

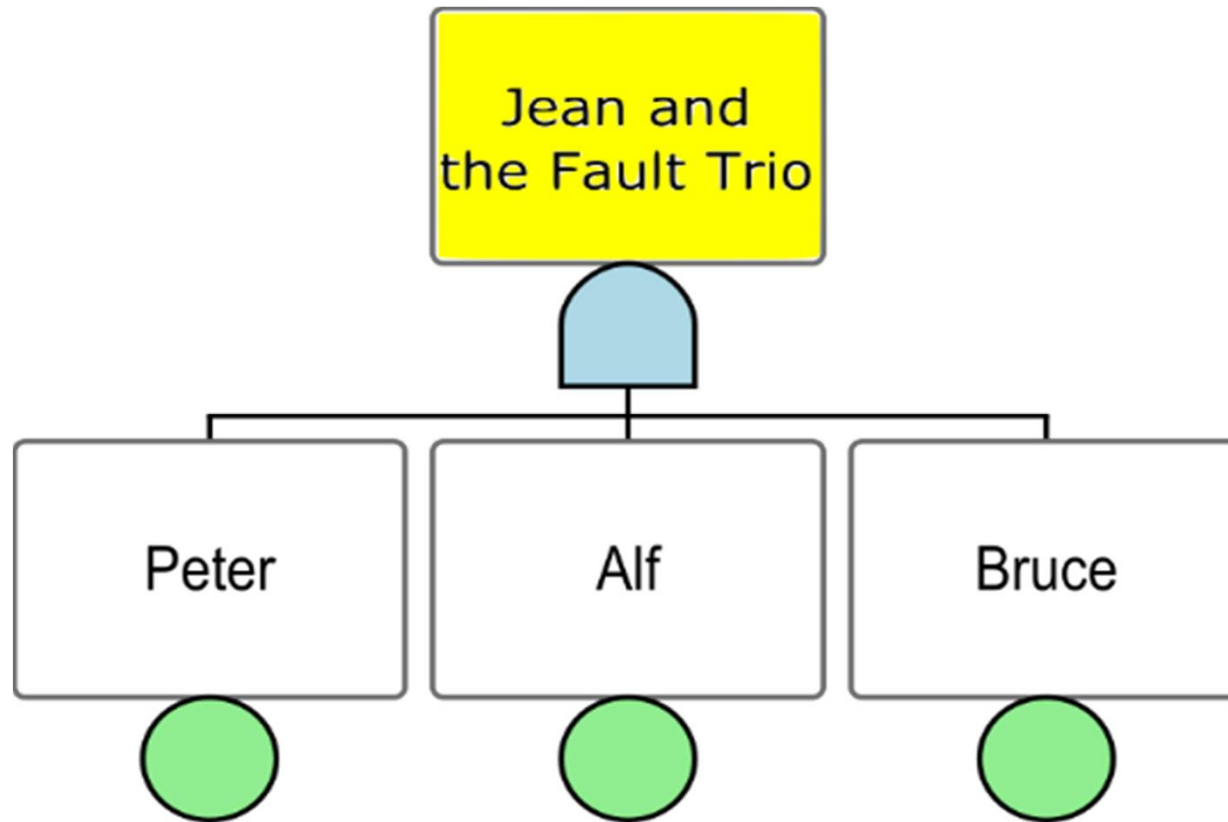
AAPM Spring Clinical Meeting



Fault Tree Analysis

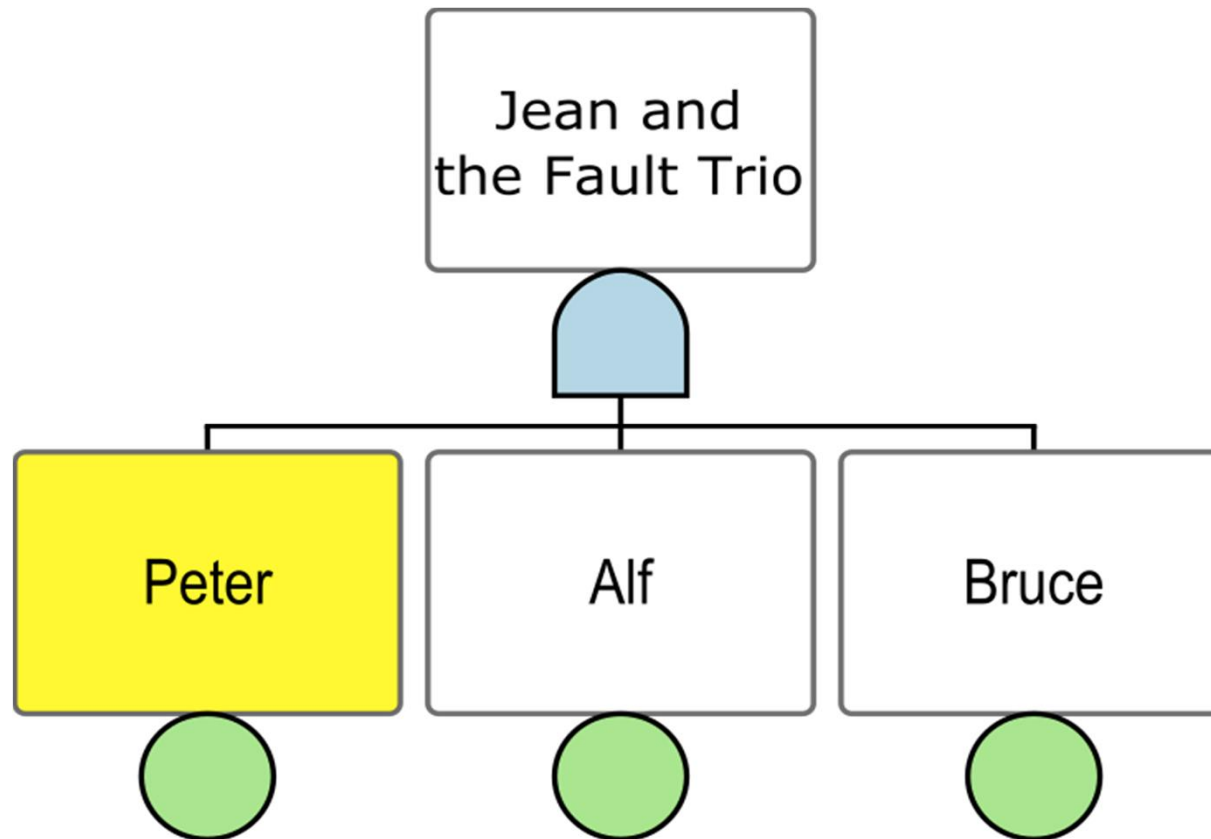
Peter Dunscombe, PhD, FCCPM, FAAPM, FCOMP
Professor Emeritus
University of Calgary

