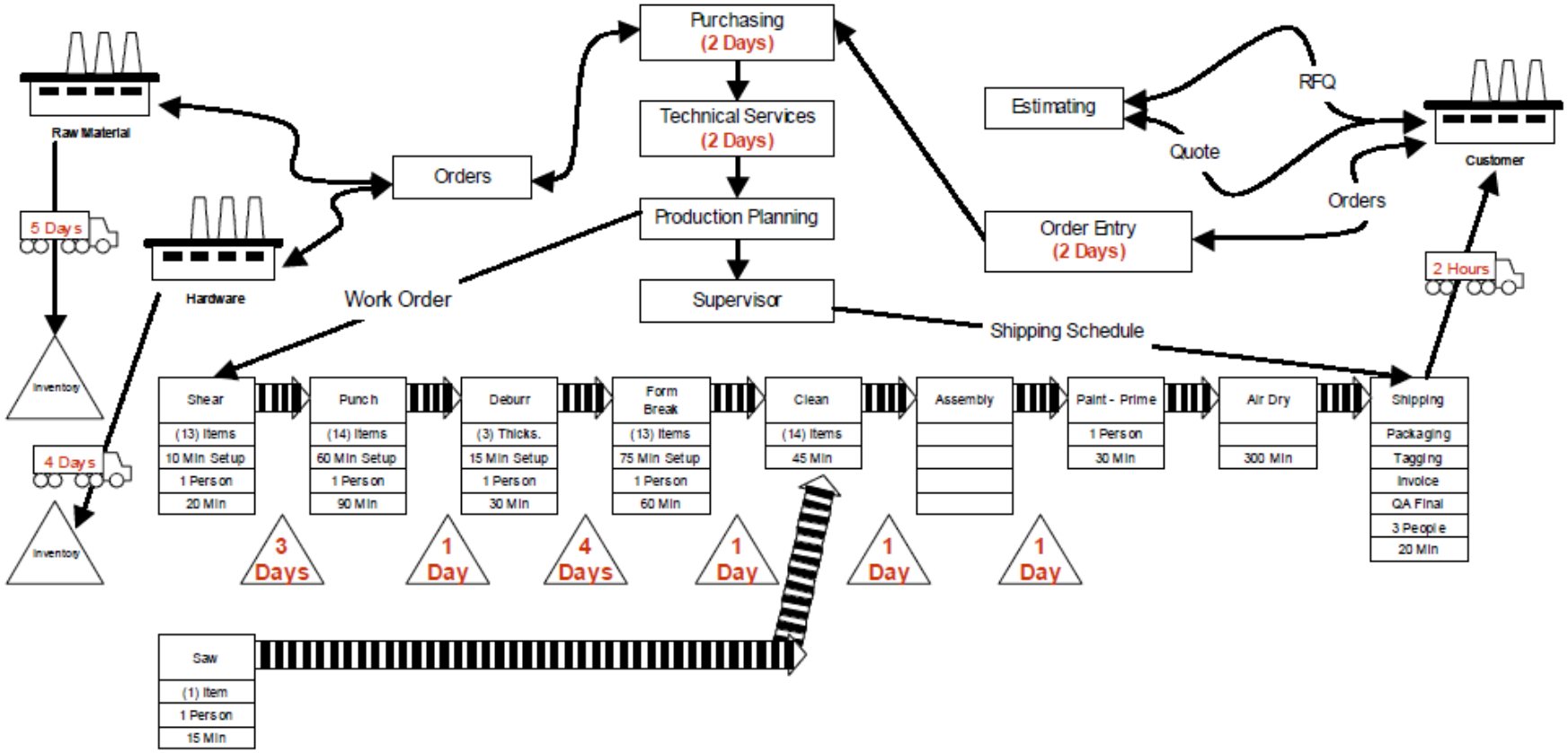
VAT = 110 seconds / 9.5 days → VAT = 128 seconds / 3.2 days

VSM – Appointment scheduling example



Value-add vs. Non-value-add times

Current State Map – 20 Days Lead-Time



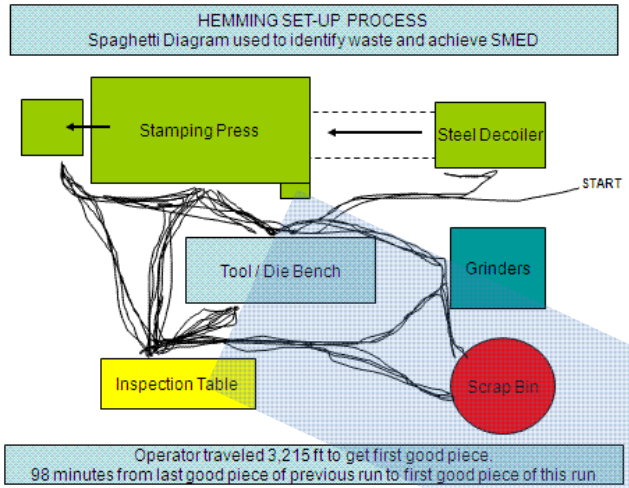
V/A Time =		20 Min		90 Min		30 Min		60 Min		45 Min		30 Min	300 Min	20 Min	= 595 Min
Non V/A =	9 Days		3 Days		1 Day		4 Days		1 Day		1 Day		1 Day		= 20 Days

$$\text{Value Added Time as a \% of Total Time in Plant} = \frac{595 \text{ Minutes}}{(20 \text{ Day})(24 \text{ Hours/Day})(60 \text{ Minutes/Hour})}$$

$$= 2.1\%$$

Waste - Travel as a form of waste

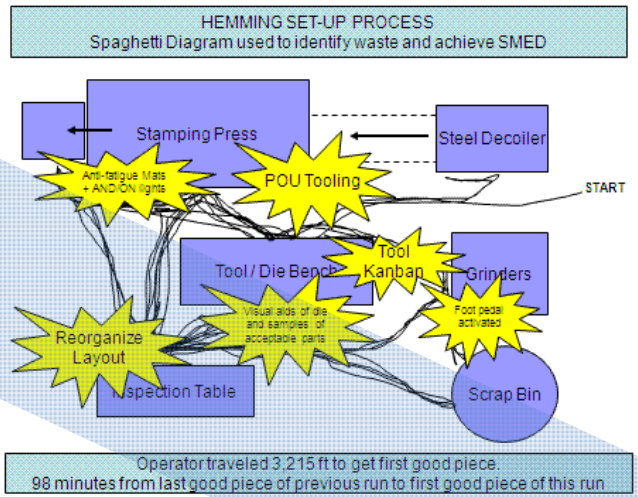
Before



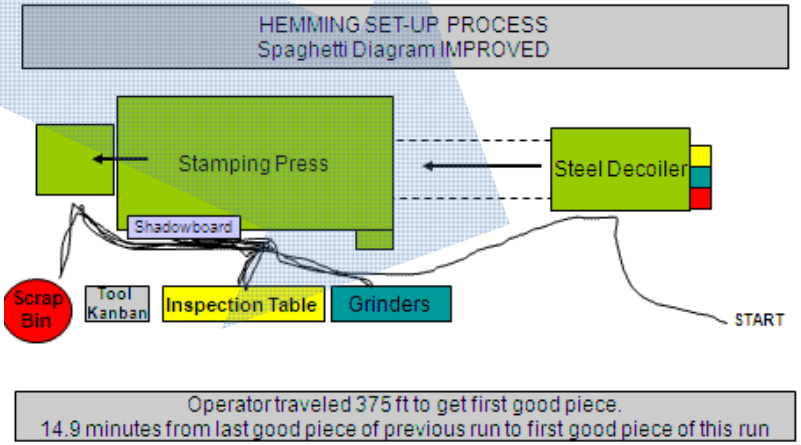
3,215 ft travel distance

98 minutes

CQI / Lean projects



New layout



375 ft travel distance

14.9 minutes

70 – 85% reduction!

Waste – NVA and travel time (50% NVA)

A 36-Hospital Time and Motion Study: How Do Medical-Surgical Nurses Spend Their Time?

Ann Hendrich, RN, MSN, FAAN
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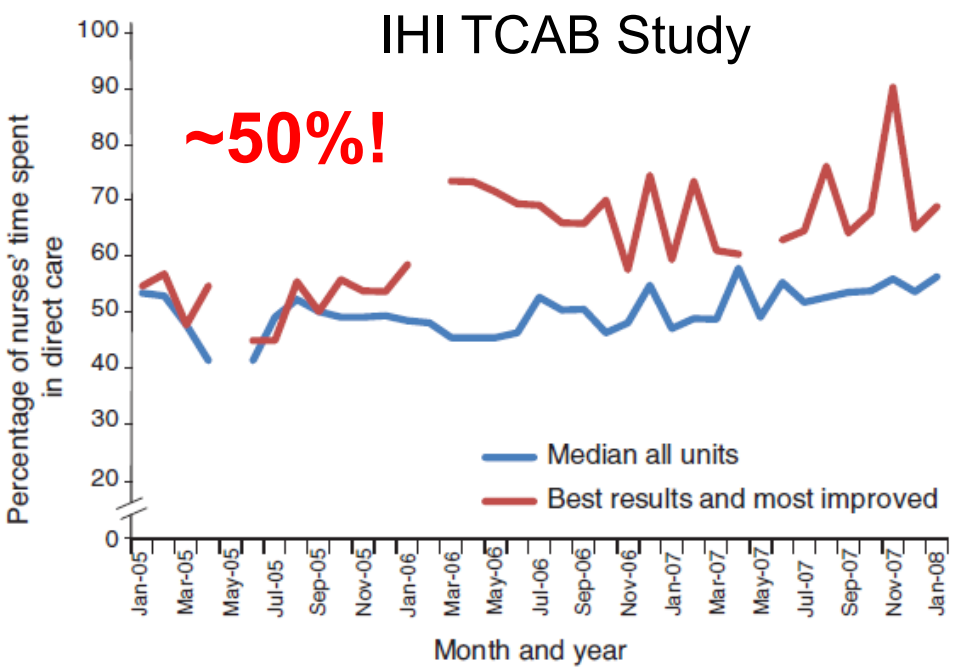
Table 2. Categories and subcategories of nursing time for protocol B

Nursing activity category	Nursing activity subcategory
Waste	Waiting
	Looking/retrieving
	Delivering
Unit-related functions[a]	Unit-related functions
Nursing practice	Patient care activities[b]
	Care coordination
	Medication administration
	Documentation
	Assessment/reading vital signs
Nonclinical	Personal time
	Patient/family care
	Administration/teaching

