Edge of the Rational CAD Universe

Chronological Time and Achronological Incompatibilities in CAD

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CAD's limitations in architecture correspond with the capabilities of its machine intelligence. Five decades of research in Computer Aided Design (CAD) have resulted in its 'mastery' of architectural practice. However, the more rational the system becomes, the more inflexible is its behavior. Another problem is invariance, a tendency for science to focus on one problem at the expense of all others. The question of how CAD can transcend its role in automated building design and engage human perception is discussed in terms of chronological and achronological time. Sequencing the design process according to common temporal requirements is proposed.

Keywords: *chronological; achronological; timeline; time-plane; time-event; time-meaning; memory diagram.*

Machine intelligence, human values

"Until now we have so worshiped our new idols, the machines, that we are in danger of losing our spiritual concept of values" (Gropius, 1968)

Five decades of struggle in Computer Aided Design (CAD) have resulted in the 'mastery' of machine intelligence in the practice of architecture – almost exclusively in the realm of rationalization of process. "But what's wrong with getting something done faster and cheaper by rationalizing the process?" Professor of Sociology George Ritzer responds, "The short answer is that the rational systems carry with them a series of irrational consequences, so they often accomplish just the opposite of what they are trying to do" (Jensen, 2002). In architecture, Computer Aided (D)esign has prospered at the expense of Computer Aided (d)esign, efficiency over values.

The rational limit of the CAD universe is at the boundary of Cartesian reality; is it conceivable that CAD can transcend its role in automated building design and engage human perception? Professor Perez-Gomez presents a pre-digital perspective, "The fundamental axiom of the sciences since 1880, as well as of the humanities, has been 'invariance,' which rejects, or at least is unable to cope with, the richness and ambiguity of the human intellect." (Perez-Gomez, 1984) A solution is at least years or even decades into the future, and may require novel concepts in artificial intelligence. This research seeks to identify limitations within present day CAD software, to introduce compensating design techniques, and to redefine the design sequence to accommodate the required changes.

Rationalization, invariance and values

'Rationalization' and 'invariance' define a cause and effect relationship that explains the present dilemma in the future of CAD. CAD manufacturers

offer a variation on this perspective, "With integrated and object-oriented 3D CAD becoming the mainstream design and documentation tool for architectural practices, traditional 2D drafting-based systems are being phased out in favor of 3D model-based solutions that allow architects and designers to create rather than draw, build rather than draft." (http://www.graphisoft.com/products/architecture: June 2001). As part of this new phase of productivity enhancements, 'creating and building' replace 'drawing and drafting' in design. However, the implied equivalency or even superiority of 3D model processes is undefined and unproven.

Problems in design synthesis

CAD's linear programmatic organization depends on chronological time, yet human factors in design are dependent on achronological time; the problem has perplexed architects for millennia. Design theories addressing synthesis are characterized in Louis Sullivan's 'form-function' axiom and are traceable back to Vitruvius, "I think that men have no right to profess themselves architects hastily, without first having climbed from boyhood the steps of these studies and thus, nursed by the knowledge of many arts and sciences, having reached the heights of the holy ground of architecture." (Morgan, 1914)

CAD exacerbates a pre-existing condition by enforcing its rules of linear logic. The extreme complexity of architectural programming, especially life-safety and accessibility, increasingly require computer management. Limitations in non-linear design capabilities are masked by the complexities of this objective, but the incompatibilities are largely a consequence of time-function conflicts in the design process.

Most built architecture does not require intensive aesthetic design exercises, especially when the primary objective is function. CAD efficiently manages the design within the limitation of the rules of its program and the selection of components from its libraries. However, when architecture and its urban environment require conceptual design development from a value oriented human perspective, CAD is not the appropriate venue.

While CAD has emerged as an excellent model builder, capable of coordinating almost unimaginable complexity, it should not masquerade as an all-purpose design tool. Its linear logic it is neither designed nor capable of addressing the complex layering of symbolic thought that is associated with non-linear design development.

Chronological and achronological time incompatibilities

Building design and human perception engage two mutually incompatible conditions of time: In building design, duration of function creates a dimensional variable in the architectural lifecycle. For example, intervals allow the simulation of energy usage, seismic design, and facilities management (FM). The present direction of CAD is to integrate chronological applications into a single, relational, database application. Consequently, architecture is emerging as one of many interrelated event on a common timeline. The function of architecture is to optimize competing interests through the lifecycle.

In conceptual design, time's second, non-predictive use (and the focus area of this study), there is no expectation of continuity or temporal reality. 'Creative-time' is achronological. Steven Kern notes the painterly manipulations of artist Salvador Dali in The Persistence of Memory (1931): "The third deformed watch curls over a hybrid embryonic form – symbols of the way life distorts the geometrical shape and mathematical exactness of mechanical time."(Kern, 1983) Achronological time permits an artist to restructure meaning without regard to the event's time or place. The restructured message creates a com-

posite memory in a synthesis of non-linear events. While achronological time is the measure of creative art, painting (implied time), theater, and film, it is the orphan of architecture.

Implied and real time design evolution

In 1829, the philosopher Goethe characterized architecture as 'frozen music', implying a compression of time and meaning in architecture as a singular event. An experiment follows that explores the translation from implied to real time, from painting to film.

Architects and traditional artists maintained stylistic references to implied time throughout the twentieth century, however the invention of moving picture technology provided the first 'real' tools for artists to manipulate time and restructure meaning. One hundred years separate film's technological invention and the more recent applications of time in architectural design. While the design issues are related, they require very different approaches; film-time engages meaning in non-linear time, but architecture engages non-linear factors only in conceptual design. Architecture's primary activity is in the development of programmatic linear functions. The problem in CAD is its inability to address linear and non-linear time simultaneously.

Chronological time in design

(X+Y+Z) +T, consists of three dimensions of space and one dimension of time; it is linear, directional, and finite. Cartesian space travels as a sectional plane from left to right along the chronological Time Line. In terms of this diagram, X, Y, &Z appear as compressed functions on the sectional plane. Traditional architecture (including basic CAD) attempts to optimize a point on the timeline of perceived need over time. CAD's immediate future is to integrate form, function, and economic utility and to optimize their combined performance throughout the architectural lifecycle. Each 'event' along the timeline defines a section perpendicular to the timeline [Fig. 1].

Achronological time in design

TE+TM define the 'Time Plane' that travels along the 'Time Line'; the plane represents Cartesian space on a compressed surface plane [Fig. 2]. Notably, TE+TM are always perpendicular to the film plane [Fig 3].

Conceptual design (as in film) is a composite of non-linear meaning; Events are accessible by content i.e. emotion, intensity, topic, or sensory quality. Restructured content creates new meaning on the timeline. The film timeline composition

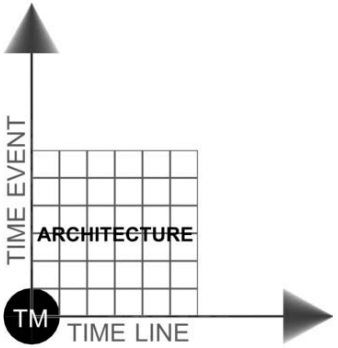

Figure 1. time-event, time-line plane

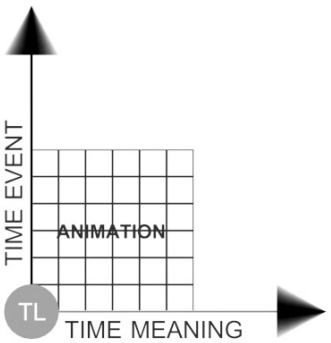

Figure 2. time-event, time-meaning plane

requires basic stacking techniques of visual imagery; the length of film timeline establishes audio length. Audio is capable of mediating the visual message as well as organizing and structuring the film timeline.

A unique attribute of film-time is the requirement of sequential memory in multi-sensory design. This is the same requirement as the television commercial; a sequence of visual imagery, reinforced by sound, that must be perceived in time and committed to memory.

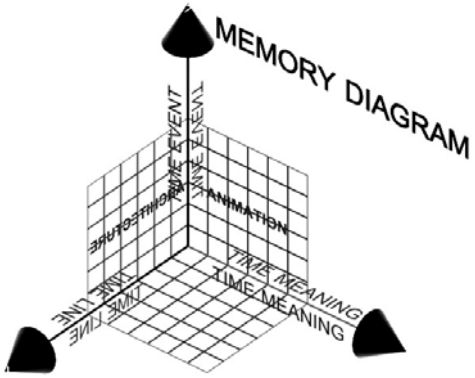

Figure 3. Memory Diagram

Competing temporal requirements of CAD

The proposed system parallels creative development in film and television; it proposes to separate achronological components into an initial film-time digital design phase (conceptual design) followed by a CAD phase (project design). The architect designs in CAD according to the design intent of the Memory Diagram. The project architect, like the film director, interprets a previously established script. A brief outline of a project that explored many of these concepts follows:

Pablo Picasso in his 1937 painting Guernica abandons the notion of a timeline and composes both event and meaning on a single time-plane, TM-TE in Fig. 2. In this research, the strategy is to create a Memory Diagram, a compact, initial design statement that is memorable, articulate, and purposeful. The Memory Diagram guides subsequent architectural development in CAD; it differs from traditional verbal, written, and visual conceptual processes by it incorporating multi-sensory input. The format is 2-4 minute of sound and video composition, of music, speech, sound, visual sketches, diagrams, photographs, or artwork (painting). The television commercial is its prototype; however, it is of longer duration, more specific in its content, and it addresses geometric symbolic development.

Conclusion

The position that computer-aided design is an issue of machine intelligence is an uncomfortable one. While I sincerely believe that the case is strong, the paradoxes and setbacks are overwhelming to the point of making this position quite self-defeating for the researcher. (Negroponte, 1972)

Five decades of development in CAD research have transformed architecture, from 1970's word processing, to 1980's vector-graphics, to 1990's 3D modeling, to present day 'relational' CAD. The nature of progress in machine intelligence is that obstacles are to be expected; Negroponte admonishes, "Without this understanding, I believe that the future of architecture, as aided, augmented, or replicated by computers, will be very gloomy in the hands of one-track-minded autocrats."

This research suggests accommodating, not changing, CAD's present direction and placing a compact digital multi-media design phase prior to CAD development. Under the best of circumstances, "Full implementation of CAD-integrated systems is a long way off." (Dell'Isotole, 2002) This research suggests that in its present form,

CAD will never contribute beyond its programmatic limitations. At present, there is no clear understanding of how this can be resolved. However, computerized tools are available today that can accomplish these objectives in sequential applications.

Until a practical object-oriented, intelligent, time-value CAD arrives, capable of addressing the human values, as in Picasso's Guernica, and bringing them to architecture, it is advisable to group and sequence digital functions in a fashion that optimizes their use.

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