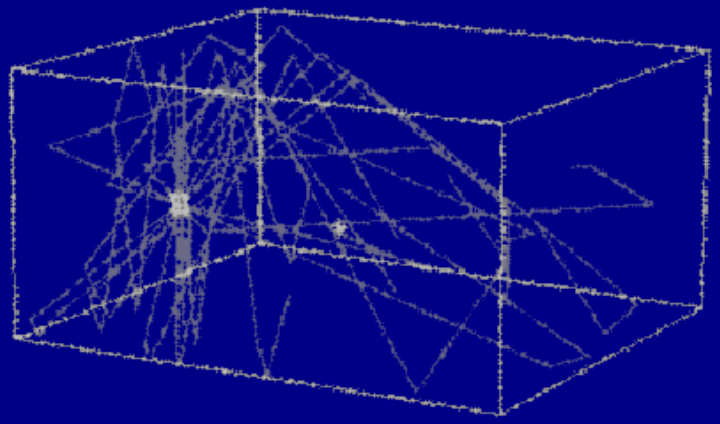
New Approach to Design Control Rooms and Studios



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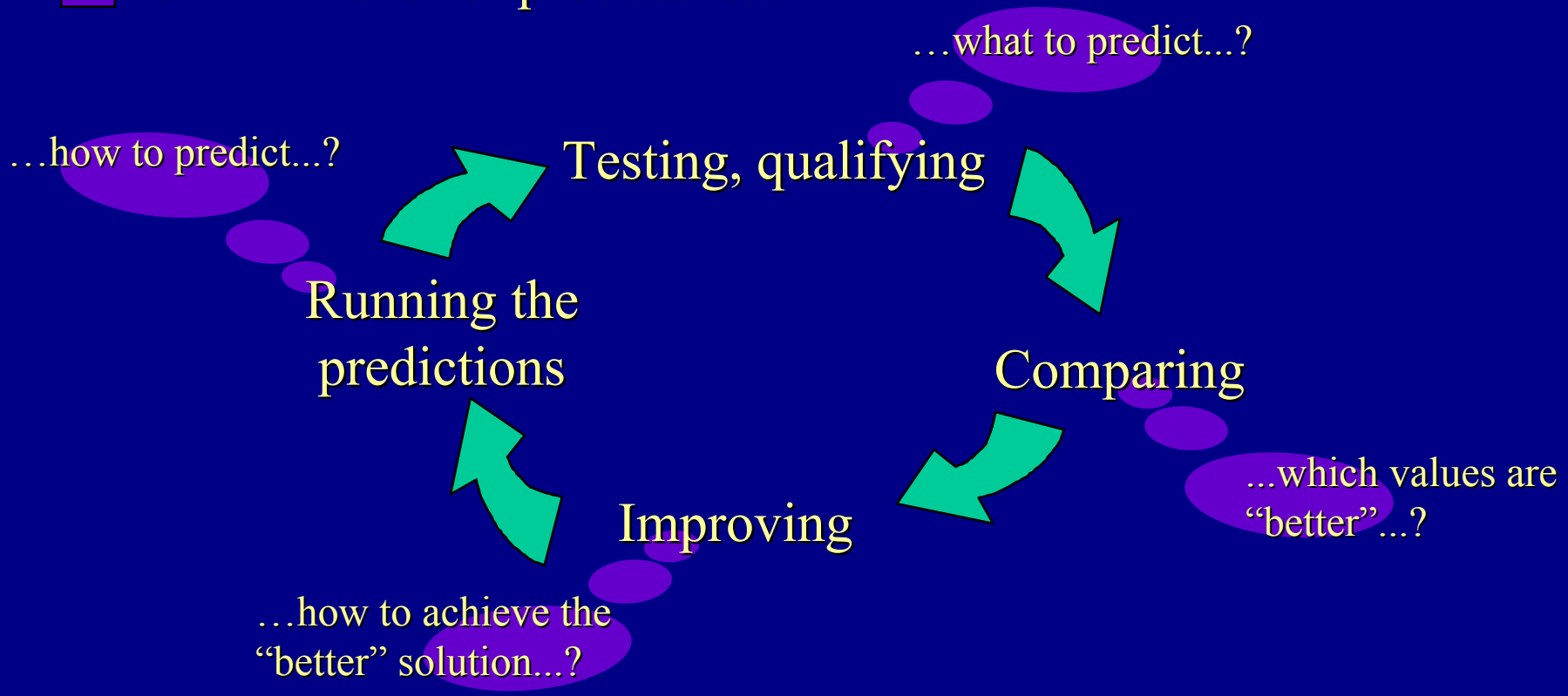
Introduction

- Problems in the design procedure
  (trial-and-error procedure, "optimum", etc.)
- Problems in using room acoustical models…
  (errors in the method and in the modelling parameters)
- New approach is needed...

