# CLINICAL EXPERIENCE WITH MOSAIQ FOR ELECTRONIC RECORD KEEPING OR...

#### WHY EMPLOY A MIXED ENVIRONMENT FOR RECORD AND VERIFY - OIS?

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#### What is a *mixed* environment?

An environment where the R&V, or OIS, system is not manufactured by the same vendor as your linacs and/or your Treatment Planning System (TPS).

E.g. Elekta's Mosaiq used to manage Varian linear accelerators or MosaiQ with Eclipse TPS.

#### Overview

- Brief chronology of R&V / OIS evolution in radiation oncology. i.e. *How did we get here?*
- Perceived advantages/disadvantages of the single vendor, non-mixed, environment.
- Perceived advantages/disadvantages of the multi-vendor, "mixed", environment.
- Questions going forward.
- Conclusions

# Chronology

#### A COMPUTERIZED RECORD AND VERIFY SYSTEM FOR RADIATION TREATMENTS

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#### ROOM # 245 02/22/1983 TECH : KP THERAC-20 01/01/1900 TEGT 000000 TEST, TEST T CURRENT FIELD : 111 226 SIZE 20.0 X 15.0 OLL ENERGY HI. HODE : X ARC TOL ARC DIR RAY GANT HEDGE VERIFICATION FAILURE PRESCRIBED OLERANCE PARAMETER NU PRESCRIBED 556 500 FIELD LENGTH RESET FIELD NUMBER / ALTER PRESCRIPTION MANUAL CHANGE SETTINGS AND TRY AGAIN PRESCRIPTION CHANGE ( AUTOMATIC OVERRIDE, GIVE REASON IN COMMENTS 0 MALFUNCTION IN R&V SYSTEM ENTER OPTION <R>

Fig. 3. Screen frame of the operator's terminal after a verification failure. In the example shown, the current settings of monitor units and field length differ from their prescribed settings by more than the allowable deviations. Therefore the treatment has been inhibited. The operator must now select one of the options from the menu at the bottom of the screen and act accordingly.





Fig. 1. All five radiation treatment machines (Mevatron-12, Therex-20, Clinac-20), Theratron-700 and Theratron-500 are connected to a certrait comparie (a dual VAX 11/780) via hitter respective Data Acquisition Systems (DAS). The Record and Verify System has been implemented only on four of these. The Theratron-80 is stebulated for reglatementa and is being only minimally monitored. The DAS of each machine allows the beam to be turned on or inhibits it, depending upon the signal received from the VAX. A VT 100 is provided with each machine for the operator to communicate with the VAX to issue commands and receive messages. The line printer is for printing reports. The switching system allows switching of treatment machines and their VT 100 terminals to the back-up of VAX in its the event of failure of the primary VAX.

### Varian RMS

- □ Late 1980's Early 1990's
- Basic functionality
- 1990 UTHSCSA
- Proprietary database that was not 'ported' forward when RMS was replaced. i.e. all our data was left behind in RMS.

## 1991 - IMPAC Multi-Access

- Broader applications
- Vision of running the entire department's operations
- Verify and Record, Scheduling, Billing
  1993 UTHSCSA
  Market leader
  Perks of the deal



Joe Jachinowski David Auerbach Jay Hoey



**Computer Networking and Information Systems in Radiation Oncology** Michael G. Herman Ph.D. Mayo Clinic, Rochester MN.

https://www.aapm.org/meetings/99AM/pdf/2755-16806.pdf

#### 1993 - Varian Varis

Varian's counter to Multi-Access

#### June 2000 - Varian announces plans to buy IMPAC Medical Systems

November 6, 2000 - Justice Department Announces Intention to Block Varian Medical Systems' Acquisition of IMPAC Medical Systems

# 2004 - IMPAC MosaiQ

- Computerized physician order entry (CPOE)
- customizable assessments
- document and image management
- DICOM-RT services for PACS implementation
- Continued to dominate market share

#### **MOSAIQ: Image-Enabled Oncology EMR** Quality Patient Workup Review Oncology Independent CPOE Verification **Radiation Oncology** RTP Patient Plan Import Positioning Plan Treatment Approval Setup Pre-Tx

QA

ELEKTA

# 2005 - Varian Aria

- A comprehensive real-time management system and database
- for operating filmless and paperless cancer clinics
- that offer radiation therapy, chemotherapy, and/or surgery.
- Focus of significant resources in effort to compete for market share.

