Discovering Cyberworlds

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In this new millennium each of us should only compose messages designed to reach one person. Global, or mass, messages often hold only momentary appeal—how long do you remember long speeches on television? A contrasting example is found in the Bible, which has increased in value for two millennia and which records individuals' messages meant for other individuals. What follows here is my personal message to you about the invariants we should rely on to live successfully in our rapidly changing real world and in cyberworlds.

Cyberworlds

The real world we live in is complex. Once upon a time on an island in the Far East, there was a grade-school boy who learned from a book that there were three hundred thousand different chemical compounds. He hated any complexity because it blocked his mental vision. A bad memory of wartime information blockages had made him allergic to the lack of vision. Upon further study, he soon found that theories about elementary particles, atoms, and molecules—the periodic table combined with the octant theory—simplified the material world. The octant theory gave eight as an invariant of molecules, indicating eight electrons at the outermost molecular orbit would predict a stable molecular formation from atoms.

In the late 1960s, the boy as a PhD student discovered cyberworlds while synthesizing intermolecular properties in an effort to understand life. The intermolecular properties were computed from the structural information of molecules assumed to exist. He realized that often he had computed the properties of hypothetical molecules, resulting in the creation of nonexistent material worlds inside computers. Such information worlds, now named cyberworlds,[1] attracted him because they could extend beyond the real world in potential and scale. (The story of the real-world creation in the Bible's story of Genesis was attractive enough.) A few years later, he initiated the creation of a new Information Science Department to study information worlds further. Created first as a research institution with a graduate program in 1970, it turned into a department in 1975.

In the late 1960s, he realized the value of raster graphics over the predominant vector graphics for displaying versatile cyberworlds with colors and textures. This led him to initiate a project to build raster graphics with 4,096 concurrent colors with a virtual frame buffer. When an object's shape changes, it usually retains the same colors and textures, and so are *invariants*. However, to publish his findings, he had to wait for the first Siggraph to meet in 1974. Even then, he had to go against the pressure of the vector graphics community, which preferred high-resolution graphics to raster graphics.

The potential of cyberworlds

Although cyberworlds lie in the information domain, they are not always virtual. Pulse motors can turn each bit directly into a step movement. Robots with pulse motors in their joints can turn cyberworld objects directly into those in the real world. Cyber business and e-business are also real. Another example is the e-business/e-financial business, which trades a GDP-equivalent amount of real-world money in a day.

Unless we identify invariants, we cannot quickly understand changing cyberworlds, which are out of human control and could put the real world into crisis. On computer graphics screens, we can display a crisis as a *singularity*, a discontinuity of the world growth. Often, a robot becomes immobile when its configuration becomes singular in its workspaces. *Singularity signs* designate invariants and play essential roles. Research provides deep insights into their nature and leads to indexes that characterize cyberworlds.

Any world spans time and space, and consists of subworlds. Time is an irreversible space. Computer graphics per se is engaged in display. To display images, we need a coordinate and a distance measure. Hence, we rely on geometry, which inherits topological properties. Computer graphics as computers are set theoretical machines using AND, OR, and NOT logic. Topology is built on the AND and OR of power sets. In terms of the abstraction of invariants hierarchically organized from general to specific for realizing the modular and incremental design of objects, the following is a reasonable example of an *incrementally modular abstraction hierarchy:*

- a set level;
- an extension level, a homotopy level as a special case;
- a topology level, a graph theoretical level as a special case;

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- a cellular structured space level;
- a geometry level; and
- a visualization level.

For computer graphics, a cellular structured space level based on *cellular spatial structures* such as CW spaces provides a far more versatile basis than that based on a graph theoretical level common in conceptual and data modeling. It allows computer graphics to specify objects in cognitive and computational spaces as cells and their boundaries. Cellular modeling also allows cellular composition and decomposition while maintaining cell dimensions and connectivity as invariants. Object identification is carried out systematically through *identification mapping* (often called *quotient mapping*).

We can model a cyberworld appropriately as an n-dimensional cellular space topologically equivalent to an n-dimensional ball B^n. A space has a dimension as a *degree of freedom.* We can construct a one-dimensional space consistently from a zero-dimensional space by attaching one-dimensional cells. By repeating cell attachment, we can inductively compose an n-dimensional space, where an n cell is topologically equivalent to an n-dimensional ball.[2] This stands for the "genesis" of a cyberworld because we are creating a new world from scratch.

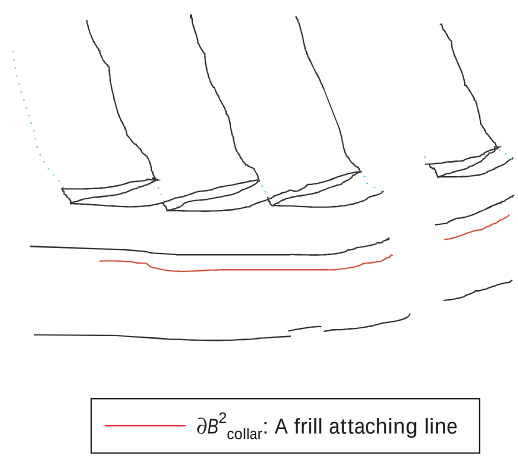
An example

The boy is now over 60 years old and a professor emeritus. He has found this cellular space to be very convenient in extensively modeling varying cyberworlds. He has also realized the complete lack of cyberworld research from this general viewpoint.[3,4]

Designing a new cyberworld from existing cyberworlds is exactly the same in its way as designing a garment frill (pleats in a shirt cuff in Figure 1). A frill design process involves the cell decomposition of every tuck (a two cell) being attached to the edge (a one cell) of a shirt cuff and the rest (a two cell). The next step is *cell composition* via *cell attachment* to identify the tucked edge $[\sqcup_i(B^1{}_i \sqcup B^1{}_i \sqcup B^1{}_i)]_{\text{tuck edge}}$ with a line ($\partial B^2{}_{\text{collar}}$ that is a one cell) on the cuff where every tuck is attached. See Figure 2. Though the garment changes shape geometrically while it is being worn, we can still see the frill as the tucks being attached to the cuff. So the frill is an invariant of the shape change.

Similarly, we can form a new cyberworld by attaching existing cyberworlds. The way we do this becomes an invariant of cyberworld shape changes through cell composition and decomposition. The garment frill example helps us understand rapidly changing cyberworlds and how to display the way cyberworlds are changing on computer graphics screens. ■

1 A shirt frill folding into a cuff.



2 Frill composition: cuff attachment to tucks via the attaching map. f: $\partial B^2{}_{\text{collar}} \longrightarrow \sqcup_i (B^1{}_i \sqcup B^1{}_i \sqcup B^1{}_i)_{\text{tuck edge}}$.

References

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