The conventional way

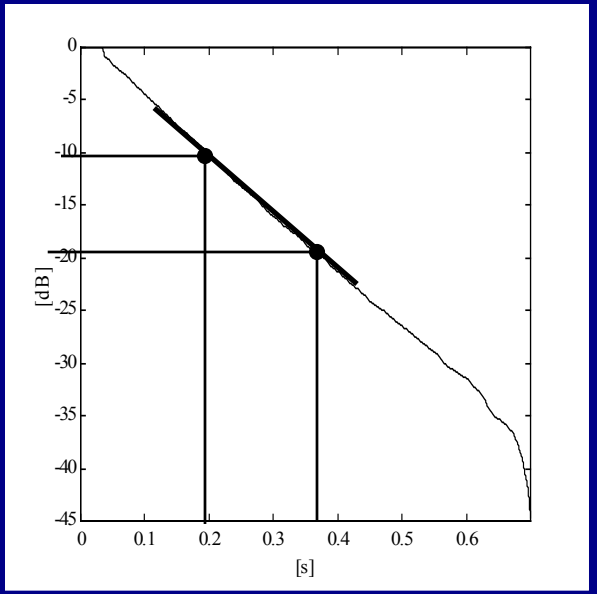
- The trial-and-error procedure...



About the "optimum"

Measures of "room acoustical quality"...

- impulse response (IR) → energy decay curve (EDC)
- frequency dependence → band limited IR
- 1-point parameters (EDC points):
  reverberation time (RT_{60}, etc.),
  energy-ratios (Clarity, Definition, etc.)
- 2-point parameters (EDC slopes):
  extrapolated reverberation times ($RT_{5\text{-}25}$, EDT_{10}, etc.),
  energy-differences (M-factor, etc.)
- others: centre-time (EDC global slope)



Modelling room acoustics

Limitations

…of approximations (e.g. geometrical models)

…of computational time (e.g. FEM)

Modelling parameters

- lack of knowledge of acoustical behaviour of surface structures
- complex sound sources…

The effect of errors in the trial-and-error procedure...

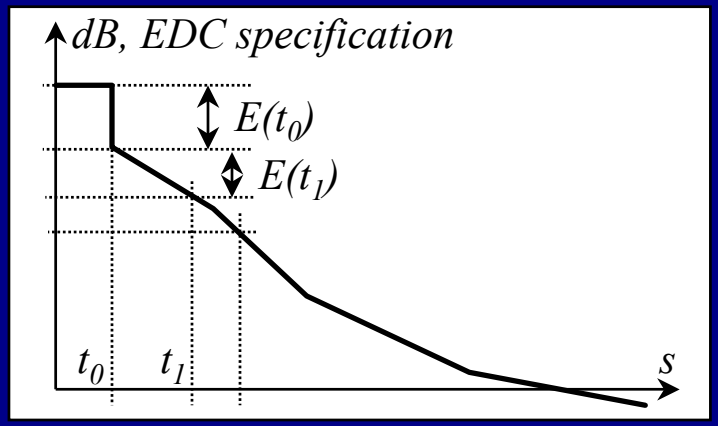
A new approach

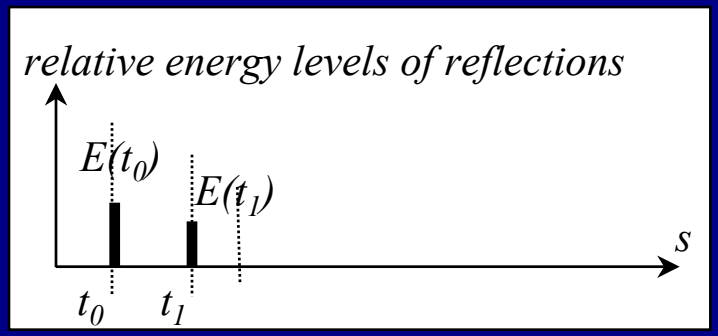
Basic idea:

EDC is the connection between modelled and real responses.

Theory:

Numerical differentiation of the EDC specification at the modelled reflection timings to get the amplitude of each reflection. - “EDC fitting”…





Application

Straightforward design

- starting with the objective acustical parameters (EDC synthesis)
- end results include: modelling parameters (like absorptions, etc.)