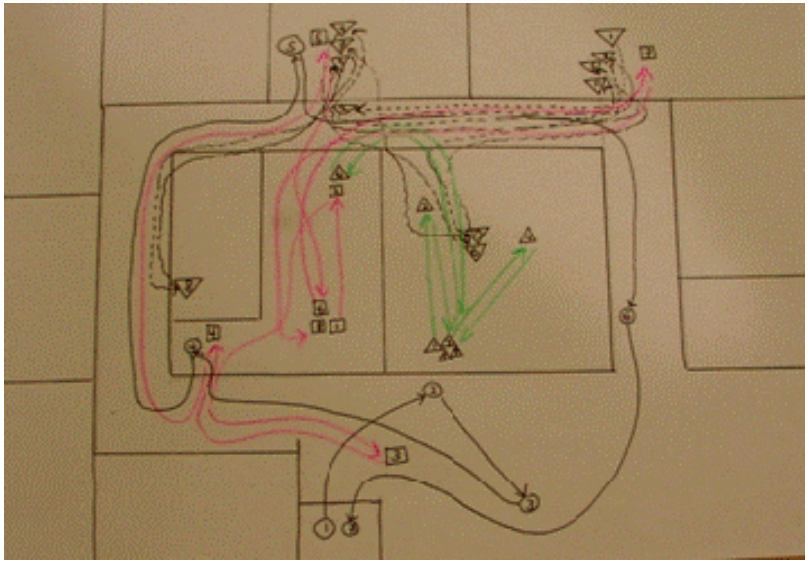


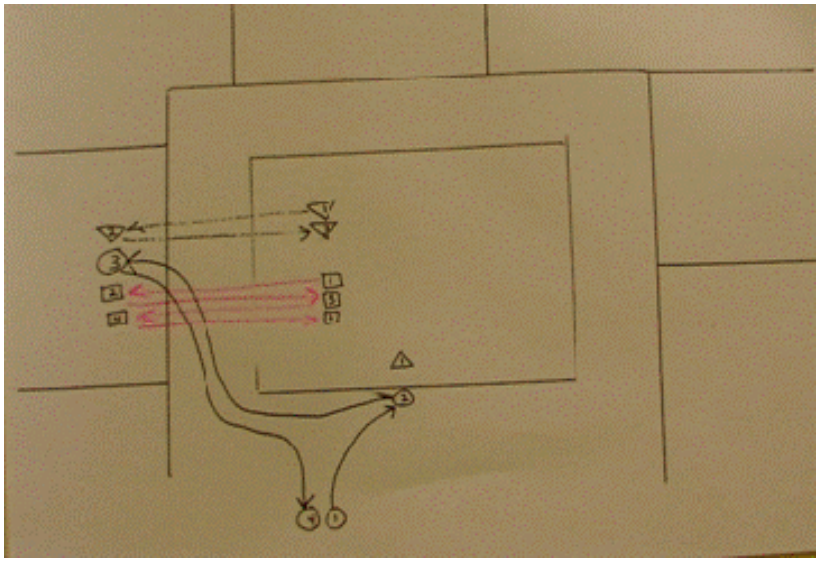
- Documentation: 35%
- Non-nursing practice: 25%
- Foraging, Travel time, Patient escorting

Waste – Spaghetti diagram

- Lean: 7 types of waste
- Travel = waste
- "Visual data"

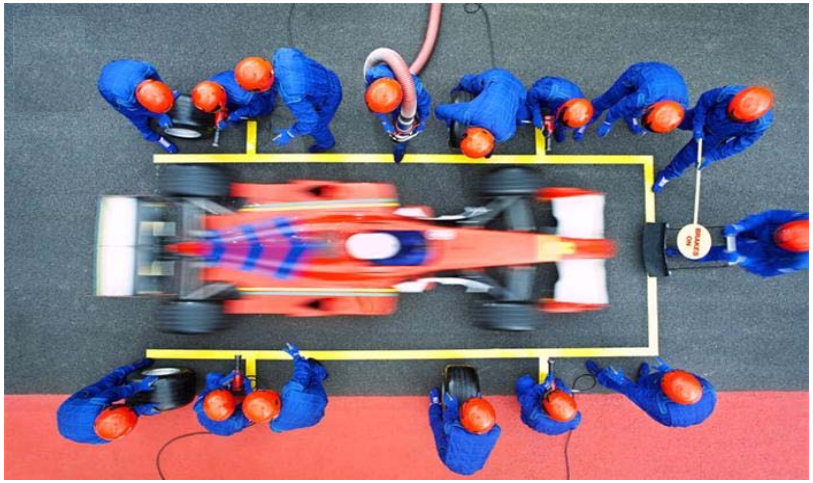
- Relocate workstations
- 75% travel reduction
- Loss cross-over congestion



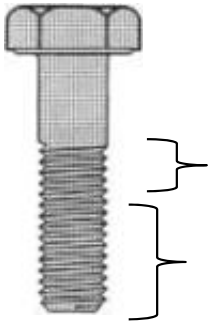


Waste - Shingo's bolt metaphor

- Single minute exchange of die
- Quick changeover and set-up
- Race pit / tire change metaphor

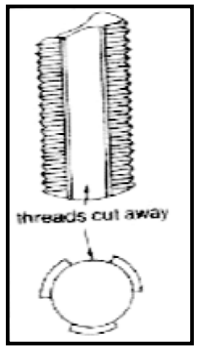


Bolt attachments requires 32 complete turns for each bolt or screw to fasten die to a machine.



Only last turn has value

No-value add > 80% time



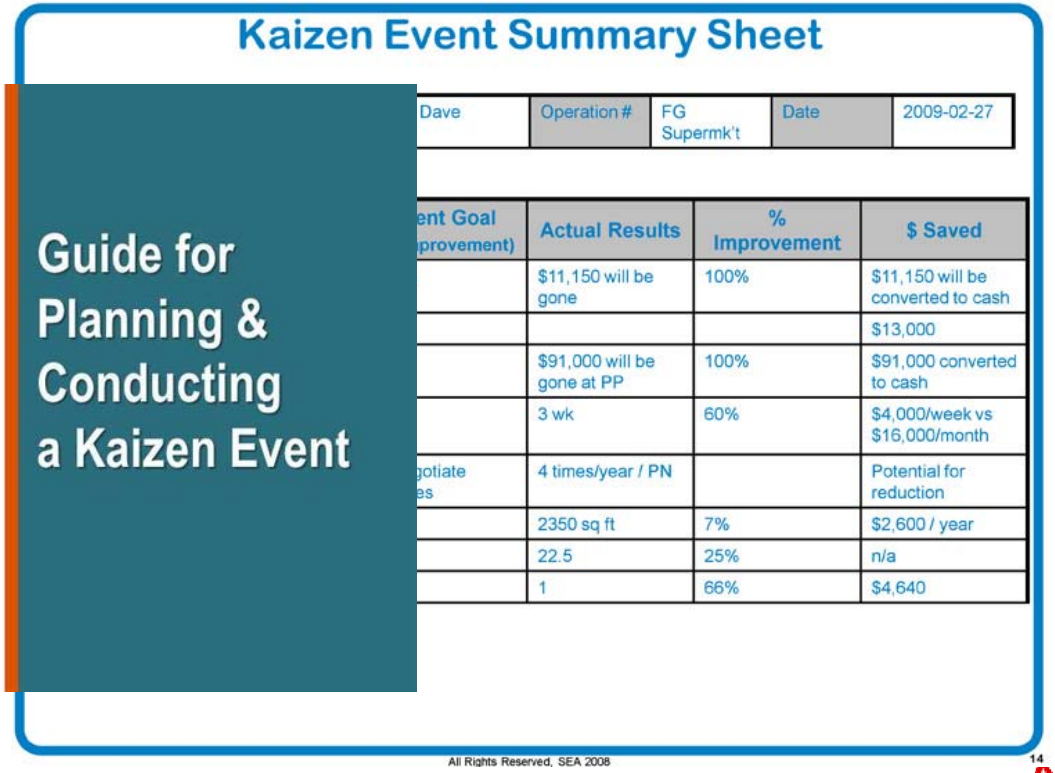
:hread bolts

Under-used concept in healthcare.
How could we implement SMED?

- OR/clinic room turn over?
- Sterile equipment reprocessing
- Lab diagnostics
- Other?

“Kaizen event”

- aka, Rapid process improvement workshop (RPIW) or Rapid Improvement Event (RIE)
- A way to rapidly do lean



What it really looks like

A3 storyboard example

Clean Catch January 2004

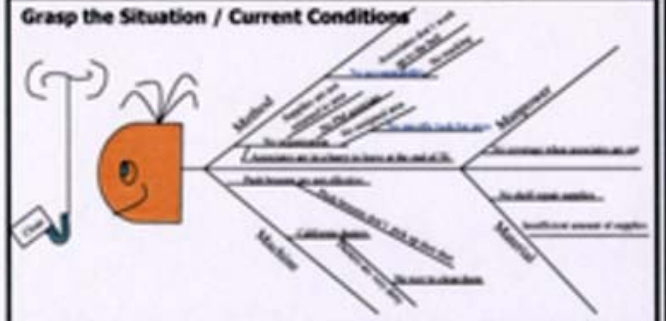
Team Lead: Mique Tatman Team members: Jeri Butts,Kathy Canfield,Troy Cooper,Keith Dorsey,Tina Neace,and Cyndi McIntosh

OBJECTIVE: Improve 5S compliance in the Bin home positions.

Background

- At launch, each associate was assigned specific areas, rotated monthly
- In 2003, 5 S responsibilities were set by teams to support teamwork
- Teams were responsible for sharing workload

Grasp the Situation / Current Conditions



- 5S assignments are not clear (SOP) - No organization – specific assignments, tracking
- No ownership/accountability of area - One area is cleaned by multiple associates
- Shelf dividers and face plates are falling and in need of repair
- A build up of dust has collected on the shelves that are not cleaned
- 5S supplies are not distributed equally and are not placed in the holders
- More supplies are needed in HP E And HP F
- No coverage for associates who are out for a extended period of time
- Parts in location are not being straighten during 5S

Root cause analysis

Problem: 5 S is not being performed at the end of the day

Why? Expectations not clear

Why? Individual feedback not provided

Why? No individual accountability

Root cause: Areas assigned by teams

TARGETS

- Establish individual accountability for 5S in HP E,F And K by January 5, 2004
- Incorporate 5S responsibilities into quarterly evaluations

PLAN

- Meet with STF associates (Troy and Cyndi)
- Add 5S key points to the binning and picking SOP
- Create a responsibilities chart for evaluation purpose
- Assign each associate a specific area for one quarter.
- Assign a P.M. associate to perform maintenance during 5S

Name: Kathy Canfield Area: Est,Est4 Temp. Reserve Loc

Responsibilities

- Sweep (As needed)
- Dust (As needed)
- Magnet Maintenance (Straighten)
- Location Maintenance (Straighten locations/check for damage/remove empty boxes/trash/debris)
- Notify/PM (Dave Rupel of shelves/dividers/grating in need of repair (note location)
- Change Mop Head (Once a month)

- Identify supplies needed for each area
- Distribute supplies equally throughout the areas
- Develop a code system for supplies for each of the areas
- Develop a evaluation scale
- Conduct a random 5S evaluations once a week for each area
- Develop a method for coverage when associates are out for a extended period of time

DO

ACTION	RESP	DATE
Assign each associate a specific area to 5S	TN KC TC KD	1/5/04
Assign PM associates to perform maintenance during 5S	VS	12/15/04
Create area charts for each associate	MT KC TN JB	12/30/04
Conduct random 5S evaluations for each associate's area	MT TN KC KD JB	1/6/04
Purchase additional supplies for 5S	DB	1/5/04
Code supplies by area - Distribute supplies equally for each HP	MT JB KC MT	1/13/04
Develop a coverage plan	Teams	
Add 5S key points to binning and picking SOPs in HP E,F and K	TN	1/6/04

CHECK

TARGET	RESULTS	EVAL
Establish individual accountability for 5S in HP E,F And K by January 5, 2004	Complete	O
Incorporate 5S responsibilities into quarterly evaluations	Complete	O

- PM associates (Dave and Shane) have been assigned and provided with the 5 S time to perform maintenance on carts and shelves
- Supplies have been color coded to insure that each rack will contain only the items that coordinate with the color on the rack

Associate Feedback

- Associates like specific responsibilities – know where to go
- Observed improvement in activity during Five S time
- Observed improvement in shelf dusting

Evaluation Summary

- Better time management – Five S up to bell
- Significant improvement in cleanliness

ACT

FUTURE ACTION	RESP	DATE
Continue to evaluate each associate weekly	TL	1/5/04
Develop coverage plan for associates who are out for a extended period of time	Teams	
Monitor 5 S throughout HP	GL/TL	
Revisit Five S evaluation process – determine Roles and Responsibilities between STF and TL/GL	GL/TL	

