TUCT prediction model

The first step in using the TUCT module is defining the audience area. To do that we need to choose an option called *Aud.area mapping:*



And next, in the new window we click Audience planes.

TUCT audience area mapping setup				
Audience planes Map step: 1.000 m Map height above audience planes: 0.500 m				
Help OK Cancel				

In the windows below we should give the numbers of planes over which the audience area surface will be created (the receivers for simulation will be placed there).

Audience planes	Audience planes Audience planes	
Range: 1 to	Range: 13 to	Range: to
Add		Add 13 113
Edit	Edit	Edit
Remove	Remove	Remove
Free form edit	Free form edit	Free form edit
OK Cancel	OK Cancel	Cancel

After accepting the changes with the OK button we can change the point's density in the simulation (the Map step option) – it significantly changes the simulations length.

TUCT audience area mapping setup					
Audience planesMap step:1.000mMap height above audience planes:0.500m					
Help Cancel					

We open the main TUCT window by choosing the

Save CAG and Run

Edit Hilitian Window Help	TUCT - sala_2
y Main:Show 2D	A MainActions
Tim X	Predst SxR. Map drect sound. Map measures Predst SxR. Map drect sound. Map measures Predst SxR. Map drect sound. Map measures Y Ectorgam Tiper: 10 type: 10 type Y Ectorgam Tiper: 10 type Bend: 11 type: 0 Map drect sound. Map measures Y Ectorgam Tiper: 10 type Bend: 11 type: 0 Map drect sound. Map measures Y Ectorgam Tiper: 10 type Tiper: 10 type: 0 V V Fill V V
	30 MainShow 3D Image: State of the sta
	PXYZIR.

It consists of three windows: Main:Show2D, Main:Show3D oraz Main:Actions.

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	Predict SxR	Map direct sound	Map measures

The Main:Actions windows allows us to pick three types of simulation:

Predict SxR – prediction of Echograms and impulse responses for each source-receiver combination by the use of one of 3 algorithms with different accuracy and computation complexity.

Map measures - prediction of acoustic parameters on a predefined audience area.

Map direct sound - Prediction of the acoustic pressure level on a predefined audience area.

The results of the simulations above can be represented in a 2D or 3D form in the windows shown below – Main:Show 2D and Main:Show 3D.



3D Main:Show 3D		
sala	 ♥ Coord. sys. ♥ Faces: Mater Plane: Ids Triangles ♥ Edges ♥ Src point ♥ Src id ♥ Src aim ♥ Rec point ♥ Rec point ♥ Rec head dir. ♥ SxR spheres ■ ERRORS ■ LEAKS 	ial V Size: x 1 V Audience mapping Surfaces Results < All > Direct Measure Type: V Band: 1 kHz V Sum(A) Fast (dots) Max: + ? Range: + ? Statistics Export map

To calibrate the model we must first conduct the computations. In order to do that we must pick an option

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		Map direct sound	Map measures

We arrive at the settings window:

Predict SxR settings					
Algorithm Closed room I: Short calculation, basic auralization					
Max split-order: 0 Closed or open room 2: Longer calculation, detailed auralization ? 3: Even longer calculation, detailed auraliz. ?					
Calculation parameters Number of rays/cones (demo limit 5000) Primary: 5000 Echogram/Impulse response					
Run on one CPU core Advanced *) Air absorption Diffraction					
Help *) normally on Run OK Cancel]				

Run

The *Algorithm* section is responsible for the computation algorithm – the first one is usually enought for our uses, we might be forced to use the second one for more comlex computations.

The *Calculation parameters* section allows us to pick a number of generated and traced rays (it is prudent to pick the *Auto* function) and the length of the generated impulse response (at least 3/4 of the reverb time calculated in our measurements – it also affects the computation time).

WARNING! In the demo version of CATT-Acoustic that number is capped at 5000 – it does not allow to conduct credible simulations in most rooms. We must calibrate the model using the full version.

After clicking

the program conducts the computations. The more sources and points we have defined and the more complex the computations algorithm, the longer they take. It is an adequate moment to brew some tea, for the computations might take as long as a few hours.

8	Main:Actions	- • ×
Stop	Map direct sound	Map measures
2:2 Remaining: 6s	Tracing from A0	
		8 threads 96% cpu

After the simulation is over the progress bar is replaced by a Done sign.