#### 2005 - Elekta announces acquisition of IMPAC Medical Systems

#### 2005 to Present

Impac MosaiQ evolving feature set and transitioning to an Elekta run product

 Varian focusing significant development commitment into Aria.

My Opinion: Aria has recently emerged as formidable competitor to MosaiQ.

## Today

- Varian still has the largest number of linacs in place in the U.S., followed by Elekta and Siemens.
- Aria has been increasing its market share due to significant improvements in its feature set and functionality.
- Because of IMPAC's initial dominance of the R&V market in radiation oncology,
- There still exists a large contingent of centers who still use MosaiQ to run Varian linacs.

#### So, what's the right decision?

Continue to use MosaiQ to run our all-Varian linac operations, mixed linac-vendor operations?

Switch to Aria, in particular, for all Varian environments?

#### Overview

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- Conclusions

Perceived Advantages / Disadvantages of a Single Vendor Solution

 Advantage:
Smoother, more efficient interaction / communication between OIS and Treatment Planning System (TPS). Example...

#### Prescription and Plan Approval example

#### With Elekta's MosaiQ and Varian's Eclipse TPS

#### Mosaiq Prescription and Plan approval - detailed steps

1. MD enters 'initial intended' prescription information in Mosaiq (not Eclipse).

Radiation Prescriptions - MRN: PHY09172013 Chartless, Test								
Dx: *Thymus							Close	
Course: 11							Add	
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Rx Site: Pelvis Status: Pending <u>V</u> iew Fractions: By Course								
Technique: IMRT PLAN	Technique: IMRT PLAN							
Modality:								
Dose Spec:				Week	[	SMTW	TFSA	Note
Rx Fractional	Number of Fractional	tion Stat	us	1 2		1 2 3 6 7 8	4 5 9 10	T <u>x</u> Plan
4,500 cGy 180 cGy	25 Daily			<u> </u>		11 12 13 16 17 18	14 15 19 20	S <u>t</u> atus
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Dose Limits	F	attern:						
Total Cum:	Cor	nment:						
								FX Notes
Radiation Rx is View Only								

MD enters 'initial intended' prescription information in Mosaiq.

Note that the technique was initially set to static gantry IMRT.

#### Mosaiq prescription approval example

- 1. MD enters 'initial intended' prescription information in Mosaiq. Sometimes. Same problem in Aria.
- 2. Based on conversation between Dosimetrist and Physician at Simulation, the Dosimetrist generates tx plan in Eclipse using the initial intended prescription.
  - Tx technique, energy, machine, etc. may change after this initial prescription was entered.





Dosimetrist generates TX plan in Eclipse based on the initial intended prescription.

Note multiple plans were run in Eclipse. We started with Static Gantry IMRT but ended up with a VMAT plan. After MD reviews and chooses the VMAT plan in Eclipse, the MD needs to communicate this information with the dosimetrist.

#### Mosaiq prescription approval

- 1. MD enters 'initial intended' prescription information in Mosaiq. Sometimes. Same problem in Aria.
- 2. Based on conversation between Dosimetrist and Physician at Simulation, the Dosimetrist generates tx plan in Eclipse using the initial intended prescription.
  - Tx technique, energy, machine, etc. may change after this initial prescription was entered.
- <sup>33.</sup> When plan is complete, MD meets with Dosimetrist and reviews and approves (verbally) the plan in Eclipse.
- Dosimetrist approves the plan in Eclipse to lock it from being changed.



# Mosaiq prescription approval detail steps

- MD enters 'initial intended' prescription information in Mosaiq. Sometimes. Same problem in Aria.
- 2. Based on conversation between Dosimetrist and Physician at Simulation, the Dosimetrist generates tx plan in Eclipse using the initial intended prescription.
  - Tx technique, energy, machine, etc. may change after this initial prescription was entered.
- 3. When plan is complete, MD meets with Dosimetrist and reviews and approves (verbally) the plan in Eclipse.
- <sup>4.</sup> Dosimetrist Approving the plan also locks the prescription, energy, TX technique. Etc.
- 5. Dosimetrist exports the plan as .pdf from Eclipse to network folder.
- 6. Dosimetrist uses Mosaiq to import .pdf of plan into MosaiQ.
- 7. MD approves prescription along with its plan in Mosaiq when it's ready
- 8. This is our "Official" Plan Approval

Extra steps and potentially problematic.



