# Visualizing Negative Space

*Curt Westergard*
*Morgan State University*

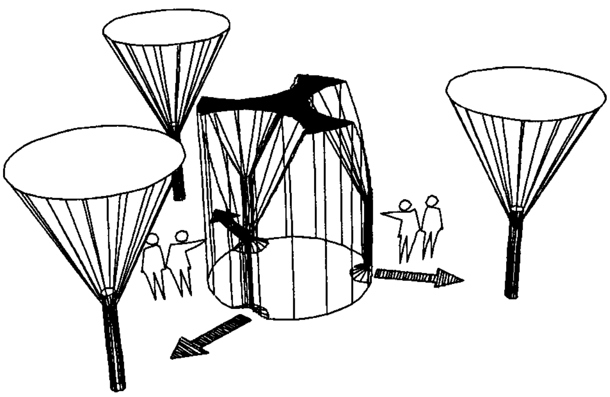

FIGURE 1: *The space-enclosing effect of trees can be more clearly visualized (and thus understood) when the negative spaces they form are transformed into a true 3 dimensional "solid" model; this exploded diagram shows a cylinder of space that has been deformed (dented) by the triad of nearby trees*

Designers and artists are, by training, accustomed to reversing figure /ground relationships.[1] They can easily picture and sketch negative (empty) spaces in plan or profile. Such perceptual reversals help them understand the voids between buildings as the dynamic and character-forming entities they are. Traditional drawing techniques like pocheing or hatching, just emphasize the static 2 dimensional aspects of these curious spaces: many sequential or layered views are needed to define their full 3 dimensional volume. Such multiple views are costly to produce and because of the 2 dimensional medium are inherently static and flat.

This research applies and further develops an under used visualization technique that depicts negative spaces (voids) as true 3 dimensional solids. It focuses specifically on visualizing outdoor spaces defined primarily by vegetation. The preliminary results are volumetrically revealing depictions of complex spaces. They give the designer and client quick spatial feedback about the intended "open" space in a given design.

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### Why look at "negative" spaces?

The benefits of altering ones perception while solving spatial puzzles are well documented in the literature on creativity.[2] The procedures range from looking at a design problem through a mirror, over ones shoulder or by toggling blacks to white. A reversal method, implied by Adams in Conceptual Blockbusting [3] is to turn a problem inside out, or around. In this mode of visualization, one is not looking for the right answer but for a different viewpoint on a troubling problem. The goal, especially in the early stages of conceptual design (brainstorming) is to rearrange information to force a different way of looking at the situation. Kirby Lockhard[4] states that turning a design upside down or inside out, provokes the rearrangement of important spatial information. It is this type of forced perceptual shift — voids portrayed as solids— that this chapter explores.

### Benefits to design

The benefits of reversing the solid void relationship are increased visual acuity and a freshened renewed approach to a given problem — two necessary ingredients to creative design. In general the purpose is to look at a problem in a non-standard way. Lockhard states, "By disrupting the original way of looking at the situation one frees information that can come together in a new way." In this respect it does not matter if the new image makes sense, so long as it unhooks you from stereotypical seeing/ seeking patterns. The main purpose is to provoke challenge or prod the designer to take a new position and attitude about the problem.

## Sharpened perception

In architecture, like the fine arts, reversing figure and ground serves as a visual aid to establish new relationships between abstract shapes. Betty Edwards[5] shows how sketching objects (figure 2), turned upside down actually sharpens perception by divorcing the stereotypical labeling and analysis common among landscape and architecture students. The artist is told to concentrate on the nonsensical negative spaces between and around the object and its visual frame. The negative "empty" space becomes the main compositional element. In fact the empty areas are easier to draw because they carry little associational baggage or distracting labels. The left half of the brain has no names or previous associations with these odd looking empty spaces.

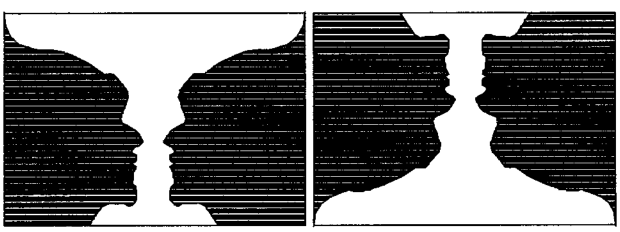

FIGURE 2: *The ambiguity within the classic wine glass/ human face silhouette (above left) is partially suppressed when the image is flipped upside down (above right); such reversals not only stimulate ideas but help designers see patterns and distances more objectively*

This popular graphic reversal technique however is usually confined to the 2 dimensional realm. Flat silhouettes projected on a flat medium. Pen on paper. Using low end PC solid modeling tools (AutoCAD and LandCADD for example) this same figure ground reversal can occur in 3 and even 4 dimensions. Empty spaces are turned into user defined solids which can be shaded and walked around. Irregular silhouettes are extruded into polygons. New and stimulating conceptual design ideas surface partly because the design's open spaces can be clearly perceived as 3 dimensional concrete masses. Useful figure ground reversals occur spontaneously depending the viewers angle. Many new possibilities and potentials emerge which this article only begins to suggest.

