DepthSpace3D

A digital tool for 3D Space Syntax Analysis

Primitive concepts

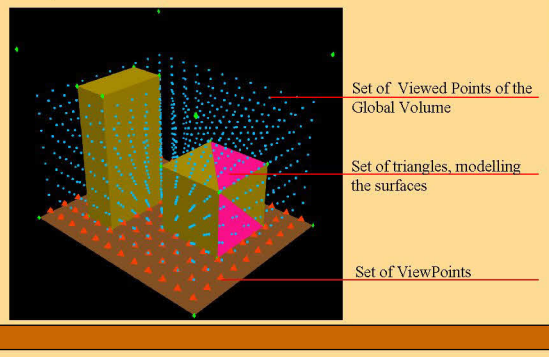
Spaces

Concept	Denotation	Discretization for the operational model
Viewing Space		
	The space of the possible viewpoints (people, cameras ...)	Set of points. Tendentiously all the points will represent the same amount of space, but they can have a different volume. And, as there can be some differences in the density of viewing agents per volume, there is also a weight attribute.
Viewed Space		
Surfaces	Surfaces of the objects in the 3D global volume	Set of points, centroids of little homomorphic triangles in which the triangles that shape the surfaces are divided.
Global Volume	The entire 3D global volume	Set of points. Although data representation does not imposes any other restriction, the user interface guides to equal amount of space for each point. Global space is cut in axial (X, Y and Z) slices of equal thickness in each axis. Nevertheless, the thickness can be different from axis to axis.
Obstacle space		
Volume opacity	A continuous loss of visibility throughout the 3D global volume (fog, optical effects ...)	
Surfaces	Surfaces with a certain degree of opacity	Set of triangles, modelling the surfaces.

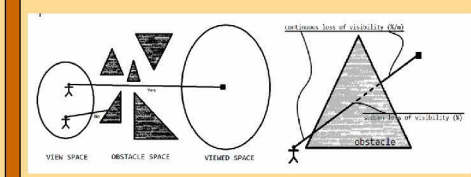
Functions (domain: 'cartesian product' of viewing space * viewed space)

Concept	Counter-domain	Denotation
Distance	set of real-numbers	Distance from any point of the viewing space to any point of the viewed space
Visibility	set of real-numbers from 0 to 1	The degree of visibility of each point in the Viewing Space to any point in the Viewed Space through the Obstacle Space
Depth (although depth is a derived concept from visibility, it is offered as a primitive to the users)	set of integers	Minimum number of straight lines in a Path of the Viewing space that need to be traversed from any point in the Viewing Space to see any point in the Viewed Space

Operational Model



Conceptual Model



Results Presentation

The Space Syntax Quantities can be seen numerically and graphically:

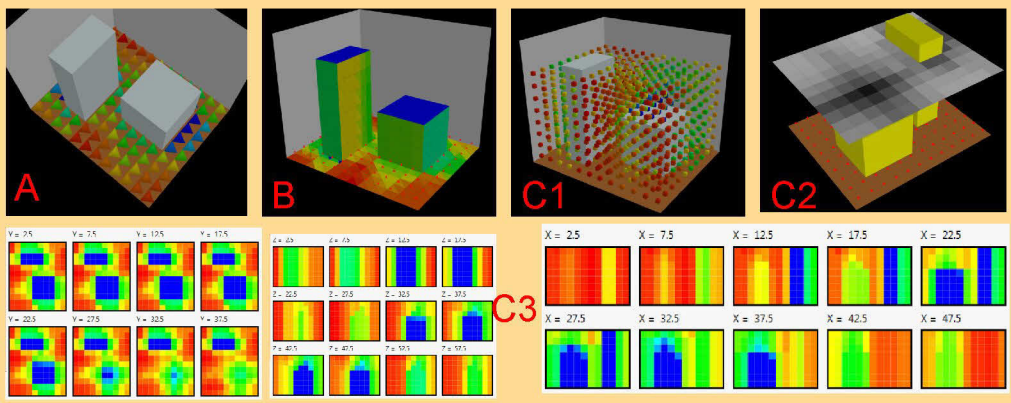
A - View Points

B – Viewed Space – Surfaces

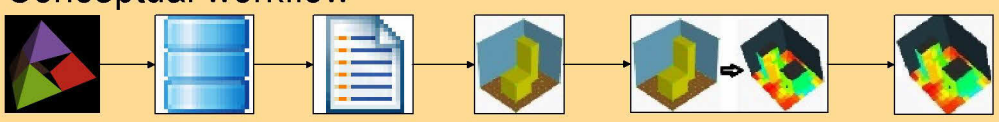
C – Viewed Space – Global Volume

- C1 – by Points
- C2 – by Slices 3D (in any axis – X, Y, Z)
- C3 – by Slices 2D

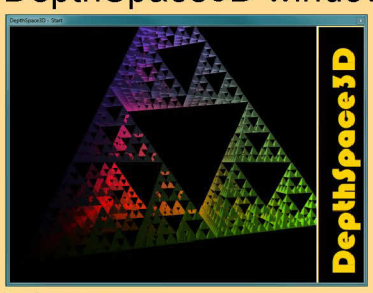
Animated graphics (run-time movies) can also be produced.



