

Self-Introduction

- Therapy Medical Physicist, RAS
 - 2003-present
- Chief Medical Physicist, Travis AFB, CA
 - 2000-2003
- 5 Years as a Diagnostic Medical Physicist
- Ph.D., University of Wisconsin-Madison
 - Advisor: Rock Mackie

Disclosure

I have no disclosures for any vendor products discussed in this talk

Acknowledgements



- ROC Physics Group for direct and indirect assistance
- Chris Piekierski, Varian Project Manager for great PM discussions

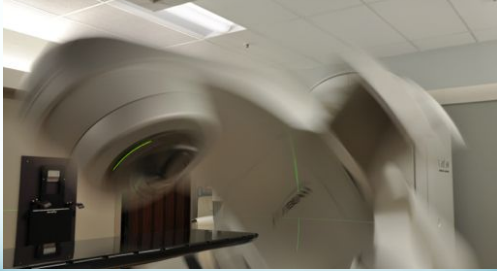
Overview

- Introduction
- The TrueBeam Linac
- The Similarities & Differences
- Project Management Concepts
- The CA Process for Installing a New Linac
- Acceptance & Commissioning
- Conclusions

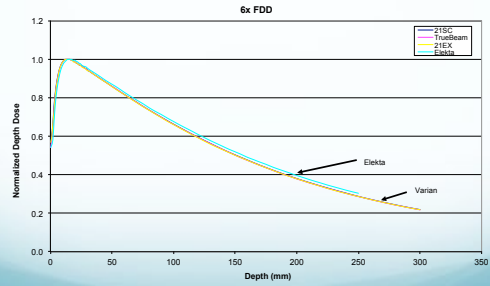
Introduction

- Background
- ROC Linear Accelerators
 - 2-TrueBeam (one STx with HD120), 1-21EX, 1-21SC, 2-Elekta Infinity, 2 Varian 2300, 1 Varian 2100, 1 Varian 600C at 7 sites, 4 counties...
- First TB installed July 2011
- Second TB, A Matched Machine. Acceptance Began on Nov 8, first treatment on Dec 31
 - TG-106: Commissioning a Linac takes 4-6 weeks...

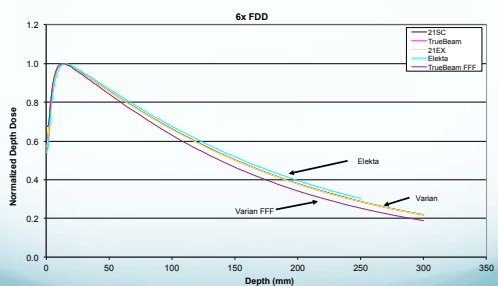
The Varian TrueBeam Linac



The Similarities...



And the Differences...



Basic Capabilities

- Mostly digital (tweaking screwdriver no longer needed)
- Customizable energies
- FFF capability, with up to 2400 MU/min (10 MV)

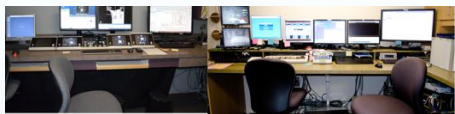
100 MU @ 2400 MU/min



Comparison to a 21 EX (Linac)



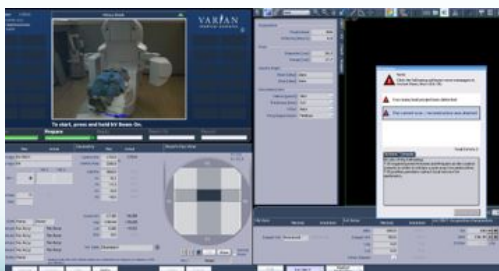
Comparison to a 21EX (console)



TrueBeam Console



Software Errors & Messages



Project Management Concepts

- What is the Problem?
- Definitions
- A Solution
- The Benefits
- The Overhead
- Our PM Process

What is the Problem?

- Clinical work is ongoing...and has a high priority
- Project work is the work that has historically been done when the physicist has "spare time"
- However → You have to do both
- Projects are often done piece-meal and unfinished projects will come back to haunt you!
- Starting and re-starting projects is very inefficient and it is avoided at all costs in project-managed companies
- Basic premise: There is always more project work to do than there is time and/or resources...what is most important?