Verification, validation, calibration of models

…the modelling parameters is not needed, since their values are the results…

Room acoustical analysis

…what can a given room configuration offer, where are the critical points, etc…

Application example: room analysis

The goal

is to describe the possibilities of a room configuration by looking for the "valid" value sets of room acoustical parameters.

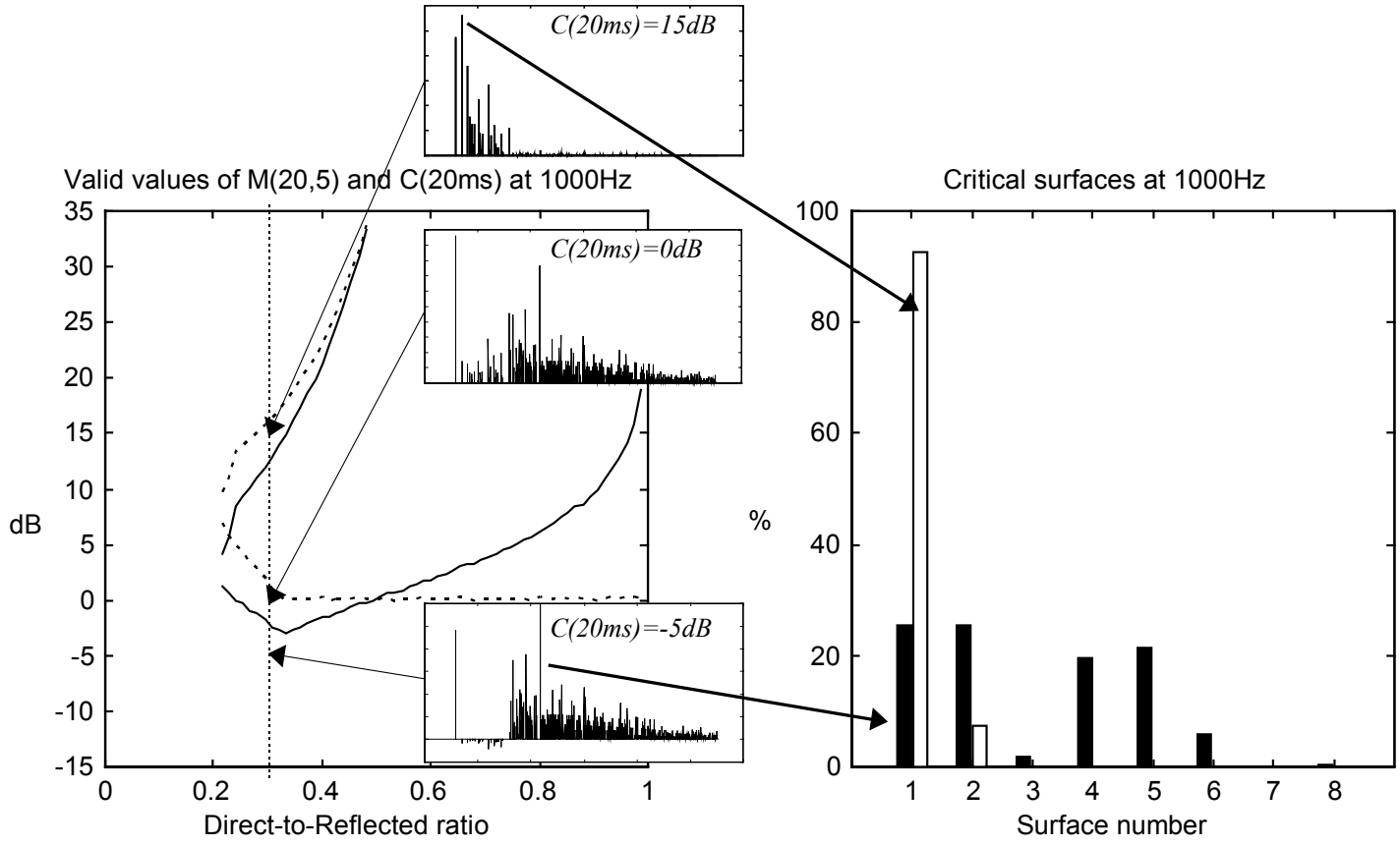
A parameter value set is "valid", if

- the EDC is valid (decreasing)
- reflection pattern is valid (direct sound has the highest amplitude and there are no negative reflections)