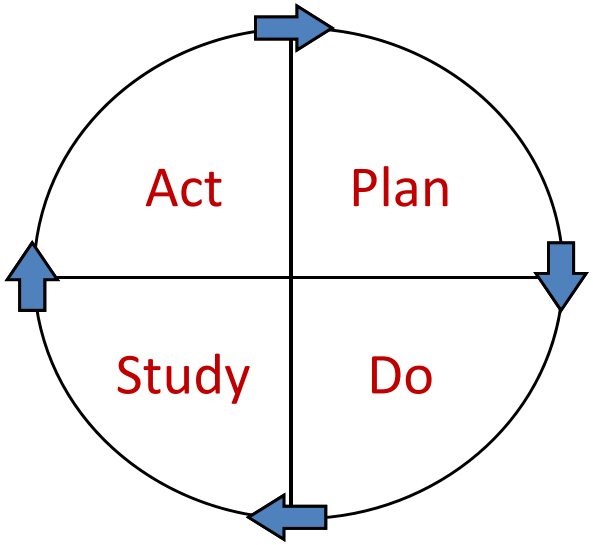
REFLECTIONS

- Good opportunity to advocate for associates – asked for specific responsibilities
- Good buy in from teams
- Experience as associates increased speed of project – 5 weeks to implementation
- 1st project completed as TLs

PDSA

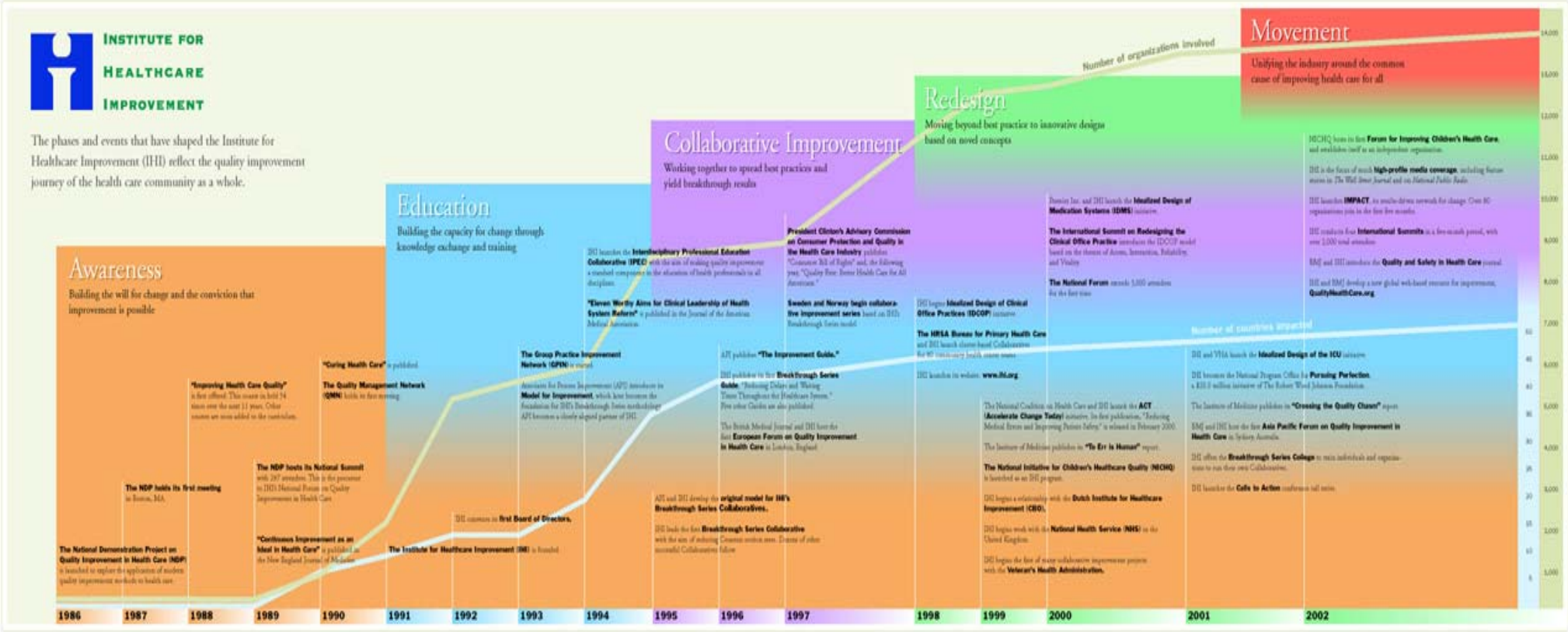
Institute for Healthcare Improvement

(A way to implement PDSA)



IHI growth & impact: 1986 - present

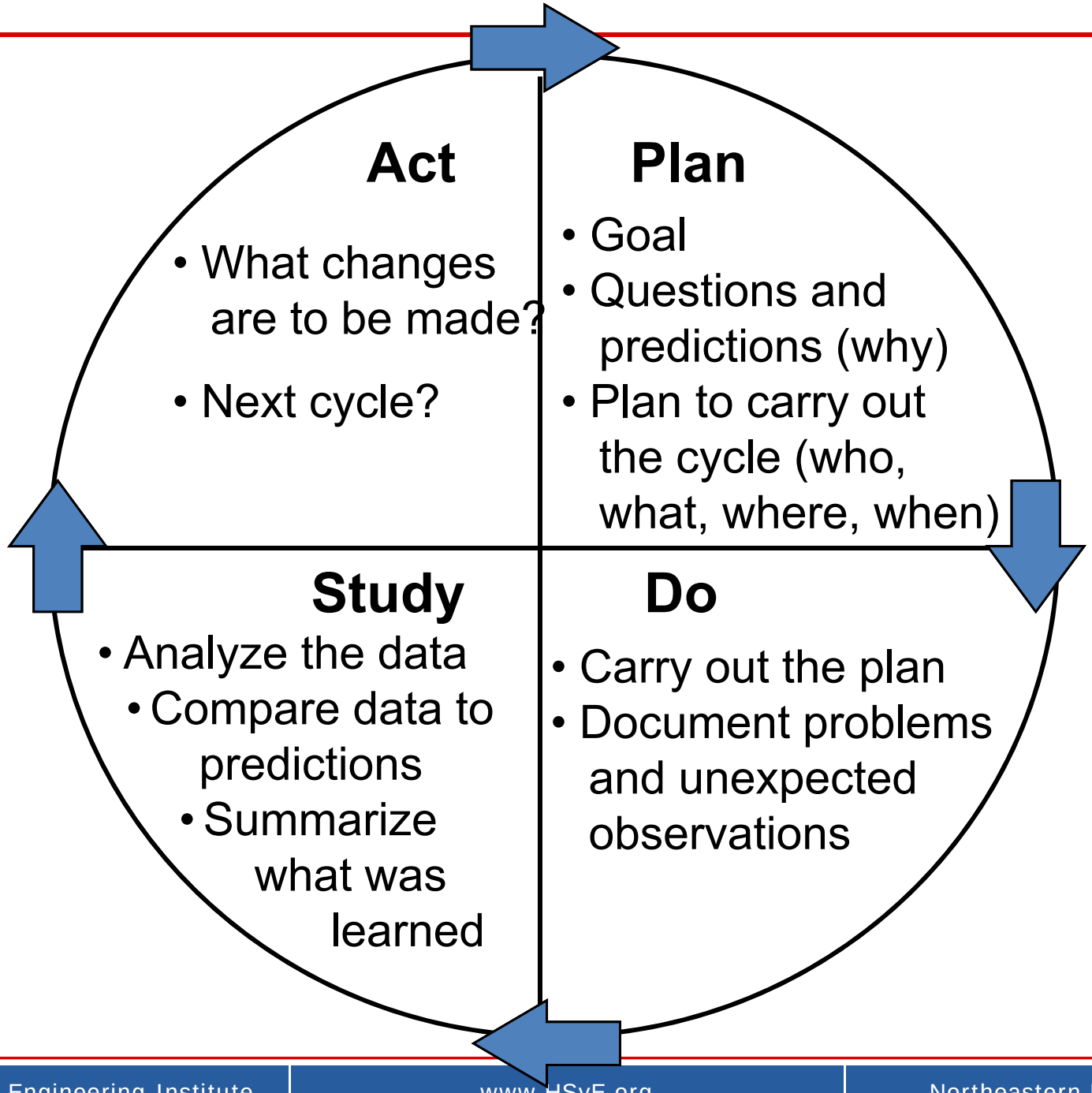
15,000 organizations. 50 countries



1986

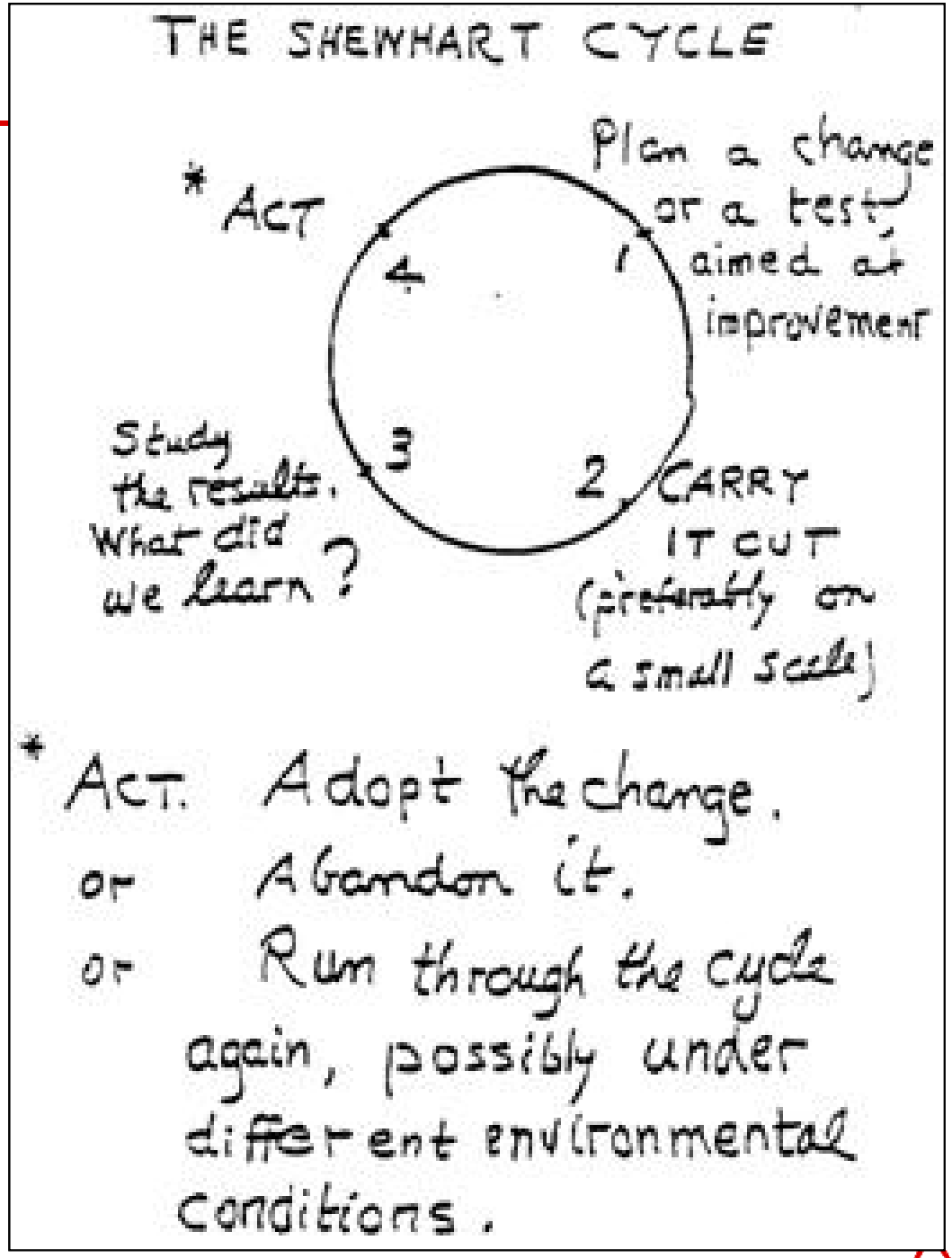
- Active in over 50 countries and 14,000 organizations worldwide
- *Modern Healthcare*: 3rd (2nd) most important person in health care
- E.F. Hutton of health care

