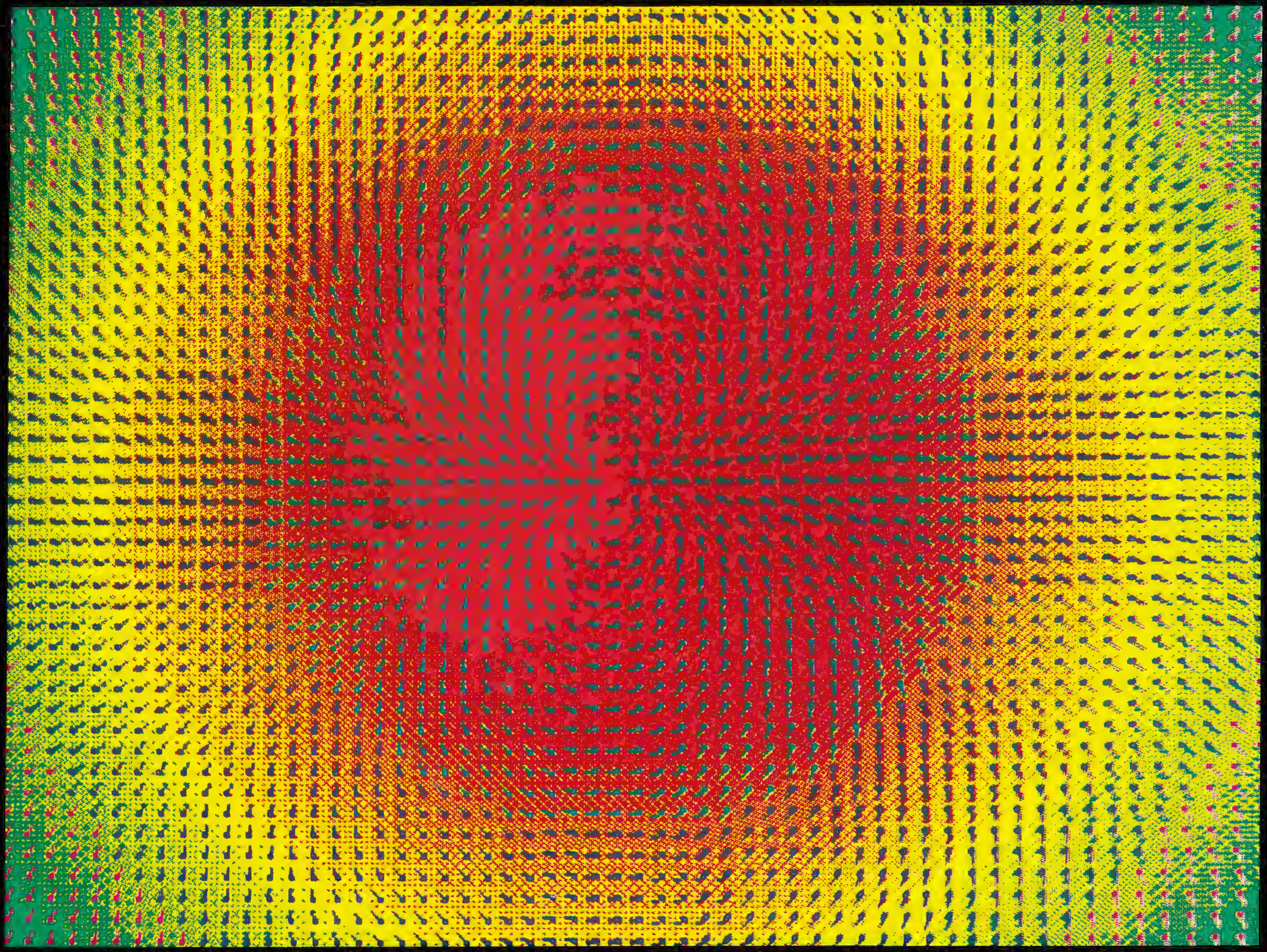


THE BEAUTIES OF MATHEMATICS II

1983 Planning Calendar featuring Colorgraphic Art

Center for Color Graphics, Florida State University

COLOR COMMUNICATES BETTER—IN ART, SCIENCE AND BUSINESS

Intelligent Systems is proud to present this calendar featuring abstract art to our customers and friends throughout the world.