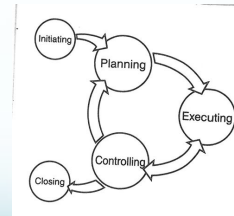
A Solution

- Develop a systematic method for prioritizing work based on stakeholder input
- Incorporate project management into your work
- Plan the project, estimate the time, have it ready to go when you have time to do the work
- All the project management books will tell you "Project Management is based on common sense", so think of it as a formalism to a many-step process to avoid forgetting something critical

Definitions

- A **project** is “work performed by an organization one time to produce a unique outcome”
- An **operation** is the “ongoing, repetitive set of activities that sustain the organization”
- Project management: the art of balancing the project objectives against the constraints of time and budget.
- The Project Definition Document is the key document to the entire project—also called a “Statement of Work”

The Project Management (PM) Process



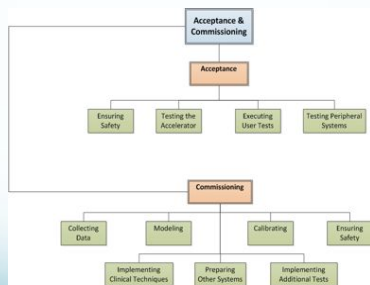
Initiating

- The only chance you'll have to get the project off to a good start
- Brainstorm
- Define the problem and propose the solution—the purpose
- Get support for the project (administrators, physicians; collectively called “stakeholders” in PM jargon)
 - 2/3 of projects fail because of lack of stakeholder support

Planning

- Lay out the road map—every objective to achieve, the work to perform, who's going to do the work, when, and the cost
- In more detailed planning, you would also define how often communications would occur (e.g. a weekly update to the stakeholders is always appreciated), who has to approve what, and how to deal with changes and risks
- Think of what things will look like at the end—write down all the “deliverables” the project will provide and then build work around it
- The document that contains the entire road map is called the Project Definition Document, or sometimes known as the “Statement of Work”
- Develop the tasks that needs to be done in a hierarchal way...the WBS

The Work Breakdown Structure (WBS)



Executing

- Otherwise called “performing the project”
- Just boils down to following the plan you created

Controlling

- If the project planning was always executed perfectly, this phase would not be needed
- This involves monitoring the plan execution—see if everything is going “according to plan”, whether the work is on schedule, and if not, make adjustments
- The normal chaos of things not always going well

Closing

- Bring the project to a graceful close...
- Finishing policies & procedures and operational guidelines
- Also, talk about “lessons learned”, with both the project and the work done—what was done well, what needed work
- A final report to the stakeholders

The Benefits

- Clear definition of the project, with a clear beginning and end
- Know upfront what deliverables (products) will be produced
- What to do, what *not* to do
- Define risks and plan for bad news if it should come
- Total number of hours/cost spent on a project
- Reuse what you’ve learned the next time you have to do it
- Increase **efficiency** of executing work
- Improve **quality** of work—end-to-end testing

The Benefits (cont)

- You break up large, seemingly insurmountable problems into smaller parts (work packages)
- You readily see you are making steady progress

The Disadvantages

- You need to take the time to implement a process
- You need to spend a lot of time planning
- When you’re planning, you’re not executing
- There is a tendency to “gold plate” your work
- You might have to invest in more software tools, but certainly this can be done with a spreadsheet

PM Tools

- Microsoft Project
 - Standalone--~\$400/copy
 - Server version--~\$1,000, but very dependent on how entrenched MS is already at your facility...
 - Check—it may already be in your hospital (it is the market leader)
 - IT-dependent
- AtTask®
 - Cloud-based
 - Sold by number of users and user type
 - Nearly IT-independent

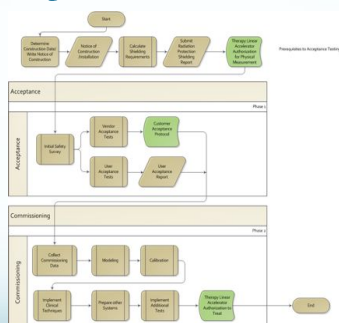
Our PM Process

- Assumption: Not all work can be done with existing staff
- Thus: Work must be prioritized, with guidelines provided by stakeholders (work in progress)
- Process:
 - Work comes in, a purpose is written, and is considered to be a project by the ROC physics project management group
 - If chosen as a project, a priority is assigned, the team chosen, and planning work is begun...
 - This will all be managed by one software tool, AtTask® starting in March 2012.

The CA Process for a New Linear Accelerator

- Title 17, Article 4 “Special Requirements for the Use of X-Ray in the Healing Arts”

Linac Implementation Flowchart



Authorization for Physical Measurements

- Notify in writing to the state of your intent to install a new linac
- Calculate shielding requirements on as-built diagrams, generate a shielding report, and submit to the state
- Remember, this is an iterative process and you will need to make sure you or someone else who knows what is going on is available to answer questions/ provide more information/etc.
- Remember to respect state turnaround time on these documents, esp. consider holidays, etc.
- From this submission will come the “Therapy Linear Accelerator Authorization for Physical Measurement” letter from the state
- With this letter, you are ready to begin acceptance & commissioning...

The Permission to Treat Package

- When acceptance and commissioning are both complete, submit the data collected to the state.
- Again, this is an iterative process and you will need to make sure you or someone else who knows what is going on is available to answer questions/ provide more information/etc.
- From this submission will come the “Therapy Linear Accelerator Authorization to Treat” letter from the state
- With this letter, you can then treat!

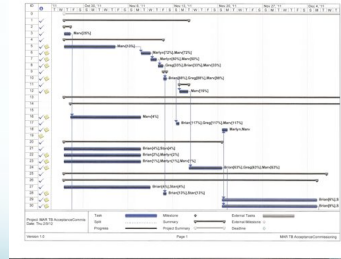
Acceptance & Commissioning

- Definitions
- The Marshall TrueBeam Linear Accelerator Project Gantt Chart
- The Marshall TrueBeam Linear Accelerator Project Schedule
- Acceptance
- Commissioning
- Timeline

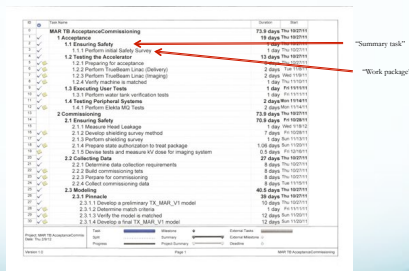
Definitions

- Acceptance Testing: Testing by the physicist to ensure that the machine meets the product specifications and the purchase agreement. These tests are conducted according to the acceptance testing procedure agreed on between the manufacturer's representative and the facility physicist¹
- Commissioning: The process of commissioning a linac for clinical use includes comprehensive measurements of dosimetric parameters that are necessary to validate the treatment planning systems used to select optimal radiation modality and treatment technique for individual patients. Commissioning also includes entry of beam data into a treatment planning system and testing of its accuracy, development of operational procedures, and training of all concerned with the operation of the accelerator¹.
- ¹: Palta, Jatinder R. **Linear Accelerator Acceptance Testing and Commissioning**, 2003 AAPM Annual Meeting.

The Marshall TrueBeam Linear Accelerator Project Schedule



The Marshall TrueBeam Linear Accelerator Project Schedule



Acceptance

- Ensuring Safety
- Testing the Accelerator
- Executing User Tests
- Testing Peripheral Systems

Ensuring Safety

- The very first summary task...
- The work:
 - Perform initial safety survey, done right after "beam on" is established.
- Varian will have you sign-off in their acceptance documents that this work has been done

Testing the Accelerator

- The work:
 - Preparing for acceptance
 - Perform TrueBeam Linac (Delivery)
 - Perform TrueBeam Linac (Imaging)
 - Verify Machine is Matched

Preparing for Acceptance (example list from the Notes)