Fault Tree Analysis



AAPM Spring Clinical Meeting

Fault Tree Analysis



Disclosure

Peter Dunscombe is a Member of
TreatSafely, LLC


TreatSafely

IMPROVING QUALITY AND SAFETY IN RADIATION MEDICINE

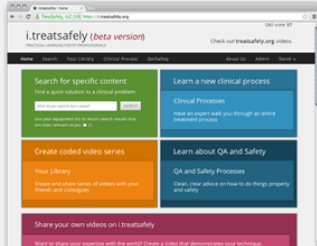
Home QI ToolBox Workshops Online Learning About

IMPROVING QUALITY AND SAFETY IN RADIATION MEDICINE

TreatSafely is dedicated to the development of novel teaching and mentoring programs that improve quality and safety in radiation medicine.



INTRODUCING I.TREATSAFELY.ORG



We've just put the finishing touches on our newest offering - **i.treatsafely.org**.

This video-based peer-to-peer training site has been developed to provide practical guidance on enhancing the quality and safety of radiation therapy. The content is provided by users like you and can be used for **educational and training purposes** as well as to **standardize practice within and across clinics**.

Once you have had a look we'd love to hear your comments, suggestions, and ideas for improving the site.

Signup for Updates

Let us keep you up-to-date and in the loop. Enter your email address below to receive news and updates regarding upcoming workshops and online learning opportunities.

email:

treatsafely.org

Peter Dunscombe. Fault Tree Analysis, Spring Clinical Meeting 8th March 2015.

Objectives

- “ To appreciate the relationship between **Fault Tree Analysis** and **Failure Modes and Effects Analysis**.
- “ To explore the similarities and differences between **Fault Tree Analysis** and **Root Cause Analysis**.
- “ To look at the practical uses of **Fault Tree Analysis**.

The AAPM's Task Group 100

Process Mapping helps us to understand the details of the patient's clinical pathway.

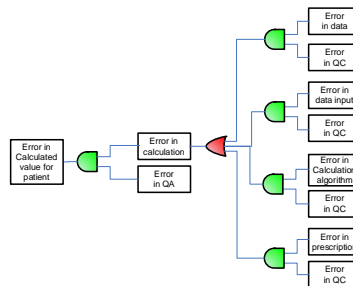
Failure Modes and Effects Analysis helps us to prioritize failure modes for further analysis.

Fault Tree Analysis helps us to identify:
“possible systemic program weaknesses
“where to put barriers and checks.

Purpose of a Fault Tree Analysis

To make the (radiotherapy) system safer through using postulated failure modes, tracing the failure pathways back and, on the basis of the FTA,

- ” Identifying possible systemic program weaknesses.
- ” Placing barriers and checks (QA and QC)



Fault Tree Analysis

Fault Tree Analyses are extensively used in high risk, high reliability industries such as the chemical, nuclear and aviation industries.