To all who appreciate the beauty and mystery of the abstract form, the merits of art are self-evident. However, the manner in which the art was produced is intriguing. Each colorful abstract was produced via mathematical formula on an Intelligent Systems desktop computer by Dr. E. P. Miles, who heads the Center for Color Graphics at Florida State University. Frequently, Dr. Miles changed the formula to enhance the art form and/or to produce different colorations and patterns.

The pictures reproduced here are the result of a merger of art and science not heretofore seen. We salute Dr. Miles, his multi-faceted talents, his leadership role in computer science and his interest in promoting the use of color graphics computers in many fields where art plays a major role—including advertising, interior design, architecture, packaging, etc.

Intelligent Systems is pleased to have been a financial co-sponsor of Dr. Miles' work. Our interest in color graphics started when the company was founded in 1973. We were the first firm to manufacture a color terminal using a microprocessor, the first to produce a self-contained alphanumeric color graphics computer using an advanced programming language, and the first to produce a color-enhanced word processing unit.

While other firms boast about their role in the color graphics industry, Intelligent Systems was the first firm to produce and ship 20,000 color graphics computers and display terminals. Today, we are among the world leaders in units shipped. Intelligent Systems' color terminals are in a majority of the process control installations in this country. We manufacture color graphics computers and terminals for use in process control, energy/facilities management, manufacturing control, data networking, measurement/testing/training, management information systems/date processing, business graphics and presentation graphics. Moreover, we manufacture complete workstations for business/presentation graphics. We invite you to contact us for further information: Intelligent Systems, 225 Technology Park/Atlanta, Norcross, GA 30392. 404/449-5961.

BEAUTIES OF MATHEMATICS CALENDAR II 1983

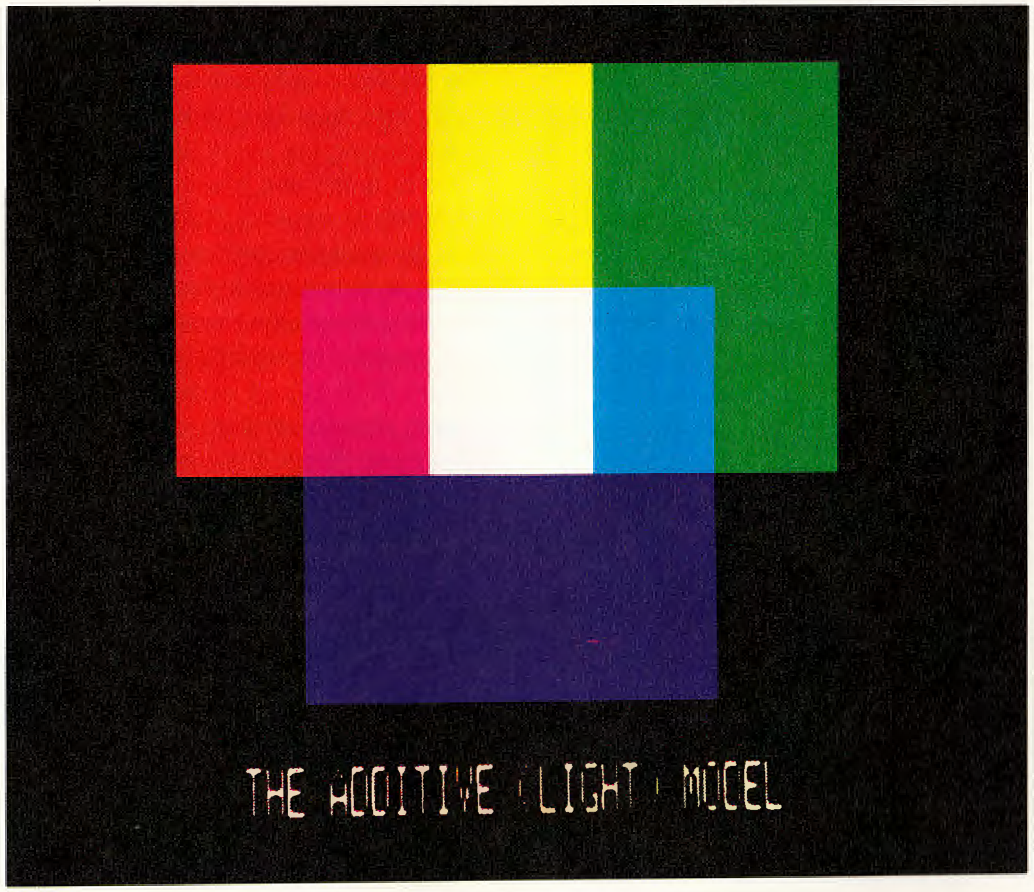
The mathematical beauties of the month for this calendar were selected from those created by Professor E. P. Miles, Jr. and associates at Florida State University in various color graphics projects during the years 1977 to 1982. They were created on display screens of desktop color graphics computers manufactured by Intelligent Systems Corp. of Norcross, GA. The color separations used by Rose Printing Company to print these graphics were performed in the FSU Center for Color Graphics on Intelligent System 8054 and 8064 computers using the Digital FACSIMILES process recently developed by Miles for which a patent application is pending. Photography was done by Ray Curci and Mark Schendel. Major programming and design support by William Jasiniecki, Eric Chamberlain, Ray Curci, Doug Martin and Mark Schendel is acknowledged. The cover, Seminole Sunburst, also used for the August display, used the new high-resolution R-series color super-pixels to graph the complex function. The background color shows the absolute value and the superimposed line the argument of the function at a point z. This method of plotting complex variables was first presented by Miles at the International Congress on Mathematics Education in 1980.