MD approves prescription in MosaiQ.

Must confirm that the treatment technique, energy, etc. are same as the Eclipse plan they verbally approved before approving the prescription. i.e. No mismatch between MosaiQ and Eclipse.

They do this be either remembering what the plan details were or by looking at the .pdf in Mosaiq.

#### How would this work with Aria and Eclipse?

#### Aria prescription approval steps

 MD enters "initial intended" prescription in Aria and approves

- The Rx can be edited later, if needed
- A plan can be linked to a Rx

### **Prescription list**



- The prescription list shows all prescriptions for the patient
- The prescriptions are organized by treatment course
  - In this example both Rx are in the course named "1 Pelvis test"
- The status of the Rx can be seen at the right
  - In this case one Rx is approved and one is a draft
- Treatment plans that are linked to a particular Rx can also be seen
  - The plan named "50.4Gy #" is linked to the Rx named "PTV50.4"

#### Prescription details (initial plan)

Prescription Review								
Course: 1 Pelvis test Diagnosis:		Intent: Curative		Template:				
PTV50.4 - [80] boost [Primary : Approved] [Boost : Draft]								
Treatment Prescription			Treatment Management			Prescription Coverage Constraints		
Rx Status:	Approved			Imaging Frequency:	CBCT: Pre Tx : Other Frequency- Daily			
Site:	Site: Pelvis		Gating:	Gating:				
Prescription Name:	ription Name: PTV50.4			Bolus:	Bolus:			
Start:				Breakpoint:				
Fractions:	28			Labs:				
Prescribe To:	PTV50.4 5040 cGy 180 cGy	/ Frac		Simulation:	No			
Mode: Photon		Notes:						
Technique: IMRT								
Primary/Boost:	Primary						Organ at Risk Constraints	
Energy:	Energy: 6X							
Frequency: Once daily, 5 times a week								
				APPROVED Wed, 3/2/	016 et 10:27 AM		Treatment Plans	
						50.4Gy #		
	Mark as Reviewed		Approve		Edit		Cancel Save as Template	

- Clicking on one of the Rx's shows its details
- The user name and date of approval is given
- MD users have the option to edit a Rx, if needed, and then must re-approve

### Prescription details (boost)

Prescription Review							
Course: 1 Pelvis test Diagnosis:		Intent: Curative	Template:				
[P	PTV50.4 - [R0] boost irimary : Approved] [Boost : Draft]						
Treatment Pres	cription	Treatment Management	Prescription Coverage Constraints				
Rx Status:	Draft	Imaging Frequency: CBCT: Pre Tx : Other Frequency- Daily					
Site:	Prostate	Gating:					
Prescription Name:	boost	Bolus:					
Start:		Breakpoint:					
Fractions:	16	Labs:					
Prescribe To:	PTV boost 2880 cGy 180 cGy / Frac	Simulation: No					
Mode:	Photon	Notes:					
Technique:	IMRT						
Primary/Boost:	Boost						
Energy:	6X		Organ at Risk Constraints				
Frequency:	Once daily, 5 times a week						
			Treatment Plans				
	Mark as Reviewed Approve	Edit	Cancel Save as Template				
	Mark as Reviewed Approve	Edit	Cancel Save as Template				

MDs can approve a Rx by pressing approve and entering their password

#### Linking Rx's to treatment plans

 A treatment plan can be linked to a Rx by going into the plan properties and selecting the Rx from a dropdown list

🔰 Plan Properties			- • •					
Comment	Equipmen	t Calc	ulation Models					
General	Dose	RT Prescription	Technical					
ID								
50.4Gy #								
Treatment Prescription								
ID PTV50.4 : R0 [Approved]								
	ス							
Туре	Plan	RT Prescription						
ID	50.4Gy#	PTV50.4 : R0						
Fractions	28	28						
Target/Prescribe To	PTV 50.4	PTV50.4						
Dose/Frac [cGy]	180.0	180.0						
Total Dose [cGy]	5040.0	5040.0						
			Undets Blaz					
			Update Plan					
		test Revision Brons						
	L	atest Revision Prope	rues					
	Li	erties						
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#### Linking Rx's to treatment plans

- The linked plan is displayed under the Rx
- The approval status of the Rx is color-coded
  - E.g., the approved Rx is green



#### Comparison

Transfer of treatment plan and associated imaging for setup from Eclipse

MosaiQ/Eclipse

Plan approved in TPS

Plan transferred to MosaiQ

DRRs sent to MosaiQ

Sim CT sent to MosaiQ

Plan approved in MosaiQ

Ready to treat



Plan approved in TPS (DRRs created) (sim CT available)

Tx approved in Aria

Ready to treat

Much of the inconveneience in Mosaiq is eliminated by a new module called Evaluate.
Evaluate allows a Mosaiq user to open a Dicom plan from any planning system in Mosaiq.
## Mosaiq Evaluate steps

- Dosimetrist exports possible tx plans from eclipse to Mosaiq for MD review.
- The plans will show up on the MD's consolidated worklist in their Mosaiq homepage.
- MD reviews the plan(s), and decides to approve or reject the plan(s).
- The approval or rejection action will automatically trigger (IQ Scripts-defined later) the next step for the dosimetrist to work on.
- Dosimetrist Promotes the approved plan in Mosaiq for MD final approval before the plan is ready for physics checks, followed by treatment delivery.



Main Evaluate window. Live view to evaluate tx plans.

Screenshot from MOSAIQ 2.60-2.64 Evaluate Training Mod



#### Evaluate display can be modified for easy review purpose.

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Review DVH in Evaluate.



Set up goals in DVH to show pass/fail result. Green check marks show the factors that pass, and red cross marks show the ones that fail.



#### MD can approve the plan if they are satisfied with the plan.



Dosimetrist promotes (similar to importing RT Plan, i.e. tx field parameters) the plan after plan approval.



Multiple plan review (plan comparison) in Evaluate. The screen capture shows live review dose distribution between two plans.



DVH comparison in Evaluate. The screen capture shows live review dose distribution between two plans.

#### Perceived Advantages / Disadvantages of a Single Vendor Solution

Better communication between EMR and Treatment Planning System. Example RX and Transfer and approval...

Advantage:No Feature Lag.

## Feature Lag

- Is the delay in one vendor's newly released functionality becoming available/enabled by the "other" vendor.
- Example, Varian may release a new 6DOF robotic couch before Mosaiq can fully support it.
- Cooperation between the vendors is required for this to be efficient, and cooperation may not always be 100%.
- But resource allocation can also be a factor, as Elekta could be prioritizing development resources to implement a cool new feature on their own linac, versus hurrying to support Varian's new feature.

## Feature Lag

- It stands to reason that a particular vendor (e.g. Varian) can more easily introduce innovative new features for their Linac, if it is supported by their own OIS (i.e. Aria).
- Versus Mosaiq having to scramble to support the new Varian linac feature (e.g. True Beam).
- The same would be true for Elekta more easily supporting new linac features in MosaiQ for their Versa HD linac.

## On Demand Imaging, example

The True Beam linac is capable of ON DEMAND imaging, which allows for acquisition of image guidance imaging that was not planned or scheduled on Treatment Calendar.

i.e. Convenient, on-the-fly imaging at the machine.

### On Demand Imaging, example

#### Problem in Mosaiq 2.4:

- If you acquire a CBCT ON DEMAND for Mosaiq v2.4 the CBCT will transfer back TO Mosaiq but will not be <u>Associated</u> with the reference CT.
- If you acquire a planar image On Demand the planar image will transfer from True Beam back to Mosaiq, but the DRR will not.
- If you acquire True Beam Triggered Imaging On Demand, only the last image acquired will transfer back, not the whole set of Triggered Images.
- In Aria everything is stored in the same database, so it all works.

## On Demand Imaging, example

These limitations may be fixed in Mosaiq v2.62
 We will know when we complete our upgrade in 2 weeks.



- When the True Beam takes a CBCT it automatically centers the couch to ensure clearance for linac rotation.
- When the imaging is done it returns the couch automatically to the treatment isocenter location.
- Problem: When Mosaiq v2.4 receives the Image Guidance couch position change from True Beam they are extremely large because the IG shifts have been combined with the <u>couch centering shift</u>.
- This is obviously a communication issue between True Beam and Mosaiq and this may be fixed when we upgrade to v2.62

## Work Arounds

- Each of these examples, On Demand Imaging and couch coordinates for Tolerance Tables, can be dealt with / worked-around in Mosaiq.
- They just involve some extra steps and understanding.
- For On Demand manually Associate or Import the Reference image.
- For couch values we have to understand that situations that are flagged by Mosaiq as Tolerance Table Over Rides are not real over rides, just a mis-communication between Mosaiq and the True Beam.
- But they are inconvenient and inefficient.
- Mosaiq will eventually correct / catch up with these features and the problem will go away.
- □ There is just some Lag time for this to happen.

## Upgrade frequency

- Many of the previously described problems are eventually fixed by an upgrade/update.
- So, how frequently should we upgrade?
- As soon as the vendor brings out a new version?
- We skipped Mosaiq v2.5 because it introduced new problems with functionality on our Siemens Artiste with CTOR.

## Upgrade frequency

- Also, remember that multiple publications, including TG142, say that careful QA of the R&V system must occur whenever changes are made to software or the overall process.
- This is a LOT of work, that may cause us to choose to delay and only do key updates that have important implications.

Multiple publications, including TG 142 on QA of Medical Linear Accelerators, suggest that careful QA of the R&V system occur whenever changes are made to software or the overall process.

20%	1.	True	
20%	2.	False	
20%			
20%			
20%			

Multiple publications, including TG 142 on QA of Medical Linear Accelerators, suggest that careful QA of the R&V system occur whenever changes are made to software or the overall process.

Answer: TRUE

References: AAPM TG 142, Strahlenther Onkol. 2006 Aug;182(8):481-8.



#### Perceived Advantages of a Mixed Environment Solution

#### Perceived Advantages of a Mixed Environment Solution

- There is a reason that Mosaiq has been a market leader for so long.
- They have led the way in implementation of new, broader applications for both R&V and overall management of our radiation oncology operations.

#### Innovative and Valuable Features

Quality Checklists

# **QCL** Definition

- MOSAIQ Quality Check Lists (QCLs) are groups of procedures, tasks, or activities. A department uses QCLs to assign and monitor tasks. QCLs can be used to remind staff of tasks that must be completed and easily monitor the status through those tasks.
- All of the individual tasks associated with a large process (e.g. External beam Treatment Planning) can be distributed in one step to all of the To Do lists (QCL's) of individuals involved in the process.
  E.g. Dosimetrist import CT from CT Sim; Physician do the Contours; Dosimetrist Do the Plan; etc.

## Which of the following are True?

20%	1.	A user Work List, called a "Quality Check List-QCL" in MosaiQ, is a list of "To Do" items for a particular User.
20%	2.	A department can use QCL's to assign and monitor tasks.
20%	3.	All of the individual tasks associated with a large process can be distributed to multiple users in a single step.
20%		None of the above
20%		All of the above?

## Which of the following are True?

20%	1.	A user Work List, called a "Quality Check List-QCL" in MosaiQ, is a list of "To Do" items for a particular User.
20%	2.	Items can be "Triggered" to be added to a worklist based on various events.
20%	3.	Events such as an added RX, or a changed observation value, or the completion of a previous step on the Work List can be used as "Triggers".
20%		None of the above
20%		All of the above.

## The problem / limitation

Is that all of these steps are distributed at once (shotgun) even though some can't be completed until the preceding step is done.
 That's where Scripting can help.

#### **Innovative and Valuable Features**

Quality ChecklistsScripting

### The solution: IQScripts

Mosaiq IQScripts will cause each To Do item to be put onto an individual's Work List only once the preceding step is complete.

 It automatically sequences, or distributes, the tasks in proper order.

