Process Improvement in Radiation Oncology

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Why Process Improvement?

A strategy, philosophy, process and leadership approach for operating in a superior way. Results include:

- **Quality**
- **Patient safety**
- **Patient and Employee Satisfaction**
- **Patient flow**
- **Efficiency**

Background
Errors in Radiation Oncology

- **Staff and public exposures**
- **Misadministrations**
  - **Underdose**
  - **Overdose**
  - **Anatomical misses**
- **Magnitude**
  - **From few percent to lethal doses**
  - **From couple of millimeters to complete misses**
- **Regulatory**
  - **Nuclear Regulatory Commission**
  - **Errors that do not necessarily affect patients but have regulatory/legal consequences**
- **Sources**
  - **Staff**
  - **Software**
  - **Hardware**
- **Random**
  - **Affect one to few patients**
- **Systematic**
  - **Affect hundreds of patients**
  - **Potentially in a short period**

Background
Our Environment

- **Diverse patient population**
- **Diverse technology**
- **Diverse procedures**
  - **Multiple and drastically different ways to treat a single cancer site**
- **Enabling culture – Very few limits**
  - **Number of patients**
  - **Procedures**
  - **Complexity**
  - **etc.**

Background
Global Problem

"…it calls into question the integrity of hospital systems and their ability to pick up errors and the capability to make sustainable changes."

Sir Liam Donaldson, Chief Medical Officer, Department of Health

Towards Safer Radiotherapy. London: The Royal College of Radiologists, 2008.

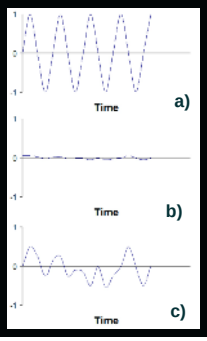
Radiotherapy Risk Profile, Geneva: World Health Organization, 2009.

System Performance

a) The demands on our operations continually change
   - Patient numbers
   - Available staff
   - Available machines

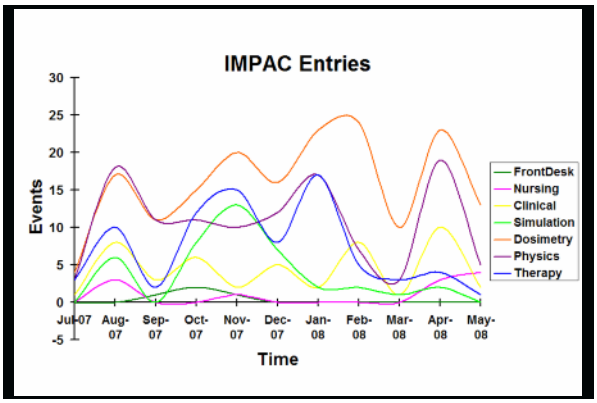
b) Well designed systems maintain constant performance

c) Poorly designed systems cannot cope with these changes



Stable System

- To achieve stable performance, a change in one system parameter must be compensated for by changes in other parameters in a timely fashion
  - This change has to be proportional and correctly directed
  - Must remain in a state where changes are expected
  - Bad things may not happen for a long time



Process Improvement

A systematic approach to improve the outcomes to meet the customer requirements.

- **Identify the *Process* *requirements* (Define)**
- **Review the *outcomes* (Measure)**
- **Identify the *opportunities* for Improvement (Analyze)**
- **Improve the process**
- **Control the process: Sustain the Improvement**

Everything that we do is a "Process"

Process Improvement Tools

- Define
  - Process flow chart
  - Pareto Chart
  - FMEA
- Measure
  - Trend Chart
  - Statistical Process
  - Control charts
- Analyze
  - Fishbone Diagram
  - Histogram
  - 5-Why analysis
- Improve
  - Brainstorming
  - Error proofing
- Control
  - Control Plan
  - 5S
  - FMEA