Plan Do Check (Study) Act



Basic idea

- Plan
  (who, when, etc)
- Execute test
  ('do')
- Measures
  ('study')
- Refine, re-test
  ('act')



Planning deliberate tests

PDSA Worksheet for Testing Change

Aim: (overall goal you wish to achieve)

Plan

Every goal will require multiple smaller tests of change

Describe your first (or next) test of change:	Person responsible	When to be done	Where to be done

List the tasks needed to set up this test of change	Person responsible	When to be done	Where to be done

Predict what will happen when the test is carried out	Measures to determine if prediction succeeds

Do **Describe what actually happened when you ran the test**

Study **Describe the measured results and how they compared to the predictions**

Act **Describe what modifications to the plan will be made for the next cycle from what you learned**

Institute for Healthcare Improvement

CABG Example

PDSA Worksheet For Testing Design Changes

Aim: (Increase overall CABG condition to 10^{-2} within 6 months.) Give appropriate antibiotic within 1 hr before incision.

Every goal will require multiple smaller tests of change

Describe your first (or next) test of change	Person Responsible	When to be done	Where to do
Tomorrow, the surgeon will request the antibiotic in the operating room. The anesthesiologist will give it. The nurse will record it. Start with one surgeon and one patient and try it on one day.	Jake	Tuesday	OR

Plan

List the tasks needed to set up this test of change	Person Responsible	When to be done	Where to be done
1-Set up time to hold discussion with nurse, surgeon, anesthesiologist.	Jake	Tuesday	Holding Area
2- Hold discussion with nurse, surgeon, anesthesiologist	Jake	Tuesday	
3-Identify patient	Jake	Tuesday	
4-Inform floor/unit not to give antibiotic	Jake	Tuesday	
5-Notify a pharmacist	Jake	Tuesday	
6-Pharmacist will have antibiotic ready	Betty Boop	Tuesday	
7-Set up measurement system (satisfaction survey)	Jake	Tuesday	
8-Set up huddle to occur same day of test	Jake	Tuesday	

Predict what will happen when the test is carried out	Measures to determine if prediction succeeds
1-Will succeed	1-Yes or No
2-Pharmacist unable to deliver dose on time	2-Yes or No
3-Anesthesia uable to deliver dose on time	3-Yes or No
4-Pre selected incorrect antibiotic	4-Yes or No
5-Dispute on correct antibiotic to administer	5-Decided at huddle

Do

Describe what actually happened when you ran the test

Study

Describe the measured results and how they compared to the predictions

Act

Describe what modifications to the plan will be made for the next cycle from what you learned

Our PDSA planning form

PDSA #1		PDSA #2	
Plan preparation	Baselines: Materials: Schedules:	**Plan** preparation	Baselines: Materials: Schedules:
Do execution	Who: When: Duration:	**Do** execution	Who: When: Duration:
Study analysis	Data Qualitative: Quantitative:	**Study** analysis	Data Qualitative: Quantitative:
Act based on results	If successful: If not:	**Act** based on results	If successful: If not:
Checklist ☐ Achievable ≤ 7 days ☐ Not possible on smaller scale		Checklist ☐ Achievable ≤ 14 days ☐ Not possible on smaller scale	

"IHI Improvement Model"

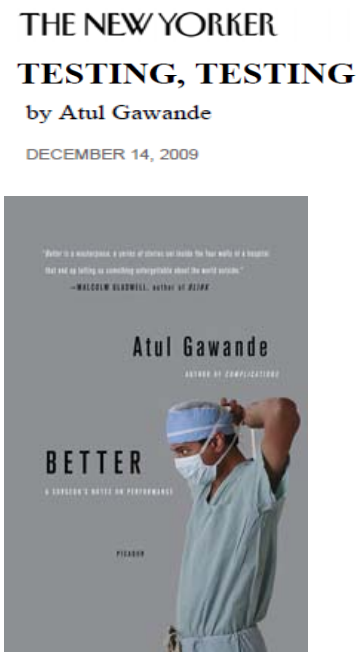
(aka, "Improvement Science")

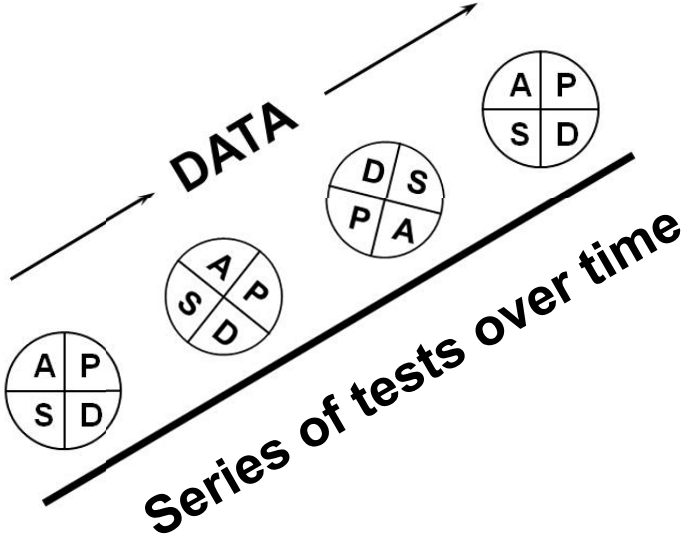
- 3 motivating questions
- Repeated PDSA learning cycles
- Rapid cycle testing/learning
- 'Poor man's' scientific method