## **IQ** Scripts Definition

- IQ Scripts are Mosaiq pre-built procedure flows that use simple scripting from preferences that connect tasks in a chain and make it easier to automate workflows.
- Once tasks are completed within the OIS (e.g. Mosaiq) then the task is removed from one person or group's Work List and can appear on the Work List of the next person/step in the process.

## IQ Script Workflow Design





#### **OIS Scripting - General Definition**

Pre-built, computerized automation of a multiple step workflow by automatically queuing sequential steps of the process on a user worklist.

#### Scripting in the Radiation Oncology EMR environment refers to:

20%	1.	The process of writing multiple prescriptions efficiently in a computerized environment.
20%	2.	The process of carefully describing the patient workflow.
20%	3.	Pre-built, computerized automation of a multiple step workflow by automatically queuing sequential steps of the process on a user worklist.
20%	4.	The process of reading from a checklist when performing a complex SBRT workflow.
20%	5.	Specification of the chemotherapy drug prescription.

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## Perceived Advantages of a Mixed Environment Solution

- In addition to the fact that Mosaiq has been the long standing market leader in OIS
- And has introduced many new and valuable features to the OIS environment
- There is also a legacy from the Impac days of Mosaiq working well with other vendor's products.
- Elekta now owns Impac, which had a legacy of supporting all vendors equipment well. Now that Elekta owns Impac will they continue this commitment?
- It is only natural that Elekta, like Varian, will commit significant resources to making their OIS fully functional with their own linacs.
- Are the days of "strong" support for other vendor's equipment gone now that both of the leading OIS's are owned by a linac manufacturer?

#### Interestingly...

RaySearch has recently announced that they will bring to market in late 2017 a new Radiation Oncology OIS called RayCare.

#### **RAYCARE - NEXT GENERATION OIS**

#### Key features

- Workflow automation
- Treatment adaptation
- Optimization of resource utilization
- Integrated follow-up and clinical analytics
- Advanced decision support
- Patient involvement in the treatment
- Easy configuration for the clinic's specific needs
- All standard OIS features, modernized

Not available for purchase. Not 510K Cleared.





#### SUPPORT FOR MIXED TREATMENT DELIVERY ENVIRONMENTS

- Collaborations with hardware vendors
- Streamlined machine-specific workflows
- Optimized utilization of clinic resources
- Access to advanced algorithms in the treatment room
  - Modality worklist support

Not available for purchase. Not 510K Cleared.





#### **STATE OF THE ART USABILITY**

- Graphical representation of data
- Complex flows simply presented
- Information visible when needed
- Modern and innovative design
- Usability experts involved at all stages
- Continuous feedback from partner clinics guides the design





### Interestingly...

"Support for mixed treatment delivery environments"

Collaborations with hardware vendors"

"Treatment Adaptation"

Can Elekta continue the strong reputation that Impac had for customer service?

- Will Varian grow its level of support for Elekta linacs?
- With Siemens out of the linac business some say that Accuray has stepped into the role of the 3<sup>rd</sup> linac vendor.
- Will either vendor grow support for Accuray's Tomotherapy or CyberKnife linacs?

Are we headed for days when mixed environments are not practical?

Or will there always be a desire amongst customers to choose products from multiple linac vendors (e.g. Varian, Elekta, Accuray, etc.)

#### Conclusions

- The Mosaiq OIS environment continues as a strong player in the market.
- Many Mosaiq users are long time users who chose Mosaiq when they were the clear market leader.
- Many of these users are so-called *mixed* environment users, who have linac and treatment planning equipment from vendors other than Elekta.

### Conclusions

- Existing in such an environment means that some compromises are required
- Such as dealing with work arounds and feature lag on the "other" vendors equipment.
- Some may see this as a major inconvenience, justifying strong consideration of a switch to Aria.

#### Conclusions

- While others see it as small relative to the advantages of remaining with the product that largely shaped the OIS field.
- These same users might argue that many of us will *always* exist in a mixed environment because will always want to be able to select the best linac and deal on the market at that time.

## At the end of the day

- It's an individual decision.
- Based on nuances specific to each user's situation and history.
- There is no single right answer.
- In the end...



# You pays your money And you takes your chances.

Thank You.



Thank You