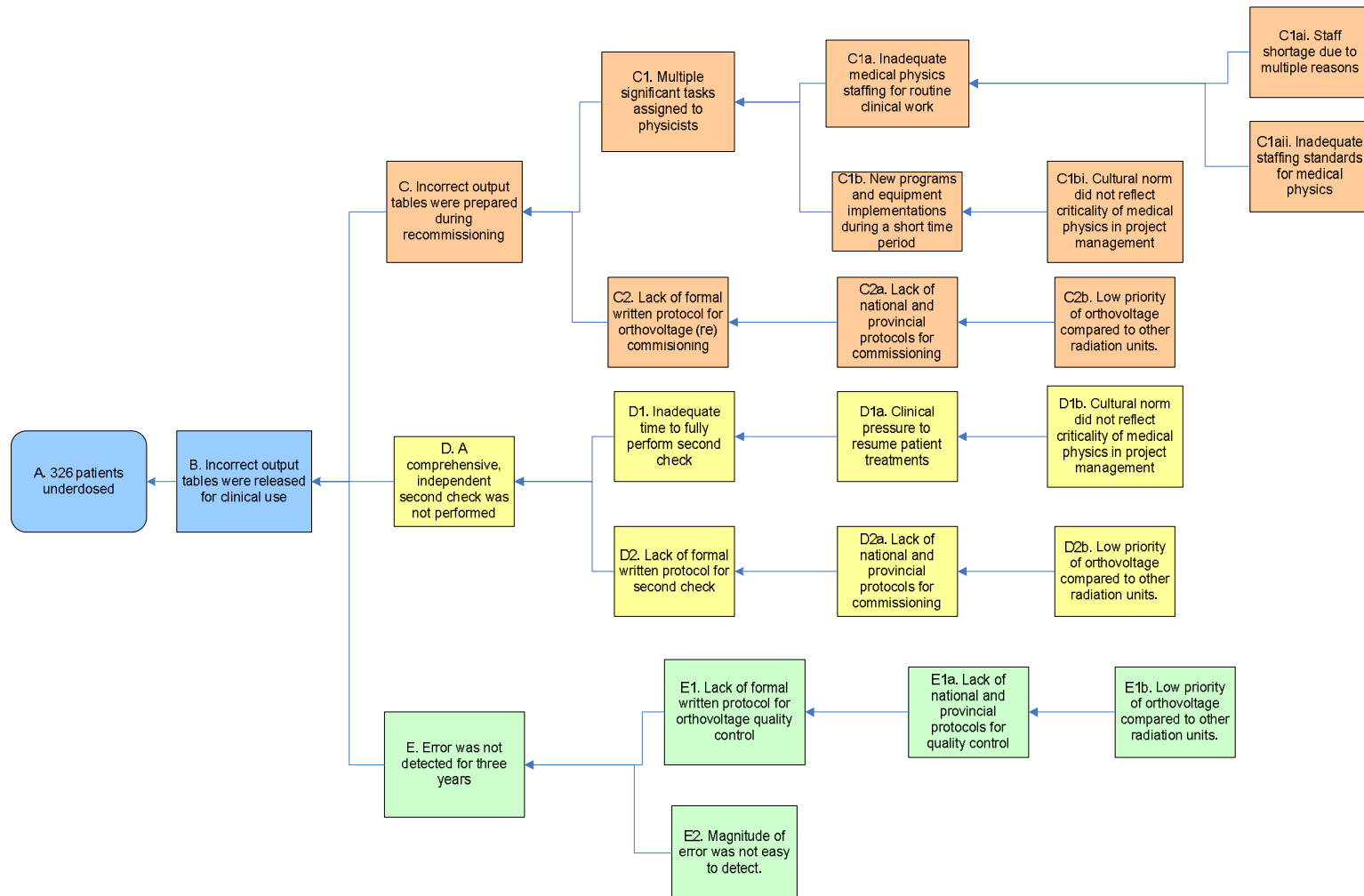
FTA in the context of FMEA

Step #	Major Processes	Step	Potential Failure Modes	Potential Causes of Failure	Potential Effects of Failure	O	S	D	RPN	Examples of Causes and Failures
178	11 - Day 1 Treatment	Treatment delivered	LINAC hardware failures/wrong dose per MU; MLC leaf motions inaccurate, flatness/symmetry, energy, etc	Poor hardware design Poor hardware maintenance. Inadequate physics QA process	Wrong dose Wrong dose distribution Wrong location Wrong volume	5.4	8.2	7.2	354	Wrong to very wrong dose affecting all patients treated on machine (or with affected beams) until problem is found and corrected.
195	7 - RTP Anatomy	Delineate GTV/CTV (MD) and other structures for planning	Contouring errors: wrong organ, wrong site, wrong expansions	User error Inattention, lack of time, failure to review own work	Very wrong dose distributions Very wrong volumes.	5.3	8.4	7.9	366	Wrong target volume contour leads directly to very wrong dose distributions and volumes. Low detectability assumes only review is by physicist and MD
31	4 - Other pretreatment imaging for CTV localization	Images correctly interpreted	Incorrect interpretation of tumor or normal tissue.	User not familiar with modality or inadequately trained. Poor inter-disciplinary communication	Wrong volume	6.5	7.4	8.0	387	

