

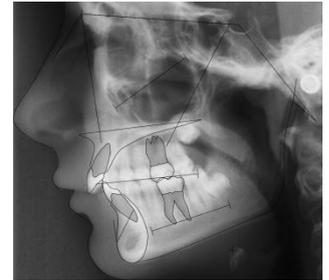
Tiops Simulation, Part I:

Simulation of Orthodontic/Orthopedic correction in the growing patient.

One of the most valuable features of the TIOPS program is the ability to aid the clinician in simulating treatment. This feature is a great help in treatment planning as it provides a means of obtaining a clear idea of the treatment possibilities and the needed dental movements as well as the anchorage needs in a specific patient.

Start up the Procedure

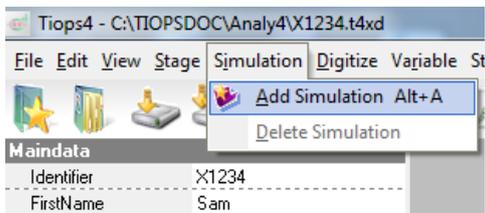
1. The process of simulating a patient's treatment requires at a minimum a digitized and saved Lateral Analysis. A superimposed lateral facial photo as well as upper and lower occlusograms will add further information as these components will be included in the simulation. The simulation process is initiated by opening the patient file and then selecting the stage to be the reference for the simulation.



2. To create or add a New Simulation to a Patient's File hold



and press



This opens several simulation options under the heading Simulation1 and automatically creates a new Simulation seen in purple on the computer screen.

Alternatively you can click the New Simulation Button located on the menu bar or use the Simulation pull down menu and click Add Simulation.



What you see on the computer screen is **not** the final treatment plan, but at starting point for the planning process.

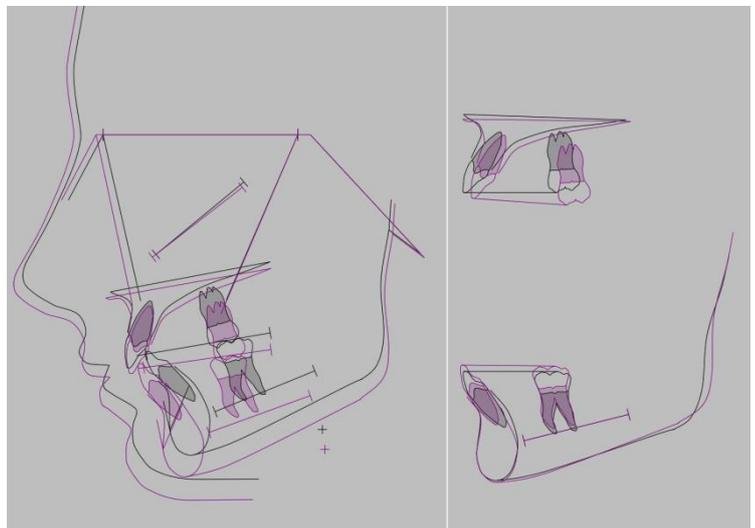
As the first step in the simulation process, the program has as a default added 24 months of facial growth based on the age, sex and the morphology of the patient. This includes the amount of growth rotation of both maxilla and mandible.

As the second step the lower incisor is placed by the program in an average position, with respect to the incisal edge and inclination. This is **not** to be considered the final position for this tooth but acts only as a starting point for the simulation.

Then the dentition, represented by the incisors and first molars, is positioned as in a virtual set up in normal or Class I occlusion as seen on the general superimposition as well as in the separate maxillary and mandibular superimpositions in the right panel that shows the actual tooth movements within each jaw.

The simulation does **not** provide a final treatment plan, but is a graphical workspace where the clinician can test different treatment strategies. When the individual treatment parameters are altered, the program immediately recalculates the changes and the illustrated simulations change accordingly.

We suggest that you use this process to test one or more preliminary treatment plans for a given patient and change the parameters you think are important for the particular treatment you have in mind. As you proceed the process will make you consider most of the treatment parameters that are important for that particular patient.