Assumptions

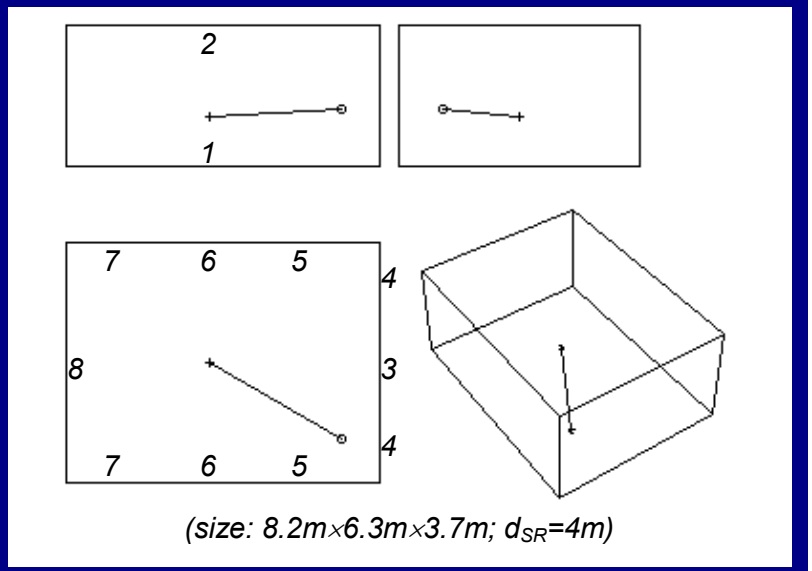
- omnidirectional sources (it means only a directional weighting)
- only specular reflections (for simplicity)
- looking for the values of C(20ms) and M(5ms,20ms)=C(20ms)-C(5ms), RT_{60} is prescribed

Room analysis - explaining the results

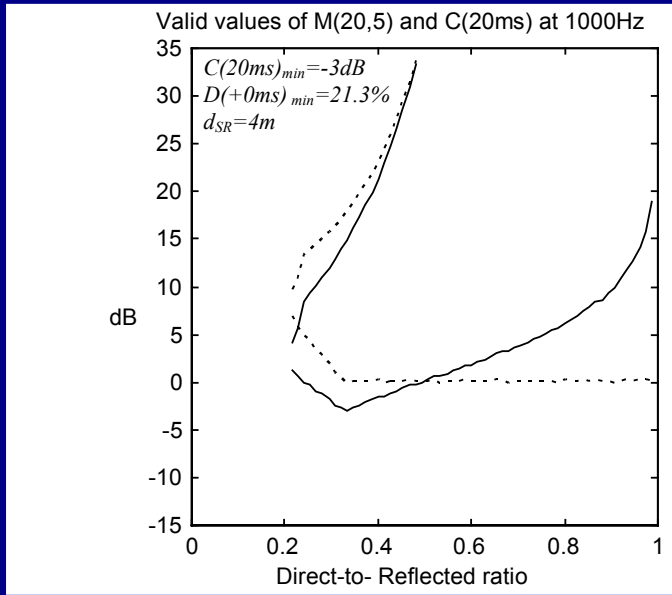


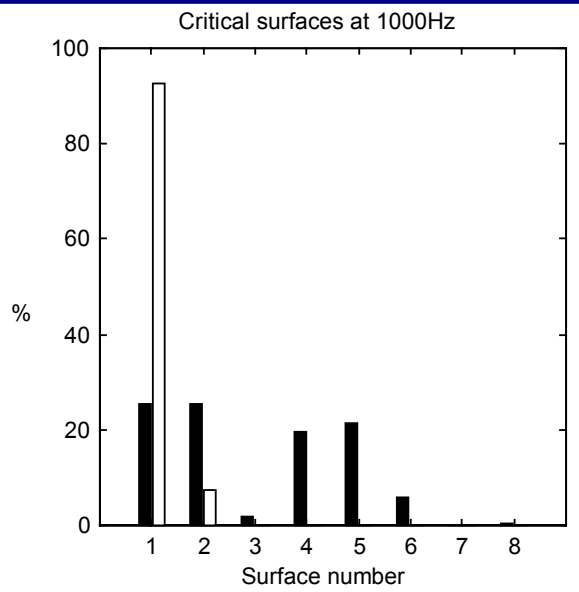
Room analysis - example 1a

- Configuration
- Result (for RT_{60}=350ms)