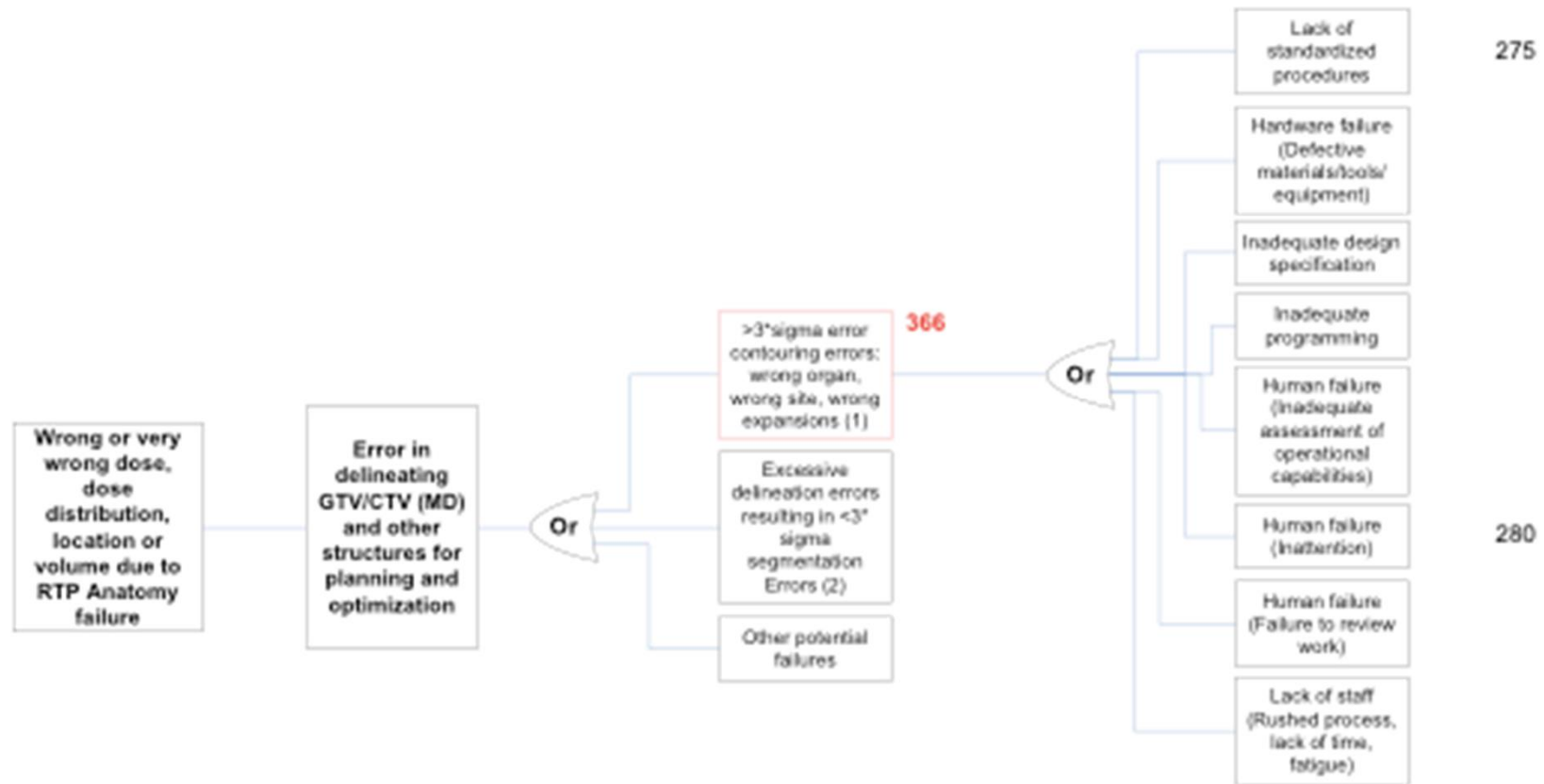
FTA in the context of FMEA

Step #	Major Processes	Step	Potential Failure Modes	Potential Causes of Failure	Potential Effects of Failure	O	S	D	RPN	Examples of Causes and Failures
178	11 - Day 1 Treatment	Treatment delivered	LINAC hardware failures/wrong dose per MU; MLC leaf motions inaccurate, flatness/symmetry, energy, etc		Wrong dose Wrong dose distribution Wrong location Wrong volume	5.4	8.2	7.2	354	Wrong to very wrong dose affecting all patients treated on machine (or with affected beams) until problem is found and corrected.
195	7 - RTP Anatomy	Delineate GTV/CTV (MD) and other structures for planning		User error Inattention, lack of time, failure to review own work	Very wrong dose distributions Very wrong volumes.	5.3	8.4	7.9	366	Wrong target volume contour leads directly to very wrong dose distributions and volumes. Low detectability assumes only review is by physicist and MD
31	4 - Other pretreatment imaging for CTV localization	Images correctly interpreted	Incorrect interpretation of tumor or normal tissue.	User not familiar with modality or inadequately trained. Poor inter-disciplinary communication	Wrong volume	6.5	7.4	8.0	387	

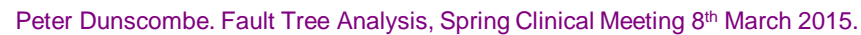
Root Cause Analysis (RCA)



Fault Tree Analysis (FTA)



Look similar?



FTA in the context of RCA

A Fault Tree Analysis can be regarded as a hypothetical Root Cause Analysis.

- “ An actual event starts an RCA
- “ Postulated failure modes are used to start an FTA.
- “ However, in both, the failure pathway is traced back.
- “ Postulated failure modes can be imported from a Failure Modes and Effects Analysis.

Performing a Fault Tree Analysis

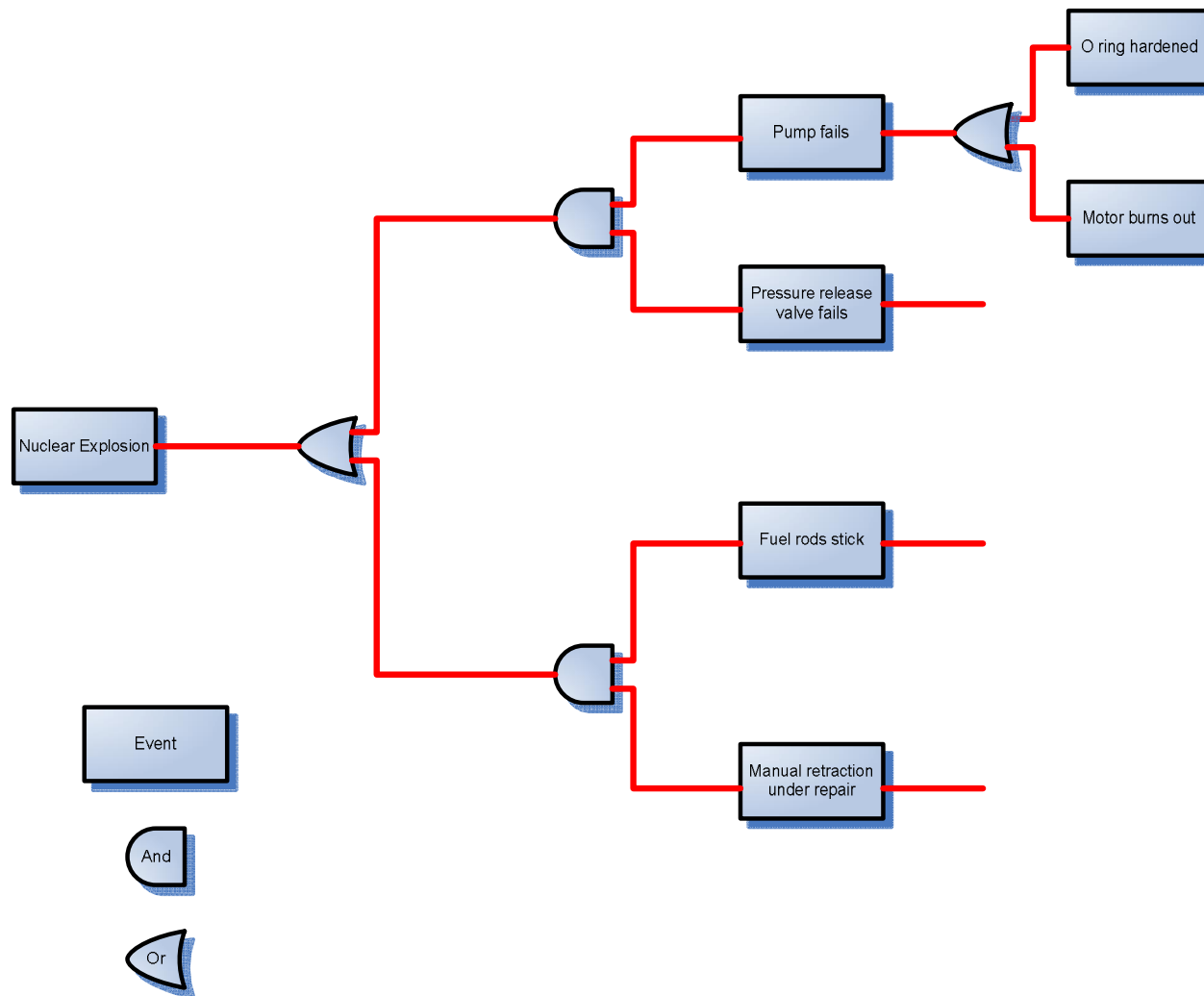
A Fault Tree Analysis is normally carried out by a small team:

“Leader . knowledge of FTA and subject area of review

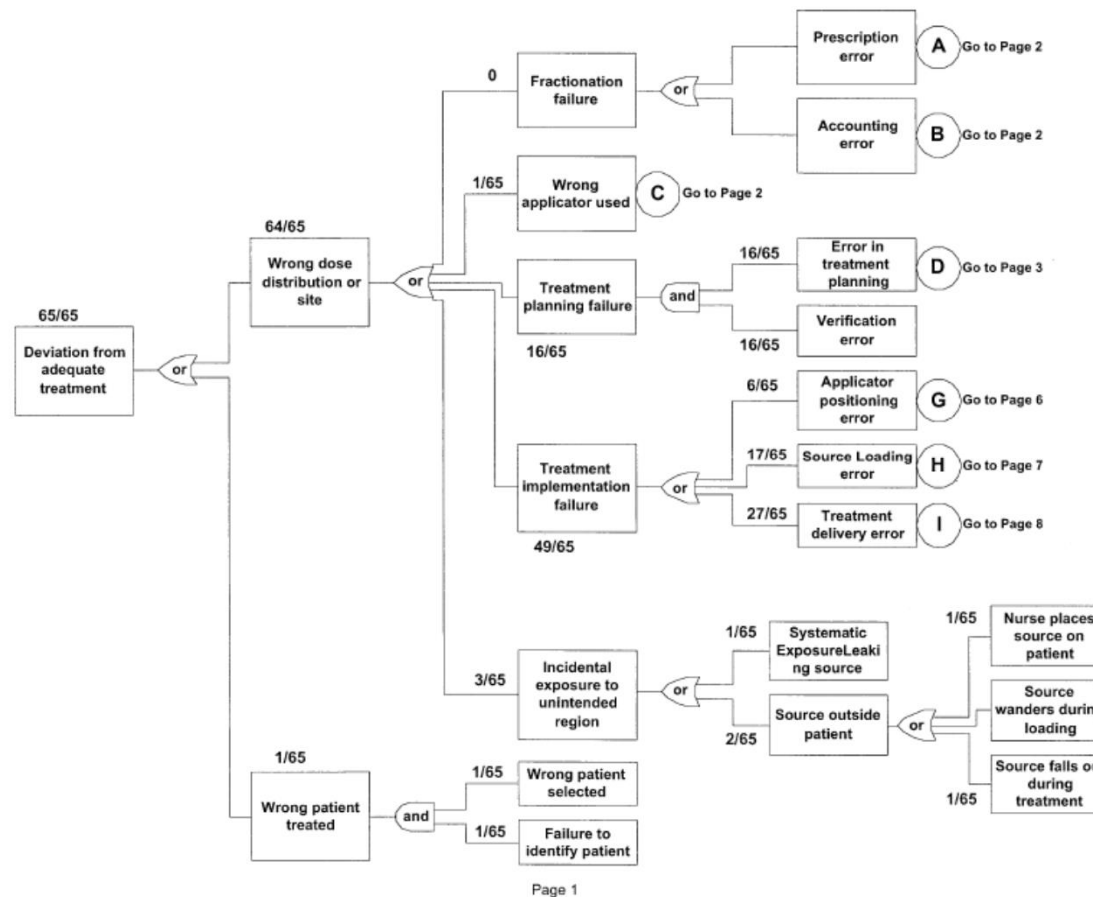
“Facilitator . expertise in FTA

“Content experts . knowledge of subject area of review and preferably multidisciplinary in our environment.