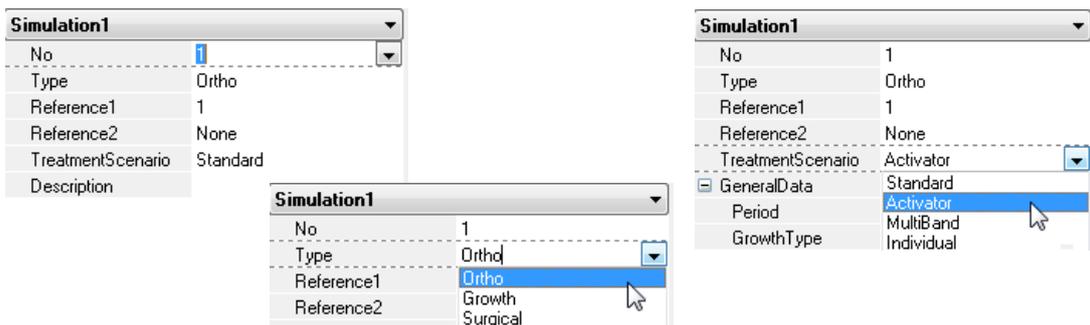


Proceed

- In the Data Input Panel on the left side of the screen move down to the field labeled **Type** and click on the arrow to open up a selection of options that include **Ortho, Growth and Surgical**. The Ortho option includes simulation of Orthodontic/Orthopedic correction in growing or non-growing patients. To change the selection click on the appropriate type or press the letters <o>, <g> or <s> without opening the drop-down list.

If you have made more than one lateral analysis for the patient, make sure to select the **appropriate analysis** as Reference1. For the Reference2 item see [note 1](#).

Then proceed to your choice of **TreatmentScenario**. For each Simulation **Type** you can choose different Scenario's. For further explanation see [note 2](#).



The field **Description** is available for inclusion of your own comments or notes.

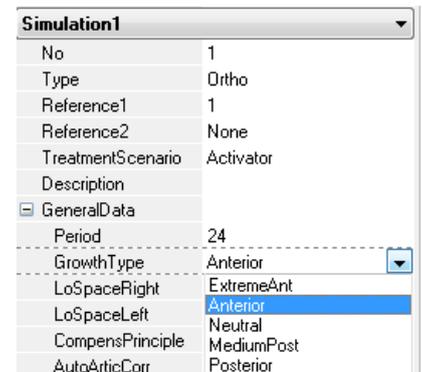
- Go to the **GeneralData** segment and make any changes needed:

Change the value for the simulation **Period** according to your expected treatment period and the program recalculates the amount of expected growth.

You may now consider changing the **GrowthType** to suit the individual patient. The options available are based on the structural signs based on the growth studies by Björk, A, 1963. One important parameter is the expected mandibular growth rotation that is automatically calculated in Tiops4 and listed in the **Variable View**.

		Stage1	Simulation1
- PREDICTIONS			
MandRotYear	deg	-2.6 -1.2 -1.4	-2.7 -1.4 -1.3

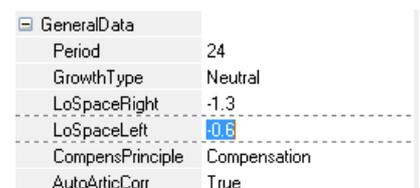
The program has built in values for each possible type and degree of growth rotation and places the lower incisors at different relationship to the ss-pg (A-Pg) line (Ricketts, 1957) according to growth rotation type, see [Note 4](#).



- Space conditions in the lower arch are important values to enter in the box labeled **LoSpaceLeft** and **LoSpaceRight**. These numbers should be accurate as they influence the simulation greatly as we will see later.

If you have included occlusograms in the analysis then use the calculated space parameters. For further explanation see [note 3](#).

		Stage1	Simulation1
SpaceR	mm	-1.3 0.0 -0.7	0.0 0.0 0.0
SpaceL	mm	-0.6 0.0 -0.3	0.0 0.0 0.0

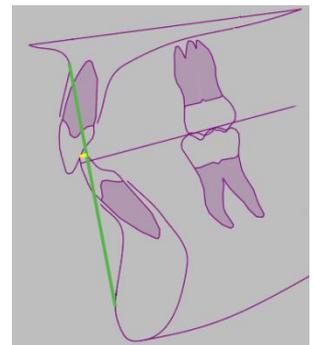


The items **CompensPrinciple** and **AutoArticCorr** will be further explained in Part 2 of this guide. Do not change the defaults values for now.

6. Now take a new look at the tracings to see what you have accomplished so far! Please notice the separate upper and lower jaw tracings in the right panel are superimposed on their respective reference lines and the tooth movements represent the true movements within the jaws. **See below for further details with respect to the automatic sequences used in the Simulation Process:**

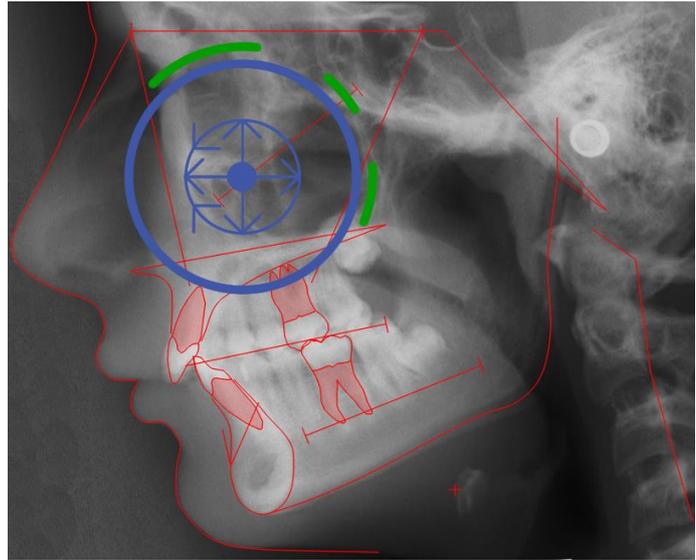
		Stage1	Simulation1
VERTICAL	NSI/IL	deg 10.7 6.7 1.3	10.0 7.1 0.9
	NSI/OLF	deg 9.8 20.3 -2.6	8.0 18.6 -2.6

- The estimated amount of growth is added to the total facial skeleton using the axis from sa (sella anterior) to pg (pogonion) as a guide. The amount is based on the age of the patient, sex and simulation period. The estimated growth and rotation of the maxilla and the mandible is thereafter calculated using the principles from the Björk Growth Studies.
- A further refinement of the estimation of stage of maturation can be obtained by using a hand wrist radiograph and the built in TW2 RUS method (Tanner and Whitehouse, 1975, 1983). You may also enter the Skeletal Age, obtained from a different type of maturation analysis in the field **ForcedSkeletalAge** under the heading **Stage** data. This will override the RUS data.
- The lower incisor is then placed with the incisal edge related to the MML (A-Pg) line depending on the GrowthType. The inclination is set to ideal to this line as well, see [Note 4](#).
- The upper incisor is then placed in an ideal (mean) relationship to the lower incisor and in a normal overjet and overbite relationship. The functional occlusal plane is overlapped by 1.25 mm of the upper and lower incisors respectively. The overbite and the overjet are adjusted to 3 and 2.5 mm respectively.
- The next step is the location of the lower first molar that is placed by the program at the initially digitized distance from the lower incisor plus or minus the amount of crowding or spacing per side. As the space estimate is critical for a reliable simulation it can be more accurately determined by digitizing an occlusogram of the lower jaw and then transfer this to the simulation, see [Note 5](#).
- The upper first molar is now placed by the program in a solid Normal or Class I occlusion. The results of these four steps are comparable to a virtual setup of the dentition. From here on the simulation can be further refined as needed to fit the treatment situation as previously explained



Applying the simulation process in treatment planning

First consider the theoretical options for modification of maxillary growth as illustrated. The green markings represent the sutures, the growth sites.

