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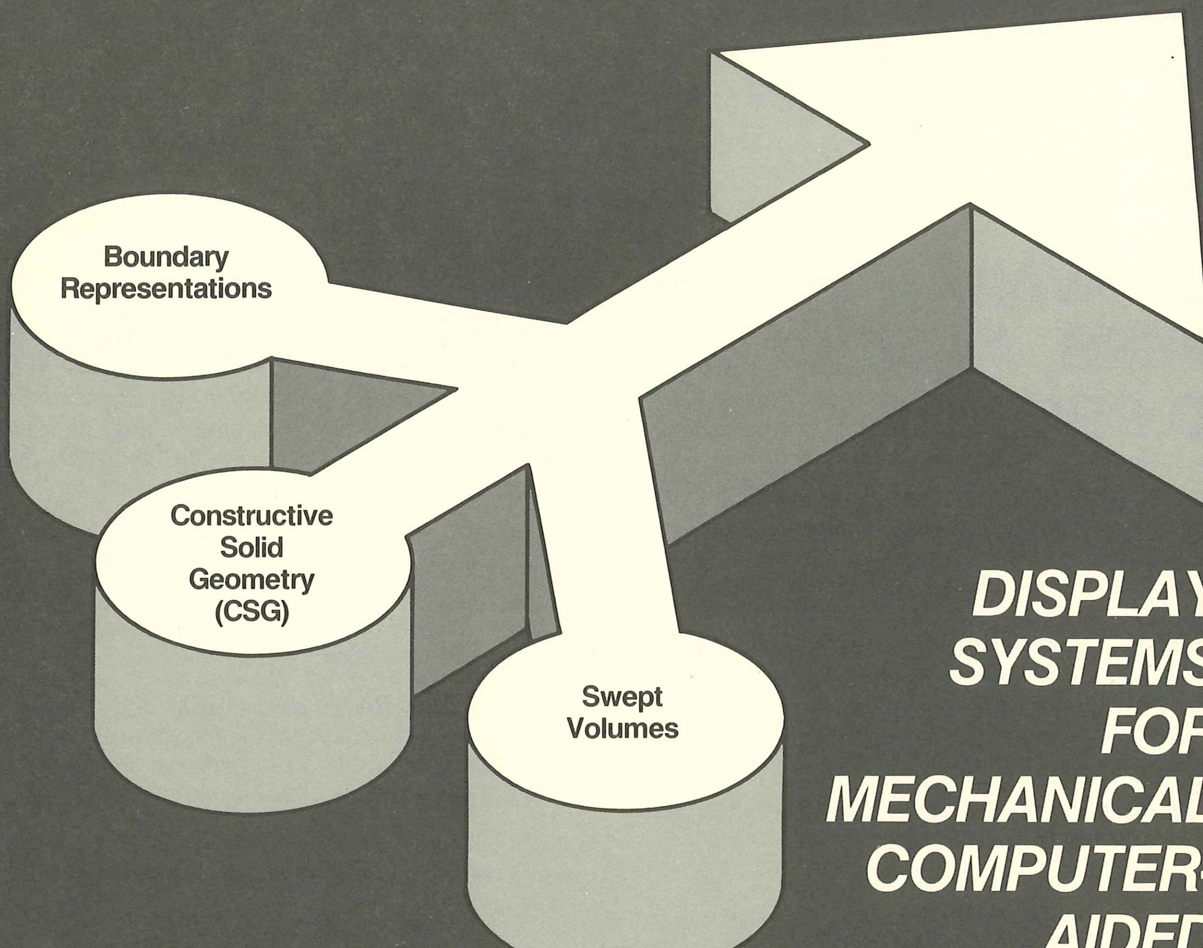
SOLIDS MODELING



DISPLAY SYSTEMS FOR MECHANICAL COMPUTER-AIDED DESIGN

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Volume 6, No. 6, July/August 1984. Managing editor: Art Andersen, ext. MR-8934, d.s. 53-077. Cover: Nancy Pearen; Graphic illustrator: Darla Olmscheid. Composition editors: Jean Bunker and Sharlet Foster. Published for the benefit of the Tektronix engineering and scientific community.

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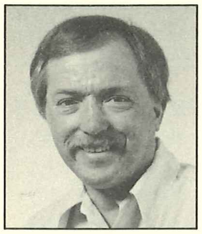
SOLIDS MODELING AND FUTURE DISPLAY SYSTEMS FOR MECHANICAL COMPUTER-AIDED DESIGN



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Digital design representations for mechanical CAD/CAM are being based increasingly on solids modeling technology. This technology is still immature and a number of competing solids modeling schemes exist. This diversity makes it difficult to design graphic display systems capable of the high performance required for interactivity. This article suggests a hybrid solids modeling scheme that combines the best of existing schemes and outlines an architecture for an efficient display system.

CAD/CAM technology is changing rapidly and profoundly. In mechanical CAD/CAM, new techniques for representing designs are just appearing in commercially available systems. These techniques are the result of industry research conducted within the last decade into the problems of design representations, especially in solids modeling. These new solids-based CAD/CAM systems are meeting with much commercial success and are predicted to dominate the marketplace by the mid 80s.

Despite this rapid acceptance and early success, solids modeling is not yet a mature technology. Each of today's solids modeling systems has limitations that prevent widespread application in production environments. But none of the limitations pose intractable problems and rapid progress toward their solutions is expected.

A fundamental component of all mechanical CAD/CAM systems is one or more programs for capturing the details of designs and storing this information in a design database. Universally, these programs – which are often *solids modelers* in advanced systems – include some form of graphical user interface which couples human spatial-data-processing ability with the speed and accuracy of the computer. The effectiveness of this user interface is largely determined by the speed and flexibility of the display system.

Few, if any, solids modelers exhibit satisfactory user-interface performance. The explanation for this poor performance is that the design-description data structures in solids modelers are designed primarily to model solid objects mathematically and not to produce pictures rapidly. Conventional graphic-display devices designed to process more graphically oriented data fare poorly when used with a solids-modeling system.

Recently, the mismatch between the sorts of data used to model solid objects and those used to produce pictures on display systems has been addressed by sophisticated display systems. These systems directly accept certain types of geometric data found in some types of solids models. These new *planar polygon-based systems* are the first step by graphic-systems vendors in targeting display devices for specific applications. However, the rapid changes in solids-modeling technology will require even more sophisticated display devices which can closely couple to whatever new solids-modeling data structures arise. Thus, display technology will be quite dependent on developments in solids-modeling technology for some time.

Where is solids-modeling technology headed? Predicting the future of a young technology is risky. However, in the case of solids modeling, there is a well-developed base of fundamental technology – and a clear vision of the goal, namely, full automation of mechanical manufacturing. I feel that most of the significant changes in solids-modeling technology in the next five years will entail consolidating existing base technology to capitalize on the best features of each of the various design-description schemes.

Historical Perspective of Mechanical CAD/CAM Systems

The first use of computers in mechanical design was in the improvement of drafting productivity. An interactive graphic system was a powerful substitute for the drafting table, allowing the creation and modification of computer files representing conventional part drawings.

It is important to note that these computer-aided-drafting systems generated *graphic* data intended for human interpretation. Higher levels of automation in mechanical design and manufacturing require design descriptions that can be interpreted *automatically.*

Automatic interpretation of part drawings never did become feasible despite much research, in part because of the poor ability of computers to process complex spatial data. Instead, drafting-oriented design descriptions were embellished in ad hoc ways to capture the more explicit geometrical details of the part design. A third dimension was frequently added so that line segments and curves could represent part edges in three dimensions rather than just two-dimensional projections of those edges. Surface descriptions were another embellishment added so complex surfaces could be represented in three dimensions rather than indirectly through loft lines or other two-dimensional methods.

By the middle 70s, it was apparent that embellishing drafting-oriented design descriptions could not provide the unified design description needed to integrate the various mechanical manufacturing functions. As a result, extensive research into *solids modeling* was started and design descriptions tailored to the geometry of solid mechanical objects were invented. From this research came many schemes for representing solid objects. Each scheme claimed advantages over the others; vendors touted these advantages extensively.

However, the promise of solids modeling to unify mechanical design and manufacturing into a coherent automated process remains elusive. Each of the descriptive schemes is suitable for some applications but less so for others. Thus solids modelers tailored for specific applications are common (see figure 1). This situation is far from ideal. Applications remain isolated from one another by incompatible design descriptions and communication of design information across application boundaries is largely nonautomated.

What is needed is a single solids modeler whose data structure suits *all* manufacturing applications (see figure 2). The source for design information would be identical for all applications, eliminating the need for different (and potentially inconsistent) design descriptions. The design description need be entered only once. Communication across application boundaries would be simplified due to the common source of design information.

Requirements of a Centralized Solids Modeler

There are a number of different descriptions used in mechanical CAD/CAM (see figure 2). The *user description* consists of the sequence of input actions generated by the user. (It is often overlooked that this sequence of actions is, in itself, a design description.) The *central description* is the computer-readable repository for the entire design description. The *computational description* is a design description derived from the central description via conversion programs; computational descriptions are in forms suitable for specific applications.

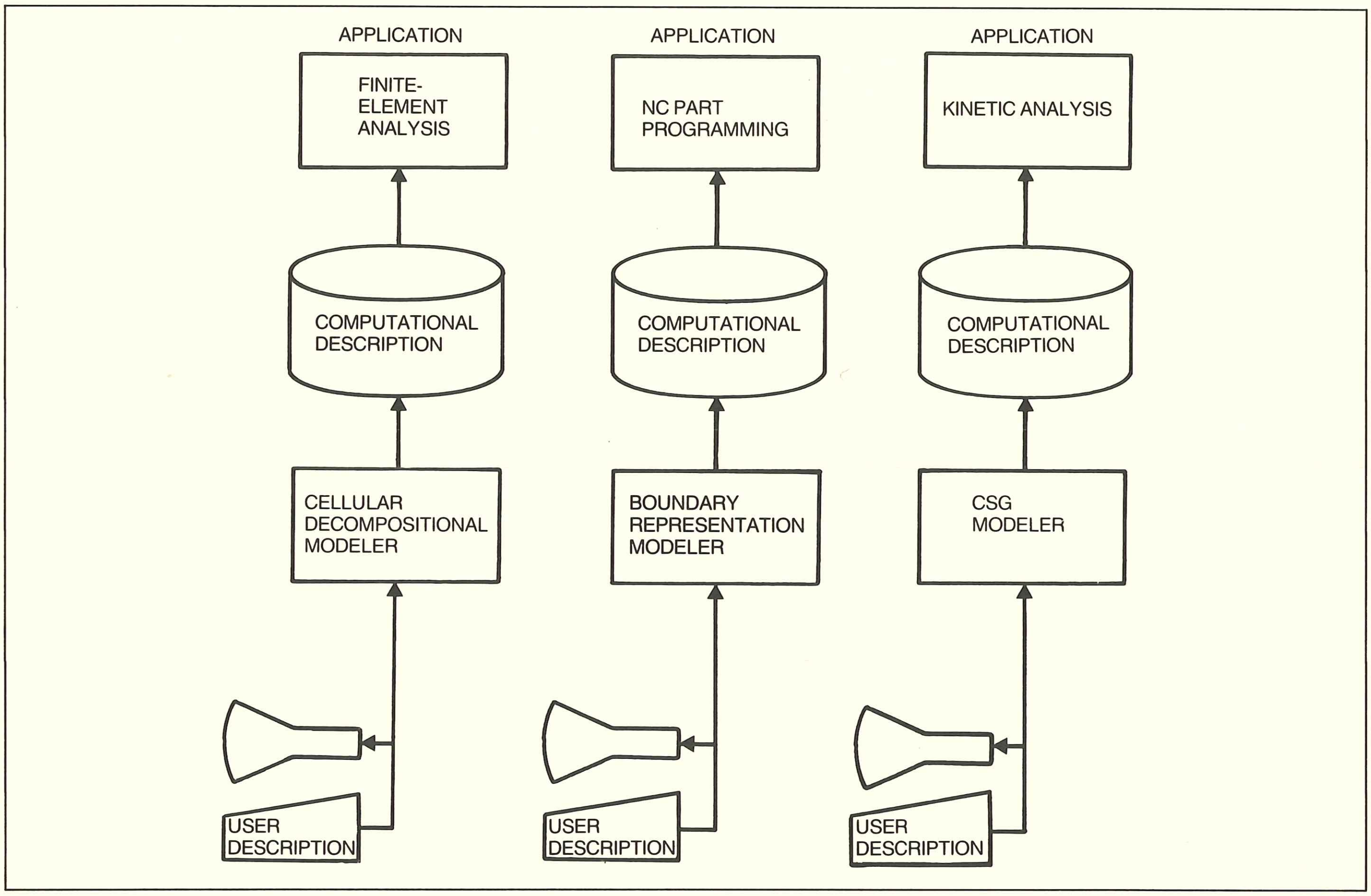

Figure 1. Application-specific solids modelers each require differing inputs of the same part description. Communications across applications is difficult.