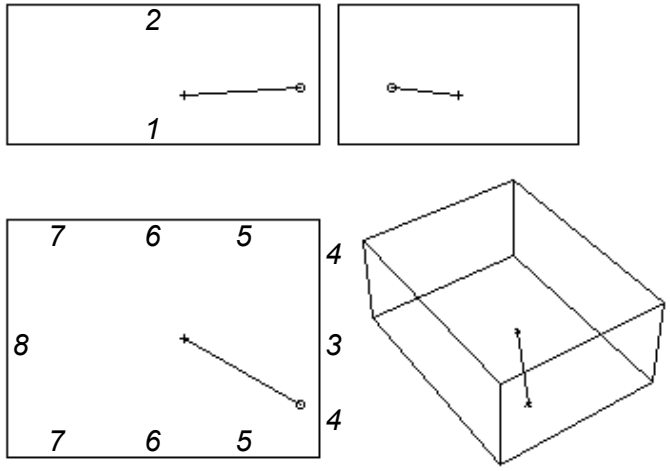
(size: 8.2m×6.3m×3.7m; d_{SR}=4m)



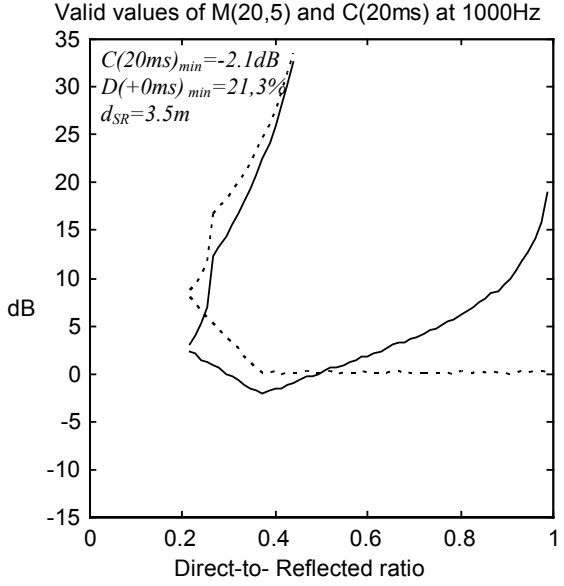


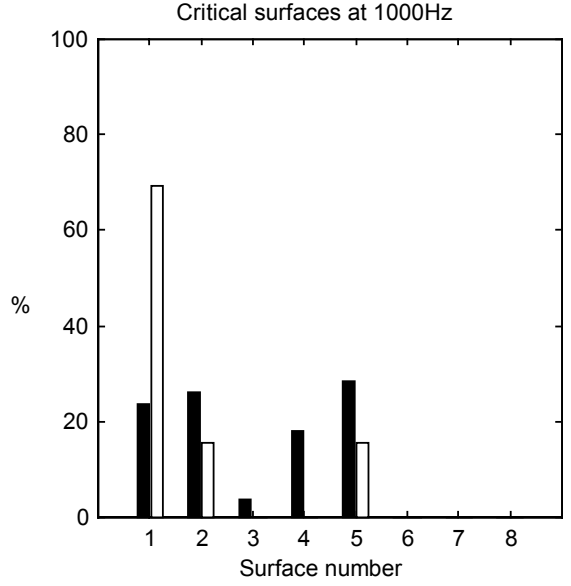
Room analysis - example 1b

- Configuration
- Result (for RT_{60}=350ms)



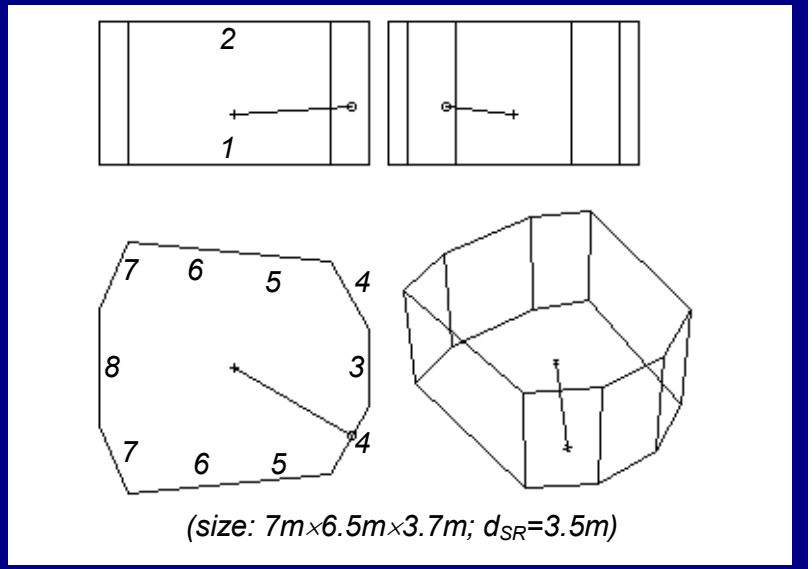
(size: 8.2m×6.3m×3.7m; d_{SR}=3.5m)