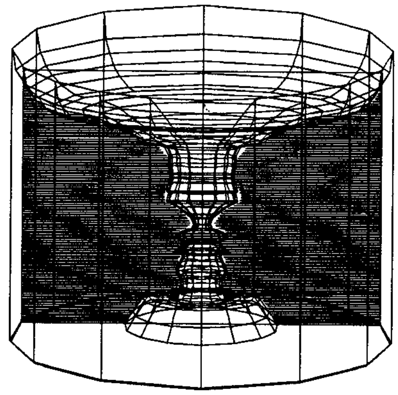

FIGURE 3: *The wine glass and the human face are "swept" 360 degrees to produce this ambiguous solid*

## Limitations with traditional media

Most figure/ground studies unfortunately are flat and 2 dimensional; reversals are expressed in a 2 dimensional medium—paper or canvas. The idea has never really been executed in a true 3d or modeling environment. Why? Its too expensive to make actual models (sculptures) that simply show the spaces between objects. If one did make a "reversed" model it would make little sense unless it was partially transparent. This would be like dropping a large blob of molten plastic over and around a building. The semi-liquid medium would soon conform to the building's shape (like the lava at Pompeii?). Once cooled you could then pull away the mold or die to leave behind the impression. Most fragile scale models of proposed landscapes could not stand up to such clumsy "impression making".

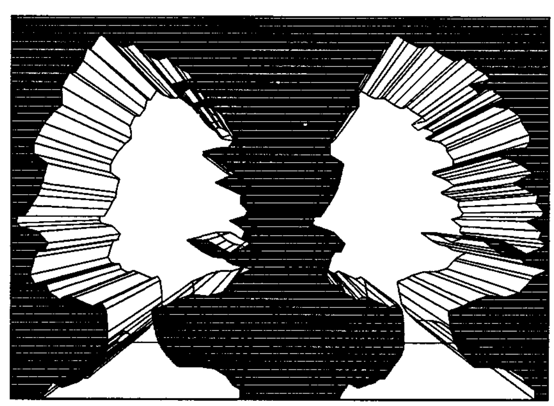

FIGURE 4: *The spaces between trees are important to communicate in a CAD environment because they not only define circulation, but are also effective at enclosing spaces around buildings; solid modeling helps to graphically highlight the extents of these corridors and enclosures*

## Alternative: solid modeling

The relatively recent advent of solids modeling tools however gives a designer the ability to cast an electronic mold around their electronic creation. With moderate increases in computational costs, an architect/site planner can now visualize and manipulate "open spaces" as "tangible" solid objects.

One of the many advantages is the increased ability to better visualize the intended space. To borrow an analogy, by seeing the doughnut HOLE as a solid, one better understands the overall shape of the doughnut RING. This capability , especially in the ambiguous and confusing wireframe environments, is critical to clear design communication. (That is at those moments in the design process when clarity and spatial understanding are preferred over visual ambiguity.)

## Existing applications

The exciting applications of solids modeling techniques remains virtually undiscovered, especially by architects and landscape architects. It is really only the industrial engineers who use this tool to shape and visualize plastic injection molds. The plastic and steel industries need such tools because they need to see how to squish or shape fluid materials. Architects I propose, could use this tool to better visualize the fluidity of a space—especially those outdoor spaces defined by trees. Specifically one could show the shape and extents of open or empty space around a building. This is similar to pouring concrete over a cluster of buildings, pulling the building and landscape elements away and examining what type of indentation was made. This would show the pattern and proportions of spaces left BETWEEN buildings. There are other ways to study these spaces, but few build directly off of the 3 dimensional electronic model already generated.