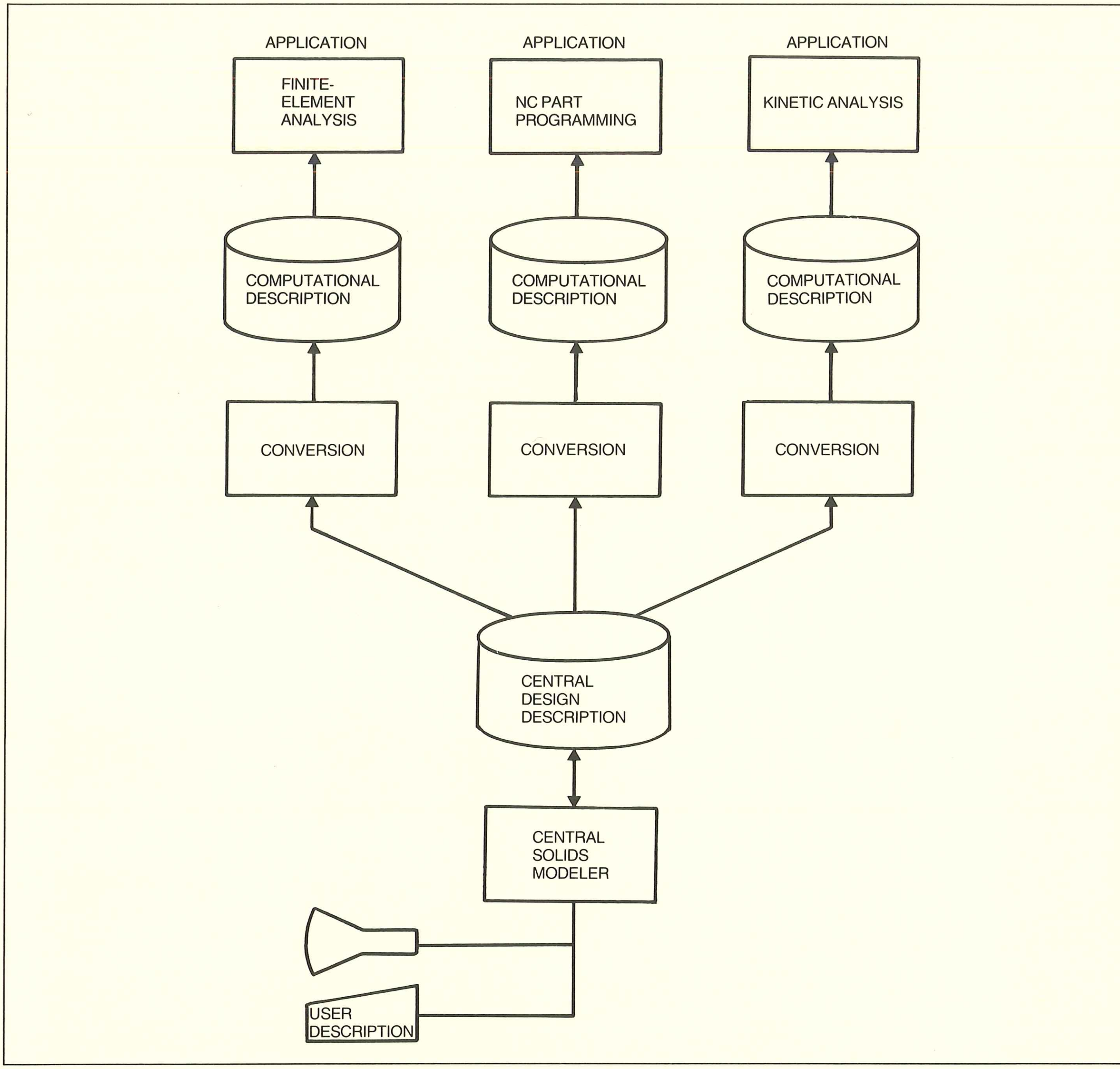

Figure 2. In contrast to application-specific modelers, a central solids modeler would require a single input of the design description. This single input would be used to create a central design description usable for all applications. This, of course, would facilitate *automatic* communication across application boundaries.

In a centralized system, two important relationships can exist between different descriptions. Two descriptions are *equivalent* if each can be converted to the other with no loss of information. A description is said to be *derivable* from another description if a process exists to convert from the first to the second.

User interface

The *user interface* supports a dialogue between the computer and the user consisting of two types of transactions: *modifications* and *queries.*

Modification transactions comprise the user description and can be of three types: add something new, delete something, or alter something.

A *query* transaction is a user request to see some part of the design description. A query is often used to see a graphic representation of the current state of the design description.

The quality of the man-machine dialogue depends upon:

Naturalness of the dialogue language – The language of the dialogue should be natural to the user. The user should be able to specify modifications and make queries in natural terms, and the system should answer using similar terms [Alle84].

Interactive speed – The speed at which queries and modifications are processed is important to the user. Slow responses have bad effects such as lowered productivity, user fatigue, and increased error rate.

Format flexibility – The user should control how a response to a query is presented by the display device. This control might include the ability to select from transparent wire-frame, opaque wire-frame, or shaded-solid representations. Also important is a choice of viewpoint, size of representation, sectioning, and perspective, or orthographic projections.

Two factors significantly impact the design-representation scheme:

First, *equivalency.* The central design description should be equivalent to the user description; otherwise, responses to queries may be in terms unnatural to the user. For example, if the system converts the user's description of geometric surfaces to a uniform internal representation, the conversion may prevent the system from responding to a query about a surface type in the same terms as the user employed.

Another editing problem occurs when design descriptions are not equivalent. If modification transactions are not recorded in the design description, consider what might happen if a transaction called for changing the design description to combine two complex objects into one. After the modification, the user may find that the modification is wrong. With no record of how the design description got to its current state, backing up and undoing the modification would be difficult.

The second factor that impacts the design-description scheme is *matching.* The central design-description database and the display system should be well matched so that speed and flexibility may be achieved. This matching can be achieved by either tailoring the design database to be compatible with conventional display devices or by designing display devices to accommodate the design database. The latter approach is more likely to succeed, considering the other constraints placed on the design database.

Descriptive power

Descriptive power is the description scheme's ability to accommodate accurate descriptions of all objects of interest. Exactly what this means is a matter of some debate.

When the mechanical parts of an office machine were classified into groups by their geometric complexity, researchers at the University of Rochester found that most of the parts could be described in quite simple geometric terms. They concluded that most real-world part designs are geometrically simple [Samu76]. However, there is a class of highly visible parts, those bounded by high-order and free-form surfaces, such as automobile fenders, airfoils, telephone headsets and ornamental objects that are not geometrically simple.

Some argue that descriptive power is acceptable if most manufactured parts are describable. Others argue that without full descriptive power, the need to handle a few parts as special cases can be too costly and thus offset any advantages of an incomplete solids modeler might have.

Efficacy in the context of applications

Differing manufacturing functions must each satisfy their information demands from the central design-description database. Although these information needs will vary both in content and form, the variations should not burden the individual users. Instead, the burden should fall on conversion programs that generate the application-specific computational descriptions from the central description, but conversion should be done only as necessary.

The descriptive scheme used in the central design-description database must not only allow computational descriptions to be derived from the central description, the scheme must also use practical, efficient conversion algorithms.

Methods for Solids Modeling

In this section, I describe and evaluate the various methods of solids modeling. A concise definition of each scheme is not included. For this information, consult [Requ80].

Cellular decomposition

This scheme for representing solid objects is based upon representing a class of "simple" solid objects, called *cells* and being able to combine these cells by "gluing;" this means the cells may form an object by sharing boundries, that is, vertices, edges, and/or faces (surfaces) – but objects cannot be formed by cells sharing volumes (spaces). There are two variations on the cell scheme: *voxels* and *tricubic hyperpatch cells.* The variations are distinguished by the flexibility of the cells used to construct a model.

Voxels are cubic volume elements that can only approximate the desired object although any degree of precision can be achieved with sufficiently small elements (see figure 3) [Meag82]. Because all surface features of an object are represented uni-

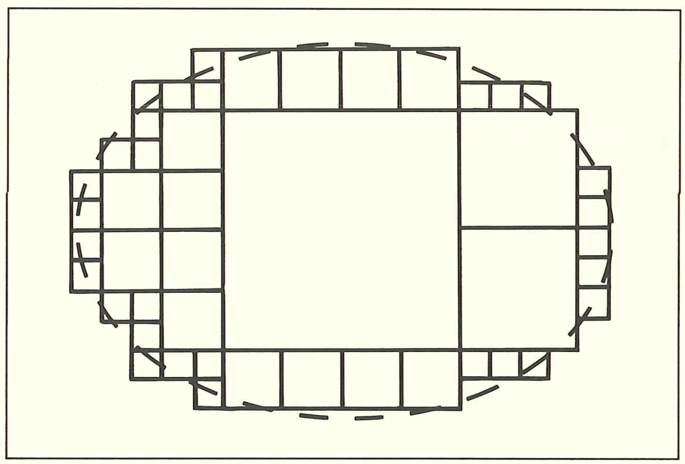

Figure 3. A solid object approximated with volume elements (voxels), one of the two forms of cellular decomposition. Although capable of high precision, the process nevertheless is an approximation, and therefore unsuitable for use in an universal central design description.

formly and only approximately, queries such as "Is this surface cylindrical?" (an important query for numerical control machine tool programming), are only answerable approximately. For this reason, cellular decomposition into voxels is not appropriate for a centralized design database.

Tricubic hyperpatch cells [Stan77] permit great accuracy when curved surfaces are involved (see figure 4a). However, the user must, generally, be responsible for the decomposition into cells. Because a tricubic hyperpatch is topologically equivalent to a cube, decompositions into solid regions that are not topological cubes cannot be done, as shown in figure 4b.

The tricubic hyperpatch scheme does not lend itself to certain modifications. For example, removal of the hole in figure 4a requires either defining a new cell to fill the hole or discarding the original decomposition and generating a new one. Similarly, adding of a hole to an existing design always requires a new decomposition, which may completely invalidate the original decomposition.

Boundary representations

Solid objects may be completely described in terms of boundaries, that is, faces, edges, and vertices. The major advantage of the boundary-representation scheme is that the faces, edges, and vertices of an object are represented explicitly. Since significant applications in CAD/CAM, such as numerical control programming and graphic rendering, are concerned with explicit boundries, this scheme has real appeal.

In one form of user interface to a boundary-representation-based solids modeler, the user explicitly specifies the topology by means of functions called *Euler operators* [Mant82]. These operators, applied to a valid boundary representation, permit new faces, edges, and vertices to be created or deleted, while maintaining the topological *correctness* of the boundary (the numbers (quantities) of faces, edges, vertices and holes satisfy Euler's equation). In addition to specifying the topology, the user must explicitly specify the geometric characteristics of the faces, edges, and vertices.

Figure 5 shows the use of Euler operators in putting a hole in a simple block by *adding* a hole through it. Three steps are required. Two create the edges that will ultimately form the intersections of the hole with the faces. The third makes the hole.

Another form of user interface for producing a boundary representation is to enable the user to combine two boundary representations into a third through the Boolean operators *union, intersection,* and *difference.* The operation of putting a hole in a block can be specified as "remove a cylindric volume from the block." As this is more natural and simpler than the sequence of Euler operators, this interface may seem preferable. However, using Boolean operators to produce a single boundary representation from two boundary representations requires a complex, often slow-to-perform algorithm. Thus the simplicity of modification gained by using Boolean operators may be offset by the time required to update the design description.

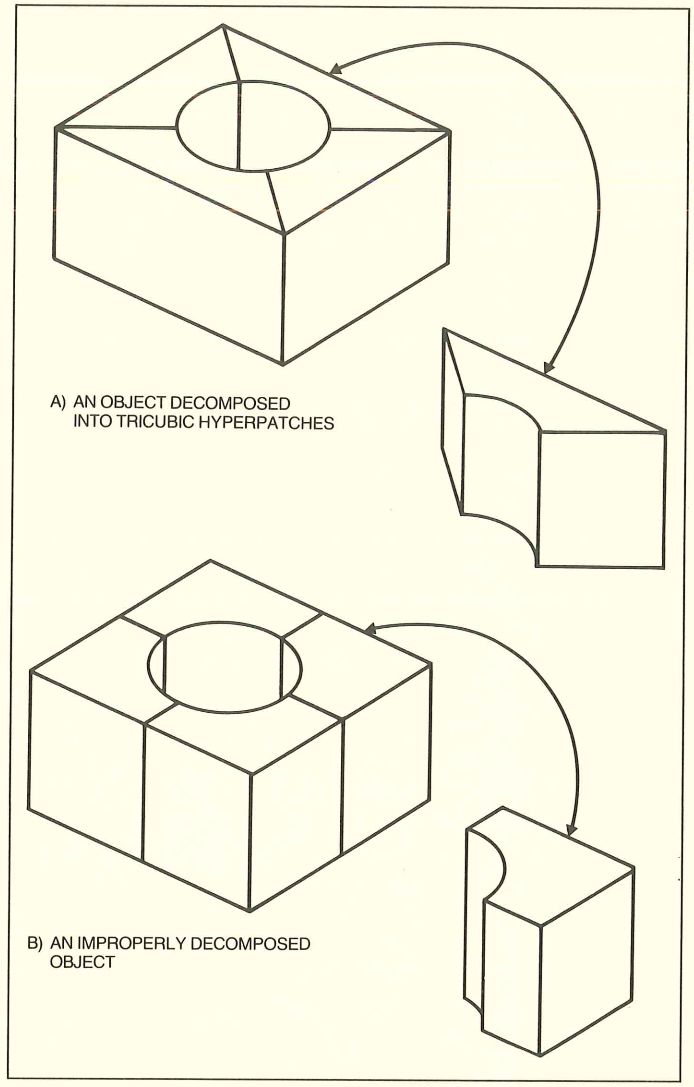

Figure 4. Solids modeling with tricubic hyperpatches, the other form of cellular decomposition. Voxels, the other form, are shown in figure 3.

The boundary-representation scheme is a natural way to integrate methods for describing complex surfaces into solids-modeling technology [Chiy83]. Surface patches such as B-splines, when used as face elements of a boundary representation permit descriptions of mathematically complex objects such as aircraft bodies.

Difficulties arise, however, when Boolean operators are used to combine two boundary representations composed of surface patches [Prat84]. Surface patches are bounded by curves that can be precisely described piecewise as polynomials or rational functions. The curve of intersection of two patches, however, may not be describable in this way. As shown in figure 6, combining boundary representations composed of surface patches

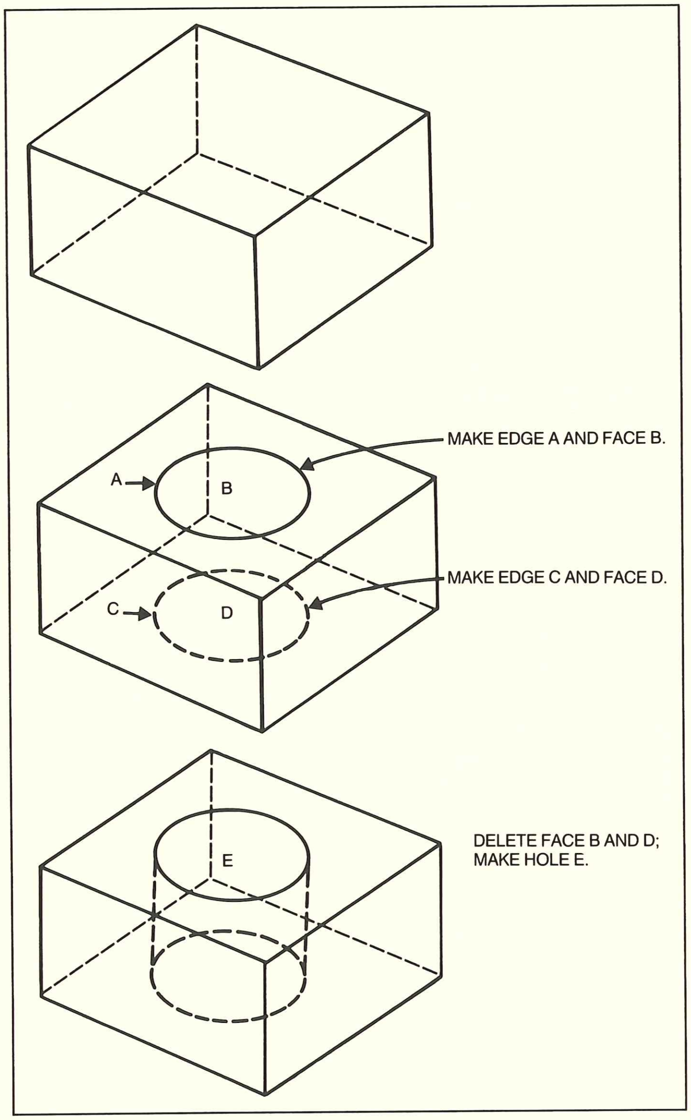

Figure 5. Modifying a boundary representation with Euler operators to make a hole.

may generate edges that cannot be exact boundaries of surface patches. Hence, some faces may not be exactly coverable by surface patches.

The usual way of handling this coverage problem is to approximate boundary representations. In approximate representations, it is not necessary for (1) edges to lie exactly in the two faces generating them, (2) faces to meet at edges, and (3) the shape of faces to exactly match its original description. While these approximations may be quite precise, high precision is costly and – in some applications – insufficient precision can have serious consequences. For these reasons, the user should choose approximation representations only when he or she knows the application which will use the description.

An additional problem with combining boundary representations using Boolean operators occurs when a user tries to undo an earlier Boolean combination. Since a boundary representation retains no information about how it was created, reversing certain changes will put a heavy burden on the user. See figure 7 for an example.

Swept volumes

Certain solids are naturally describable in terms of the volume "swept out" as a surface follows a path. Examples include extrusions and part features turned out on lathes (see figure 8).

While the swept-volume scheme has limited description power, designs within its domain can be described succinctly and naturally by describing the surface to be swept and the sweeping path. For turned parts, the surface is simply describable as the part profile and its axis of revolution; the path is implicitly a circle. Extrusions are describable in terms of the profile, with the path being implicitly a straight-line segment.

Constructive Solid Geometry (CSG)

Constructive solid geometry is based on Boolean combinations of geometric elements called *halfspaces.* A halfspace is intuitively described as all of the points to one side or on a surface described by a mathematical function (usually a polynomial). Thus the set of all points in space that satisfy $f(x,y,z)\leqslant 0$ are points of a halfspace. The CSG description consists of an expression tree whose leaf nodes are halfspace descriptions and whose interior nodes are Boolean operators.

One notable characteristic of CSG is that faces, edges, and vertices are not represented explicitly. Thus, when required by an application, these details must be derived.

A disadvantage of CSG is that complications arise when an attempt is made to extend halfspaces beyond simple polynomials to include complex surface types describable by patches. Surface patches are not the same as halfspaces because halfspaces partition space into two sets while patches do not, as they are only defined over a limited domain [Prat84]. Thus pure CSG solids modelers have limited descriptive power.

The user interface to a CSG-based solid modeler can be easily constructed if the user simply describes halfspaces and combines them using the Boolean operators, thereby directly forming the expression tree. Queries can be directly answered since the design description remains quite similar to the user description. The editing problems found with boundary representations are largely eliminated with CSG because the expression tree completely records the steps used to create the description. Thus, for example, removing the keyway from the object in figure 7 could be done by simply deleting the action of subtracting the block that formed the keyway.

An Outline of a Centralized Solids Modeler

As shown in the previous section, none of the various solid modeling schemes are ideal choices as the descriptive scheme for a centralized modeler. This section outlines a solid modeler based upon a composite of some of the schemes. This composite overcomes many of the difficulties.

A hybrid design-description scheme

Figure 9 shows a design-description scheme that includes aspects of CSG, boundary representations, and swept volumes. As the figure shows, a CSG tree structure combines geometric elements from a much richer set than just the polynomial halfspaces available through pure CSG.

Because one of the geometric elements available in the hybrid scheme is the polynomial halfspace used in pure CSG descriptions, conventional CSG is a proper subset of the hybrid scheme. This is an advantage in that existing CSG descriptions can be readily adapted and included in this more powerful form.

As mentioned earlier, pure swept volumes have limited descriptive power. Nevertheless, swept volumes are important in describing many mechanical objects. The hybrid scheme integrates swept volumes so that they can be used only when necessary to describe features in a natural way.

The descriptive power of surface patches can be included in the hybrid modeling scheme by restricting patches to occur only as faces of *bounded* boundary-represented geometric elements. Thus, while a single surface patch is not compatible with the Boolean structure, because a patch does not define a halfspace, a volume bounded by patches is effectively a complex halfspace. The boundary-representation geometric elements are bounded by rational B-spline patches. Because of the general nature of rational B-splines, and their ability to deform in useful ways, these boundary representation elements can be used to describe sculptured features and deformations having more regular features, such as bends in pipes.

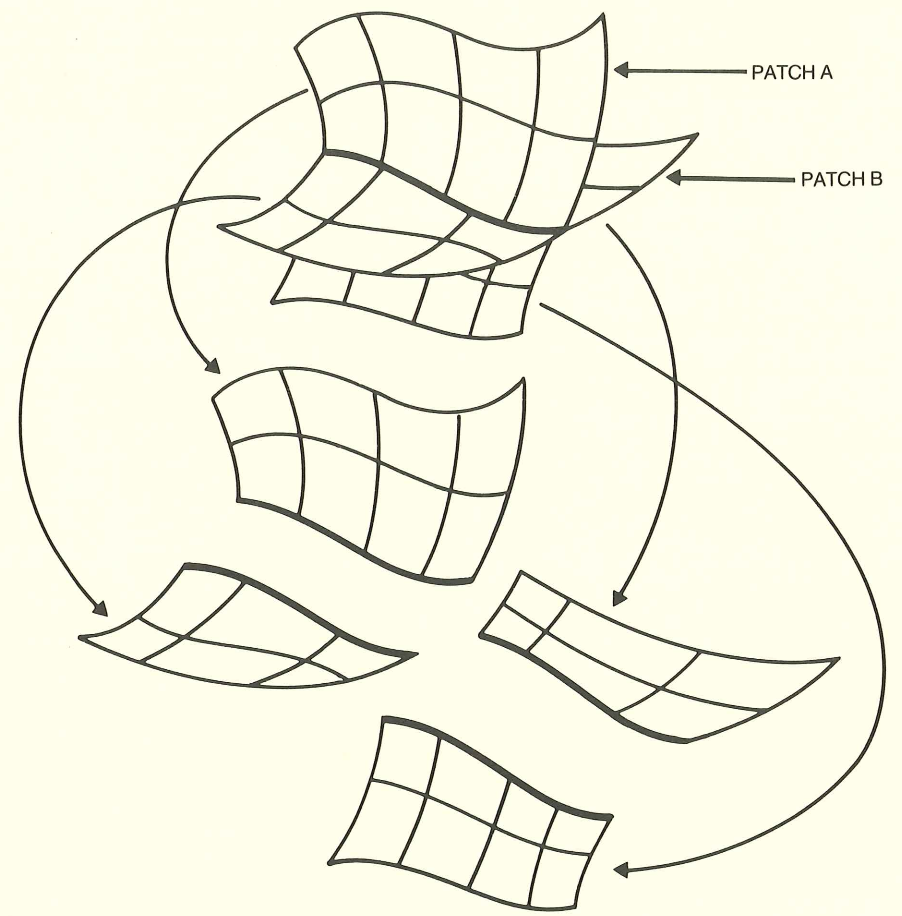

Figure 6. The regions formed by the intersection of two surface patches may not be describable as surface patches.

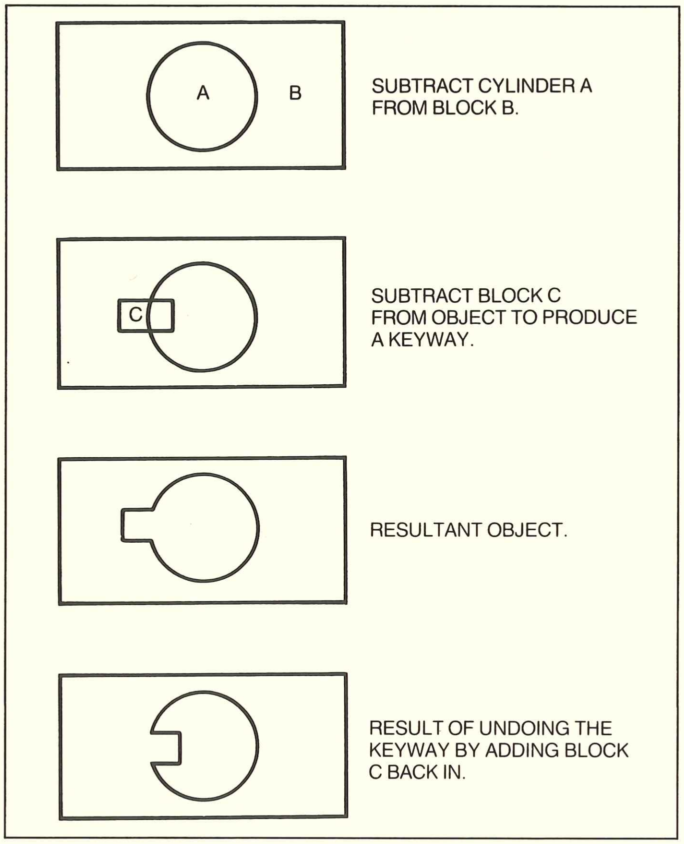

Figure 7. Many systems create editing problems. For example, the design boundary-representation description was modified to create the keyway in this figure. How do you undo it, that is get rid of the keyway? You cannot simply reverse the keyway-creating process.

Descriptive power

The descriptive power of the hybrid scheme is much greater than just the sum of the descriptive powers of CSG, swept volumes, and boundary representations. Some objects cannot be described without using a combination of polynomial half-spaces, patches, and swept volumes. These objects cannot be described at all by any one of the simpler schemes. Boolean combinations of boundary representations composed of surface patches is an important example. Further, the hybrid scheme includes the advantages of each of the simpler schemes because each is a proper subset.

User interface

In the hybrid approach, there are important advantages for user interfaces.

The naturalness of combining objects with Boolean operators to form more complex objects is generally accepted. (Almost all commercial solid modelers support Boolean operators at the user interface, even when the underlying description scheme does not utilize it.) The hybrid approach directly supports Boolean combinations of objects. Modification transactions where objects are combined can be directly translated into additions to the CSG tree.

Handling query transactions is easy because the central design description *remains equivalent* to the user description. In other words, no information is discarded in going from the user description to the design description.

The problem of undoing some action when the design description is a pure boundary representation does not occur with the hybrid representation. Modification transactions can be undone by simply removing the part of the CSG tree that caused the ac-

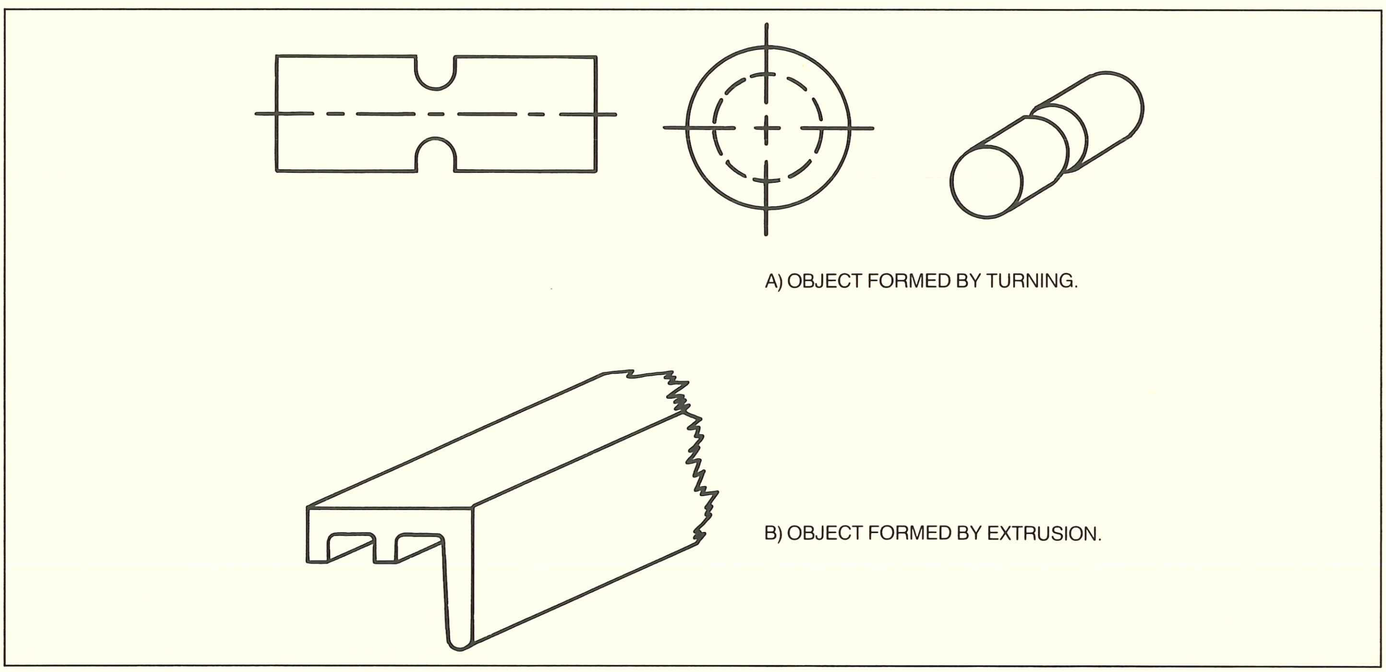

Figure 8. Examples of objects naturally describable as swept volumes. Although limited in descriptive power, swept volumes can describe many real-world parts.

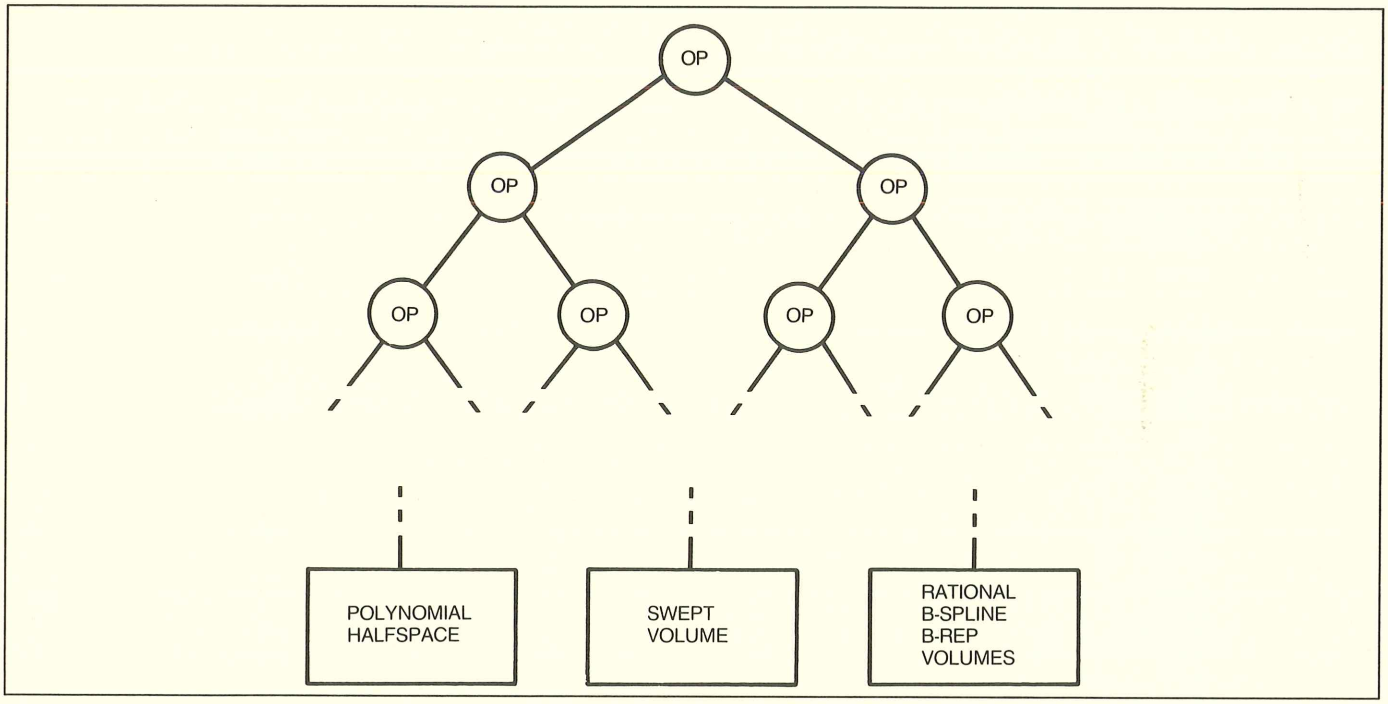

Figure 9. This hybrid design-description scheme combines the best features of three well-known description schemes. It can describe all part shapes efficiently so that user interfaces can act naturally (respond fast). Interapplication communication can be automatic since all users can share a single central design file for individual needs in modifying or manufacturing a part. Such a scheme also allows the data to efficiently and accurately drive special display systems that are tailored to the data structures employed. Research and expected VLSI technology advances, in the author's opinion, point to this architecture as a solution to the shortcomings of today's mechanical CAD/CAM systems.

tion originally. Thus, in the example in figure 7, the keyway may be removed by just indicating through the user interface that the block should no longer be subtracted.

Conversion to computational descriptions

In the hybrid scheme, the central design description is not generally suitable as input to application programs without conversion to an appropriate form for computation. But such conversions do not present difficulties as conversions are made automatically and only when needed and with full knowledge of the needs of the *specific application* using the data.

The central design description avoids the mathematical problem of generating a pure boundary representation from the Boolean combination of two boundary representations composed of surface patches. These conversions can be done only approximately and they are generally slow because they require a great deal of computation.

In contrast, the two-representation combination is simply a binary tree with the Boolean operator at the root and the two representations as leaf nodes. Creating such a tree to represent such a combination takes little computation. The conversion to a pure boundary representation is done only when needed for a specific application whose accuracy requirements are known. Further, because this conversion can be done automatically, with no interaction from the user, the conversion does not affect the efficiency of the user interface.

The same factors apply to conversions to other computational descriptions. While it is not generally possible to convert from *any* simple description scheme to any other, it is possible to convert from the hybrid scheme to the computational description forms common to manufacturing, namely cellular decomposition and pure (although approximate) boundary representation [Requ83].

Generating Displays from the Hybrid Scheme

As mentioned, modifications to the design description in the hybrid scheme requires little computation. But the other aspect of the interactive dialogue, namely answering graphic queries, cannot be done as easily. To be useful in responding to queries, the hybrid scheme must produce graphic displays quickly and in a choice of formats.

There are two ways to produce a graphic display from a hybrid description. The first would be to convert the hybrid description to some form compatible with a conventional display device. One such form is a planar-polygon pure boundary representation that approximates the design.

The faces in this polygon description can be sent directly to a display system that accepts three-dimensional planar polygons as graphic primitives. The problem with this approach is that creating and maintaining this approximate boundary representation is slow, degrading the user interface.

The other way to produce a graphic display avoids time-consuming conversions of the hybrid descriptions into other forms. Instead, this approach uses a special graphic-display system that accepts directly, as graphic primitives, the data found in the hybrid description.

This second approach of using a special graphics-display system is especially attractive when dealing with design descriptions that are structured as Boolean combinations of simpler objects. The ray-casting algorithm [Roth82], for example, has many of the characteristics that make it adaptable to implementation in special hardware. Figure 8 shows one possible architecture that performs the ray-casting algorithm by using a processor for each node of the description tree. High performance is achieved by exploiting the parallelism and pipelining possibilities inherent in the algorithm.

The processors assigned to the leaf nodes of the ray-casting tree must solve the following problem: "Determine the points along a line where the line intersects the boundary of the primitive element found at the corresponding leaf node of the description tree." Since the geometric elements in the hybrid description can be either (1) polynomial halfspaces, (2) volumes of rotation, or (3) volumes bounded by rational B-splines, the leaf-node processors must be able to solve the problem of each of these cases. If the processor cannot solve each the three cases, all cases must be converted into a single form. For hardware simplicity, a single form is desirable. Unfortunately, there is no satisfactory technique for converting to a single form; some research remains to be done in this area.

The processors assigned to the interior nodes are simple and perform the same function as they do in a pure CSG ray-casting display processor.

The performance of a display processor of this type, using VLSI and the high speed technologies becoming available, will be suitable for an interactive user interface. Current VLSI technology is marginally practical for speed, costs and integration densities. Speed, costs, and integration densities should improve by factors of two to four in the next four years, opening the way for commercial systems based upon this approach.

Conclusions

Existing problems

Although industry views solids-modeling technology as becoming important to mechanical CAD/CAM, they have not given it much acceptance for two reasons:

First, existing solids modelers cannot interface effectively to the entire range of applications comprising mechanical CAD/CAM. The source of this defect is in the design-description schemes now used.

The second reason for not using solid modelers is poor interactive performance. This defect is caused partly by chosing a poor design-description scheme and partly because the schemes require costly conversions from the data structure used in the design description to the structure needed by the graphic-display system. It is not possible to solve both problems separately.

When correcting design-description deficiencies, whatever design description scheme is to be used must produce graphic representations efficiently. Also, graphic-display systems must be engineered to reduce the conversion bottleneck, with close attention given to what form the design description is taking.

The hybrid design-description scheme

I think the hybrid design-description scheme combines the best features of three well-known description schemes. It resolves the problems of descriptive power and user interface efficiency. This hybrid scheme should receive acceptance because it is based upon component technologies that are known today and that have a broad base of user experience.

The proposed display architecture appears capable of the interactive performance CAD/CAM users will need in the next few years. While I judge its practicality from some research results and the predicted improvement in VLSI technology, rather than from actual application, neither "uncertainty" seems to pose much risk to those who pursue the advantages.

For More Information

For more information, call Jack Gjovaag 627-6160 (50-662).□

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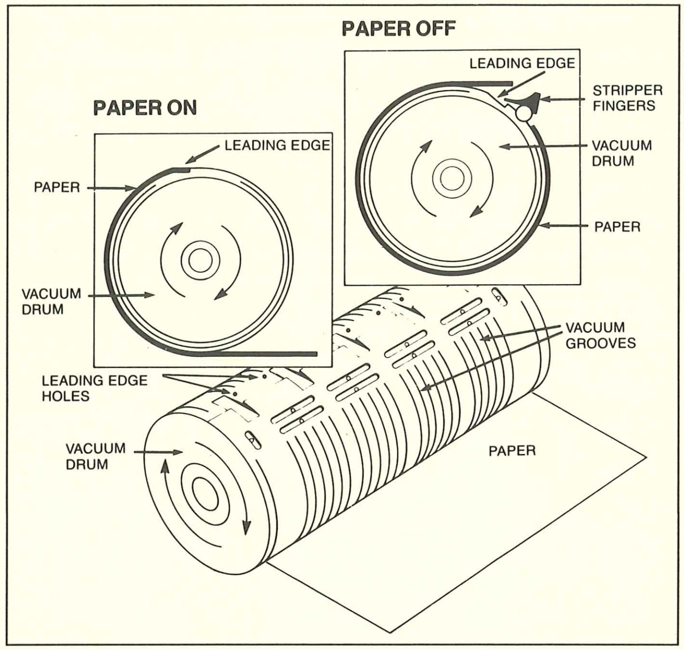
SIMPLER MEDIA HANDLING SYSTEM REDUCES COSTS/INCREASES RELIABILITY

The new 4692 Color Graphics Copier uses a simpler media-handling system designed by Arthur (Ace) Van Horne of GPP Engineering. A patent application has been filed in Van Horne's name.

In the media-handling system, a blower lifts the media – a sheet of paper or a transparency – against the drum and simultaneously creates a vacuum at a set of holes on the drum. This vacuum grabs the leading edge of the media and as the drum rotates it wraps the sheet around itself. Grooves on the drum conduct the vacuum around the drum's exterior, holding the media in place. A second set of holes under vacuum grip the trailing edge.

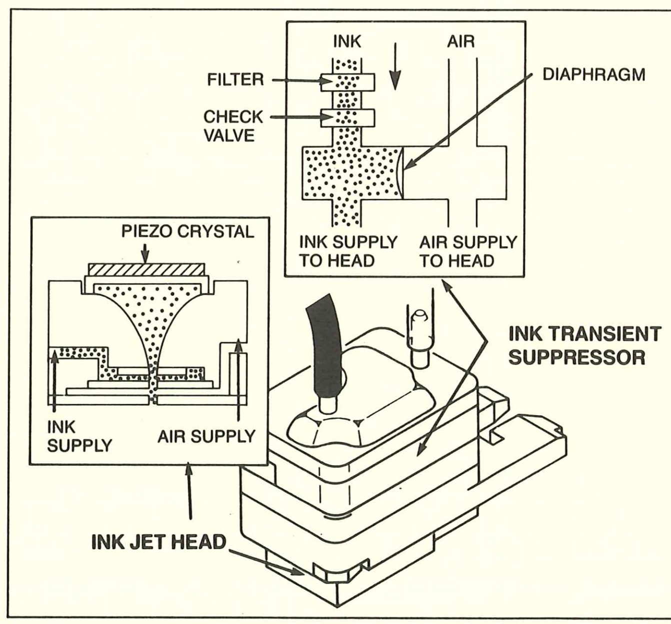
The drum spins up to speed and the four ink-jet heads create an image as they "travel" along the drum. After the image is completed, a set of stripper fingers slip under the paper's leading edge and break the vacuum. The drum's forward momentum sends the paper into the receiving tray. ☐



FEWER CLOGS AND BUBBLES

David B. Kreitlow, Edward L. Sheufelt and Jeff Hall of PGG Engineering (Wilsonville) have improved copier performance with the Ink Transient Suppressor. The Suppressor is being introduced in the 4692 Color Graphics Copier. A patent application has been filed in their names.

In copiers, bubbles and particles can seriously degrade ink jet performance. The Ink Transient Suppressor reduces these problems significantly. Part of the head assembly, the Suppressor is composed of a one-way valve, a 5-micron-mesh filter, and an ink chamber with a flexible diaphragm. This diaphragm is exposed to ambient air and thus equalizes ink pressure within the chamber with the outside pressure. The one-way valve prevents back surges of ink that suck air bubbles into the ink-jet head when the copier is jarred. The fine mesh filter traps other bubbles and particles that may get into the system. ☐



VOLTMETER USAGE ON NONSINUSOIDS

Vern Isaac manages CRT Quality Assurance, part of Display Devices in the Technology Group. Vern joined Tek in 1961 after serving in the one of the electronic labs in the US Department of State's Foreign Service. He has an associate degree in electronics from the Oregon Institute of Technology and a BA and an MBA from Portland State.

AC voltmeters provide straightforward answers to simple questions such as: What is the RMS voltage of a 60-Hz sinewave? But if the waveform is nonsinusoidal or of a high frequency, the instrument's answer can be wrong. Wrong answers accepted at their face value caused some CRT reliability problems recently. This article describes how these wrong answers could have been avoided by using correct methods of measuring the voltages and currents of waveforms rich in harmonics.

Tektronix oscilloscopes generally use radio frequency (25 to 40 kHz) oscillator power supplies to generate high voltages for CRT operation. These supplies also provide the heater voltage, nominally 6.3 VAC – elevated to cathode potential. When measured with a typical voltmeter such as the triplett 630NA, the heater voltage reads 6.3 VAC but when measured by a true RMS voltmeter, having sufficient bandpass, we found some heater voltages exceed the nominal values by as much as 13% or approximately 800 mV.

The resultant over-heating of the cathode had reduced the reliability of some products. Cathode engineers in the CRT Reliability Failure Analysis group have verified that the cathode emissions of Tektronix CRTs are reduced 10% for every 100 mv the 6.3 VAC heater voltage design exceeds nominal.

Because heater voltages are primarily determined by the number of turns on the secondary of HV transformers, filament voltages are not routinely measured. However, these voltages should be measured during the transformer design, verified when design of the power supply is completed, and checked any time there is concern about premature CRT emission failure in a particular oscilloscope or family of oscilloscopes.

Measurement Method

CRT heaters are elevated to cathode potential to prevent cathode to heater conduction. Since these voltages can be as high as – 10 KV (typically about – 2 KV), AC powered voltmeters cannot be used unless an isolation transformer rated at 15 KV or above is used to isolate the power line. Some battery-powered meters can be used to measure the true RMS voltage of filaments accurately if their frequency response is above 40 kHz; the Tektronix 213 Oscilloscope/DMM fits this requirement. The 213 is battery powered and its voltmeter function has a bandpass that permits AC RMS values to be determined to within 1% at 40 kHz.

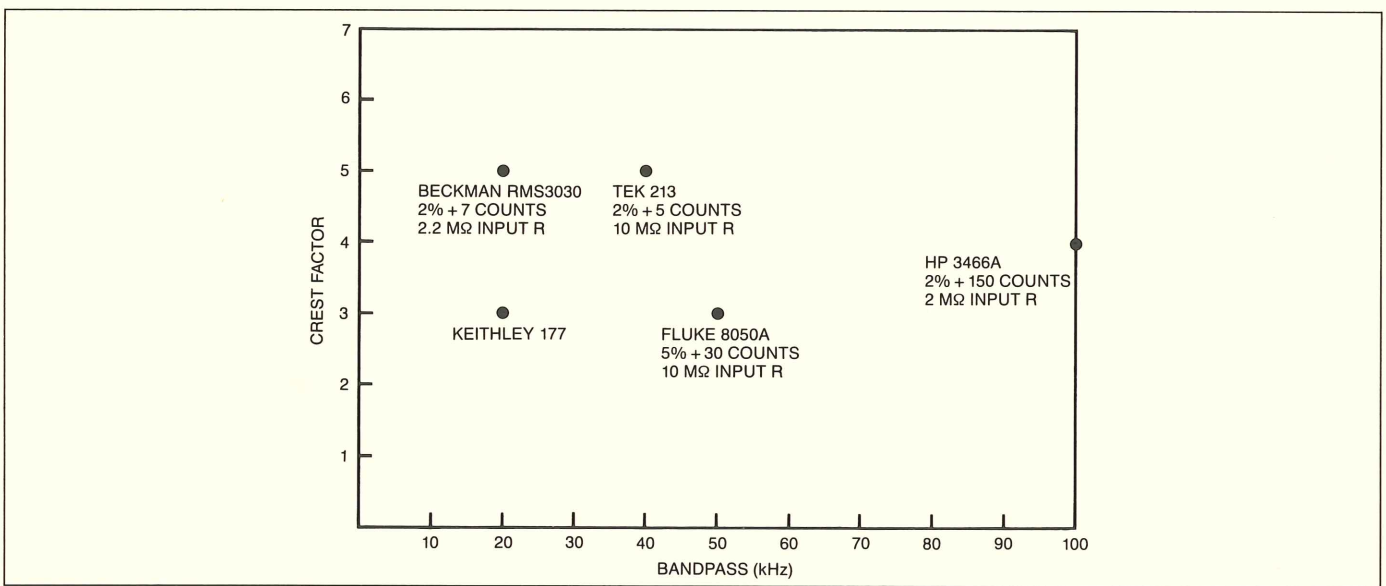


Figure 1. The performance of a few true-RMS voltmeters.

It is critical that extreme caution be used in measuring heater potential measurement because the voltmeter will be at the cathode potential. Carelessness can destroy the meter, if it is not properly isolated – and injure the person making the measurements.

Figure 1 shows the performance of five true RMS voltmeters including voltmeter accuracy and input impedance.

True RMS Measurements

Complex or random waveforms may be characterized by their total energy content as indicated by the root-mean-square (RMS) amplitude given can be calculated from the equation:

$$\Psi = \sqrt{\frac{1}{T}\int_0^T x^2(t)dt}$$

where Ψ = RMS Value
T = Integration Time
X(t) = Input Waveform

Effects on Measurement

Digital voltmeters (DVMs) typically measure voltage and current using one of two types of AC to DC converters.

The *average-responding* converter responds to the average voltage or current of the rectified wave times a constant (1.11 for a sine wave). If the waveform contains harmonics, the average value will vary as a function of the amplitude and phase of the harmonics. Therefore multiplying this average by a constant produces the wrong RMS reading.

Since errors in average-responding converters are produced by harmonics in a waveform, the magnitudes of the harmonics as well as the phase relationships of the harmonics to the fundamental waveform determine the amount of error. Figure 2 shows error percentages for several harmonics as a function of harmonic phase.

The error caused by the magnitude of the distortion can be calculated from the equation:

$$\text{Error} = \frac{Eh}{N\,E_f}$$

where Eh = magnitude of the harmonics
Ef = magnitude of the fundamental
N = order of the odd harmonics

The *true-RMS* converter responds to the DC heating effects of the DC component in the rectified waveform, the fundamental and each harmonic contribute to the total heating value. The true-RMS converter in essence sums each component of the waveform by the square root of the sum of the squares method. The converter analyzes the wave and "computes" RMS economically. Harmonic phase relationships do not effect the converter's response.

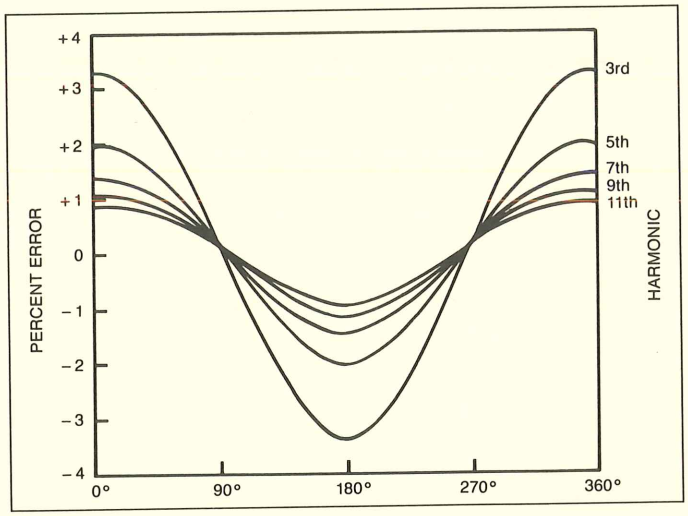


Figure 2. Error versus harmonic phase. The amplitude of each harmonic is 1% of the amplitude fundamental.

True-RMS Measurements

Typically, two interrelated reasons dictate the use of an RMS-responding instrument: a desire for accuracy and the need to measure nonsinsoidal waveforms. However, it is important to understand that even true-RMS instruments are subject to fundamental errors caused by DC-coupling, inadequate crest factors, and low bandwidth.

DC coupling

Many waveforms contain a DC component. That is, the average voltage or current of the waveform isn't zero. Depending on the application, you may want to measure just the AC component; in other cases, the DC component is definitely part of the desired measurement result. Yet most AC voltmeters – true RMS or not – are not DC coupled. (AC-coupled circuits are simpler and less expensive to make.)

Sizeable errors can result from omitting of the DC term. Such DC-omission errors can be accounted for by separately measuring DC and AC and then performing some arithmetic:

$$V\ rms\ total = [(V\ rms\ ac)^2 + (V\ dc^2)]^{1/2}$$

This process is inconvient and you may need to watch for error in the DC measurement if the the DC voltmeter does not sufficiently reject AC.

Crest factor (CF)

Crest factor is the ratio of the peak value to RMS value of a waveform (see figure 3).

Specification sheets for RMS voltmeters typically account for the effect of crest factor on dynamic range. All a specified crest factor really means is that signals lower than the CF will not exceed the dynamic range of the instrument. But you should consider more than just dynamic range.

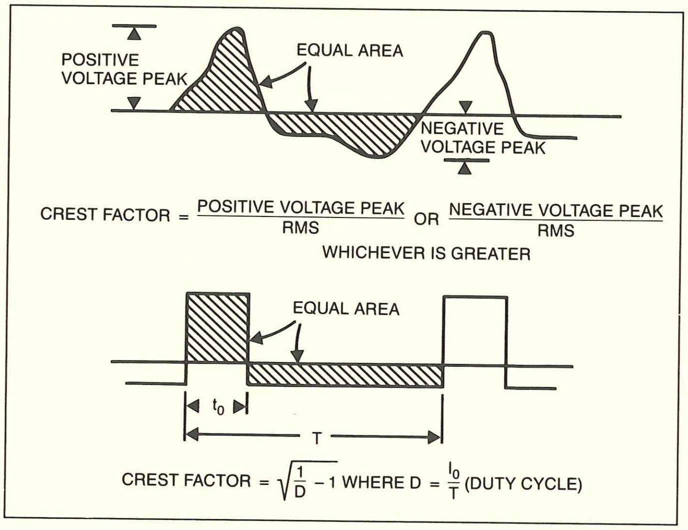


Figure 3. Definitions of crest factor.

Bandwidth

Anyone familiar with Fourier analysis knows that you can produce any periodic waveform by the appropriate summation of harmonically related sinusoids. For a system (such as a voltmeter) to pass such a waveform it must respond to all of these sinusoidal components. If a given component is not faithfully transmitted through the system, then the error in transmitting that component shows up as an error in the RMS value indicated by the voltmeter.

It is interesting to note that although the primary reason for using RMS voltmeters is to accurately measure the voltage of nonsinusoidal waveforms, bandwidth specifications are always determined using sine waves. This means bandwidth specs alone are inadequate.

How much error will you get if the voltmeter's bandwidth is limited? Figures 4 and 5 show the relationships between crest factors, bandwidth limits, and resulting transmission errors. These plots were made from data obtained by passing a given pulse train through various sharp-cutoff low-pass filters.

Figures 4 and 5 point out two important facts:

1. Precise voltage measurements (better than 0.1% accuracy) of waveforms with large crest factors require a measuring system with extreme bandwidth.
2. Low to moderate accuracy (1.0% to 0.1%) requires wide bandwidths where the crest factor is high (see above).

Accuracy-bandwidth tradeoff

Unfortunately, design techniques that achieve high accuracy tend to limit bandwidth. Conversely, techniques that offer wide bandwidths usually result in lower accuracies.

Many digital RMS voltmeters boast accuracies around 0.1%, but most have narrow bandwidths. These instruments are adequate when the measured waveforms have low crest factors (below 4-5). For some measurements more bandwidth at lesser accuracies would actually give better results.

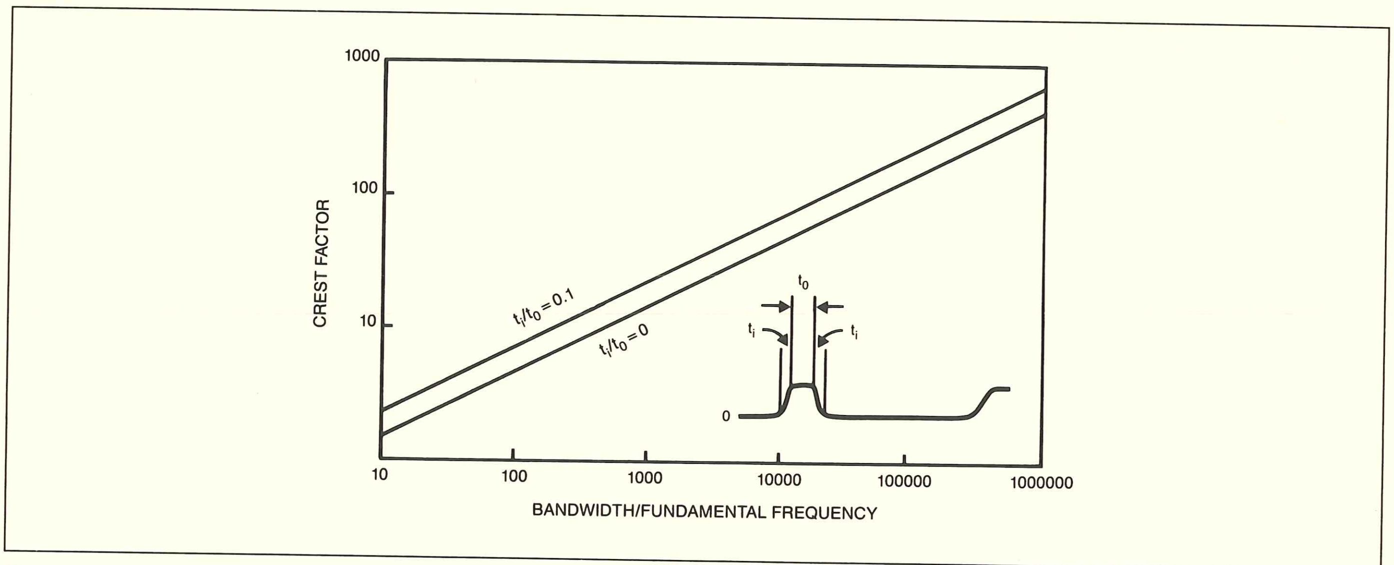


Figure 4. Bandwidths required to pass the RMS value of a train of rectangular pulses with 1% accuracy.

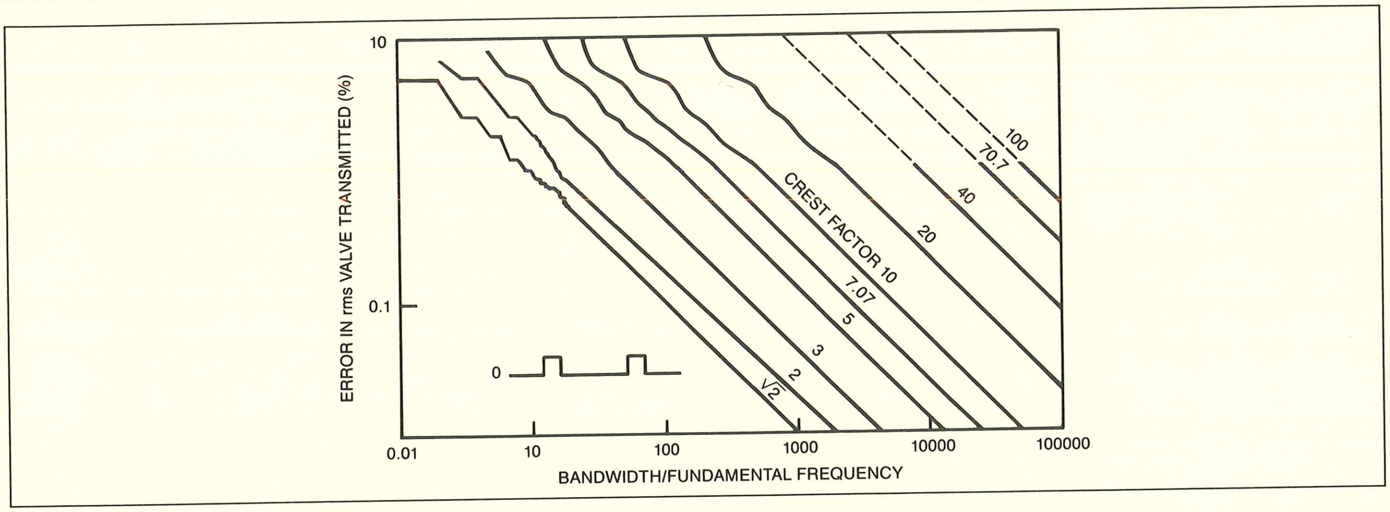


Figure 5. Error versus crest factor and bandwidth for rectangular pulse trains.

For More Information

For more information, call Vern Isaac, CRT Product Assurance Manager, 627-0585 (46-234) or Alan Yielding, failure analysis engineer, 627-0566 (46-234). ☐

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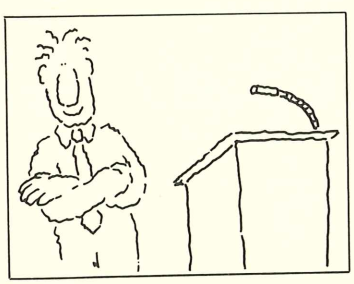
BEEN ASKED TO ORGANIZE A SESSION OR TO TALK AT A CONFERENCE?



Professional conferences are an integral part of the information-transfer process. The success of such conferences depends on many things. The theme, the facilities, even the weather are important, but the speakers and the organizers are critical.

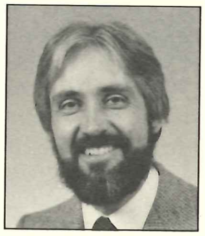
To help session organizers and speakers, Technology Communications Support has prepared two guides, each based on extensive experience in preparing and supporting professional communications.

If you've been invited to talk, *So You're Giving a Talk at a Professional Conference* will help you organize your talk and prepare effective slides to go with it. The rules in this booklet are few and simple, but they can help you look like a "pro" instead of an ill-prepared amateur.

If you've been invited to organize a session, you'll be expected to be not only the manager of a team but the coach, scheduler, and expediter as well. *So You're Organizing a Session for a Professional Conference* gives the basic rules and guidelines.

To get a copy of either or both guides, and to get professional support in preparing talks and slides, contact Eleanor McElwee, d.s. 53-077 (MR-8924). ☐

ELECTRO-POLITICAL ENGINEERING: WHAT IT TAKES TO SET A LOCAL NETWORK STANDARD



Maris Graube is the manager of Corporate Interface Engineering, part of the Digital Products Coordination Group. He is the chairman of IEEE Standards Project 802, which is finishing up local network standards. Maris joined Tektronix in 1976. He previously worked at Western Digital, Autonetics, and Standard Computer. Maris received his BS in scientific engineering from the University of Michigan.

This article first describes the process for setting an IEEE standard and then goes on to introduce the international procedure. Both processes are lengthy; they have to be. Standards are like laws, we have to live with them. In some cases we find it difficult to live without them. One thing is sure, we live best with standards that reached by good electro-political engineering – everyone has bought in.

To the casual observer, formulating and setting a standard may seem to be a mysterious and overly long process. One may well ask, "Why don't 'they' just agree on something and get it over with?" Well, it's not that simple. Here is what goes on behind the scenes.

Idea

Like many other endeavors, a standard starts with an idea. For example, someone may say, "Wouldn't it be nice if there were a local network standard so I could connect computer X with computer Y and disk Z without having to hire an electrical engineer and a systems analyst? Just look how easy the IEEE-488 standard makes the interconnection of programmable instruments. Let's do the same for local networks."

Charter

Neither an individual nor a special-interest group can just unilaterally declare something to be a standard. By definition, a standard is a widely accepted, common way to do something.

To gain wide acceptance, an organization has to be found that will sponsor the standards-setting activity. For the Local Network Standard, that organization is the Technical Committee for Computer Communications (TCCC) under the Computer Society of the IEEE. The sponsoring organization prepares a project proposal detailing the future standard's scope and objective(s) and submits it to the IEEE Standards Board.

The Standards Board checks with other standards-setting organizations, such as ANSI (American National Standards Institute), to ensure that similiar standards activity is not already under way. If all goes well, the the Standards Board authorizes the standards project and assigns it a number. The number assigned to the Local Network Standard is 802. The Board appoints a chairperson to produce the requisite technical document (what most people call "The Standard"). The standard-setting activity is now chartered.

Technical Committee

The chairperson organizes a technical committee by inviting various experts in the field and other interested parties to help formulate the standard. Committee meetings are open so that anyone may participate. The committee then refines the scope and the objective(s) of the standard, detailing the functional requirements of the discipline or activity that will be standardized. The experts and committee members submit proposals on how particular goals of the standard are to be met. Lively discussion usually takes place and compromises are reached – eventually.

A draft of the standard is written and then refined until the technical committee believes it's technically sound. The draft standard is then submitted to the sponsoring organization to determine if the draft has its support.

Consensus

To determine the acceptability of the standard, the sponsoring organization sends it with a ballot to representative vendors who would use the standard to build equipment and to users who eventually would buy such equipment. The ballot has three voting choices:

1. Abstain. A person may not have the time, the interest, or the expertise to evaluate the draft standard.
2. Approve.
3. Not approve. The not-approve vote must be accompanied by a statement of what it would take to change the "not-approve" vote to "approve."

To gain the widest possible consensus, all not-approve comments are examined and an attempt is made to incorporate the proposed changes into the draft. This can be tricky because in this process, care must be taken to see that those who voted to approve the draft are not offended by the proposed changes. The process of reaching a consensus can occur in both the technical committee and the sponsoring organization. A consensus is attained when 75 percent of the sponsoring organization votes to approve the draft standard. It is then sent on for higher-level approvals.

Approval and Production

The Local Network Draft Standard was first approved by the Technical Committee for Computer Communications, then sent to the Computer Society's Standards Board. The board reviewed it to verify that all the procedures were correctly followed, that a consensus has been reached, and that no one was arbitrarily excluded or not accommodated in the consensus-seeking process.

After this level of verification and approval, the draft standard was sent to the IEEE Standards Board for its approval. There, again, the development processes for the standard were examined. The IEEE standard was approved in 1983. The standard is being put into its final form, as specified by the *IEEE Standards Manual.* After it is printed, the standard will be ready for official distribution.

The Second Step: Going International

Often, just getting an IEEE or another organization's standard approved is not enough. If the particular technology, such as local area networks, has worldwide applicability, then an international standard is needed. There are three main international standards organizations:

1. CCITT, the Consultative Committee of International Telephony and Telegraphy, deals with telephone and global data communications standards such as X.25.
2. IEC, the International Electrotechnical Commission, deals with the things traditional electrical engineering is concerned with – power generation and transmission, connectors, instrumentation, etc. The IEC equivalent to the IEEE-488 (GPIB) standard is IEC 625-1.
3. ISO, the International Standards Organization deals with everything else. For data communications, the technical committee is TC97. This is where the international local area network standards will be developed.

Normally, an international standard gets started by a sponsoring organization – in this case ISO TC97 and SC6 – setting up a committee to consider the particular issue. Member countries submit proposals which the committee drafts into a *Draft Proposed International Standard.*

Note the words "member countries." Individuals or companies are not represented in ISO. A country's national committee in the area of interest formulates a position and then represents that position in the ISO. For local area network standards, the U.S. national committee is X3S3, a group under CBEMA, Computer and Business Equipment Manufacturers Association.

Are you lost in the alphabet soup yet?

In the past, relations between X3 the parent of X3S3 and the IEEE have been less than cordial, their positions differed on things like Pascal standards. So, how do you get the IEEE local network standards through X3S3 to the ISO? You get some influential X3 people to become the leaders of some of the IEEE local network standard's parts.

But, I digress.

Normally, several countries will submit proposals for a particular standard. Depending on how entrenched the various national positions are, it can take years to get a Draft Proposed Standard, the first step in the international process. The subsequent voting procedures take even more time. But, in the case of the local network standards, a faster approach was taken.

A good liaison was set up with ECMA, the European Computer Manufacturers Association. ECMA has a committee, TC24, which is also formulating local area network standards. The people in ECMA are also very active in the European national committees. With a lot of document exchanging and attending each other's meetings, the differences were resolved to where the IEEE and ECMA standards for local area networks were virtually the same. So, when it came time to submit proposals to the ISO, ECMA defered to the IEEE (the U.S. position as presented by X3S3) to submit the only proposal to ISO for local area network standards.

The Draft Proposed Standards have now gone through the first round of voting and are now *Draft International Standards,* the second step. There is some editing to be done as a result of this voting, things like changing inches to centimetres and referencing U.S. military standards to international standards. If everything goes as smoothly as it has so far, we should have complete ISO International Standards of local area networks in 1984.

Conclusion: The End Product is Worth the Effort

If anyone is interested in a career in electropolitical engineering, get involved with some standards committee.

In formulating and setting a standard, there are often many twists and turns. The people involved are volunteers and, thus, come and go as they change jobs or interests. Also, it takes financial support to attend week-long standards meetings six times a year all over the country. This support is often supplied by forward-looking companies, but often economic uncertainties make this support erratic. And, it simply takes time to make compromises and reach a consensus. Despite all this, many people and companies dedicate themselves to the task of setting standards because the end product is worth the effort.

For More Information

For more information, call Maris Graube, 627-1792 (50-473). □

MAKING A STANDARD ISN'T A STANDARD PROCESS

Even with its structure and protocols, making a standard isn't a clear-cut process. It's a human process with both order and disorder. Some years ago, A.Q. Mowbray vividly described the smoke-filled-room realities of standards politicing in these words:

Not For Hire

You are sitting in a meeting room in the Conrad Hilton Hotel in Chicago. It's getting late. Your hurried supper rests uneasily on a stomach tensed by tight schedules and fatigue. The air in the room is over-tired, smoke-laden, oxygen-depleted. Neckties are loosened and sleeves rolled up, but still the close-packed, sweaty faces of the audience are attentive, the voice of the speaker is strong.

These men were up until one or two a.m. the night before in a meeting of a task force or subcommittee, hammering out agreement on the details of a specification or test method, reporting test results, arguing, cajoling, listening. They were up again five hours later for another full day of the same. Between meetings they collar each other, cluster in hallways, impede traffic with the earnest, arm-waving accompaniment to their discourse. Meals are often a quick sandwich and a cup of coffee with the brief-case within arm's reach. If an opening appears in the schedule, they run to a session room to hear a paper or two that they had checked on their program.

Toward the end of the week, the fatigue lines begin to show. Why do they do it? Well, you hear a lot of reasons, all of them good. (1) They have to protect their company's interest in the standards-writing forum. (2) Working with these committees is good education, not only technically, but also in the art of democratic give-and-take, organizing research programs with one's peers. (3) Talking with authors and others at paper sessions is a good way to keep up on what is going on. And so on.

As you sit in this hot crowded room speculating on these things the presentation of the paper ends and questions begin to come from the floor. You are admiring the openness and freedom of inquiry and criticism inherent in this centuries-old format and reflecting on the self-correcting nature of scientific investigation, when, in answer to a question, the author replies, "Well, I was so pleased with the results (of a test) that I wanted to tell somebody." This statement shoots through the stuffy room like a fresh breeze. You feel the laughter that goes through the audience springs from the rare and pleasant recognition of simple truth, simply spoken. For, after all the other reasons are given, the root cause for all this effort is the pleasure of the exertion. No truly good work was ever done reluctantly, or with distaste. This man, and dozens like him, had done good work, and in the end, the reasons for having done it were first, the enjoyment of doing good work, and second, the pleasure of reporting it to others. Wherever this attitude appears, whether in the scientist, the carpenter, or the bus driver, it is the truly professional attitude. No employer can buy this dedication, no minimum wage can produce it, no incentive plan can take its measure. (A.Q.M. 1964).

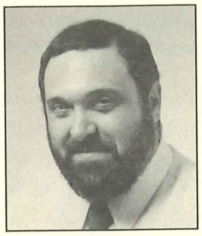
> "The root cause for all this effort is the pleasure of the exertion. No truly good work was ever done reluctantly, or with distaste."

The preceding was published in *Standards and Standardization,* Marcel Dekker Inc., by the late Chuck Sullivan. Chuck was the manager of Technical Standards here at Tek. The late A.Q. Mowbray was the editor of *Materials Research and Standards,* now *Standardization News.* Chuck added his own comments:

"My own experience with standards committee work has not been on such an intense level, but there is no doubt about the dedication of these men, who often forego personal vacations with their families in order to attend committee meetings. Without the incentive of being a part of something good and worthwhile, there would be no committees of a voluntary nature.

One should not forget, however, that these are just ordinary men, although experts in a particular field, and sometimes in meetings arguments can become a little personal. Two experts can't both be right on opposite sides of an argument. It requires a comprehensive awareness of the high degree of mutual respect among the members of the committee to safely bridge these moments of individual pique." □

ANSI X3xx REPRESENTATIVES MEETING



Mike Meyer is manager of CAX Data Management in the CAX Center, part of the Computer Science Center. He joined Tektronix in 1983 after working for a year in Sweden for Honeywell Information Systems. Mike has over twenty years experience in data and systems management and has worked for Computer Sciences Corporation and Planning Research Corporation in domestic and overseas locations. Earlier, he was assistant director of the Computer Center at the University of Kansas. Mike has an LL.B from LaSalle University, BS in Business from the University of Maryland, and a MSA in information processing technology from George Washington University.

In May, seven Tektronix people met to discuss their activities as members of the various committees that are structured under ANSI X3, the umbrella committee for information processing standards. Although Tek is represented on certain subordinate committees, we are not represented on X3 itself. Without this representation, who knows what the "rules" of the information processing game might be – and whether our products will easily comply.

Tektronix ANSI X3 Representatives

Kenneth B. Warner	Alternate, X3J2 (Basic)
Robert Dietrich	Principal, X3J9 (Pascal)
David Straayer	Principal, X3H3 (Graphics)
Jim Maynard	Principal, X3L2 (Codes/Character Sets)
Mike Meyer	Principal, X3H4 (IRDS)
Robert Edge	(IDG)
Farzin Maghoul	(ECS)

X3H3 Graphics — David Straayer

The X3H3 committee is determined to develop a family of compatible standards. Among ANSI X3 committees, this one is the most significant to Tek's display products. X3H3 is working on three graphics standards:

- GKS (ISO D157942) – GKS is likely to be the first ANSI X3 Standard. It will have great impact on Tektronix display products. Public review closed on July 1, 1984.
- CORE (SIGGRAPH) – The 4100 product line implements this standard.
- PHIGS – This standard is a "super" GKS and is being promoted by X3H3's Task Group 1. It can be described as an attempt to produce the "ultimate" standard (second-system syndrome).

Other X3H3 committee efforts:

- Virtual Device Driver (VDI)
- Virtual Device Metafile (VDM)
- Bindings

GKS, PHIGS, VDM, VDI, and Bindings are the most active efforts of the committee. VDM has had public review and is close to being a standard. VDI is still in the early development process, having just gone through its first X3H3 letter ballot.

X3/Tek issues – Tek has a potential problem. Since Tektronix is *NOT* a member of X3, we can not fully protect our interests. The atmosphere within X3H3 is competitive, and the committee is large (more than 80 experts). X3H3 needs tight control by X3.

X3J2 Basic — Kenneth B. Warner

This committee is not controversial. It expects to have their new dpANS (Draft Proposed American National Standard) to X3 in June, and out for public review by the end of the year.

X3/Tek issues – Tektronix was *NOT* represented at the crucial point when X3 directed X3J2 to ensure that Basic be compatible with GKS (X3H3). We could not deliberate in the discussions that resulted in that directive. Thus, we had no way to fully protect Tektronix interests.

X3J9 Pascal — Robert Dietrich

X3J9 is working on the extended-Pascal standard and expects to conduct an internal-letter ballot in the spring of 1985. They expect to ask for public comments in the summer of 1985.

X3/Tek issues – If Tek had a representative on X3, we could address two big issues more completely:

- X3 may need to do some pushing to get ISO to tackle extended Pascal as a new work item. Since Tektronix business in Europe is substantial, we should be helping X3 push ISO to work on extended Pascal.
- Since X3 is in the dpANS-approval loop, representation here could provide Tek with a fall-back position or check point if an unfavorable dpANS made its way through *any* committee.

X3L2 Codes/Character Sets — Jim Maynard

This group maintains the ASCII standard. Its proposed new standard now includes a conformance section.

X3/Tek issues – The conformance section may effect Tektronix. Another level of voting on a dpANS including a conformance section would be very helpful.

X3H4 IRDS (Information Resource Dictionary System) — Mike Meyer

This committee's actions haven't directly affected Tektronix products yet.

X3/Tek issues – Because several issues are tearing at the fabric of the entire committee, Tek desparately needs a high-level X3 Representative for leverage within ANSI. Other companies on X3H4 have that leverage! It is in Tektronix' best interests to be represented.

General

General discussion at the meeting centered on how best to represent Tektronix interests within ANSI. Perhaps representation within SPARC (Standards Planning and Requirements Committee) might be a way.

Although Tek is a member of CBEMA (Computer and Business Equipment Manufacturers Association), no Tek representative has attended recent meetings. The purpose of CBEMA and its advantages to Tektronix were clear to the people a the meeting and they ardently agreed that Tek should actively participate.

IDG keenly desires to particpate in X3, according to Robert Edge. They are actively researching the costs and benefits of participation.

The group asked Mike Meyer to look into the CBEMA, SPARC and X3 membership responsibilities for Tektronix. He will write a job description for an X3 Representative from Tektronix.

The X3xx group would share their trip reports with the other Tektronix correcting ANSI X3 Representatives and *Technology Report.* The group will either meet "on demand" or periodically meet with the Tek X3 Representative, if and when one is named.

The meeting was encouraging, if for no other reason than the opportunity for Tek's ANSI X3xx representatives to meet and discuss issues. Sharing our reports and having a forum with which to discuss important ANSI X3 issues can only be beneficial for Tektronix.

For More Information

For general information, call Mike Meyer 627-2628 (50-560).

For information on a specific committee, call the appropriate person listed above. □

IS ANYONE IN HERE WITH ME?
ANSI STANDARDS' WORK AT TEKTRONIX

Michael E. Meyer, manager of CAX Data Management, CAX Center.

My work with the ANSC X3H4 Committee (Information Resource Dictionary System a.k.a Data Dictionary), has been hampered by two problems:

- An inability to determine, except from my own perspective, how to best serve the interests of Tektronix.
- I can't determine if I am aiding or inhibiting the other Tektronix representatives by the stands I take in my committee.

As a result of my frustrations and also because some issues seem to transcend individual committee work, I feel that the ANSI/X3xn representatives at Tektronix need to do the following:

- Identify *all* of the principals and alternatives (persons) that represent Tektronix in ANSI X3 committees.
- Convene a meeting and discuss:
  1. The general strategies that Tektronix should follow in the ANSI committees that we participate on.
  2. The issues that transcend each particular X3xn committee.
  3. A case for the membership of Tektronix on the parent X3 committee.

Unfortunately, politics are very real in ANSI. Many of us would like to focus only on the critical technical issues but are constantly being bogged down by the political morass in ANSI. If we had a representative on X3, Tektronix's interests would be better served and the technicians could get on with the technical work.

I've attempted to list ANSI committee participants within Tektronix. Please look at the list (see table) and fill in any names you can and send it to me. When we have a more complete list, we need to proceed with step 2, and meet on the issues I have raised (above).

If you have any other standards issues or concerns, please let me know, Mike Meyer, 627-2628 (50-560). □

ANSI PARTICIPATION AT TEKTRONIX

Committee	Principal	Alternate(s)	Observer
X3J2 (Basic Language)	Andrew J. Klossner ECS/61-183 685-2505	Kenneth B. Warner ECS/61-183 685-2792	David D. Levine ECS/61-261 685-2155
X3J9 (Pascal)	Bob Dietrich MSG/92-134 629-1727		
X3J11 (C Language)	Jim Besemer DAG/MDPD 92-525 629-1758		
X3H2 Database)	Glen Fullmer ECS/61-161 685-2685	Donna Murphy ECS/61-161 685-2092	
X3H3 (Graphics)	David Straayer* IDG/63-296 685-3544	Bob Ross GPP/63-356 685-3582 OR John Steinhart ECS/61-277 685-2787	Bruce Cohen ECS/61-183 685-2597
X3H4 (Information Resource Dictionary System)	Michael E. Meyer** CAX Data Management Computer Science Ctr. 50-560 627-2628	NONE	NONE
X3L2 (Codes and Character Sets)	Jim Maynard GDP/63-523 685-3276	NONE	

NOTES:

International Standards Organization Group Membership

* TC97/SC5/WG2 (Graphics)
** TC97/SC5/WG3 (Conceptual Schema)

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