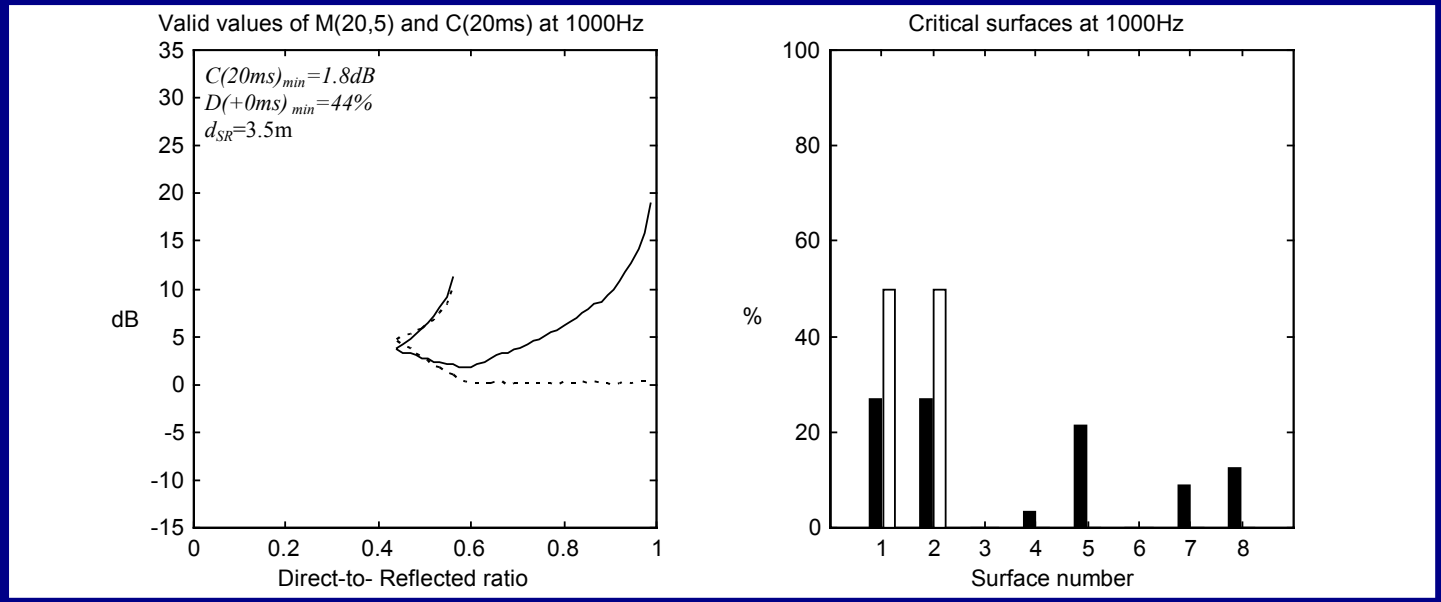


Room analysis - example 2a

- Configuration
- Result (for RT_{60}=350ms)

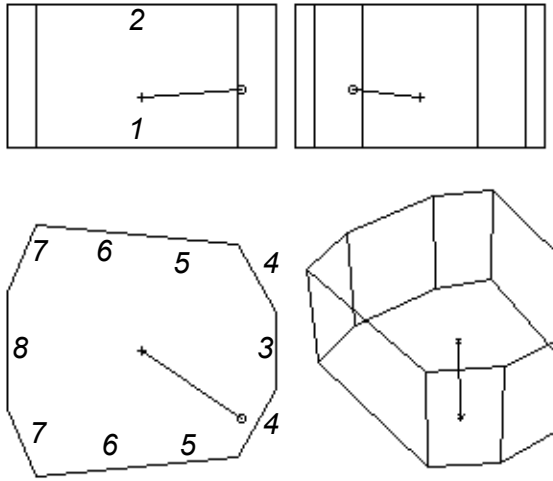


(size: 7m×6.5m×3.7m; d_{SR}=3.5m)