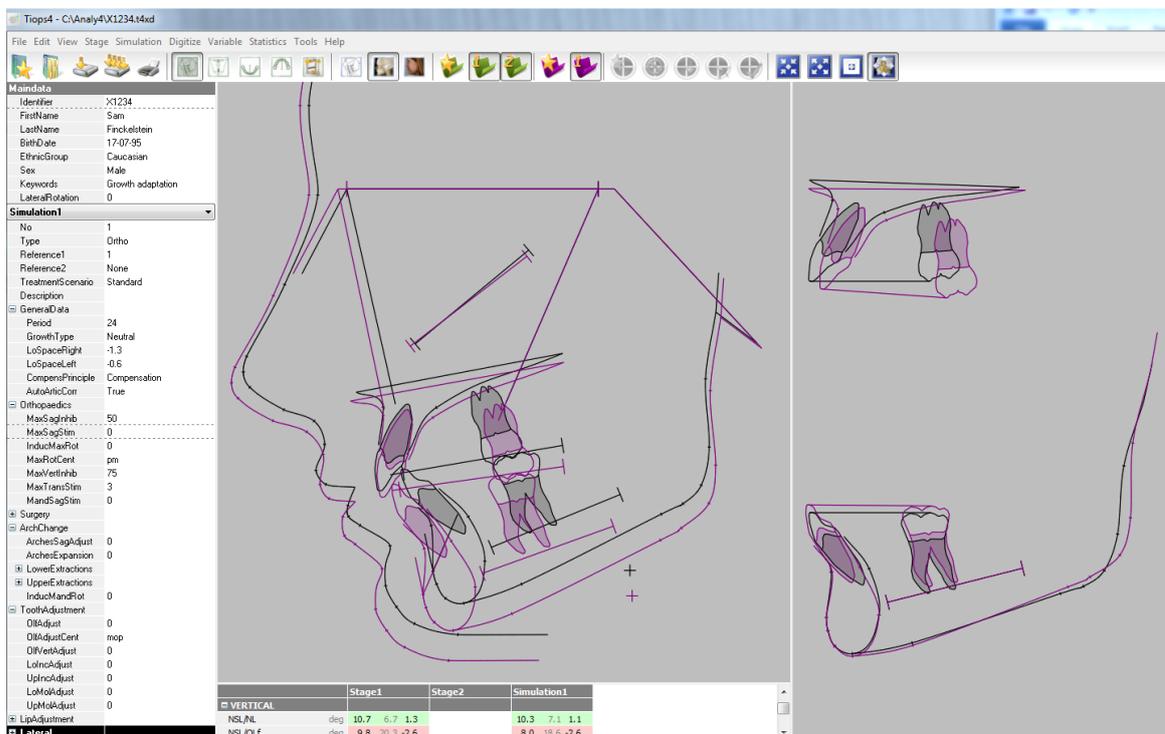


Orthopaedics	
MaxSagInhib	50
MaxSagStim	0
InducMaxRot	0
MaxRotCent	pm
MaxVertInhib	75
MaxTransStim	3
MandSagStim	0

7. In the segment labeled **Orthopaedics** you should enter values for each treatment option as appropriate. Here are some suggestions:
 8. If you plan to use an Activator in treatment of a Class II malocclusion we suggest you put an estimate of 30-50% of restrain on the predicted amount of maxillary sagittal growth in the field labeled **MaxSagInhib**. This will reduce the amount of forward maxillary growth simulated and is what is generally seen in activator treated cases. When using skeletal anchorage the inhibition might reach as much as 100%.
 9. Maxillary Sagittal Stimulation is used in cases where a protraction headgear is planned. Enter the expected amount of advancement in mm.
 10. If you expect that during treatment you will have some downward rotation of the Maxilla then enter the amount in degrees, but be conservative. The center is in most cases located in the posterior nasal spine area, pm/(PNS). However, if you are using a reverse pull headgear it may be at sp (ANS). In most instances the rotation of the maxilla will induce an unwanted posterior (counterclockwise) rotation of the mandible, so it is desirable to reduce this tendency as much as possible with the correct treatment mechanics.
 11. In the field **MaxVertInhib** you can enter the percentage of the expected vertical inhibition when using a HP headgear, skeletal anchorage or similar. If you have no idea of the amount, leave it blank.
 12. The option **MaxTransStim** provides the possibility of expanding the maxilla. Entering 1 mm will expand the upper arch with 1 mm at the molars and 0.66 mm at the canines. You can follow this on your upper occlusograms if included in the analysis/simulation. For each mm of expansion there is 0.25 degrees of induced opening (Posterior rotation) of the mandible built into the program so an accurate estimate of the need for expansion is important to get a realistic simulation. If you don't agree with this adverse effect of the expansion you may counteract this by entering some negative value in the box **InducMandRot** (See later).
 13. The item **MandSagStim** (in mm) is provided for users of the Herbst, Forces or Jasper Jumper appliances.

It is important to remember that once the lower incisor and molar have been digitized they are linked together and will move as a unit when you change the incisor position or changed the space conditions. If you add values in the simulation for either crowding or spacing in the lower the arch the molar will move back or forward accordingly, whereas the incisor is locked in place and does not change position unless you move the whole lower arch backward or forward using **ArchesSagAdjust**. Anytime you change the lower arch position the upper arch follows these changes as you will see on the maxillary superimposition in the right panel as it maintains the normal molar occlusion. Another choice that affects the lower molar position is extraction of teeth in the lower arch that similarly affects the position of the molar only.

14. Until now we have not discussed the standard placement of the lower incisors determined by the program itself. The superimposition of the original head film and the simulation, seen below, shows that according to the stage of maturation of this patient and the information from the cephalometric analysis a downward forward growth trend is anticipated for the next 24 months with a greater than average degree of anterior growth rotation of the mandible. The transverse expansion of the upper jaw, needed in this patient, has induced a 0.75 deg. posterior rotation of the mandible. (explained previously)



The maxillary superimposition shows that the right molar, see [Note 5](#), in order to obtain a normal occlusion, needs to be moved distally about 4mm after the incisors have been placed in the ideal position for this facial type, in order to obtain normal occlusion. In the segment labeled **ArchChange** three possibilities are now available for correcting this rather difficult tooth movement:

ArchChange	
ArchesSagAdjust	1
ArchesExpansion	3
LowerExtractions	
UpperExtractions	
InducMandRot	-1

15. First, the lower incisors could be moved forward 4 mm by entering 4 in the **ArchesSagAdjust** field. This will move the upper molar forwards towards their original mesio-distal position. However, this might place the lower incisors in an unstable position with an increased risk of relapse and periodontal problems long-term.
16. Second, you may instead consider expanding the upper and lower arches transversally. A value entered in the **ArchesExpansion** box will expand upper and lower arches with the same amount. 1 mm of expansion (at the first bicuspid and the molars as well) will provide extra space in the lower arch of ca. 0.95 mm. Notice that the lower and upper molars move forward simultaneously and take up the space made available while the lower incisor position maintained. Negative values can also be entered in case of constriction of the arch width.

17. Third, another option to consider is extraction of teeth. In the sub-segments:
LowerExtractions and **UpperExtractions**
 your extraction decisions can be entered.

For the he individual teeth there are three choices: **Erupted**, **Missing** or **Nonerupted**. To extract a tooth click on **Missing** (or press <m>) and move to the next tooth you wish to extract. Then do the same in the Upper arch to complete the extraction process if you are planning a four bicuspid extraction treatment.

Click on **Nonerupted** if you will make space for a missing tooth.

ArchChange	
ArchesSagAdjust	1
ArchesExpansion	3
LowerExtractions	
l6	Erupted
l5	Erupted
l4	Erupted
l3	Erupted
l2	Missing
l1	Nonerupted
r1	Erupted
r2	Erupted
r3	Erupted
r4	Erupted
r5	Erupted
r6	Erupted
UpperExtractions	
InducMandRot	-1

As you enter the extraction command the molars will move forward and take up the space made available while the incisor position is maintained, see [Note 5](#). To answer the question "first or second bicuspid extraction?" look at the molar movements on the superimpositions for what is most appropriate for your patient.

From this it can be determined how much molar movement is needed to maintain the incisors in the decided position and how much anchorage, especially in the upper dental arch, is needed to achieve the treatment goals.

18. Now consider the field **InducMandRot**. This item is an important one concerning the treatment induced effects on the mandibular inclination (rotation). Could treatment possibly result in an undesirable backward mandibular rotation? If this is a possible scenario then a simulation with this change should be made to determine the resulting tooth movements and anchorage requirements....