8	M	- • •	
	Predict SxR	Map direct sound	Map measures

It is now worthwhile to check if the computed curve is even. In order to do that in the Main:Show 2D we choose:

2D			Main:Show	2D		
dB SPL:	86.8 84.2	EDT: 0.40 0.63	T-30: 0.60 0	74 Schröder (a	abs.) 1 kHz	Plan/Section View: YX (top) Predict SxR results SxR:
70 60 50	All and a second s					O Measure Type: SPL ✓ I Chogram I Regr. lines
40		0				Type: Schröder (ab: ✓ Time: 10 lg(p,) 10 lg(E) Band: Schröder (ab.) Range: Schröder (norh%) Forward integral
20	200	400	600	800	ms	Echo-disturbance Directional Polar Type: Binaural Demo
sala LMB-click-dr	ag to change time ar	id scale			A0x01	Time: 200 ms V WAV off V

As we can see it is very jagged, in practice with the simulation parameters chosen like that we will be receiving different results in every simulation – it will successfully prevent us from calibrating the model. A solution might be to pick a more accurate computation algorithm or to increase the number of rays.

Repeating the computations (choosing *Predict SxR* or the 2nd algorithm) allows us to get much better results:



If we can get an even decay curve we can save the computed reverb times, for example in a form of an Excel sheet – to do so we pick:

#		TUCI	- sala_2			- 8 ×
File Edit Utilities Window Help						
CAG-file/Room Info	Main Show 2D					
SxR Measures	, , , , , , , , , , , , , , , , , , , ,		- 10	Main:Actions		J
dB ?x? Measures	 Show Table 1 k 	Hz Plan/Section	P	Predict SxR Map direct sound	Map measures	
?x? T-30 Statistics	Export To Lipboard	View: YX (top) V Cut z V				
SxR Save	Export To File	Predict SxR results		Done		
Convolve with corrispondence	Export To MATLAB File	SxR: A0x01 V				
70 Sequence Processing		OMeasure				
60		Type: SPL V				
50		● Echogram ✓ Regr. lines				
		Time: 5 a				
40		Pand 1 klas M				
30		Banger 70 dB				
20 200 4	00 600 800	ns O Impulse response Play/Convolve				
20.7 221 4	21 621 821	Type: Binaural V Demo V				
sala		A0x01 Time: 200 ms V WAV off V				
LMB-click-drag to change time and scale		R ,	J			
		30	Main:Show 3D	✓ Coord. sys. ✓ Faces: Mate	rial V	
				Plane: Ids	∨ Size: x1 ∨	
				Triangles		
				✓ Edges	Audience mapping	
				Stepoint	Surfaces	
				Sicia Sicia	Results < All >	
				Src aim	O Direct O Measure	
				Rec point	Type: v	
				Rec id	Band: 1 kHz V	
				Rec head dir.	sum(A)	
		^ ^		SxR spheres	Fast (dots)	
				ERRORS	Max: • + ?	
				LEAKS	Range: +	
		6212			Statistics	
		I MB-rotate BMB-ristance I MB-BMP	-shift (SHIFT-man values)		Export map	
		Emp-rotate, rimp-distance, EMp+hMp or clintEmp	-smir (omminishing Values)			
Exports to clipboard, as TAB-delimited text, all me	easures for selected source and receiver combination	HHHHHH		v1.1a:1, demo version (for evaluation purp	oses only)	

In the window that has appeared we can choose, for which sources and receivers should the program save the computed results. We disable the h i E-h options, enabling only E (the echogram data) and confirm by clicking OK.

	Export	to cl	ipboard	
	Sources Include h	✓ E	Receivers	
Help]		OK Canc	el

Next we launch the calculation sheet and we paste the contents of our clipboard:

	4	в	С	D	E	F	G	H	1	1	J.	К		L	м	N	0	Р	Q	R	S	т	U	v	w	х	Y	ž 🔺
1 CAG	file :C:\	CATT-ku	urs\OUT\sala	_2.CAG																								
2 Proje	ect : sal	la																										
3 Crea	tor : CA	TT-Acou	istic v9.0c (b	uild 1.01) /	TUCT v1.1	a:1																						
4 Date	/Time ##	*****																										
5																												
6 Algo	rithm : 2																											
7 Prim	.rays : 50	000																										
8 Diffr	act.: off	f																										
9 IR le	ngth : 10	00 ms																										
10 Air a	bs. : on																											
11 roor	n consid	ered clo	sed (fraction	lost rays:	0.0%):																							
12 mfp	= 4.4	14 m																										
13 volu	me = 6	89.21 m	3 (calculated	from mfp).																							
14																												
15 Mea	sures for	r sum of	selected sou	irces																								
16 A0																												
17 and :	selected	receive	rs:																									
18																												
19 C-7			125	250	500 1k	()	2k	4k	8	Bk	16k	lin	A-	w	Hz													
20																												
21	1 (E)		-4.55	-3.01	-2.77	-2.78	-2.9	19 -	2.83	-1.82	0.68	3 -1	L.49	-2.21	dB													
22																												
23 D-50			125	250	500 1k	c :	2k	4k	8	Bk	16k	lin	A-	w	Hz													
24																												
25	1 (E)		65.95	78.71	81.58	82.06	82.7	7 8	3.12	88.66	96.9	8	38.4	85.89	%													
26																												
27 C-50			125	250	500 1k	()	2k	4k	8	Bk	16k	lin	A-	w	Hz													
28																												
29	1 (E)		2.87	5.68	6.46	6.6	6.8	2	6.92	8.93	14.95	i 8	3.82	7.84	dB													
30																												
31 U-50			125	250	500 1k	c :	2k	4k	8	Bk	16k	lin	A-	w	Hz													
32																												
33	1 (E)		2.87	5.68	6.46	6.6	6.8	2	6.92	8.93	14.95	j			dB													
34 Bkg r	noise		unchanged																									
35																												
36																												
37 C-80			125	250	500 1k	c 1	2k	4k	8	Bk	16k	lin	A-	w	Hz													
20	_																											
4	Þ.	Arkusz	+															÷ €									_	Þ

Here we can find detailed simulation data and the calculated parameter values. We are interested in the mean reverb time values T20 (we should skip the next part of the sheet):

52													
53	EDT		125	250	500	1k	2k	4k	8k	16k	lin	A-w	Hz
54													
55	1	. (E)	0.88	0.69	0.66	0.65	0.63	0.53	0.34	0.22	0.74	0.79	s
56													
57	T-15		125	250	500	1k	2k	4k	8k	16k	lin	A-w	Hz
58													
59	1	. (E)	0.96	0.91	0.96	0.97	0.96	0.89	0.66	0.26	0.78	0.77	s
60													
61	T-20		125	250	500	1k	2k	4k	8k	16k	lin	A-w	Hz
62													
63	1	. (E)	0.99	0.86	0.85	0.89	0.84	0.79	0.66	0.28	0.86	0.87	s
64													
65		(E)	0.99	0.86	0.85	0.89	0.84	0.79	0.66	0.28			
66													
67	T-30		125	250	500	1k	2k	4k	8k	16k	lin	A-w	Hz
68													
69	1	. (E)	1.16	1	1.01	1.5	0.98	0.8	0.59	0.32	1.23	1.26	s
70													
71		(E)	1.16	1	1.01	1.5	0.98	0.8	0.59	0.32			
72													
72	L C		125	250	500	1k	2k	4k	8k	16k	lin	A-w	Hz
15	LF		12.5	200									
74			125	200									
74 75	1	. (E)	25.22	25.43	25.99	26.21	26.74	26.39	24.15	17.99	23.06	24.9	%

We only have one receiver in our model, when there are more of them in the marked region (under the short-dashed line) the mean reverb time value is located. Those are the numbers that must fit in our +- 5% deviation of those acquired through measurements.

We calibrate the model by changing the absorbance and scattering coefficients for the materials placed on surfaces bordering the model. We should remember that to adjust the absorbance characteristic so that it is compatible with the physical characteristics of the material (inter alia the growing absorbance characteristic for the suspended ceilings and draperies, selective suppressing for the resonant acoustic treatments). The real impulse response measurements of an investigated room were probably conducted without the audience, which is why the absorbance coefficients of the audience block must conform such a situation.

Useful hints:

- While calibrating the model it is useful to use the material's statistics generated by the Interactive RT estimate tool
- The absorbance of the surface located opposite the scene is important.
- It is worth to stay focused on large surfaces, like the floor and ceiling.

After calibrating the model we can go in for the assessment of the interior's acoustic depending on the object's purpose.