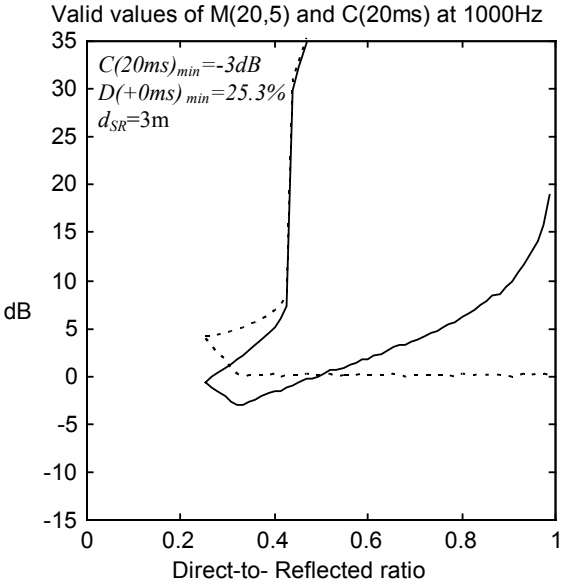


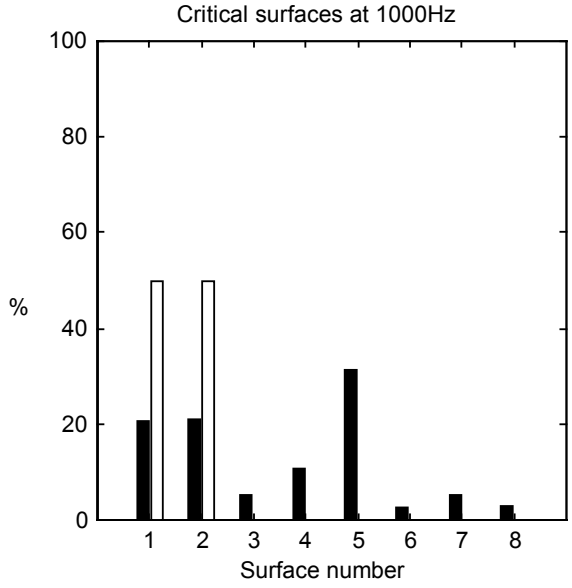
Room analysis - example 2b

- Configuration
- Result (for RT_{60}=350ms)



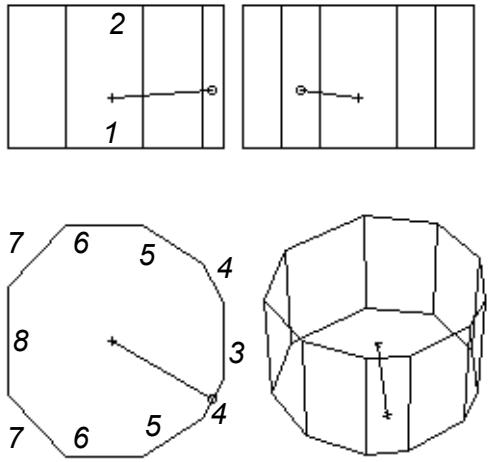
(size: 7m×6.5m×3.7m; d_{SR}=3m)