Conceptual workflow



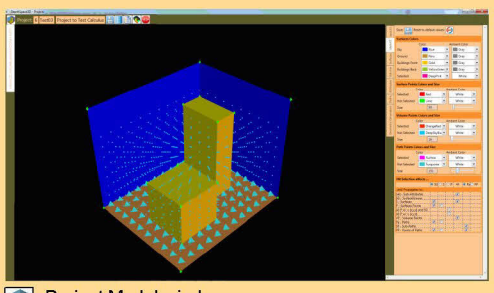
DepthSpace3D windows



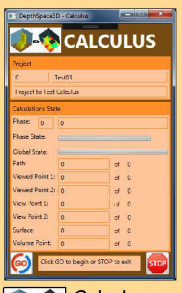
Start window

DataBases and Global management window

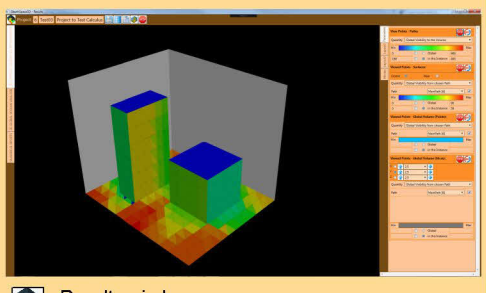
Project Selection window



Project Model window

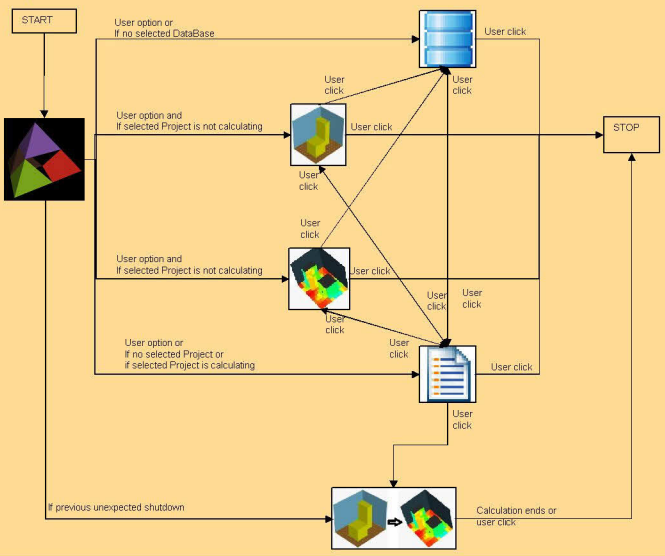


Calculus window



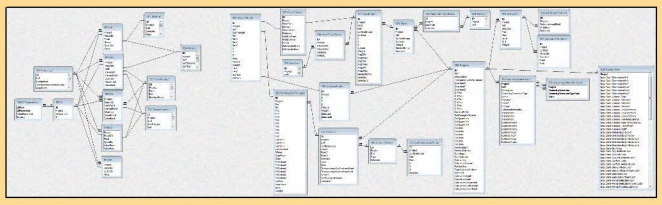
Results window

Operational workflow



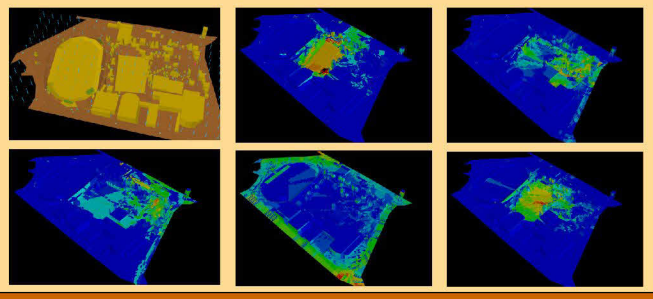
Databases

DepthSpace3D implements separation of data and algorithm. A SQL database stores all the information of the case studies.
The great advantage of this implementation is the openness of the software. The structure of the database is provided and can be used outside the DepthSpace3D application, by everyone interested in other developments.



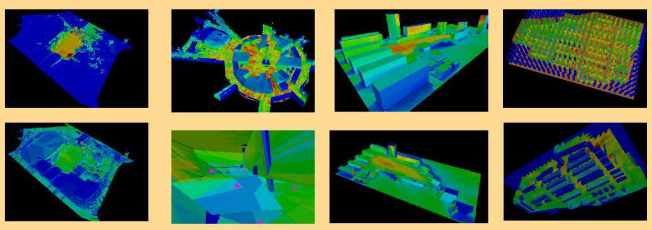
Paths

Paths constitute sets of View Points that have this same attribute. It is intended to model variegated situations of the Viewing Space. Each path has its density that represents the amount of viewing people. This density multiplied by the volume of each View Point gives the weight of each View Point.
This organization allows the study of different scenarios of human distribution.
Paths for exterior walks, wandering, crossings and remarkable points of a sports park are represented in the figure



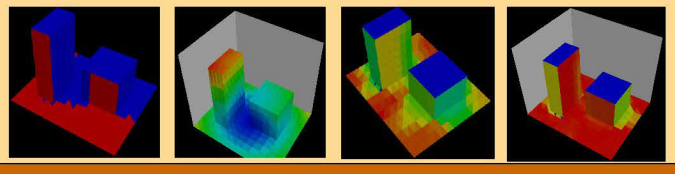
Applicability

3D analysis seems to bring better results in rough topography of the urban spaces; dynamic volumetric geometry: size, configuration, elevation and interpenetration; joint analysis of the interior of each building and its urban environment, in particular when there are high-rise buildings.
Due to operational constraints (time and memory) the use of DepthSpace3D should not be extended to large scale case studies.
Some case studies are presented in the figure – interior and exterior spaces, small-scaale urban spacess, commercial and complex buildings, landscape studies.



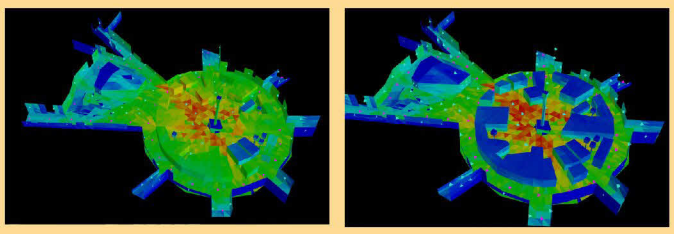
Generative grammar for Space Syntax Quantities

Depth Space3D includes an editor for a generative grammar that can expand the Space Syntax lexicon to be used. The primitive quantities are visibility, distance and depth. But it's possible to declare how to produce new quantities.
This is done through SQL queries, a very well known and widespread query language for SQL databases
Isovista, visual integration, depth,



Degrees of opacity

Visibility from the viewing space to the viewed space is a continuous quantity varying from 0 (not visible) to 1 (full visibility). The figure represents visibility of the same model, considering the changes in visual permeability of the trees in winter and summer.



Geometry Generators

Users may use and create geometry generators, parametric shapes that facilitate the modeling of the case study.
The shapes on the figure (modeling current types of trees and shrubs in the Portuguese landscape) were created with the help of geometry generators.

NORTE2020 PROGRAMA OPERACIONAL REGIONAL DO NORTE
PORTUGAL 2020
UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional