Potential Improvements of Planning Workflow by Automatic Generation of Planning Support Structures for Nasopharyngeal Carcinoma (NPC) Treatment Planning

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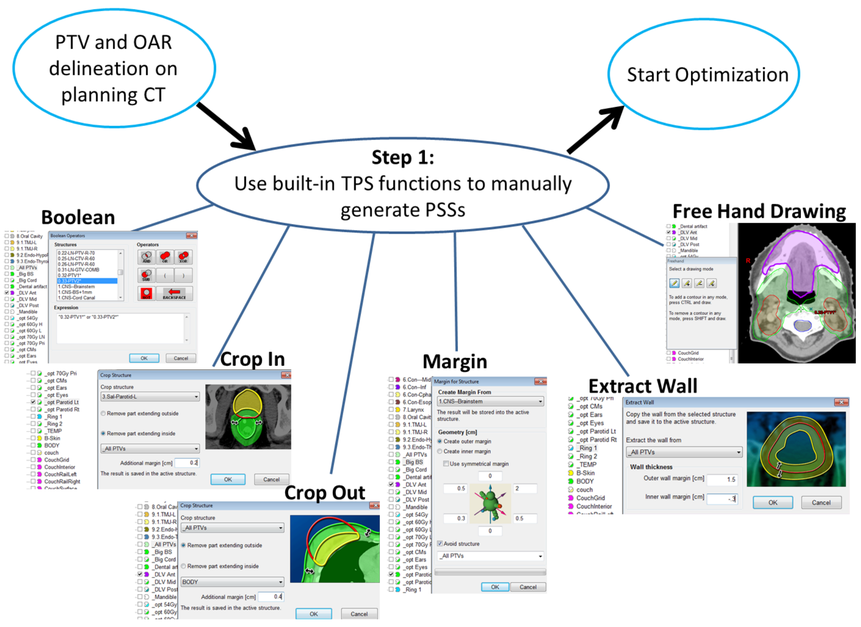
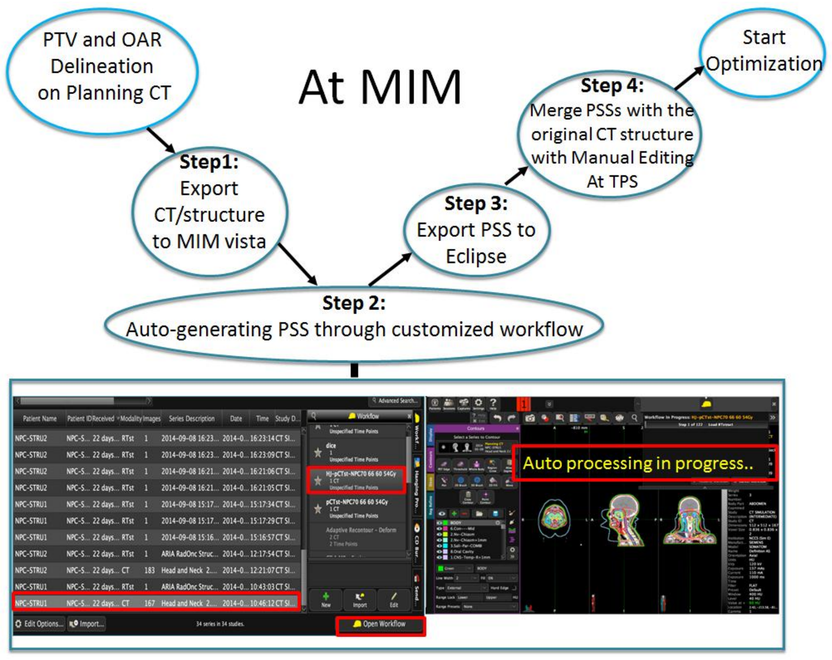
Introduction:
Due to the complex anatomy of the Nasopharynx, modern inverse planning has been implemented as a standard of care for Nasopharyngeal Carcinoma (NPC) radiotherapy treatment. Planning support structures (PSSs) are routinely created by dosimetrists based on the Planning Target Volumes (PTVs), Organs-at-Risk (OARs) and normal tissues, prior to optimization, to achieve a desired dose distribution. It is a time consuming process, as the list of PSSs can be very long, especially when planning for complex target volumes in the H&N region. Many strategies have been developed for automation of OAR contouring as well as the transfer of contours from the initial planning CT to Re-CT images. However, little to no study has been performed on the automatic processing of PSSs. The reason might be that PSSs vary widely among different centres and that the contouring of PSSs is also dependent on planners' personal experiences and preferences**.** At National Cancer Centre of Singapore (NCCS), a typical NPC case will have 25 target volumes and 31 OARs contoured by the physician, and a dosimetrist could spend on average 80min (40min to 120min) to generate as many as 40 PSSs, which include boolean structures for targets, overlapping OARs and dummy structures.

Materials and Methods:
Two methods of creating PSSs were compared in 3 different staged NPC cases: T3N2M0, T2N3M0 and T1N0M0.

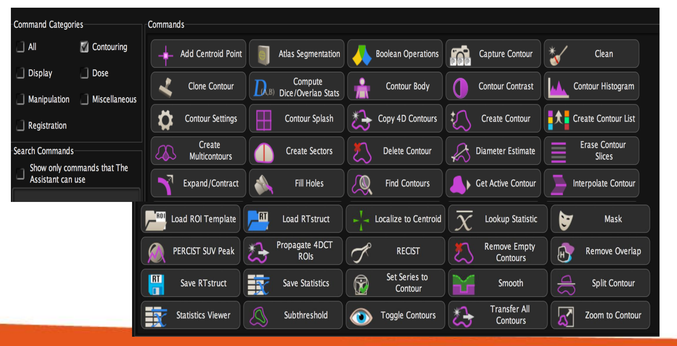
Method 1: Manual creation of PSSs with Varian's Eclipse TPS (V10.0.28) by using built-in contouring functions such as boolean operators, structure cropping and freehand drawing.



Method 2: Using a customized workflow in MIM Vista (V6.2.4) for the automated generation of PSSs, which would be exported to Eclipse for treatment planning. Automated workflows can easily be created in MIM Vista using a visual scripting language, without any prior programming knowledge or experience.

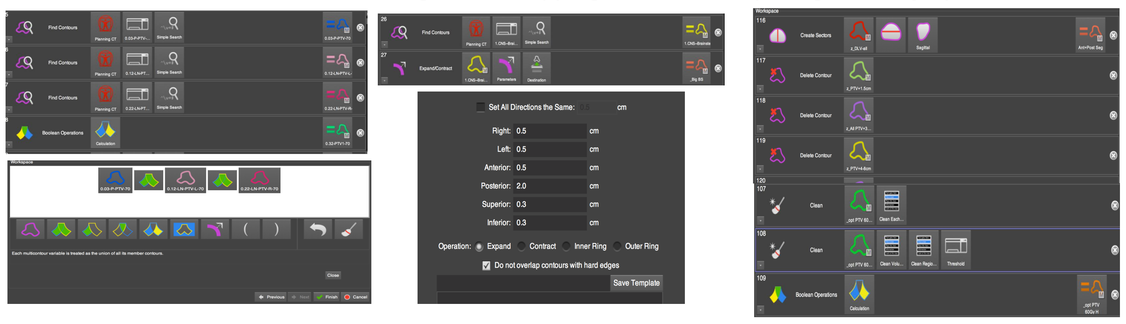


* Commands for creating customized workflow at MIM. A 122 steps workflow has been created for this project prior to comparing the 2 methods.

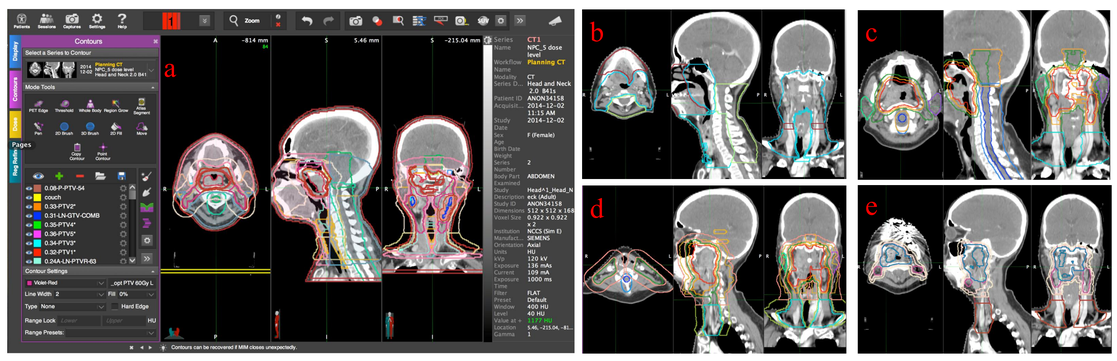


*Examples of creating steps for generating PSS as per manual way:

Boolean *Margin and Cropping* *Splitting and Tidy up Final Vol. List*



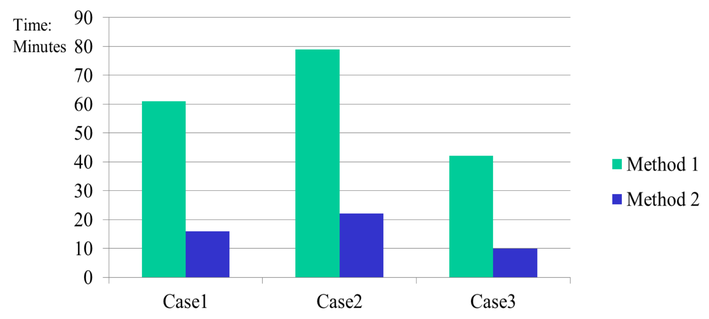
*Results of some Auto-processed contours:



a: Post processed PSS contours; b:Ant/Post DLVs; c:Rt/Lt Opt. Parotid; d:Ring; e:Opt. PTVs

Results:
The time spent using the manual method (Method 1) for the 3 cases was 61, 79, 42 minutes respectively, and with the automated method (Method 2) was 16, 22, 10 minutes respectively. The average time saved was 74%. This time included the time taken to export the structure set to MIM and re-import it back into Eclipse with manual editing when necessary.

	Case 1-MIM-01 (T3N2M0)		Case 2-MIM-02 (T2N3M0)		Case3-MIM-03 (T1N0M0)	
Total Planning Support Structures processed	38		37		32	
Method:1	61min		79min		42min	
Method:2	16mim		22min		10min	
	@MIM	@TPS	@MIM	@TPS	@MIM	@TPS
	3min	13min	3min	19min	3min	7min
Overall Time saving on Method 2	45min (73.77%)		57mim (72.15%)		32mim (76.19%)	



Discussion and future work:
Customized workflows can a save remarkable amount of time in plan preparation and also minimize potential human errors associated with manual processing. Moreover, a consistent methodology in generating PSSs can pave the way for more automated processes, such as template based planning, can shorten learning curves and harmonize planning techniques between individuals and departments. If such an automated system was setup within the system used for contouring and optimization, the time savings would be even more significant.

Caveats:
- Automated workflows generally need consistent structure naming to work.
- Automatic processing can not replace all pre-optimization preparation thus careful checking through all PSSs and manual editing may still needed before optimization.
- The PSSs may need to be transferred between systems (MIM Vista to Eclipse in our case) if the automation workflow is not available on the TPS where planning is done. This process needs to be validated, to make sure that the volumes are not being altered too much due to differences in the way different systems handle contours and structures.

Conclusion:
Automating the process of PSSs can significantly shorten the overall planning time for better planning throughput and the time saved may be used to further improve treatment plan. MIM Vista provides a good platform to automate the generation of PSSs without prior programming experience from Dosimetrists.