- Verify processor and film are in place for Varian. 1 hour, 10/29/11
- Arrange for the delivery of the scanning system by 11/8.
- Arrange for a key for access to roof on 11/13. Doug assisting. 11/3/11
- Arrange for Aaron for MQ integration on 11/14/11. 10 AM.
- Create new TB machine in Argus. 30 min on 11/3/11.
- Take LA48 to MAR. 11/7/11. m.jg

TrueBeam Linac (Delivery)

1. Mechanical Verifications
2. Radiation, Isocenter, and Beam Stability Verification
3. Energy & Beam Profile Verification
4. Dosimetry Verification
5. Dynamic Therapy
6. LaserGuard II Collision Prevention System (just rec'd 510k)
 - Optional—we do not have on either TB

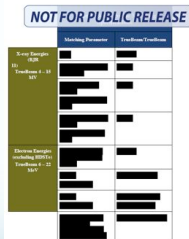
TrueBeam Linac (Imaging)

- Preliminary Machine Checkout
- Interlock Demonstration
- Positioning Unit (MVD, KVD, and KVS)
- Imaging Acquisition
- KV Imaging Acquisition
- CBCT Image Acquisition
- Final Machine Checkout

Verify TrueBeam is Matched

- A work-in-progress when we did it.
- Will be formal part of TB acceptance

TrueBeam Draft Matching Criteria TrueBeam to TrueBeam



NEW: Field-intensity match: Point-to-point field intensity comparison of the central axis profiles (in each plane), at a depth of 10 cm, normalized to the dose at beam centerline.

Executing User Tests

- Should be arranged in advance with vendor...
- Either an additional test, or a different method than is done by the vendor.
- We chose to perform our own water tank verification tests...
- Always had ~2% disagreement with Buddelship measurements (at both TB installs) done by Varian—never could resolve, but used our data

Testing Peripheral Systems

- Any acceptance of devices that support your clinic that is not the linac vendor
- The tests involved the integration of Elekta MQ and Calypso to TrueBeam
- If you have Aria, there are acceptance tests are part of the Varian protocol

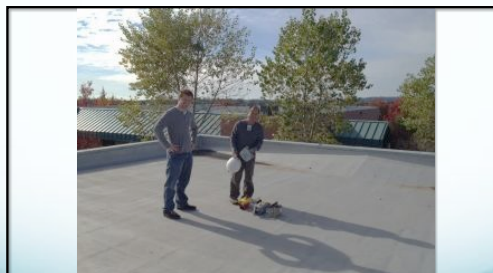
Commissioning

- Ensuring Safety
- Collecting Data
- Modeling
- Calibrating
- Implementing Clinical Techniques
- Preparing Other Systems
- Implementing Additional Tests

Ensuring Safety

- Measure Head Leakage
 - **NOTE:** Head leakage is required by the state--here is a quote from Mark Pietz: "The particular reference, in 17 CCR 30306, is a performance standard and was inserted in 1973, presumably in anticipation of Federal regulations to be adopted. Whether or not the test is performed any longer (presumably during acceptance testing), it is still in force, and subject to verification by the Department!"
- Develop shielding survey method
- Perform shielding survey
- Prepare Authorization to Treat Package
- Devise tests and measure kV dose for Imaging System

Performing the Shielding Survey



Collecting Data

- Determine data collection requirements
 - What set of data to take for a "matched" machine
- Build Commissioning Tests
- Prepare for Commissioning
- Collect Commissioning Data

Data Collection (desired)

- PDDs & Profiles
 - 3x3, 5x5, 10x10, 20x20, 30x30, 40x40 for 6x, 10x, 15x, 6x FFF, & 10x FFF, 6e, 9e, 12e, 15e, 18e
- Wedged Fields
 - 6x, 10x, 15x
- Open Field Output Factors
 - 6x, 10x, 15x, 6x FFF, 10x FFF, 6e, 9e, 12e, 15e, 18e
- Point Dose
 - 6x, 10x, 15x, 6x FFF, 10x FFF
- Jaw & MLC Transmission (HD120 vs Millennium 120)
 - 6x, 10x, 15x, 6x FFF, 10x FFF
- IMRT Dose Rate Validation
 - 6x, 10x, 15x, 6x FFF, 10x FFF
- Energy Check (reference depth plus one other)
 - 6x, 10x, 15x, 6x FFF, 10x FFF

