Some highlights on low-resolution color graphics

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My work in low-resolution color graphics dates back to 1955, when I had had no involvement with computers. Yet the keystone of my work in computer-generated color block graphs for the past five years has been the algorithm described in the abstract from the 1955 Annual Meeting of the Alabama Academy of Science, quoted here in full:

Let us consider any plane area divided into a grid of equal squares by two perpendicular families of parallel lines. We associate with some centrally located square the coordinates (0,0). The square a squares to the right of the origin and b squares above it is given coordinates (a,b). Squares to the left of the origin have a negative first coordinate; those below the origin have a negative second coordinate. Suppose we wish to create a block design using a certain number of colors or individual block designs; say, for instance, a five-color design. We associate with each of the numbers 0, 1, 2, 3, and 4 a different color. By using various integer-valued functions $f(x,y)$ reduced modulo 5, we associate one of these numbers and its color with each square in the grid. In case the function used is a polynomial in x and y, this produces a design formed by repetition of basic 5 by 5 groups of 25 squares. By taking $f(x,y)$, the greater integer in $f(x,y)$, patterns can be formed for functions of integers which may take on non-integral values.

Using $f(x,y)$ modulo n, we may also form color patterns in ordinary rectangular Cartesian coordinates. In this instance the color at any point (x,y) on the design would be that corresponding to the greatest integer not exceeding the value of $f(x,y)$ reduced modulo n. This technique may be used with polar coordinates also. A tablecloth sold at the International Congress of Mathematics 1954 uses the distribution of the Gaussian primes to develop a two-color block design.

Although I met my first computer, a Univac I, at the David Taylor Model Basin in 1957, when I wrote a program to generate basic sets of homogeneous harmonic polynomials, another twenty years passed before I could implement the above color graph algorithm. This was done on an Intelligent Systems Corporation 8001 terminal that had just been connected with the Cyber systems at the Florida State University Computing Center. The resultant color block graphs proved useful in my National Science Foundation cause and LOCI projects then under way to develop instructional modules for courses in mathematics, computer science, statistics, physics, meteorology, and engineering technology. For instance, the displays for the Dirichlet problem shown in "Displays on Display" on page 102 resulted from a series of modules created for classes in partial differential equations.

During 1977-80, a series of donated upgrades converted the 8001 terminal to a fully equipped Intelligent Systems 8054 H series desktop computer. This made it possible to implement the above algorithm and related extensions entirely within the ISC unit. FSU awarded me a 1979-80 sabbatical to expand my color graphics activities. Although the early part of the year involved continued science education applications under the terminating NSF grants, other sabbatical matching funds from ISC and CDC enabled me and my student associates to implement software for other university fields such as creative arts, textiles, interior design, advertising, television, business, art education, and scientific research. Special characters were designed to graph complex variables or other vector functions in the manner illustrated in "Displays on Display."

At first, authors, editors, and publishers who saw our color graphics and expressed interest refrained from using them because of the high cost of color printing, especially the cost of producing the color-separated film needed to prepare the plates for a full-color press. The first professional publishing was for the cover of the Proceedings, ACM Southeast Regional Conference, March 1980, with traditional color separation costs funded by a grant from the Intelligent Systems Corporation. In the intervening two years, book cover rights have been purchased for 15 textbooks by five major publishing houses, where reproduction was done from traditional color separations.

Color separation costs can be reduced significantly by a digital separation process performed on the creating com-
computer. I developed such a process and filed a patent application for it in August 1981. The availability of this process should lead to expanding markets for computer-generated color graphics at volume publishing levels. I produced a 1982 calendar called "Beauties of Mathematics" and saved 40 percent in reproduction costs by producing the color separations with my process. Three other appearances of donated graphics and separations include the complete cover design for the nationally distributed catalog of the film library at the Florida State University Multi Media Center; the cover design for the spring 1982 issue of the Journal for Interior Design Education and Research, in which my 1980 ACM Proceedings article, "Creative Art and Custom Interior Design in the 80's," is reprinted with a 1980-82 update; and the design entitled "Blue Lady Dancing" on the cover of this magazine and the four images shown here.

The function used to produce the black-haired, purple-blue lady dancing on the cover is \(3(x^3 - y^3) \sin((x+y)/20)/(x^2+y^2+0.3)\). The central figure corresponds to the area of the screen in which the generated function lies between 0 and 1.

The flounder and butterfly patterns are closely related—identical, in fact, on the right half of the design. Symmetry with regard to the x axis is introduced in the butterfly by inserting one absolute value term in the generator function. Both graphs have jumbled color patterns along the lines \(y=x\) and \(y=-x\) because of divisors' being near 0 (actually equal to 0.03) in the generating function along those lines. The blue background occurs because the non-negative function diminishes rapidly away from those diagonal lines.

The two versions of the \(k\cdot z\)-cubed pattern demonstrate the 120-degree polar symmetry of the function, which might not be expected from its representation in rectangular coordinate form. They also illustrate the ability of the artist or designer to choose subsets of the colors available to produce patterns suitable for a particular decor. With our software, one can instantaneously substitute personal color choices for those displayed on the screen, a valuable tool to the artist because it applies equally well to any pattern, whether created by function evaluation or the individual selections of the artist.

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