You Want It By When!?

Automating Effective Radiation Oncology Workflows

Matthew A. Meineke, PhD, DABR

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Creating a Cancer-free World.
One Person, One Discovery at a Time.

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Disclosures

▪ None

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Introduction

▪ This will be a review of Automation topics
▪ I will include links to presentations for further in-depth follow-up on any given topic.
  ▪ The slides will be available as the handout on the meeting platform and later in the virtual library.

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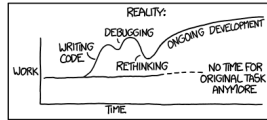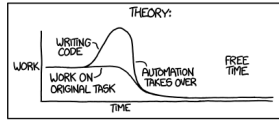## Automation for effective time management

"I SPEND A LOT OF TIME ON THIS TASK. I SHOULD WRITE A PROGRAM AUTOMATING IT!"

THEORY: WRITING CODE — WORK ON ORIGINAL TASK — AUTOMATION TAKES OVER — FREE TIME

REALITY: WRITING CODE — DEBUGGING — RETHINKING — ONGOING DEVELOPMENT — NO TIME FOR ORIGINAL TASK ANYMORE

https://xkcd.com/1319/

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Automation as an Effective Quality Management Tool

TABLE III. Ranking of QM tools based on the effectiveness with examples, in part following the suggestions of ISMP (Ref. 67). The lower numbers are the most effective.

1. Forcing functions and constraints
   - Interlock
   - Barriers
   - Computerized order entry with feedback
2. Automation and computerization
   - Bar codes
   - Automated monitoring
   - Computerized verification
   - Computerized order entry
3. Protocols, standards, and information
   - Check-off forms
   - Establishing protocol/clarify protocol
   - Alarms
   - Labels
   - Signs
   - Reduce similarity
4. Independent double check systems and other redundancies
   - Redundant measurement
   - Independent review
   - Operational checks
   - Increase monitoring
   - Add status check
   - Acceptance test

5. Rules and policies
   - Priority
   - Establishing/clarify communication line
   - Staffing
   - Better scheduling
   - Mandatory pauses
   - Repair
   - PMI (preventive maintenance inspection)
   - Establish and perform QC and QA (hardware and software)
6. Education and information
   - Training
   - Experience
   - Instruction

- One major driving force for automation in our clinics, is the promise of safety
- Automation can remove the burden of repetitive and tedious checks from a clinician or therapist.

M. Saiful Huq, et al. "The report of Task Group 100 of the AAPM: Application of risk analysis methods to radiation therapy quality management." Med Phys. vol. 43 (7), July 2016, p.4209-4262
- https://doi.org/10.1118/1.4947547

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How did we get here?

- J. Daniel Bourland: "The History of Automation In Radiation Oncology"
  - https://www.aapm.org/education/VL/vl.asp?id=12836
- In his presentation, Dr. Bourland traces the role of automation on some of the major foundations of a modern radiation oncology clinic.

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Historical Examples of Automation in Radiation Oncology

- Computed 3D Dose distributions
- MLC Shaped Beam Apertures
- Record and Verify Software
- Automation is not just a new concept that we are wrestling with, but a continuation years of work and progress.

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Machine QA

- Jonathan Rogers: "Automation in Machine QA"
  - https://www.aapm.org/education/VL/vl.asp?id=13499
- Eclipse Scripting Application Programming Interface (ESAPI)
  - A powerful utility for scripting clinical automation tools and machine QA routines.

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Machine QA

- Rogers walks through a variety of QA examples using ESAPI to:
  - Extract Multiple PDDs from Eclipse for Annual / Commissioning comparison
  - Extract beam profiles for comparison
  - Extract point doses
  - Analyze images with software library add-in for monthly imaging QA

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Contouring

- Minsong Cao: "Automated Contour Segmentation for Treatment Planning: Challenges and Potentials"
  - https://www.aapm.org/education/VL/vl.asp?id=12984
- An excellent primer on current automated contouring routines and some of their challenges.

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Contouring

- Automated Contouring Strategies
  - Atlas Based Segmentation
    - Utilizes a database of pre-drawn reference sets which are deformably merged to the target image set.
  - Machine Learning (AI) Segmentation
    - Utilizing large databases of pre-drawn references sets to train advanced machine learning algorithms to draw directly on the target image sets.
  - Statistical Model Segmentation
    - Seeks to confine segmented contours to anatomically plausible shapes or appearances through statistical fits of the test image to a training dataset.

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Treatment Planning

- Laurence Court: "Automation in Treatment Planning"
  - https://www.aapm.org/education/VL/vl.asp?id=12601
- Laurence presents on some of the work UT MD Anderson is doing to fully automate the treatment planning process
- He presents on their work to auto-plan 3D Conformal female pelvis patients
- He also presents on their work with auto-planning VMAT head and neck patients
- Both Routes represent complete automation of contouring → Isocenter placement → planning → and 3D dose calculation.

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Treatment Planning

- K. Kisling, et al, "A Risk Assessment of Automated Treatment Planning and Recommendations for Clinical Deployment" Med Phys. **46** (6), June 2019, P. 2567-2574
  - https://doi.org/10.1002/mp.13552
- The same team carried out a FEMA analysis of their auto-planning tool in order to determine risk mitigation strategies
- The three highest scoring potential failure modes
  - Wrong Isocenter
  - Inappropriate Jaw Positions
  - Inappropriate MLCs
- All can be caught by physician plan review

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Implementing new automated routines in the clinic

- Charles Mayo: "The Clinic of the Future: Automation in Treatment Planning"
  - https://www.aapm.org/education/VL/vl.asp?id=13500
- He talks about the previous FEMA study
- Extends the point beyond this to weigh the risks of automation that creates more <u>complex</u> workflows within the clinic.
- Safe implementation should augment and not replace current workflows
- Treat it like a new trainee

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TG-275

- E. Ford et Al. " Strategies for effective physics plan and chart review in radiation therapy: Report of AAPM Task Group 275" vol. 47 (6), June 2020, p. e236-e272
  - https://doi.org/10.1002/mp.14030
- The main focus of TG-275 was to provide a comprehensive view of what current medical physicists are including in initial plan and chart review checks
  - Then to make recommendations of where to go with all of the information.
- This was undertaken through a large scale survey of the entire AAPM membership
- FEMA analysis of the results of the survey

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TG-275 continued

- One key finding, was the growth of automation and its greater role in Chart QA
- Importantly, automation facilitates the collection of "big data".
  - Which can be used to identify errors not easily visible to a human reviewer.
- In the Appendix tables, TG-275 Includes their FEMA analysis of all reported initial plan and chart review check components.
  - They also took the step of identifying which could be full or partially automated
  - The final count showed **64%** of reported components were eligible for full or partial automation

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Beware the "Paradox of Automation"

- Stephanie Parker: "The Paradox of Automation
  - https://www.aapm.org/education/VL/vl.asp?id=12837
- The more automated a system:
  - The more important the human interaction
  - The less likely the human interaction is to be effective

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Paradox of Automation

1. Automated Systems accommodate incompetence
2. Automated Systems erode the skills of experts
3. Automated Systems tend to fail in unusual situations, or failure results in unusual situations.

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Automation Bias

- Automation Bias can be described as following the recommendations of an automated system, even when it contradicts training and other valid and available indicators.

http://nymag.com/selectall/2018/01/waze-app-directs-driver-to-drive-car-into-lake-champlain.html

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Thank You

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