Engineering Fault Tree



Example: Probabilistic Fault Tree (Thomadsen)



Thomadsen et al. IJROBP 2003 (57) 1496

Peter Dunscombe. Fault Tree Analysis, Spring Clinical Meeting 8th March 2015.

Interesting quote from Thomadsen's paper

“In industries such as nuclear power, where probabilistic risk assessment originated, most failures occur only when several systems fail concurrently, and the combination of probabilities becomes important. Most medical events, although they have several root causes and concurrent unusual situations, fail along a single branch of the fault tree”

Thomadsen et al. IJROBP 2003 (57) 1496

Peter Dunscombe. Fault Tree Analysis, Spring Clinical Meeting 8th March 2015.

Prescient observation by Thomadsen

2003

“Errors often follow violations in protocols, particularly failures to perform verification procedures, and indicators that things are not correct are often present yet ignored during events.”

Thomadsen et al. IJROBP 2003 (57) 1496

2006

Radiation Offers New Cures, and Ways to Do Harm

By WALT BOGDANICH



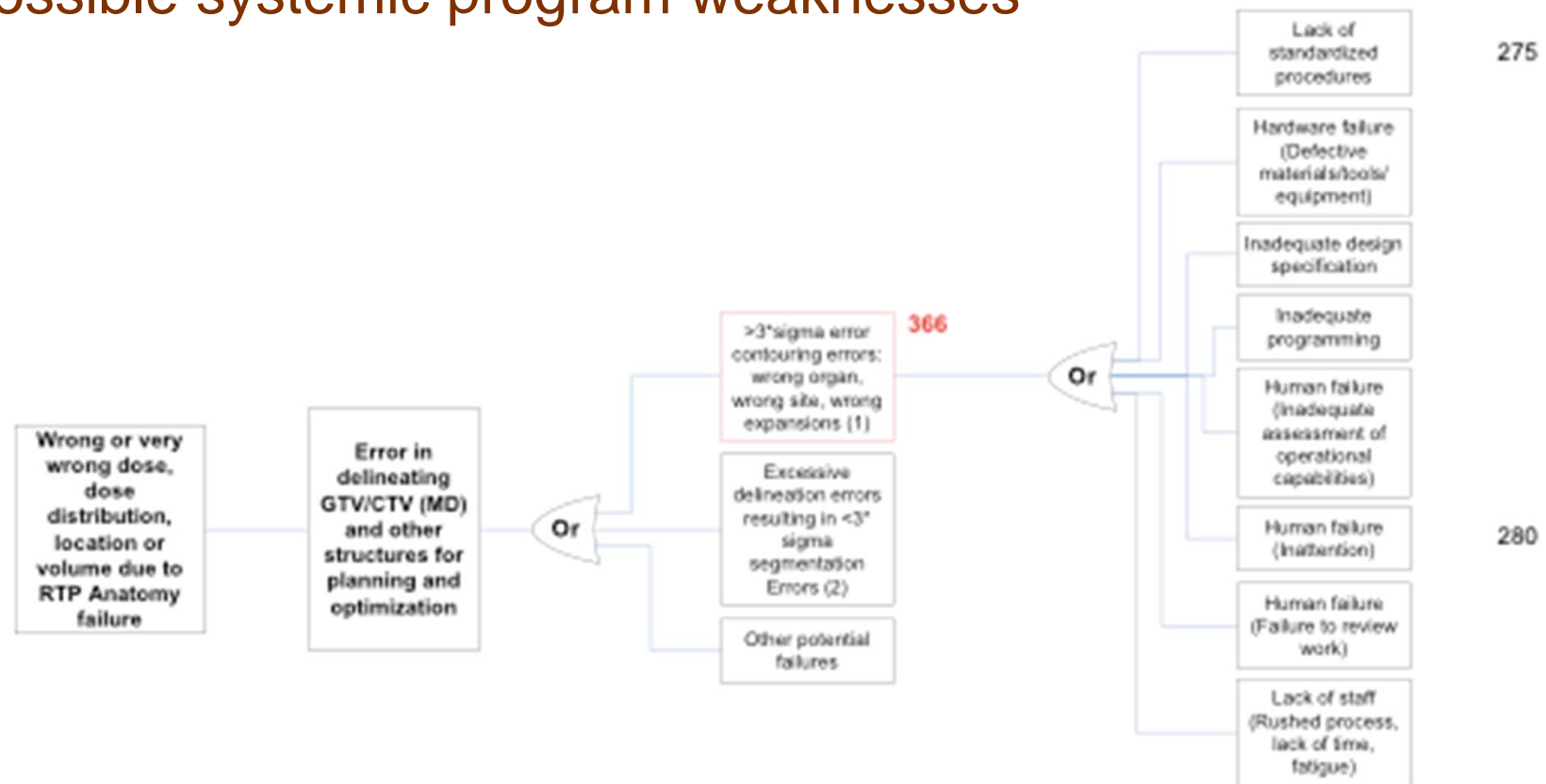
Fault Tree Analysis– FMEA input

Failure Modes and Effects Analysis helps to prioritize failure modes for further analysis.