Data Collection (actual)

- PDDs & Profiles
 - 3x3, 5x5, 10x10, 20x20, 30x30, 40x40 for 6x, 10x, 15x, 6x FFF, & 10x FFF, 6e, 9e, 12e, 15e, 18e
- Wedged Fields
 - 6x, 10x, 15x
- Open Field Output Factors
 - 6x, 10x, 15x, 6x FFF, 10x FFF
- Point Dose
 - 6x, 10x, 15x
- MLC Transmission (HD120 vs Millennium 120)
 - 6x, 10x, 15x, 6x FFF, 10x FFF

Modeling

- Pinnacle
- RadCalc

Pinnacle

- Develop a Preliminary Model
- Determine Match Criteria
- Verify the Model is Matched
- Develop a Final MAR Model
 - Slight complication—the CTB on focal spot size

RadCalc

- Build the Marshall TrueBeam Model
- Perform commissioning tests to verify

Modeling

- Important Suggestion—Inform dosimetry and physics when both the Pinnacle and RadCalc models will be ready for use.
- The final TPS models are important “deliverables”
- From a PM perspective, ensure this is in the Communications Plan or just add to the Project Notes...
- They’ll be asking anyway, because there are quite likely many plans to be completed on the new machine..

Calibrating

- TG-51
- Irradiate OSLDs for RPC

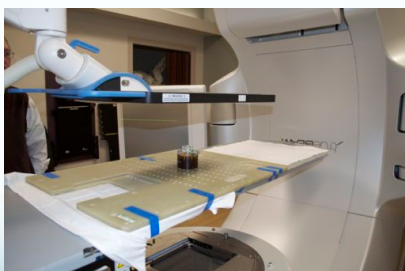
Implementing Clinical Techniques

- SBRT
- IMRT/VMAT
- Create certificates for clinical procedures—input to ACR accreditation
- Done as part of “End-to-End” Testing

Preparing Other Systems

- Calypso
- ArcCheck
- Daily QA3 / Atlas
- MapCheck

Calypso Qfix Couch Verification



Implementing Additional Tests

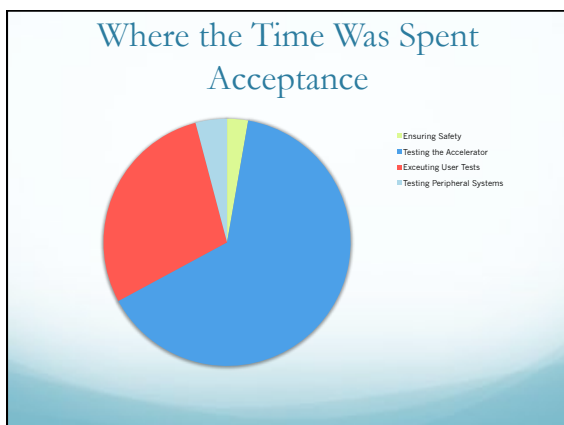
- QA Tests
- End-to-End Tests
 - Use Humanoid (Rando) in the CT you normally use
 - Don't skip steps...
 - Set up test patient in TPS and EMR and then export to TB
 - IMRT, SBRT, VMAT, and arc cases—5 cases covering H&N, prostate, breast.
 - 4 errors discovered and fixed—the most serious related to incorrect field sizes from MQ to TB...

Timeline

- Huge benefit of PM...information is readily available
- 464 hours of direct work, among 4 team members
- ~ 30 hours of indirect work, supporting team members to do QA, special procedures, etc.

Where the Time Was Spent





Conclusions

- Lessons Learned
 - Planning takes time, but is well spent—Look forward to having for the next Linac install
 - Don't underestimate ebbs and flows of physics work—confounds a "perfect" implementation of PM
 - However, PM planning is well-suited for physics work—plan upfront and implement when the time permits...
 - Don't make the same mistake twice!
- Future Directions
 - Implement AtTask® into PM process—proposal, priority, plan, implement, group discussion with social-media type interface
 - Standardize patient-specific QA using Dosimetry Check