Aim

Measures

Changes

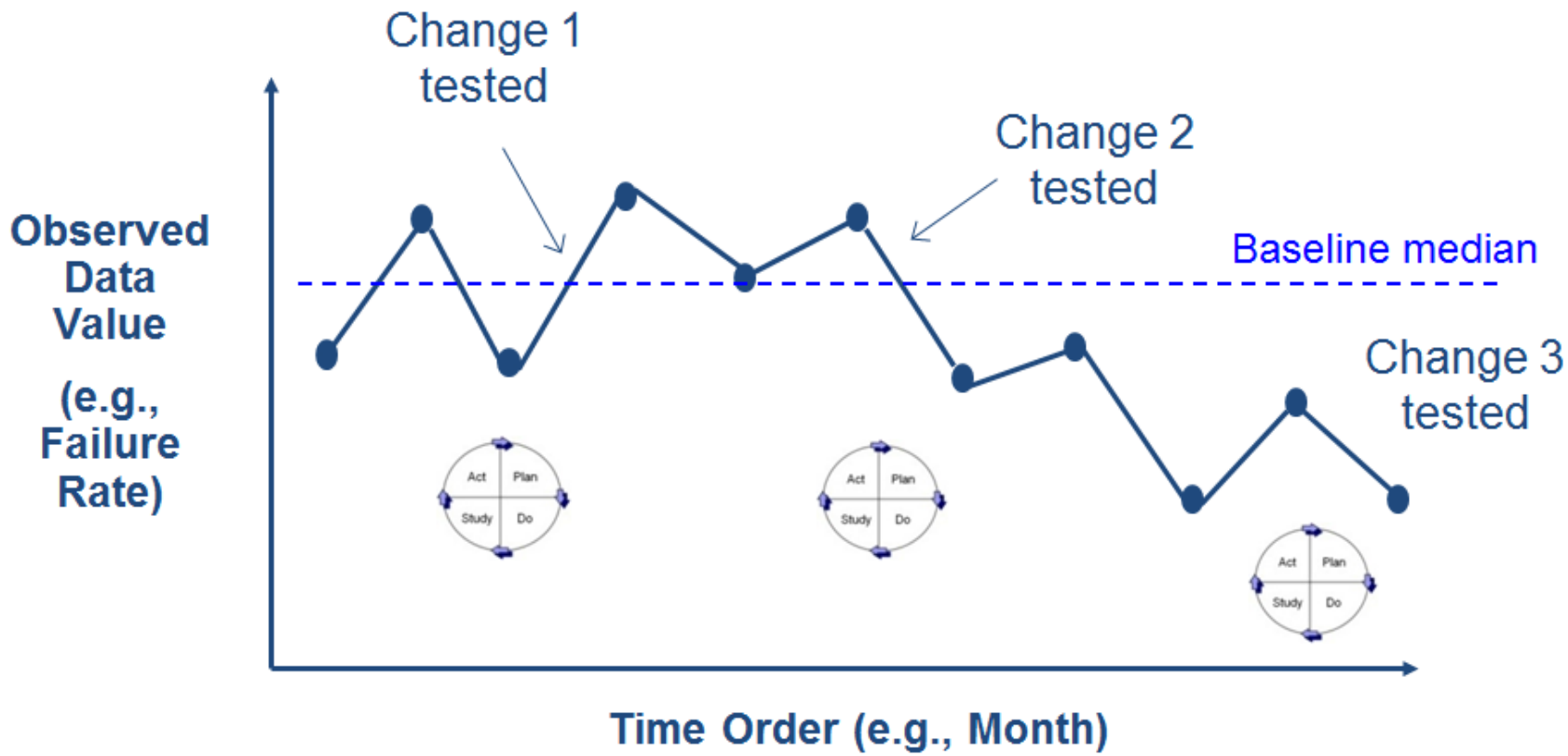




3 motivating questions

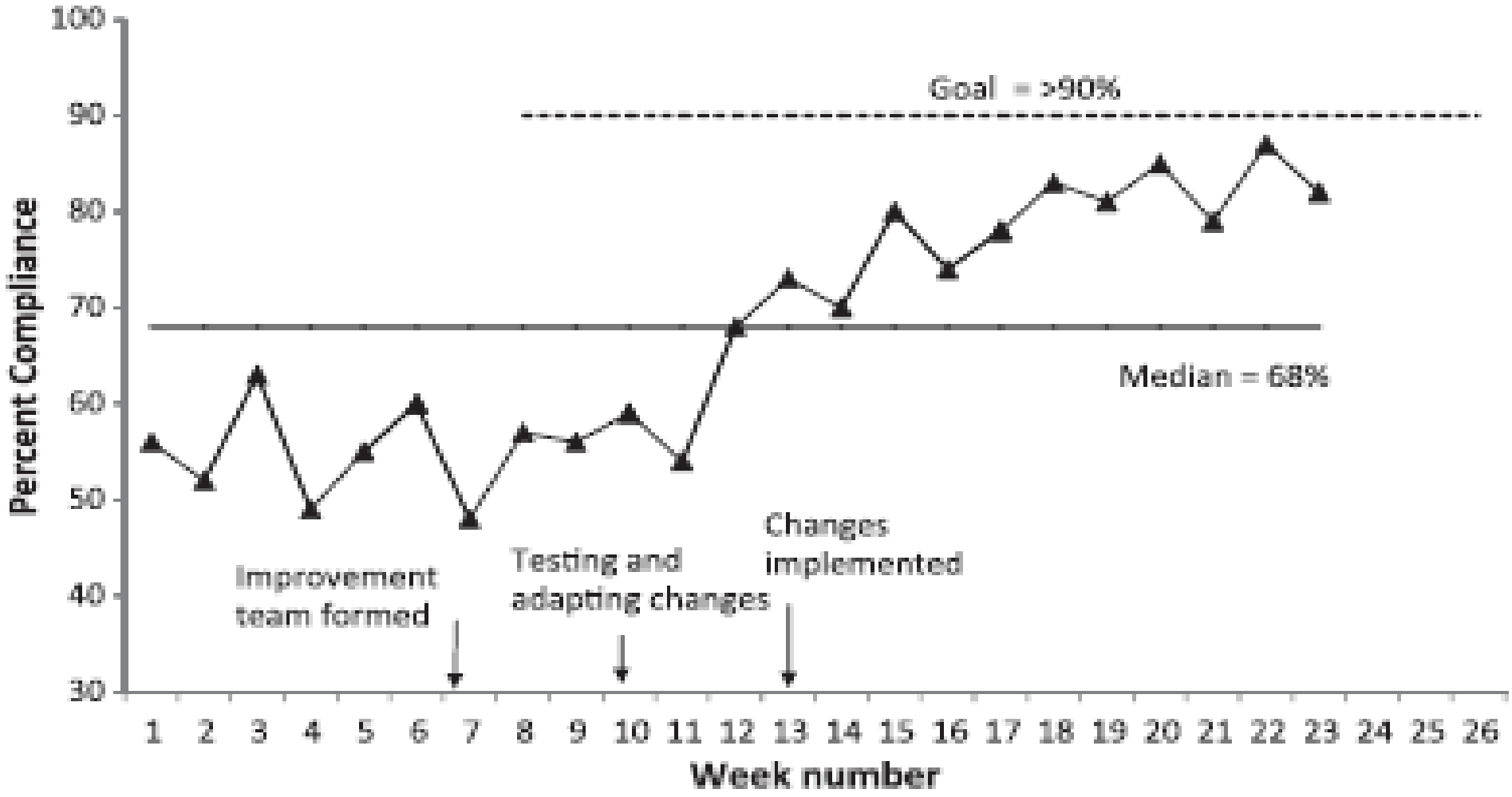
Question	Explanation	Example
1. What are we trying to accomplish?	- Guides and focuses improvement effort. - Includes a specific measurable goal and timeline.	Reduce surgical site infection rate in OR to .05 (10^{-1}) in the next 6 months
2. How will we know a design change is an improvement?	- Measures used to test design changes - Outcome, process, & balancing measures	- SSI rate - Percent receiving appropriate prophylaxis - Time / effort required
3. What deliberate designs can we test that may result in improvement?	Use 3-tier model to develop specific ideas Test using PDSA model	- Antibiotic guidelines (standardization) - Reminder system - Etc

Measuring improvement - Run charts

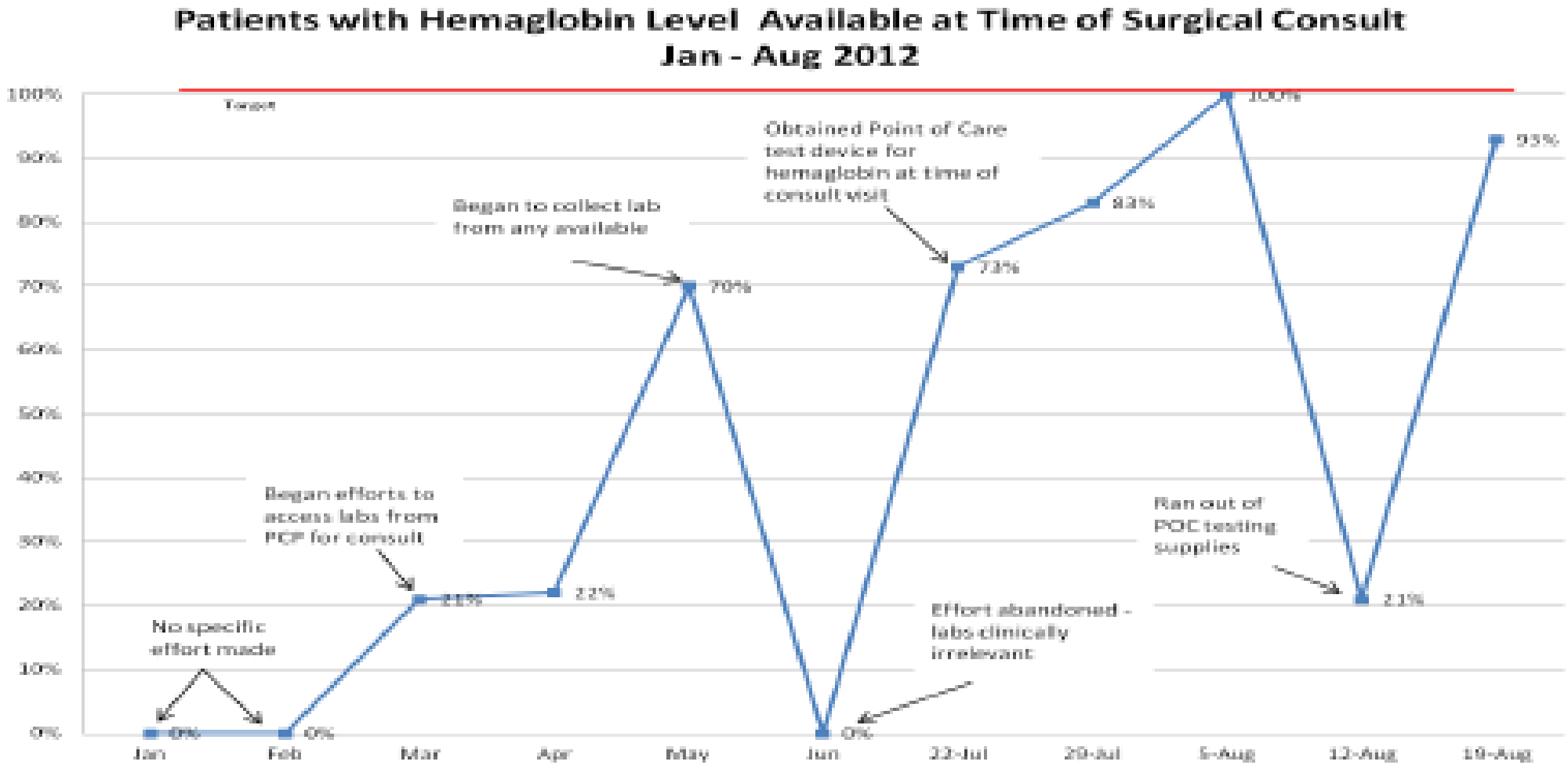


- Visual display of data over time, annotated
- Test if/not changes "result" in improvement

Annotated run chart - Example



Second example



Providence

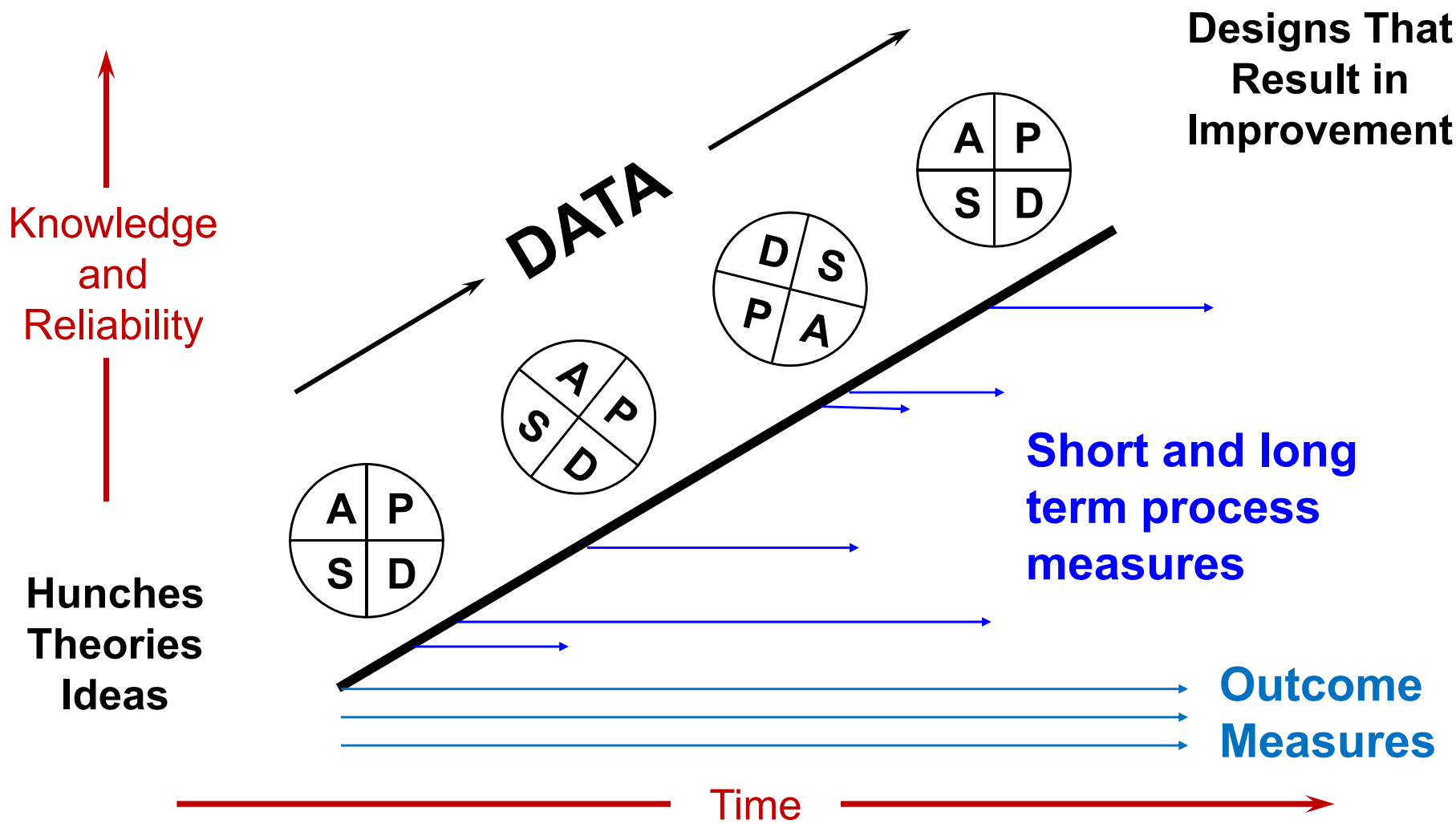
Putting it into practice

- Starting small (smallest 1st test as possible)
- Linked tests over time
- Highly iterative. (Number tests = PI measure)
- Building knowledge, culture, comfort, degree of belief, support, learning
- Testing across contexts, settings, days
- Improvement advisor (IA) coaching role

Small multiple tests - why

- Rapid small tests accelerate learning and improvement
- Start with smallest possible test
  - "one afternoon, one doc, one type of patient, etc"
- Learn what works and what does not
- Learn how to make process robust
  - Test in multiple environments
  - 2nd doc, 2nd shift, 2nd department, weekends, etc

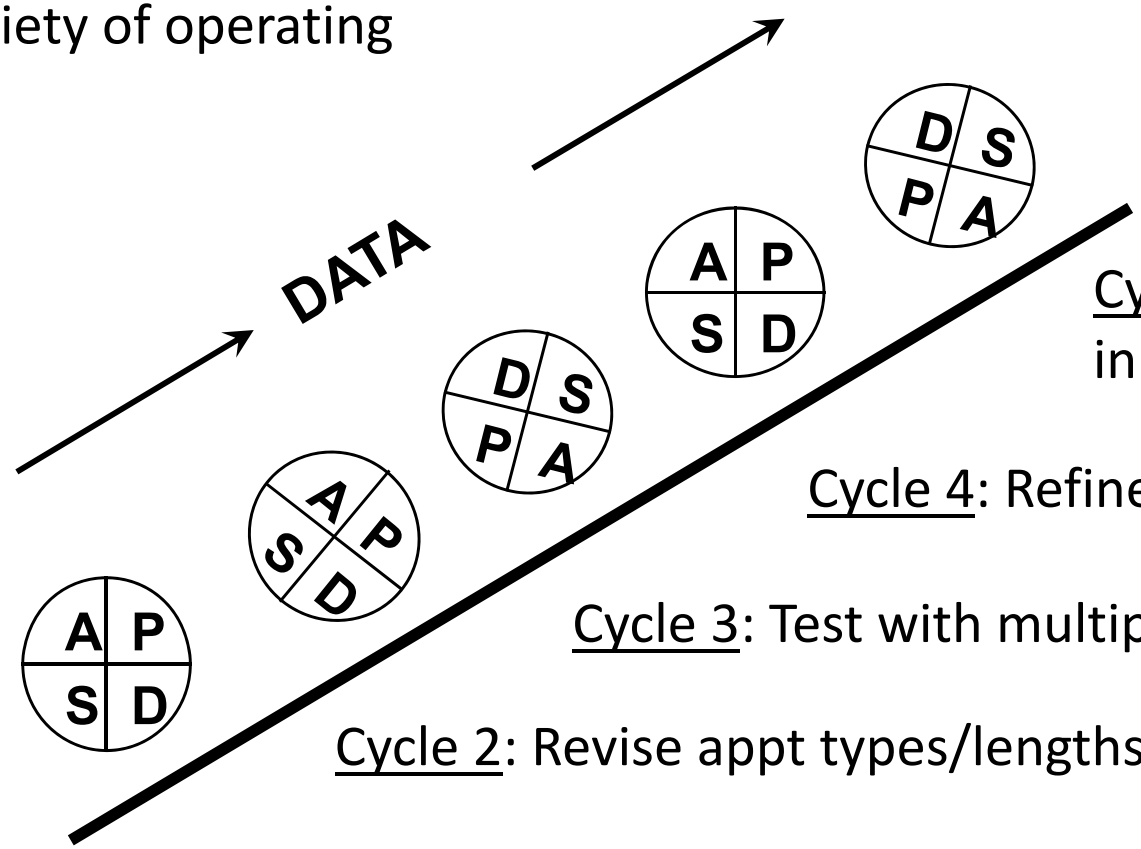
Multiple testing context



Example (appointment access)

Approach: Multiple (rapid cycle) tests and refinements of change across a variety of operating conditions

Improved appointment access / satisfaction



Cycle 5: Test robustness in other depts, refine

Cycle 4: Refine, test dept-wide

Cycle 3: Test with multiple docs/days

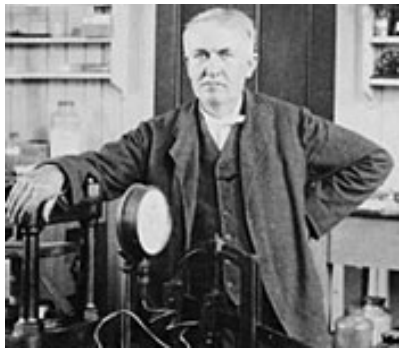
Cycle 2: Revise appt types/lengths based on learning

Cycle 1: Test a small number of appt types in 1 dept/doc

Hypothesis: Reduction of appointment types will increase appointment availability

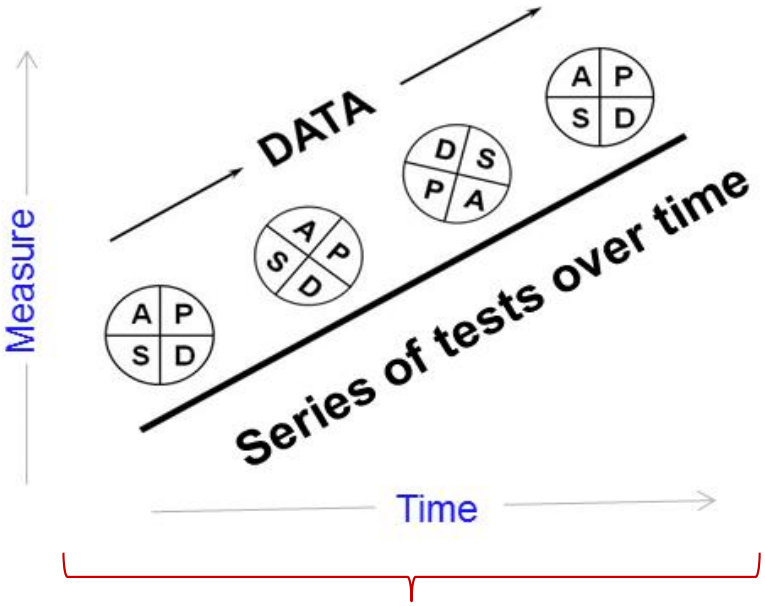
Useful quotes / ideas

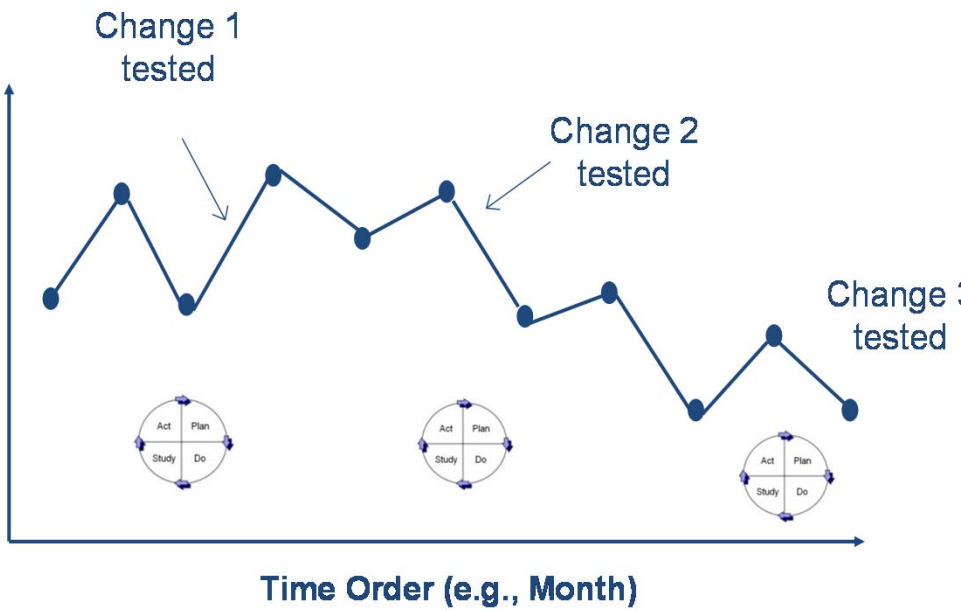
- ‘All processes are optimally designed to get exactly the results they produce’
- ‘The definition of insanity is doing the same thing and expecting different outcomes’
- ‘All improvement requires change, not all change leads to improvement’
- ‘What can you test by next Tuesday?’
- ‘All failed tests are successes’ (learning)
- ‘Good enough data for learning and improvement’
- ‘Improvement soon vs slow perfection’



(WHY REPEATED TESTS)

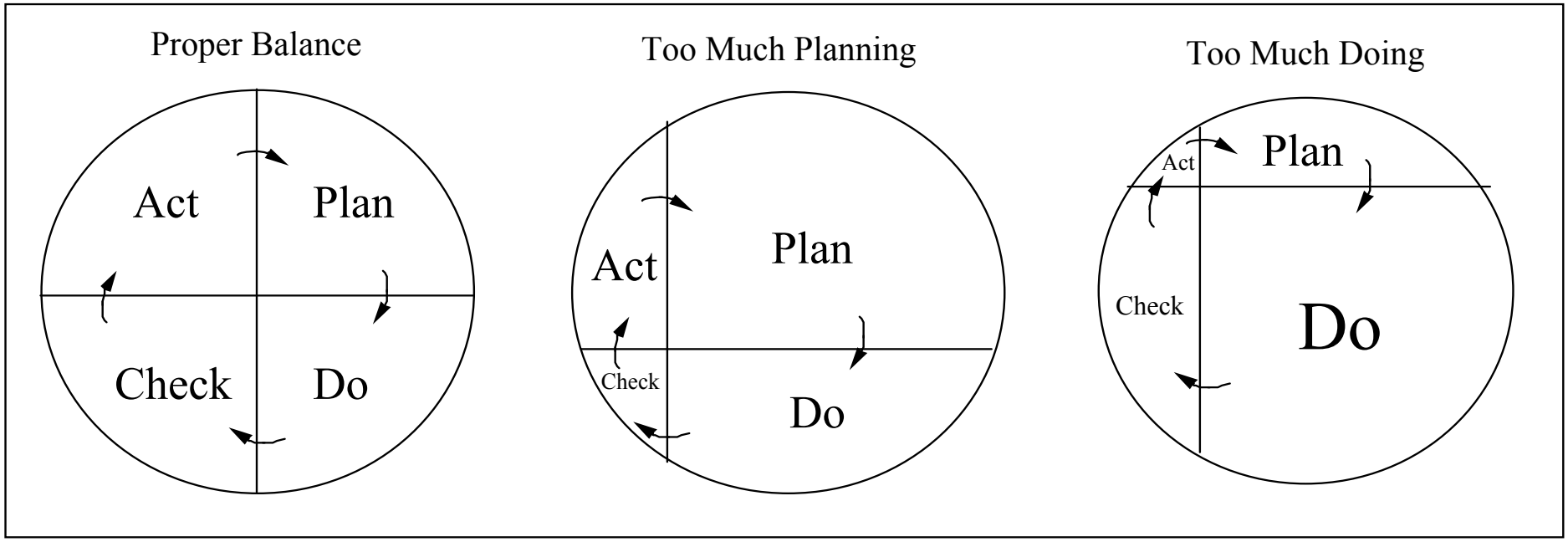
"All improvement requires change,
But not all changes result in improvement"





"All improvement is local"

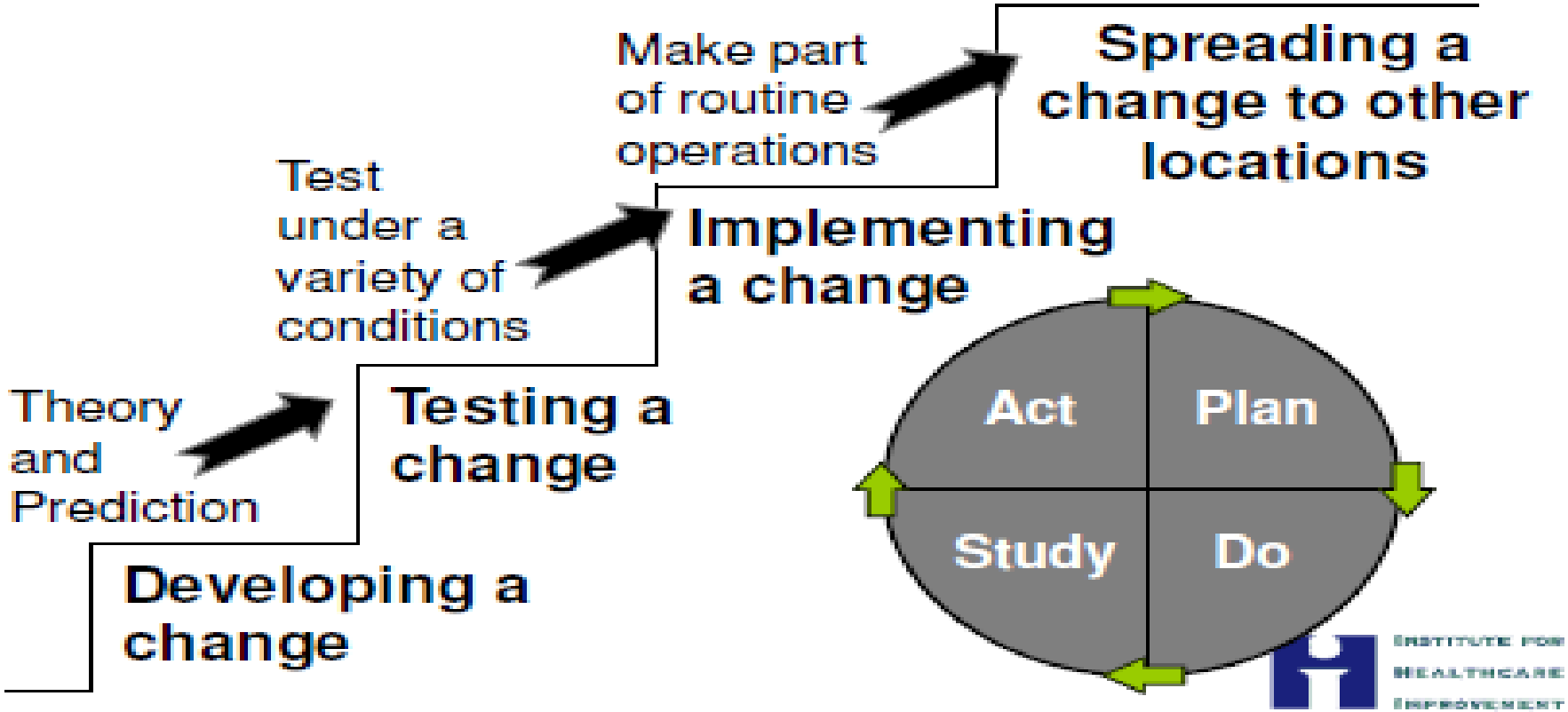
Balanced PDSA's = Actual tests



<u>Pitfalls</u>

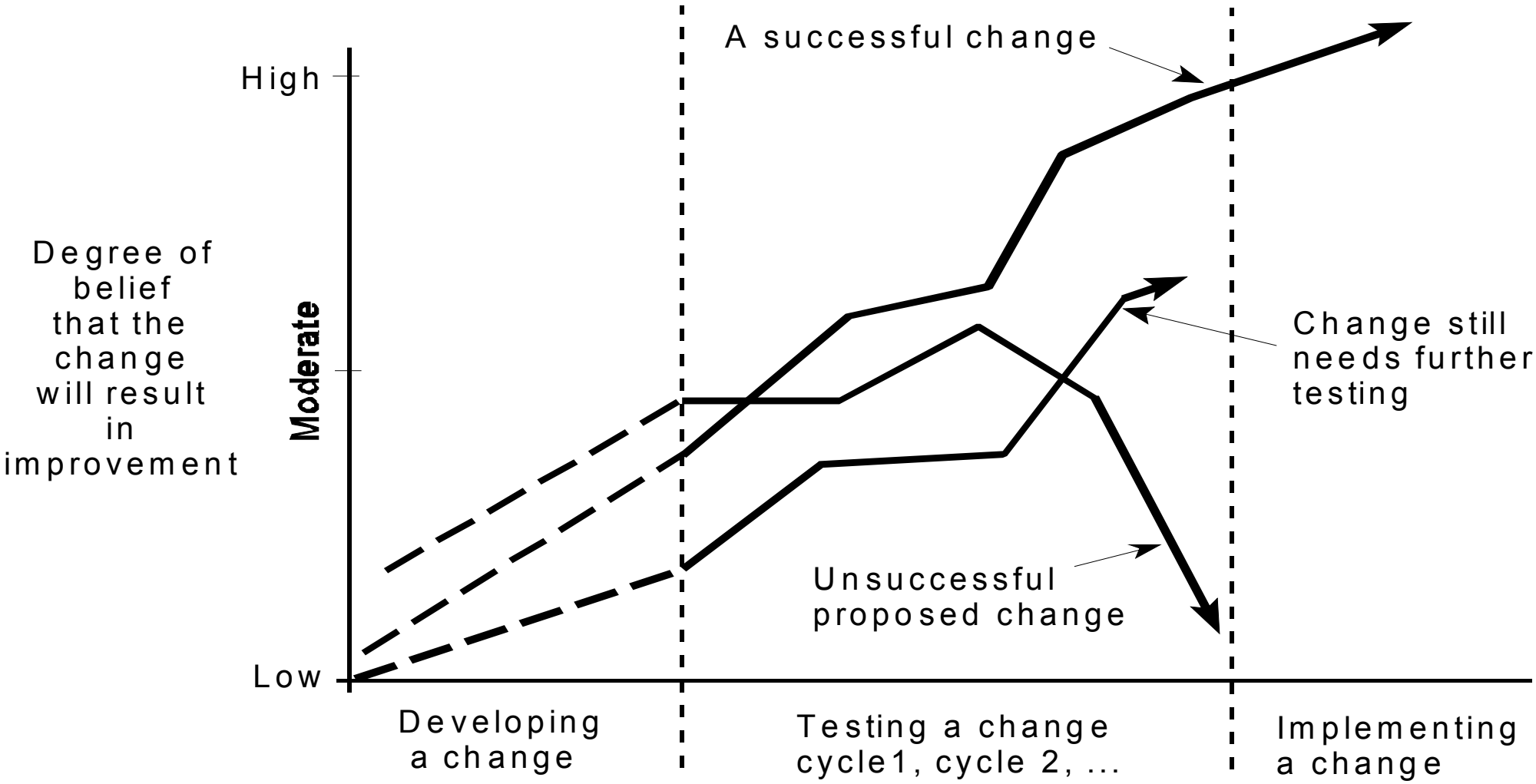
- PDCA ≠ Please don't change anything
- Killer syndromes and epidemics: Perpetual meeting syndrome, perpetual analysis syndrome, and perpetual modeling syndrome

Size and duration of tests



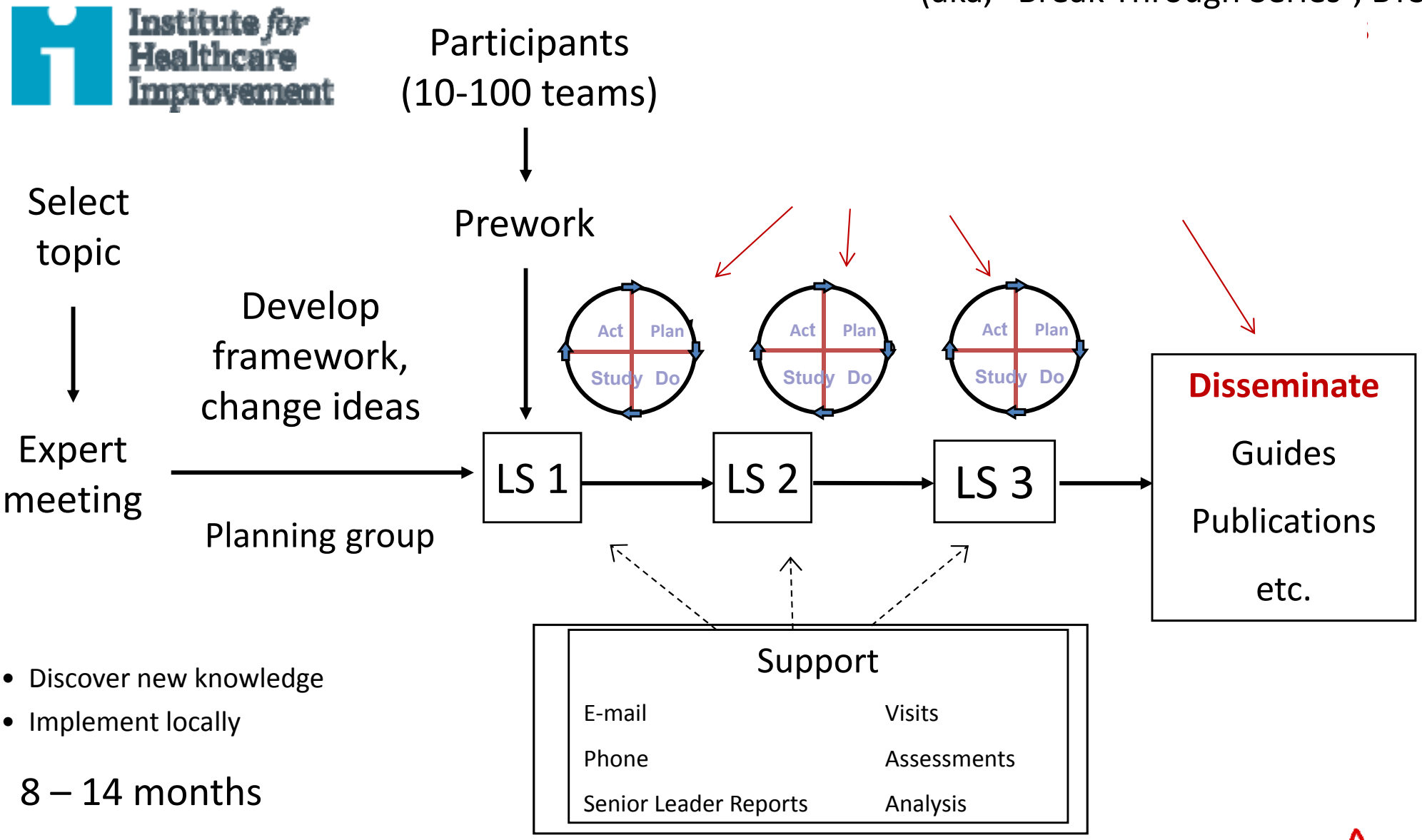
Size:	Small	Medium	Large
Purpose:	Learning	Evidence	Impact