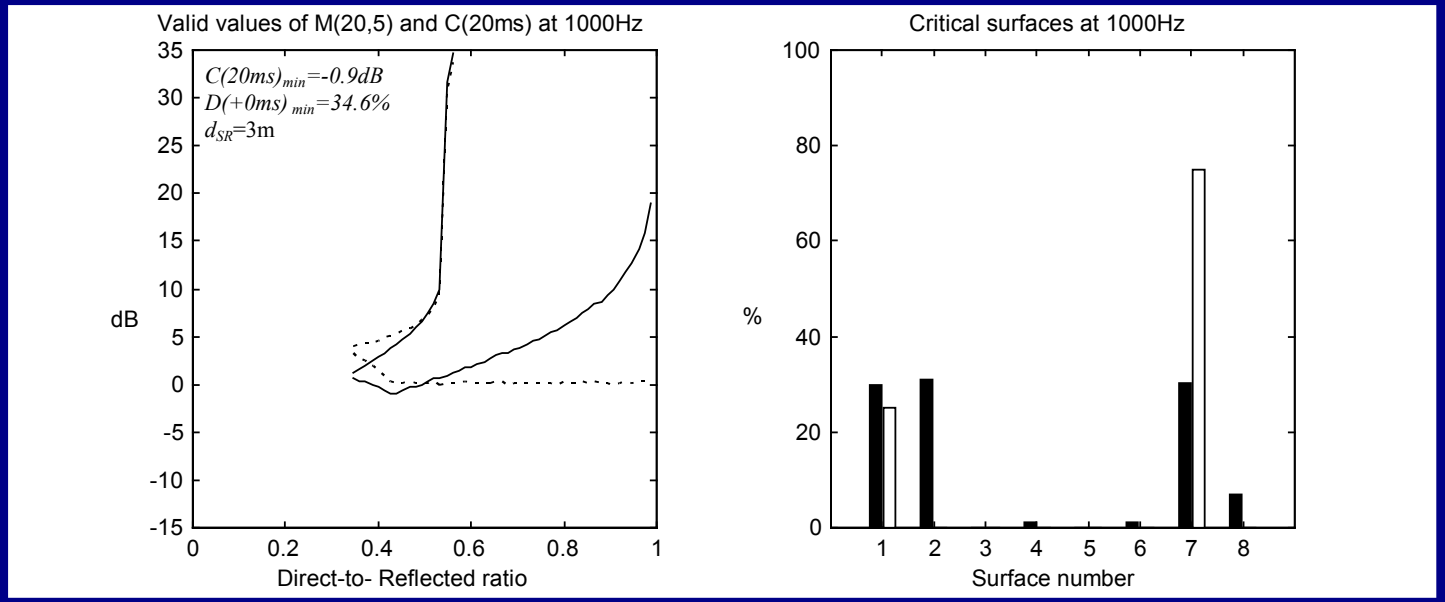


Room analysis - example 3a

- Configuration
- Result (for RT_{60}=350ms)

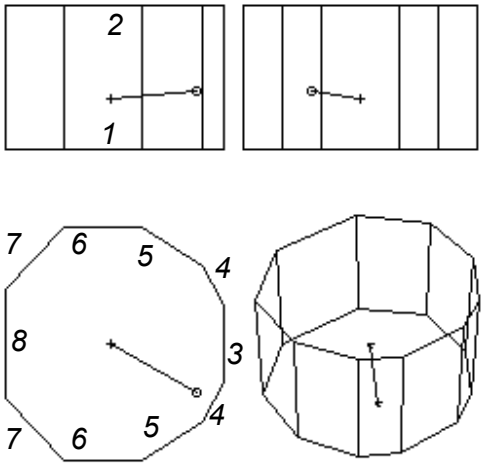


(size: 5.6m×6m×3.7m; d_{SR}=3m)

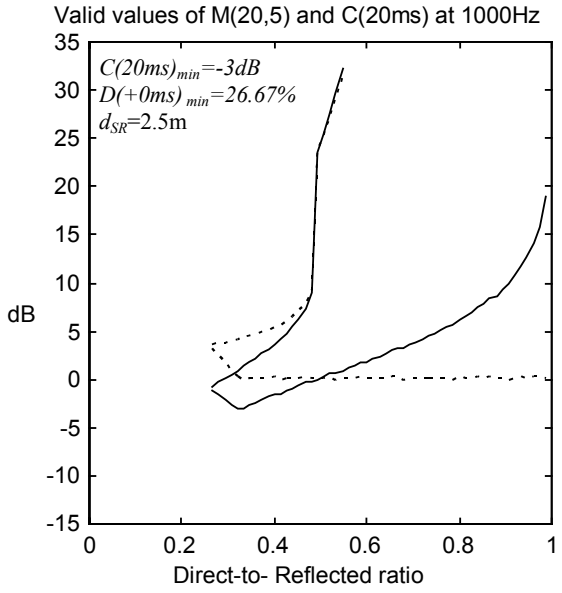


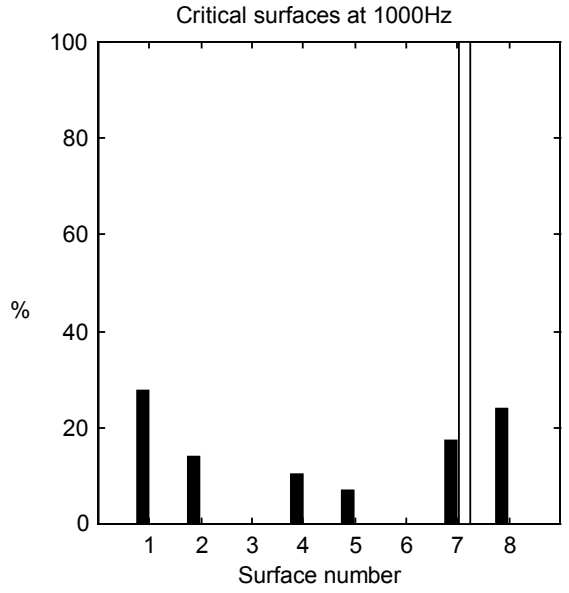
Room analysis - example 3b

- Configuration
- Result (for RT_{60}=350ms)



(size: 5.6m×6m×3.7m; d_{SR}=2.5m)





Conclusions

- EDC: the connection between measurement, modelling and perceptual requirements
- Simple, but useful tool: EDC fitting
- Future work: verification of other applications
- EDC should be used for comparison of different models, measurements etc., because differences are more clearly to see and express…