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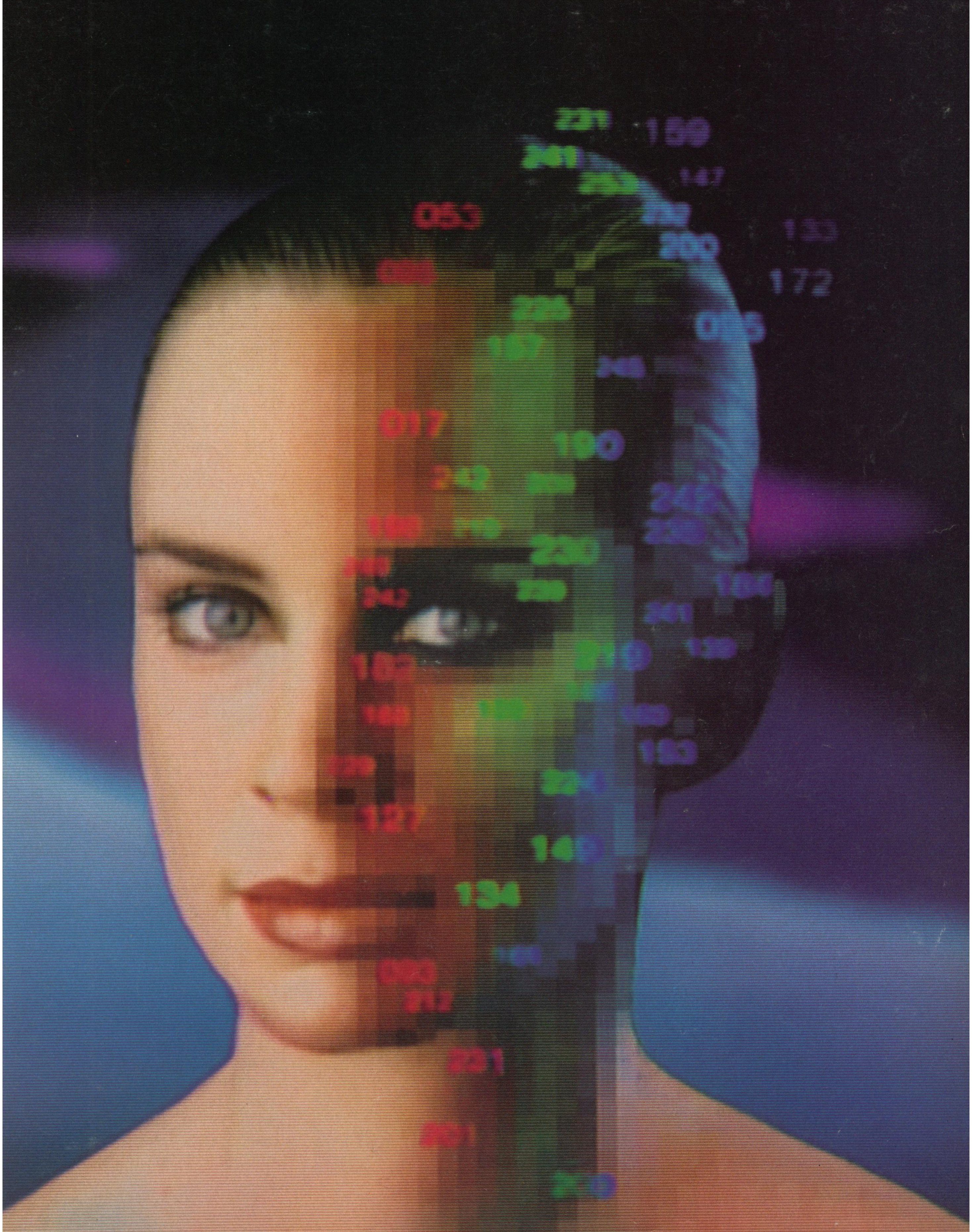
COVER

View from a porthole on the research platform *FLIP*, looking out at one of the booms used to lower instrumentation into the ocean away from *FLIP*'s hull. Oceanographic instrumentation hangs down below the boom; meteorological instrumentation (including anemometers and solar radiometers) is mounted on the boom. See page 1552. [Jerry Dean, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543]

The Reflective Vision



The Reflective Vision

A highly advanced design tool developed at the General Motors Research Laboratories uses computers to generate visual images from mathematical data with such accuracy that, soon, in-depth aesthetic evaluations of new concepts may be made prior to creating a costly physical model.

Interactive Display

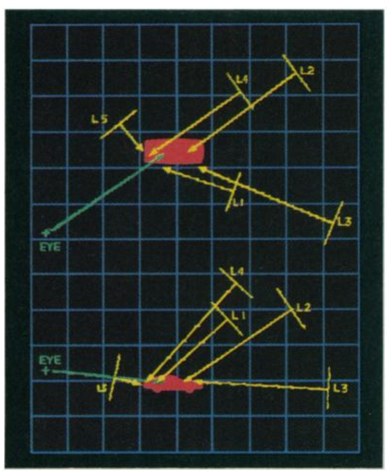
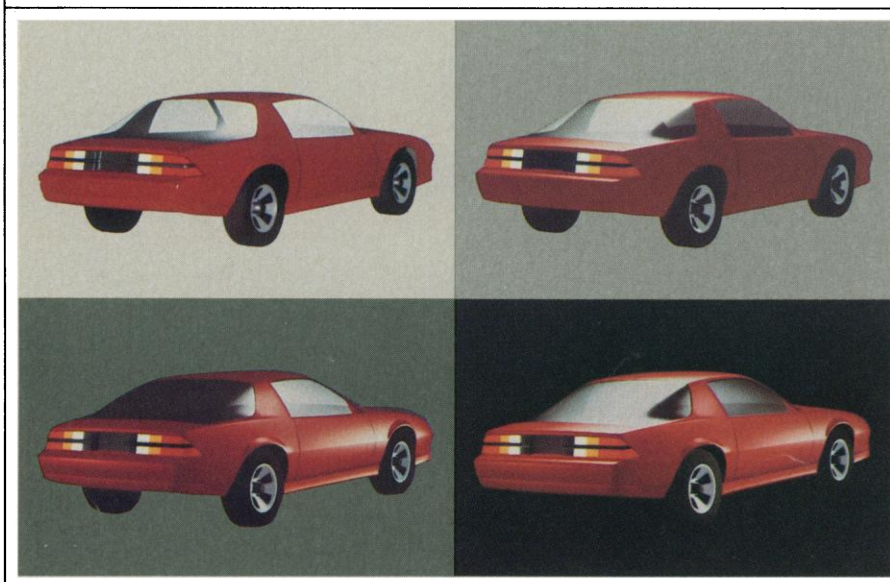


Figure 1: Computer display of plan view (upper) and side elevation (lower), indicating automobile location (red), lighting selections (L1-L5), and viewing position (EYE).

Figure 2: Four Autocolor images, showing the same view of an automobile as background and lighting change.



WITH AUTOCOLOR, users can synthesize three-dimensional, shaded images of design concepts on a color display and then quickly explore how major or minor changes affect the overall aesthetic impression. The system is completely interactive. By choosing from a menu on the screen, the designer can redefine display parameters, select a viewing orientation, or mix a color. Each part of an object can be assigned a surface type with associated color and reflectance properties. Built-in lighting controls generate realistic "highlights" on simulated surfaces composed of differing materials.

Before developing the system, David Warn, a computer scientist at the General Motors Research Laboratories, observed the complex lighting effects achieved in the studio of a professional photographer. By simulating these effects, Autocolor can produce results unattainable by conventional synthetic image display systems. Previous systems used a point source model of light, which allows adjustments only in position and brightness.

The versatility of the lighting controls constitutes a major advance in Autocolor. An unlimited number of light sources can be independently aimed at an object and the light concentration adjusted to simulate spotlight and floodlight effects. The lighting model even includes the large flaps or "barndoors" found on studio lights. These comprehensive controls permit the user to view the simulation in studio lighting conditions, as well as to make revisions in color, paint type, and materials.

With real lights, direction and concentration are produced by reflectors, lenses, and housings. It would be possible to model these components directly, but that would introduce considerable overhead to the lighting computation. Instead of modeling individual causes, Autocolor models the overall effect, reducing complexity by simulating those aspects needed to produce realistic results.

Autocolor approximates the geometric shape of an object with a mesh of three or four-sided polygons. These polygons are grouped to form parts. For a car body, there might be separate parts for the door, hood, roof, fender, and so on. Each part is assigned a surface type, such as painted metal or glass, and each type of surface has associated color and reflectance properties. The entire data structure is stored in tables using an interactive relational data base developed at the GM Research Laboratories.

THE LIGHTING model determines the intensity of the reflected light that reaches the eye from a given point on the object. It takes into account the reflectance properties of the surface as well as the physics of light reflection. A hidden surface algorithm determines which point on the object is visible at each point on the display. For each of these visible points, the intensity is computed for each light source. The displayed intensity is the sum of the contributions from all the lights plus an ambient term which indicates the general level of illumination.

Using the point source lights of conventional image generation systems, highlighting a particular area of an object can be a difficult task and can result in unwanted highlights in other areas. By contrast, the light direction and concentration controls found in Autocolor make it possible to isolate the effect of a light to a particular area, and achieve a desired highlight easily and quickly (see Figure 2). This is not because Autocolor's lighting model computations are faster, but because its controlled "lights" behave in a more natural way.

Another unique feature of Autocolor is the ability to portray realistically a variety of different materials and lighting conditions. The color seen from a surface is really a combination of two colors: the color of the surface or material itself (diffuse reflection) and the color of the reflected highlights (specular reflection). The highlight color may be the color of the material, the color of the light, or a color derived from the material and the light.

A different highlight color can be used for each different surface type that is defined. This makes it possible to simulate materials such as plastic, painted metal, and chrome—each of which has different reflectance properties and requires a different highlight color.

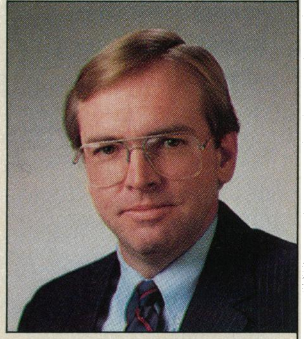
The user can interactively adjust the blending of the surface and highlight colors, watching the image change dynamically on the screen until a desired effect is achieved.

"Autocolor will free designers to be more creative," says researcher Warn. "Our goal is to move from controls that show changes in lighting, color, and materials, to software that will let the user change the actual shape, manipulating the image on the screen like a flexible clay model."

General Motors

MARK OF EXCELLENCE

THE MAN BEHIND THE WORK



David Warn is a Senior Staff Research Scientist in the Computer Science Department at the General Motors Research Laboratories.

He received his undergraduate degree in mathematics from Carnegie-Mellon University, and his M.S. in computer science from Purdue.

He has done extensive research in relational data management systems with special emphasis on user interfaces and human factors. He also designed the prototype for the network data manager used in the GM Corporate Graphic System. His previous work on other aspects of computer-aided design include system design, file management, and simulation models.

His foremost research interests are in color synthetic image generation and interactive surface design. He joined General Motors in 1968.

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Patents

Since the administration of President John F. Kennedy, Congress has deliberated periodically over the acquisition of patent property by the government. The enactment of general legislation, setting forth a definitive policy for the management of government-owned patent rights, has not been realized. Senate Majority Leader Robert J. Dole has now introduced legislation that may finally accomplish this longtime objective.

That inventors should be rewarded for their creativeness is a belief that was written into our Constitution. It is the basis of our federal patent system. The government is not in the patent business, and it is no secret that of the thousands of patents that the government owns, after decades of title-taking, few have been put to productive use. Evermore in this age of onrushing technology it is being recognized that private industry is better equipped than government to promote the commercial application and development of inventions, stimulate new ideas, increase industrial productivity, and improve the international competitiveness of U.S. goods. Let us take a look from Kennedy to Dole.

On 10 October 1963, President Kennedy directed a memorandum to the heads of all executive departments and agencies that said:

> From the extensive and fruitful national discussions of government patent practices significant common ground has come into view. First, a single presumption of ownership does not provide a satisfactory basis for government-wide policy on the allocation of rights to inventions. Another common ground of understanding is that the government has a responsibility to foster the fullest exploitation of the invention for the public benefit.*

In the U.S. Senate on 3 January 1985, Senator Dole submitted a bill "to amend Title 35 of the United States Code for the purpose of creating a uniform patent policy and procedure concerning patent rights and inventions developed with federal assistance," and then said:

> For a quarter of a century—just about as long as I have been in this city—efforts have been underway to develop a comprehensive uniform government patent policy. In this Congress we have the opportunity to take the final major step by enacting this proposal which simply helps the free enterprise system to do what it does best: produce new products the public seeks; create new jobs the public requires.†

The Kennedy-Dole advocacy for a uniform patent policy is best expressed through specific legislation making such a policy mandatory. The Kennedy memorandum forced government to think of alternatives to federal title-taking. As a result, much of government has come to recognize that it is not necessary to retain the rights to inventions beyond those needed to use the inventions for government purposes. There is no present reason or justifiable need for the government to hold anything beyond a nonexclusive royalty-free license on inventions derived from federal research and development contracts.

These years have seen an onslaught of new technologies and a shrinkage in the time that it takes for knowledge to be turned into application. New government-industry-university relations have forced new institutional arrangements. Antitrust barriers are being lowered so that industry joint ventures in basic research are no longer barred, and private industry is recognized increasingly as the place where commercial application and the development of inventions thrive.

The challenge that President Kennedy initiated through executive action has obvious limitations. An executive memorandum is no substitute for legislation. The Dole proposal would, in the senator's words, "eliminate the hodgepodge of agency patent requirements built up over the years." That appears to have been President Kennedy's view as well.—EMILIO Q. DADDARIO, *Wilkes, Artis, Hedrick & Lane, Washington, D.C. 20006*

*"Government patent policy," *Fed. Reg.* **28** (No. 200), 10943 (12 October 1963). †*Congr. Rec.* **131** (No. 1, part II), 5186 (3 January 1985).