Degree of belief



Collaborative improvement approach

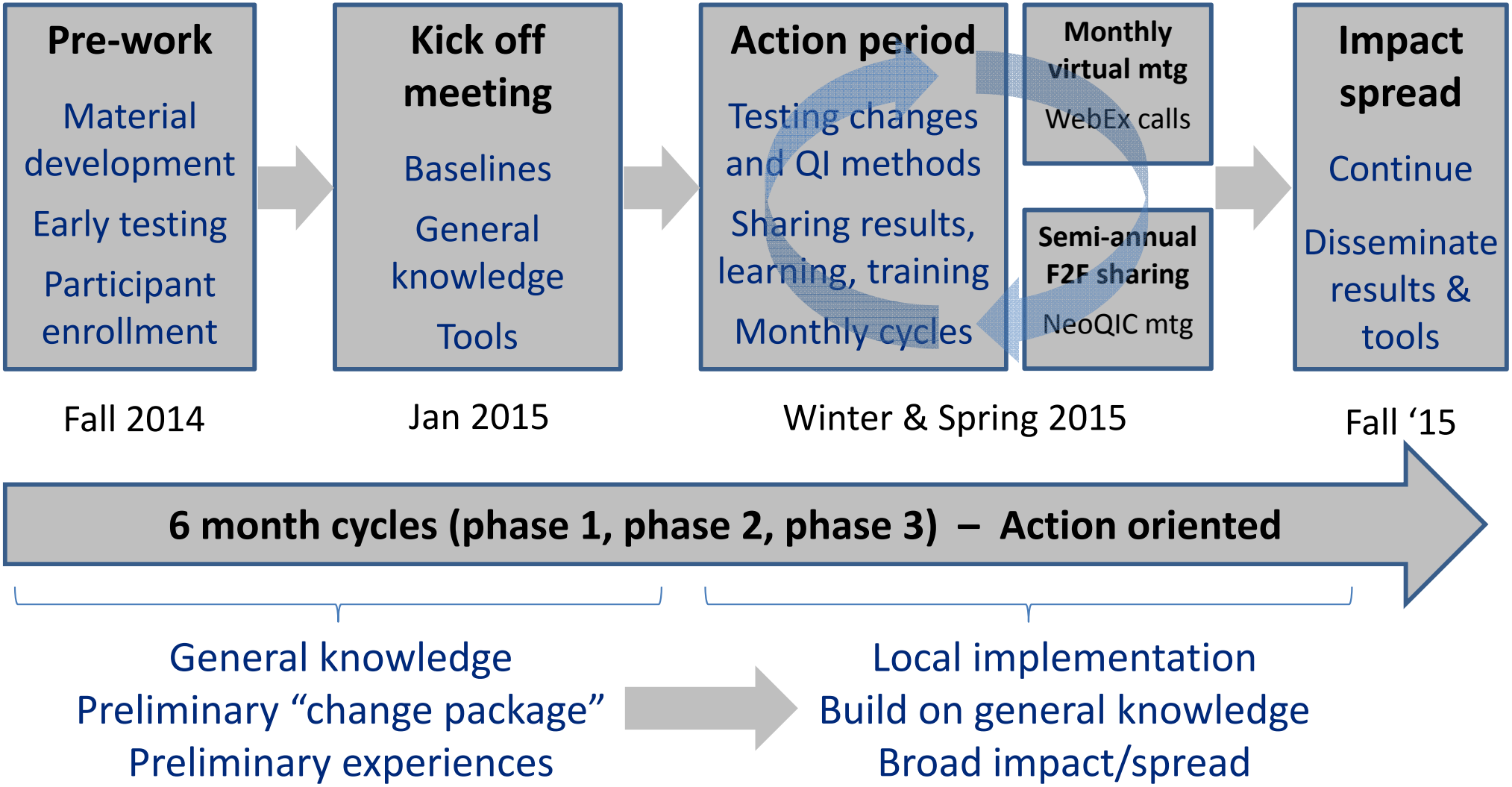
(aka, "Break Through Series", BTS)



- Discover new knowledge
- Implement locally

8 – 14 months

General collaborative approach



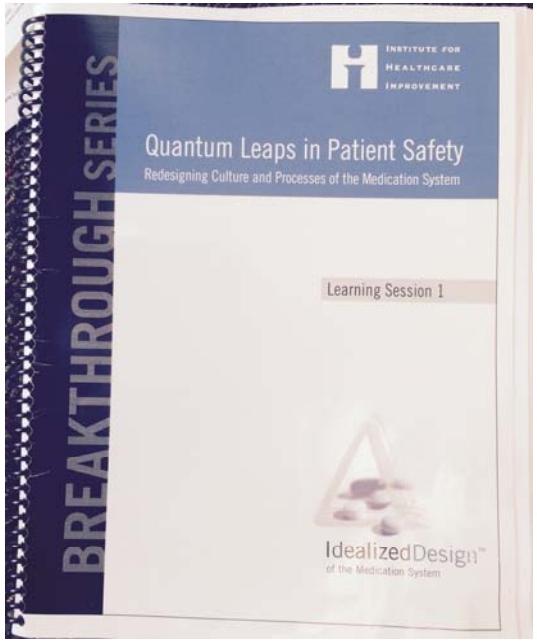
General knowledge
Preliminary "change package"
Preliminary experiences

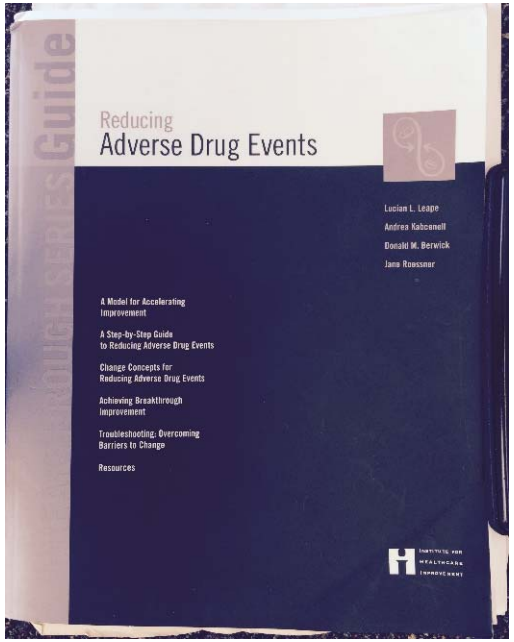
Local implementation
Build on general knowledge
Broad impact/spread

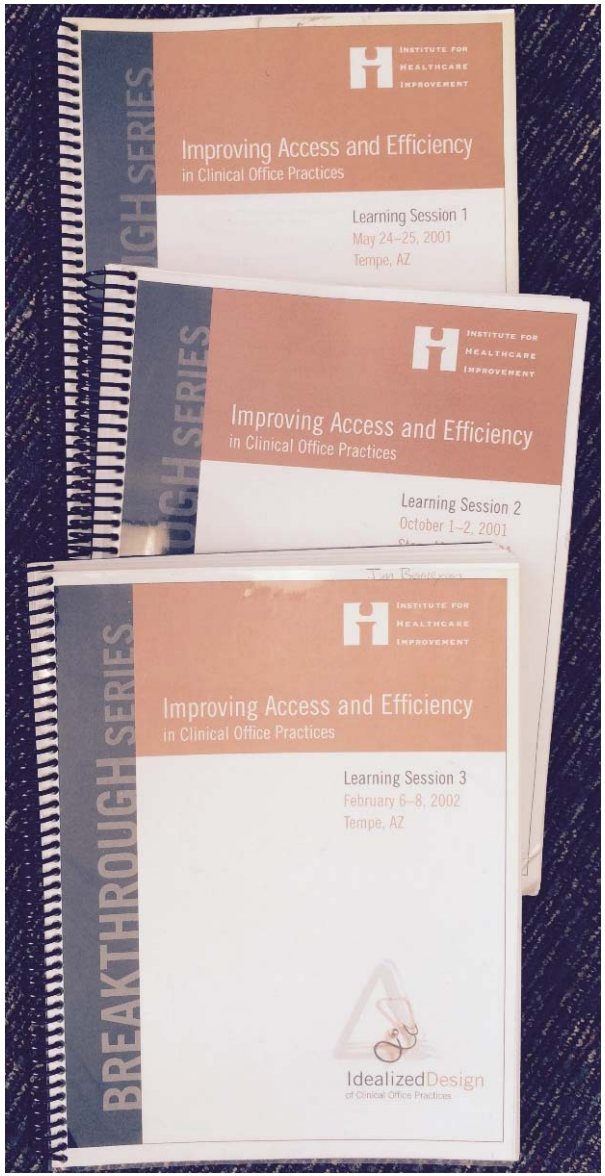
All improvement requires change… testing testing testing…

Examples

- Patient safety, Readmissions (∞)
- Flow and delays
- Specialty care access
- Pain management
- Dozens others







100,000 Lives Campaign

- **Campaign sense of urgency**
- **Save 100,000 lives by 6/14/06 (9 am EST)**
- **Focus on six areas:**
  - Adverse drug events (2k)
  - Surgical site infection (8k)
  - Myocardial infarction (10k)
  - Ventilator pneumonia (10k)
  - Central line infection (10k)
  - Rapid response teams (60k)

- **Over 3,200 U.S. hospitals participating**
- **90% of acute care beds**
- **Accomplish via 'bundles' of proven interventions**

100k *lives* Campaign

SOME IS NOT A NUMBER. SOON IS NOT A TIME.

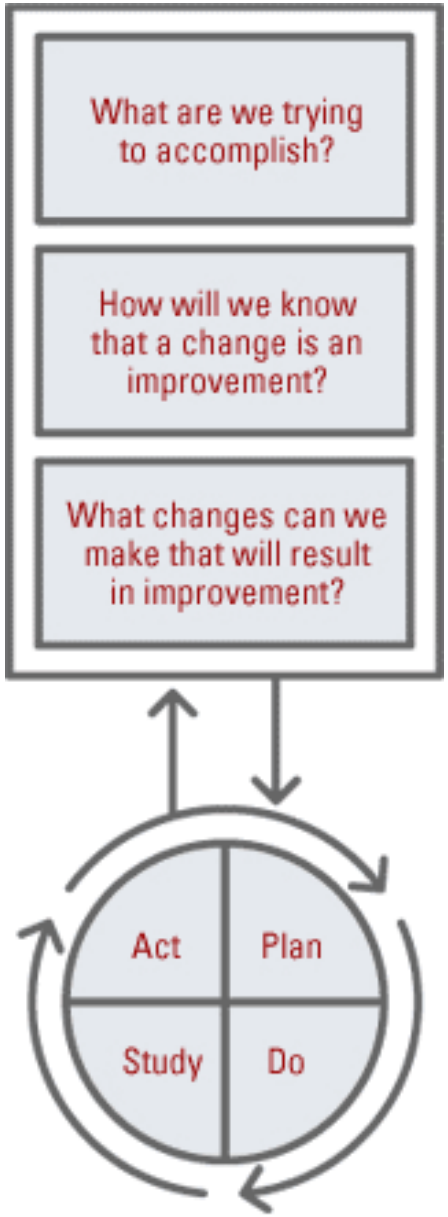
recap

Putting it all together

 © 2012

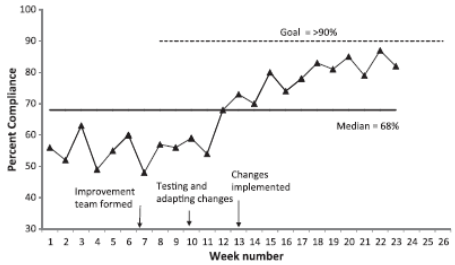
Recap - putting it all together

S specific
M measurable
A action oriented
R realistic
T timeline

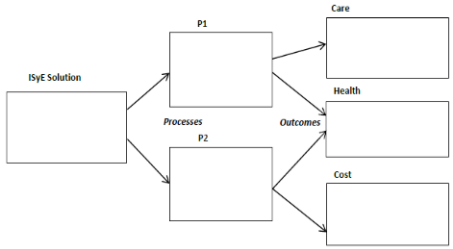


Specific aims

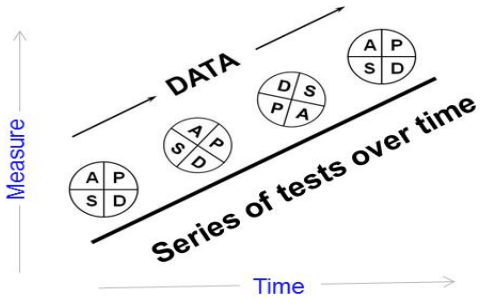
Run and control charts



Driver diagram



Repeated testing, sharing, and co-learning



Zen of Improvement Science

1. "Rapid cycle testing" is rapid (1 per week)
2. QI projects < 6 months
3. First focus on adapting known knowledge, then on discovering new improvements
4. Measure and test locally, with near immediate feedback and evaluation
   - Fast manual > slow electronic data
   - 'Good enough' > slow perfect data
5. Linked PDSAs (≥ 6 in ≤ 3 months)

Discussion

www.hsye.org

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