Step #	Major Processes	Step	Potential Failure Modes	Potential Causes of Failure	Potential Effects of Failure	O	S	D	RPN	Examples of Causes and Failures
178	11 - Day 1 Treatment	Treatment delivered	LINAC hardware failures/wrong dose per MU; MLC leaf motions inaccurate, flatness/symmetry, energy, etc	Poor hardware design Poor hardware maintenance. Inadequate physics QA process	Wrong dose Wrong dose distribution Wrong location Wrong volume	5.4	8.2	7.2	354	Wrong to very wrong dose affecting all patients treated on machine (or with affected beams) until problem is found and corrected.
195	7 - RTP Anatomy	Delineate GTV/CTV (MD) and other structures for planning	Contouring errors: wrong organ, wrong site, wrong expansions	User error Inattention, lack of time, failure to review own work	Very wrong dose distributions Very wrong volumes.	5.3	8.4	7.9	366	Wrong target volume contour leads directly to very wrong dose distributions and volumes. Low detectability assumes only review is by physicist and MD
31	4 - Other pretreatment imaging for CTV localization	Images correctly interpreted	Incorrect interpretation of tumor or normal tissue.	User not familiar with modality or inadequately trained. Poor interdisciplinary communication	Wrong volume	6.5	7.4	8.0	387	

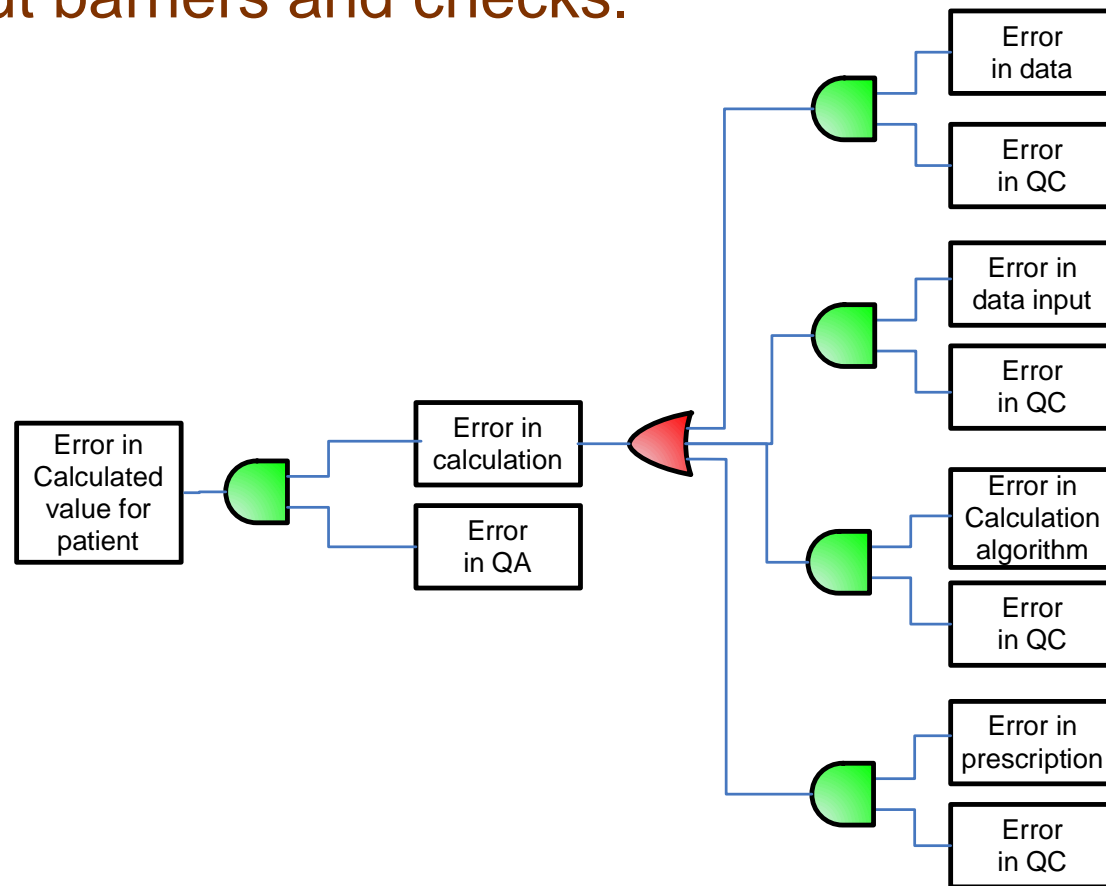
Fault Tree Analysis– systemic program issues