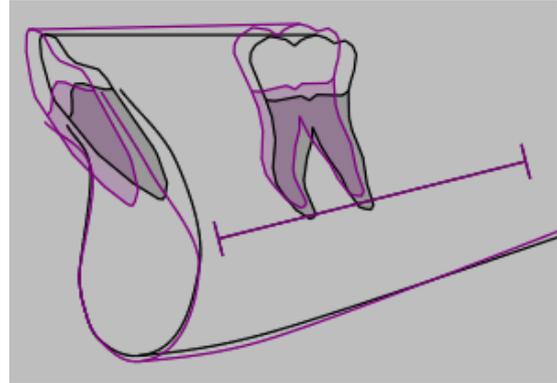
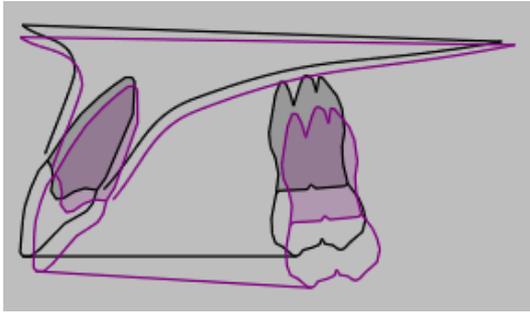
ArchChange	
ArchesSagAdjust	1
ArchesExpansion	3
LowerExtractions	
UpperExtractions	
InducMandRot	-1

Here we have chosen to be optimistic by entering the value of -1, which will produce this result:

	Stage 1	Simulation 1
CRANIAL		
n-sar	deg 129.3 124.0 1.1	129.4 124.0 1.1
n-s-ba	deg 132.5 130.5 0.4	132.5 130.5 0.4

The amount of treatment induced mandibular rotation is one of the most difficult factors to estimate, something you will recognize when analyzing your own treatment results. Don't be too discouraged as unwanted posterior mandibular rotation happens to even your most experienced colleges!

19. One of the final steps in the simulation process is to adjust the inclination of the incisors and molars to realistic inclinations. As the program moves the teeth in a linear fashion it is necessary that an experienced clinician makes adjustments to the inclinations so that the final tracing shows meaningful movements of these teeth.



20. In this patient the lower incisor needs to have the root moved back towards the original position to a more realistic inclination. The upper incisor root may then be moved forward toward the original position of the apex which will ease the Activator treatment without compromising the inter incisal relationship.

ToothAdjustment	
OlfAdjust	1.5
OlfAdjustCent	mop
OlfVertAdjust	0
LoIncAdjust	7
UpIncAdjust	-4
LoMolAdjust	0
UpMolAdjust	0

Notice that root movement towards the labial is indicated as a - value (degrees) to the lingual as a + value (degrees).

21. The item **OlfAdjust** is used to make the necessary treatment induced changes of the inclination in degrees of the occlusal plane. In this case the activator will probably induce some posterior rotation centered at the molars, see [Note 6](#).
22. The item **OlfVertAdjust** is used to make the treatment induced vertical change in mm of the occlusal plane. Such changes may be generated by use of skeletal anchorage.
23. Below is the final result:

The screenshot shows the Tropsoft software interface. The main window displays a 3D simulation of a patient's teeth. The teeth are outlined in purple, and a horizontal line is drawn across the top of the upper arch to indicate the occlusal plane. The lower incisor is shown with a root that has been moved back towards its original position. The interface also includes a sidebar with patient information and simulation parameters.

	Stage1	Simulation1
CRANIAL		
m-se	deg 129.3 124.0 1.1	129.4 124.0 1.1
m-s-ba	deg 132.5 130.5 0.4	132.5 130.5 0.4