The example in figures 5 through 8 show how this technique works. First a 3 dimensional model is built in an AutoCAD/AME/LandCADD drawing environment. Simple primitives or extruded polylines are used to rough out tree massing and bollards. A large cylinder is then placed on top of the site. All the trees and bollards are then subtracted away from the cylinder using the Boolean SUBTRACTION operation. What you see in figures 5 and 6 are what remains after the landscape elements were subtracted from the solid cylinder. Figure 5 shows the open space available at 2.75', figure 6 shows the open space at 12'. It is interesting to note what is revealed when using the short vs. the tall cylinder. Obviously where and how deep one pours this imaginary electronic concrete over their design has a lot to do with the resulting solid shape. But then again the purpose is to alter the designer's perceptions and to clarify complex 3d spaces—and this should rightfully be under the control of the designer.

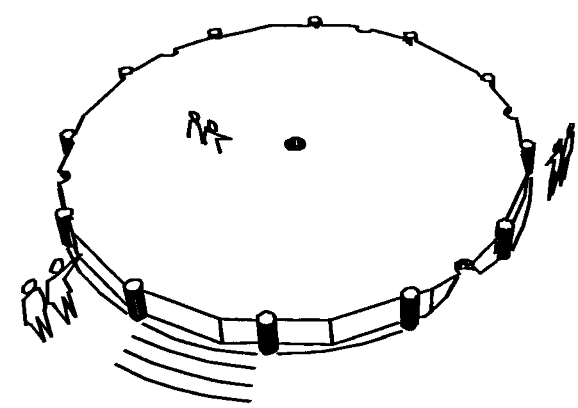

FIGURE 5: *Like an imaginary cylinder being filled with water, this solid disk represents the park's open space at waist level (2.75')*

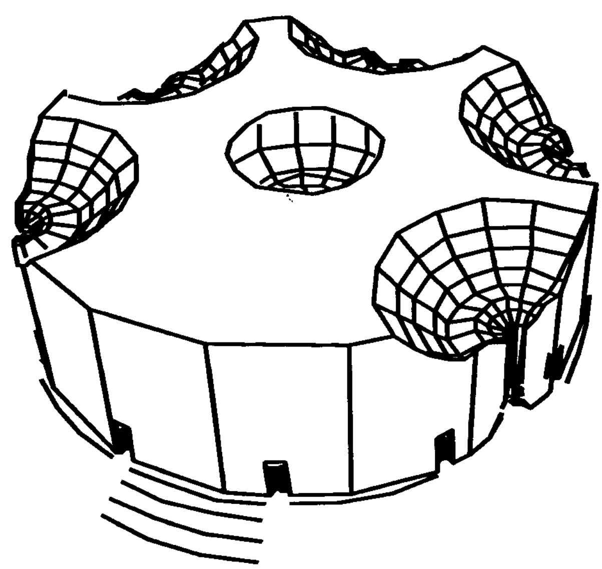

FIGURE 6: *The same cylindrical envelope has now been "filled" up to 12'; the trees and bollards make significant indentations on the supposedly "open" space*

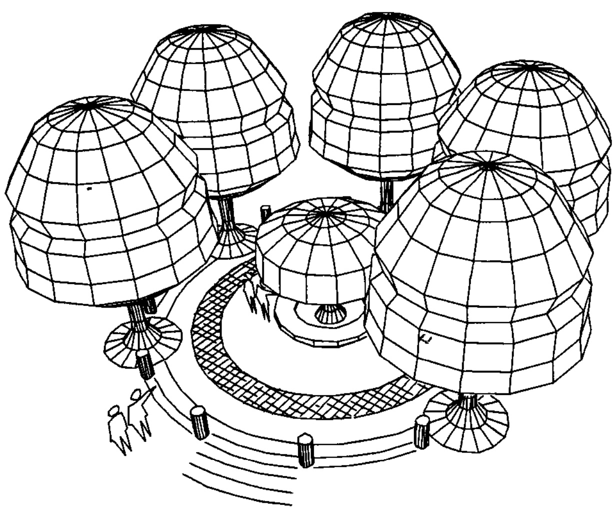

FIGURE 7: *This space, defined primarily by trees, is a good example of how solid modeling can give designers useful feedback about the open spaces they are creating*

**Future applications**

One obvious example for applying this tool is to see how proposed structures fit in (or violate) pre-defined space envelopes. One could be explicit in defining such an envelope and then check that all subsequent "infill" buildings do not violate the restricted space. Interference is quickly and dramatically flagged in solids modeling by using the Boolean "subtraction" operation.

One unique urban planning application is to use this tool to monitor infringements on complex zoning envelops. In the new town of Louvain Belgium for example a complex ' 3 dimensional space frame serves as the towns organizing spine. All buildings and plants have to 'toe the line' and respect this sinuous 3d space. Planners insisted that architects design their facades to abut tightly against a predefined medieval space envelope. (The way water conforms to a bowl). Computer aided solid modeling could be quite useful. By first isolating and then solidifying the desired space sequence, one would have a clear idea of exactly how the facade meets the streets. More specifically one could see how the nearby vegetation (including berms) disrupts or compliments the space structure.

By extension the simulation of "solid" solar envelops have great potential. This is not a new concept, but having the models quickly generated from within the same (AutoCAD) environment makes it easier to apply.

Yes, any imaginative architect/landscape architect could visualize same spatial problems in his/her head. But with solids modeling, one can more quickly and accurately see where interferences would occur. Spatial infringements (overlaps) between building (or plants) and 'reserved' open space would be clearly flagged. Those parts of the building or tree mass that projected into the space could be sheared off or set on an "interference" layer. Solid blocks could be sequentially added, like filling your bathtub with water, to high various profile lines.

**Advantages**

One great advantage in computer assisted modeling of "empty" spaces is that the void itself, once made visible, can be easily dimensioned and evaluated for its proportions. This is because the negative spaces between trees and a building facade are easily accessed and measurable. They begin to represent tangible spatial units of their own. Furthermore the space's volume and center of gravity are easily extracted. (Volume is important because it dictates relative ratios between open spaces and built or closed spaces. Volume calculations by hand within a complex 3 d shape (like a bosque of trees) would otherwise be cost prohibitive.

Another advantage in consciously modeling "empty" space is that one becomes cognizant of the space's proportions. The space itself, because it is now tangible, is dimensionable. Height/width dimensions are measured off of the solidified empty space itself. Because the space is a real entity it can be dimensioned. The space's proportions could be displayed as conventional dimensions or as a dynamic display of the space's length-width ratios. Either way, the proportions can be compared to see how and when they fit into the larger family of proportions already used in the surrounding buildings.

For spaces defined primarily by living vegetation, multiple models would need to be generated to reflect the dynamic changes in a space's proportions due to tree growth over time. You would have to make a separate solid model for each 5, 25 and 50 years of tree growth simulated. Thus as the size of the open space decreased with surrounding tree growth, one could roughly forecast the proportions of the space at various points in time. (Four dimensional growth models are still not sophisticated enough to reflect the many conditions effecting tree growth).

**Disadvantages**

As with most PC based design/visualization techniques, limitations often stem from processing speed. Outdoor spaces formed by even moderately complex trees or building facades will bring even a 486 computer to its knees. The more complex spaces, a bosque of trees for example, tends to make the computer sluggish. This tends to dampen the exciting and stimulating effect that this tool could otherwise offer. (A temporary hardware related problem with many work-around solutions). One is forced to use primary shapes which is hardly conducive to advanced landscape or urban design. Obviously every leaf does not need to be drawn, but from a landscape architect's point of view the basic branching pattern, trunk structure, silhouette and crown mass need to be suggested.

As with most forms of visualization there is a great deal of subjectivity involved. With solid modeling this subjectivity appears when the designer defines the area of so called open space. In these examples, I've tried to make the desired solid "chunk" closely reflect the geometric shape of the design itself. Hence a 40' cylinder was placed on top of a 40' tree-ringed park. This tends to flatter the parks desired shape and form. A larger or smaller or even a triangular mass could have been placed in the space but that would not have revealed much of the parks initial intention. If used honestly to compare the desired open space with the actual space, the tool is effective. If used, like many renderings today, just to hide mistakes or show off a design, then the tool has limited or negative application in the design process.

**Summary**

There is certainly potential in a tool that can quickly reverse three dimensional voids with solids. The strength of this tool is best realized when applied to moderately complex outdoor spaces. One gets a revealing and stimulating reflection on the spaces contained in a given design. The real virtue of using solid modeling to visualize outdoor spaces is that it gets you to pay closer attention to the size and proportions of these "empty" areas.

The ability to quickly and accurately transform empty spaces into solid spaces has immediate applications in shaping and verifying how buildings or planting designs fit into complex space frames. Violations of a space frame are easily flagged giving the designer useful spatial feedback about his/her structure impacts surrounding space.

**References**

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[2] Edwards, Betty. *Drawing on the Right Side of the Brain.* Van Nostrand Reinhold, 1979 .
[3] Adams, C. *Conceptual Blockbusting.* 1985.
[4] Lockhard, Kirby. p. 225. *Design Drawing.* Van Nostrand Reinhold, NY, 1974, 1982.
[5] Edwards, Betty