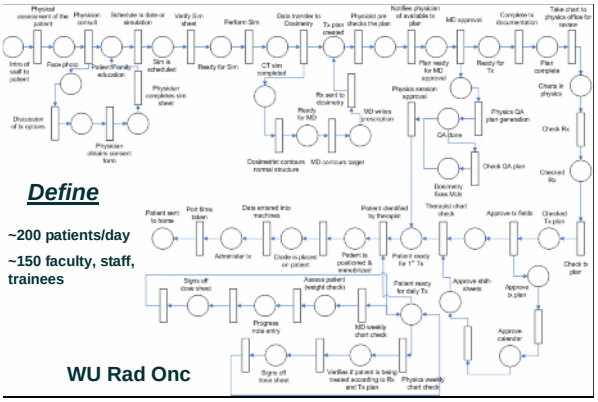
Lean, Six Sigma, Theory of Constraints

DEFINE

We can do this very well

Petri Nets

- **Petri net is a graphical tool for describing and studying systems that are concurrent, parallel, distributed and stochastic**
- **A Petri Net consists of four components**
  - ***Place*, drawn as a *circle*, denoting event**
  - ***Transition*, drawn as a *thick bar*, denoting event transfer with a period of delay time**
  - **Arcs, drawn as arrow, connecting places and transitions**
  - **Token, drawn as a dot, contained in places denoting the data**



Define

~200 patients/day

~150 faculty, staff, trainees

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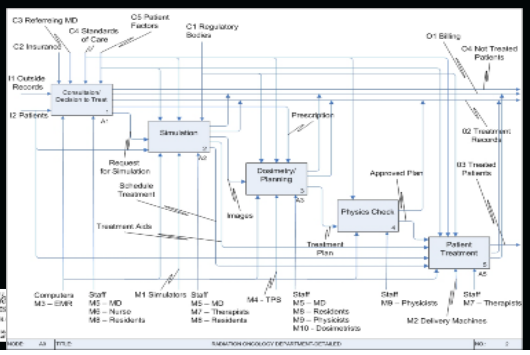
IDEF$_0$

- **Developed on an initiative by the US Air Force**
- **Method to model activities of an organization or a system**
  - **Inputs**
  - **Outputs**
  - **Controls**
  - **Mechanisms**
- **Model starts at the highest level and can describe activities and processes down to the smallest steps**

Define - Radiation Oncology Process



MEASURE

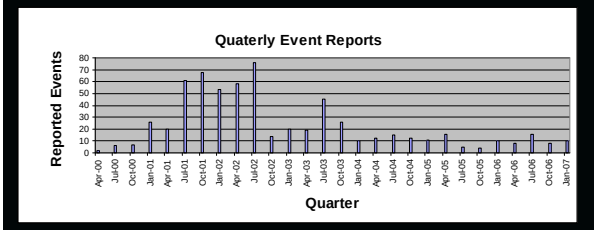
Still learning how to do this

Quantifying Event Rates

- We have developed a ***voluntary*** electronic reporting and analysis system
- Potential and actual events (near hits and errors) are tracked
- Track explicit and random errors
- Use the data to feed the process improvement for our department and potentially for other institutions

TH-D-BRD-3 – Mutic – Experience with error reporting and tracking database tool for process improvement in radiation oncology

Quantify - Historical Data

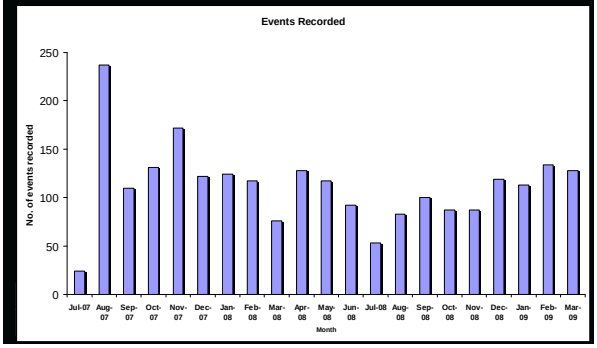


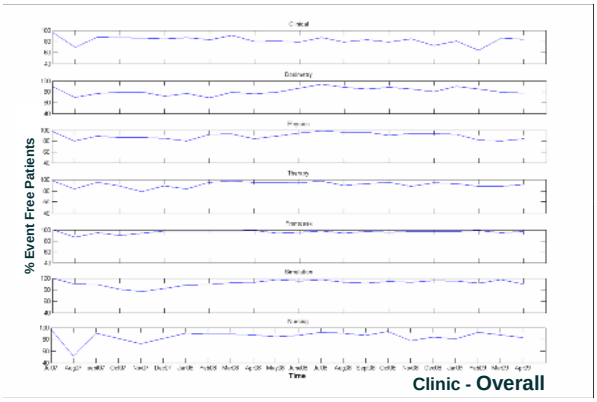
Small to Sentinel Events

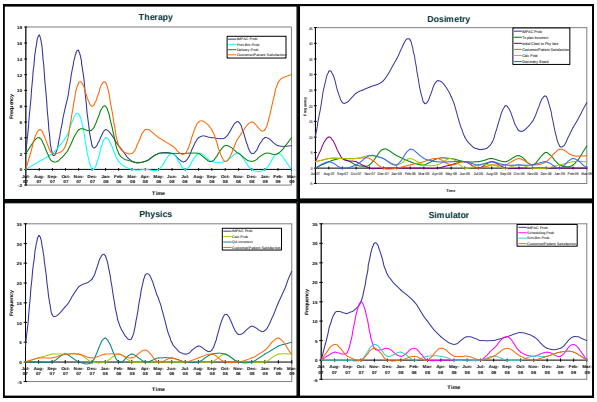
"We know that single events are rare, but we do not know how small events can become chained together so that they result in a disastrous outcome. In the absence of this understanding, people must wait until some crisis actually occurs before they can diagnose a problem, rather than be in a position to detect a potential problem before it emerges. To anticipate and forestall disasters is to understand regulations in the ways small events can combine to have disproportionally large effects."

K.E. Weick, "The vulnerable system: an analysis of the Tenerife air disaster" in P.J. Forst *et al* Reframing Organizational Culture

Our Current Data



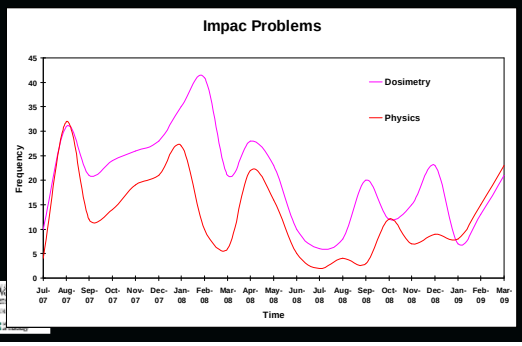




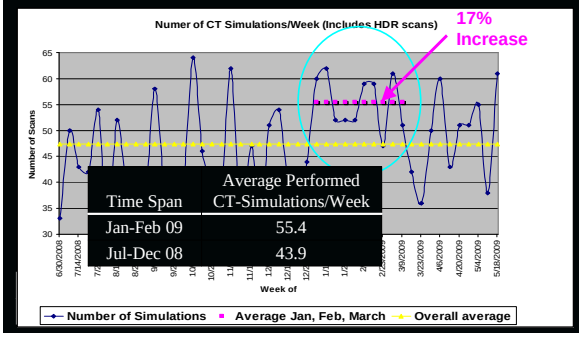
ANALYZE

Still learning how to do this

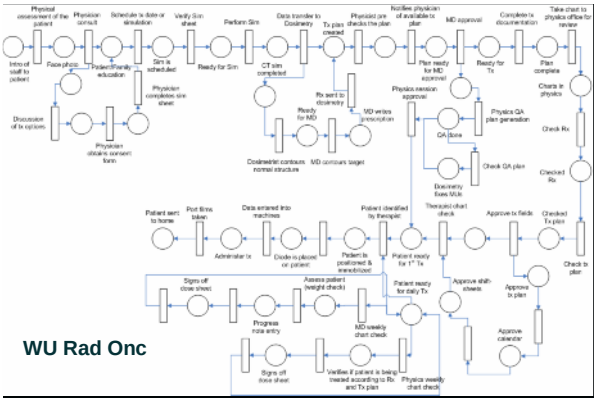
Why Fluctuations?



Why Fluctuations?

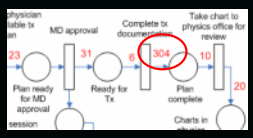


Time Span	Average Performed CT-Simulations/Week
Jan-Feb 09	55.4
Jul-Dec 08	43.9

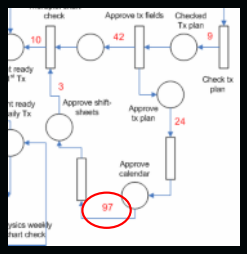


WU Rad Onc

Our Data



Dosimetry



Physics

Facilitates Critical Point Checklists

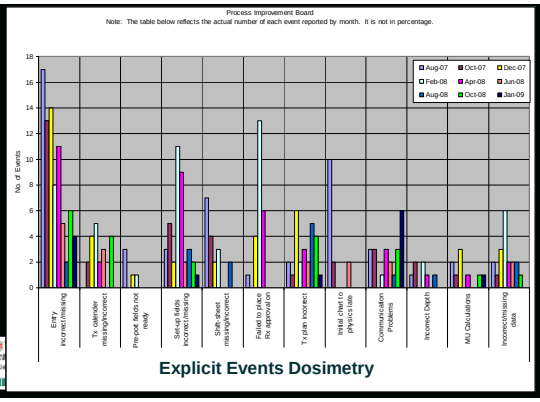
Correlation Data

	Clinical	Dosimetry	Nursing	Physics	Therapy	Front Desk	Simulation
Clinical		0.0765	0.39	0.31	0.32	0.26	0.00
Dosimetry			0.37	0.66	0.31	0.32	0.62
Nursing				0.47	0.80	0.72	0.40
Physics					0.51	0.49	0.48
Therapy						0.83	0.55
Front Desk							0.38
Simulation							

Factor	Correlation
0.1-0.3	Small
0.3-0.6	Medium
0.6-1.0	Large

IMPROVE

Becoming much better at this



Explicit Events Dosimetry

IMPROVE

R&V Related Events

The downside to the electronic world
As implemented today

- **Record and Verify (R&V) system was originally designed to operate as an independent system (Big Brother)**
- **Today these systems are integral part of the delivery process and the independent verification process is missing**
- **If data in the R&V system is wrong there is much less opportunity and chance that the error may be discovered**

Possible Solution

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Radiation therapy plan checks in a paperless clinic

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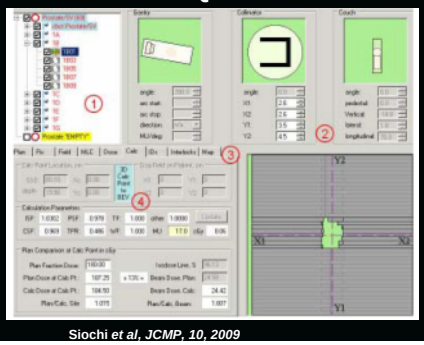
- Electronic QA system (EQS)
- Independent system which compares TPS data with the data in the R&V system
- Greatly improves ability to compare initial data transfer and consistency of data in the R&V

EQS



Siochi *et al, JCMP, 10, 2009*

EQS

- Parameters that can be checked electronically
  - Plan quality and merits
  - Plan parameters
  - Data transfer
  - Ongoing data integrity
  - Weekly chart checks
- Still need manual process as the final check

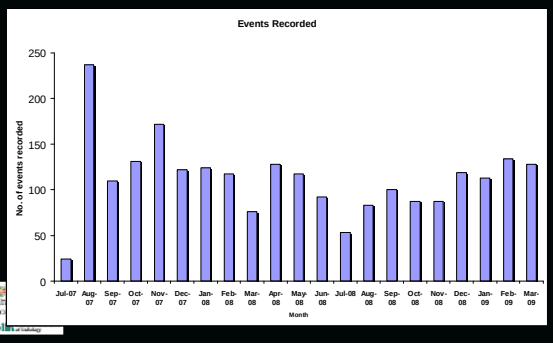
EQS

- An independent system
- Meant to complement the electronic process and enhance patient safety
- Not intended as the only check
- The greatest benefit in pointing out potential problems

Sustain

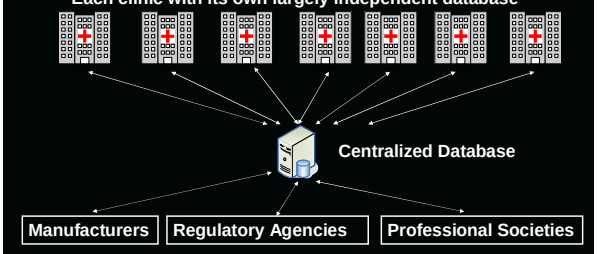
Great culture, need better feedback process

Issue of Reporting Fatigue



Software Distribution and Data Collection

Each clinic with its own largely independent database



Conclusions

- Ability to define radiation oncology processes is very good
- Sustainable data collection possible
- Need to collect broader parameters to determine failure triggers
- Electronic processes could facilitate standardization among institutions and benchmarking