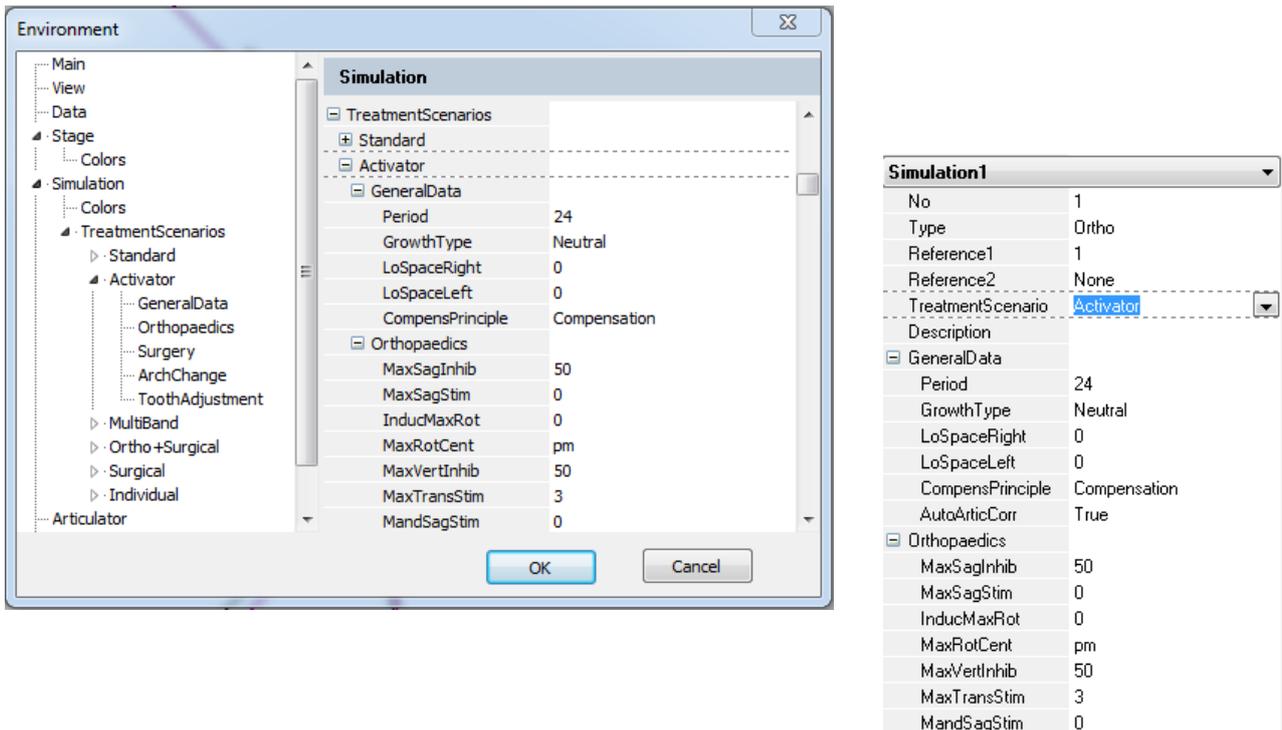
NOTES

Note 1:

In case you have performed a Growth Analysis (GA) by superimposing two successive stages, covering a certain time period without treatment, the simulation process uses the actual growth amount instead of the growth standards built into the program

Note 2:

Under tools/environment options... /Simulation/TreatmentScenarios you can enter the default parameters you wish to use when you begin the simulation procedure and have chosen a specific scenario.



Note 3:

The result of the simulation procedure is that the space condition in the lower arch is equal to zero. If you add values in the simulation for either crowding or spacing in the lower the arch the molar will move back or forward accordingly.

Note 4:

This table shows the initial placement values for the upper and lower incisors relative to **GrowthType** as used by the program.

Point cp is the intersection point between MML and Olf.

By significant movement of the **Upper Incisor** and resulting remodeling of the landmark **ss** the **Lower Incisor** will appear more prominent.

GrowthType	Inclolnc-cp	LoIncl/MML	Uplnc/MML
ExtremeAnt	3,50	27	33
Anterior	2,50	25	31
Neutral	1,50	23	29
MediumPost	0,75	21	27
Posterior	0,00	20	26
Unit	mm	Deg	Deg

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Note 5:

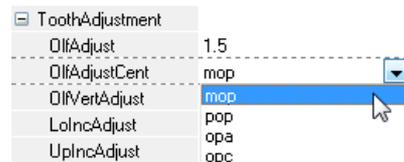
The displayed upper and lower molar can represent either the right-side ones or the mean of the right and the left molars. If you wish to see both molars the left molar can be included from the start by using the **RightLeftFron** regimen or added by the procedure in Digitize/Add/Remove Structures after changing the regimen to RightLeftFron or **Complete**.

If both (right and left) molars are included the **LoSpaceLeft** and **LoSpaceRight** values will be used to place the molars according to the particular side.

If you do not include both molars the two values for the space conditions left and right will be **divided evenly**. Similarly, the molar on the lateral tracing will only show a movement when right side extraction is entered, but is of course seen on the occlusograms for both sides.

Note 6:

The occlusal plane can be rotated at these centers:



OcclusalPlane		
MolarOcclPoint	pop	Cusp tip of the first lower molar
BicuspidOcclPoint	pop	Cusp tip of the first lower bicuspid
AnteriorOcclPoint	opa	The anteriormost point of the occlusal plane on the tracing
CaudalOcclusanPoint	opc	The posteriormost point of the occlusal plane on the tracing

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