Fault Tree Analysis helps to identify possible systemic program weaknesses

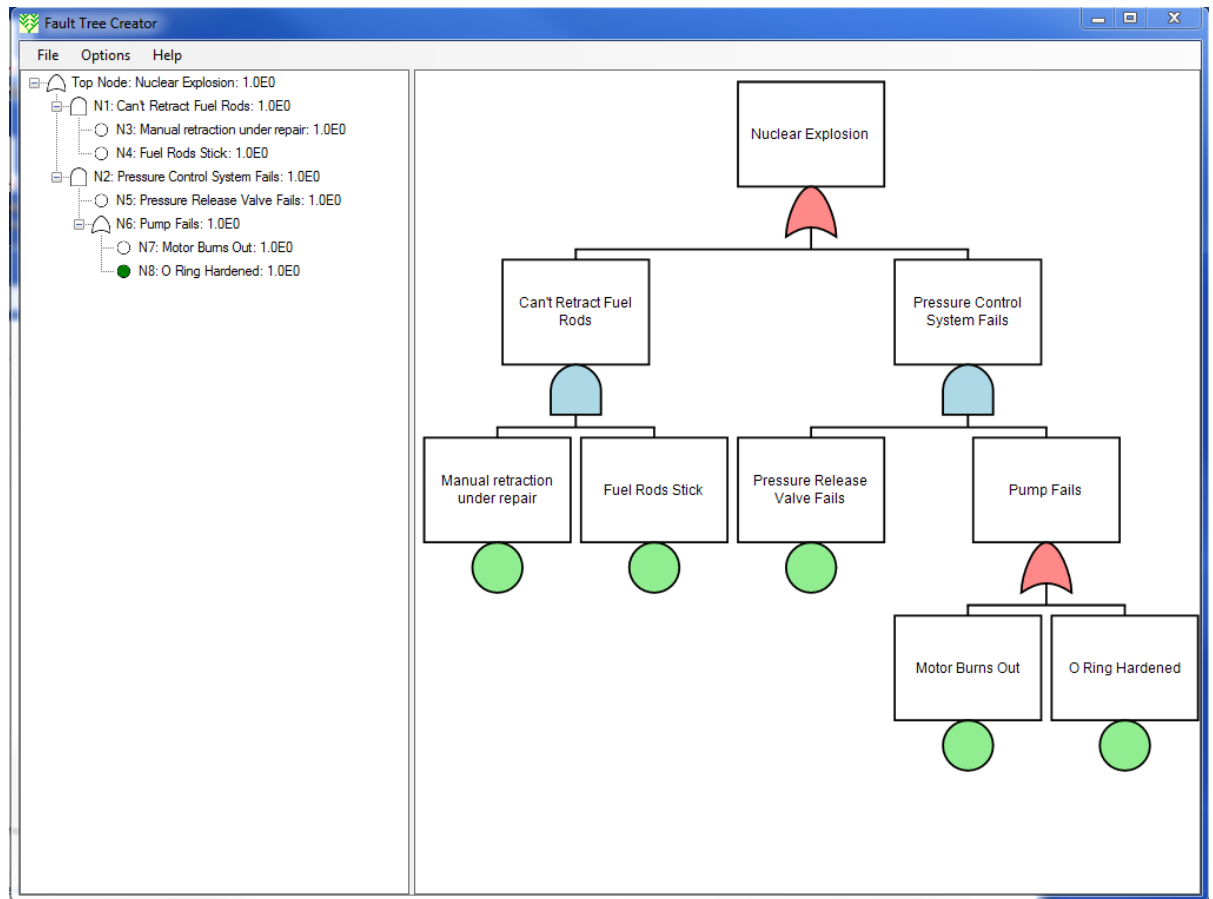
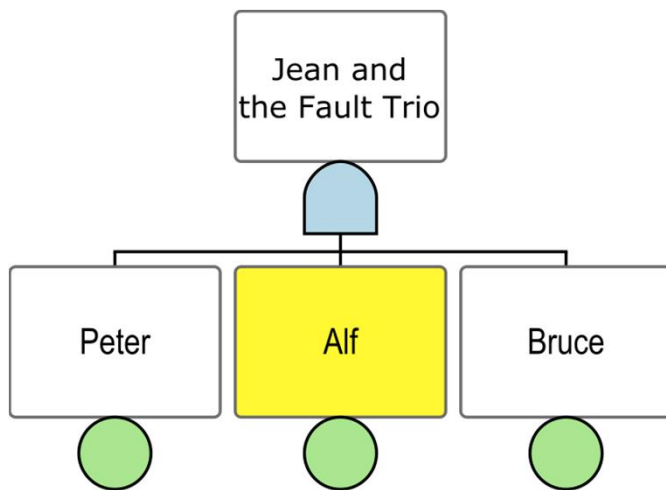


Fault Tree Analysis - safety barriers and checks

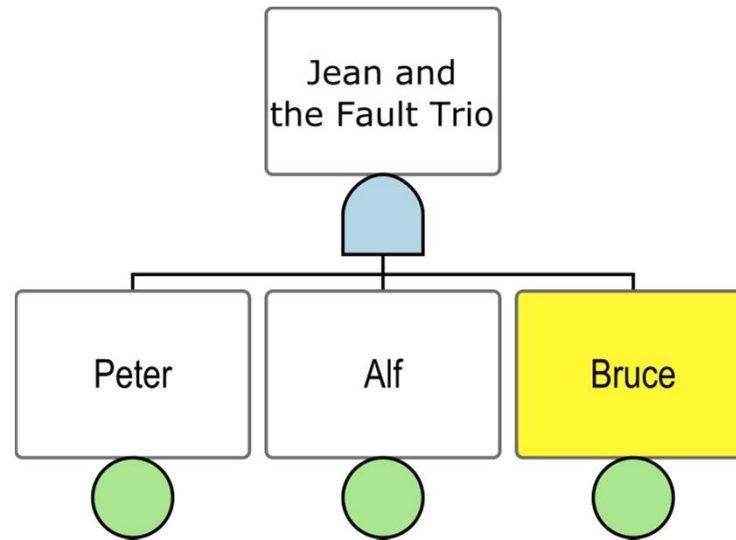
Fault Tree Analysis helps to identify where to put barriers and checks.



Fault Tree Software - Alf



Quality Management - Bruce



The prevention of events can be by:

- “ Eliminating progenitor causes,
- OR
- “ By interrupting the propagation.

Fault Tree Analysis Exercise

1. Choose 1 of the 2 TG 100 Failure Modes.
1. Develop a Fault Tree for this Failure Mode.
1. Make sure each branch ends (on the right) on a progenitor cause/ contributing factor or latent condition.
1. Make sure the (right) branch ends are actionable.
2. Do not include safety barriers and checks at this time. We'll do that later.

Fault Tree Analysis Exercise

You should generate something like this