The dual models for additive and subtractive colors in January and December are the basis for the eight-color digital separation process. The color block graphs of mathematical functions were generated by computer implementation of an algorithm described by Miles' 1955 paper, "Functional Design and Colorful Mathematics". It was the intent of that paper to use hand-created color patterns which would show the beauties of mathematics to students at the high school entry level who had mathematical abilities but saw no relevance to further studies in mathematics because of their likely career choices. Then, as at the present time, a large number of able students, male, and especially female, were closing doorways to future scientific careers or technical aids for non-scientific careers by declining to study mathematics prerequisite for studies in such areas.

The widespread use of color computer graphics in the 1980s makes it important for students in many non-science areas such as art, advertising, interior design, architecture, business communications, etc., to continue studies of mathematics and computer science to levels which have become useful attributes to the practice of those fields. It is hoped that the preparation of this calendar and its wide distribution may help acquaint the general public with some of the beauties of mathematics which might help them convince students in their formative years that mathematics has much to offer people pursuing careers in the arts, social sciences, and other so-called non-technical areas.

Color block graphs of functions z = f(x,y) provide an alternative way of studying such relationships to the traditional perspective drawing of a mathematical surface. The color graphs are produced in a rectangular grid in which each block is assigned integer coordinates, x and y, over specified ranges. The function z is computed at each point (x,y) and the numerical result obtained is converted mathematically into one of the numbers 0,1, . . . , n-1, where n is the number of colors available for assignment. For each of the number ranges, a particular color is assigned which has been associated with that number by the input to the computer program generating the pattern. The resulting color map of the function is similar to television weather graphics which identify, by colors, those regions on the map where high temperatures are in the 90s, 80s, 70s, etc. Similar color representations of data ranges are applied in presenting census population or economic data by density of value levels in geographic sub-units of a map.

Recognition of support for generation of the graphics is given to the National Science Foundation, the Florida State University, the Control Data Corporation, Rose Printing Company, and most of all, to Intelligent Systems Corporation for generous equipment gifts and software development project support.



VENN DIAGRAM FOR ADDITIVE COLORS

Miles Color Art, Slide A-44.

January begins the year. Our Beauties of the Month began as computer screen images formed by combinations of red, green or blue additive primary light sources. Yellow is formed by mixing red and green light sources, magenta by combining red and blue light, and cyan by combining blue and green.

This model from the Proceedings covers for both ACMSE 80 and ACM 80 will appear on eleven book covers in a Holt-Rinehart-Winston series on Programming the IBM personal computer. To learn how our Beauties end up in print, see the December subtractive model.

1983 JANUARY 1983

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
DECEMBER 1982 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	FEBRUARY 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28					New Year's Day 1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23 30	24 31	25	26	27	28	29

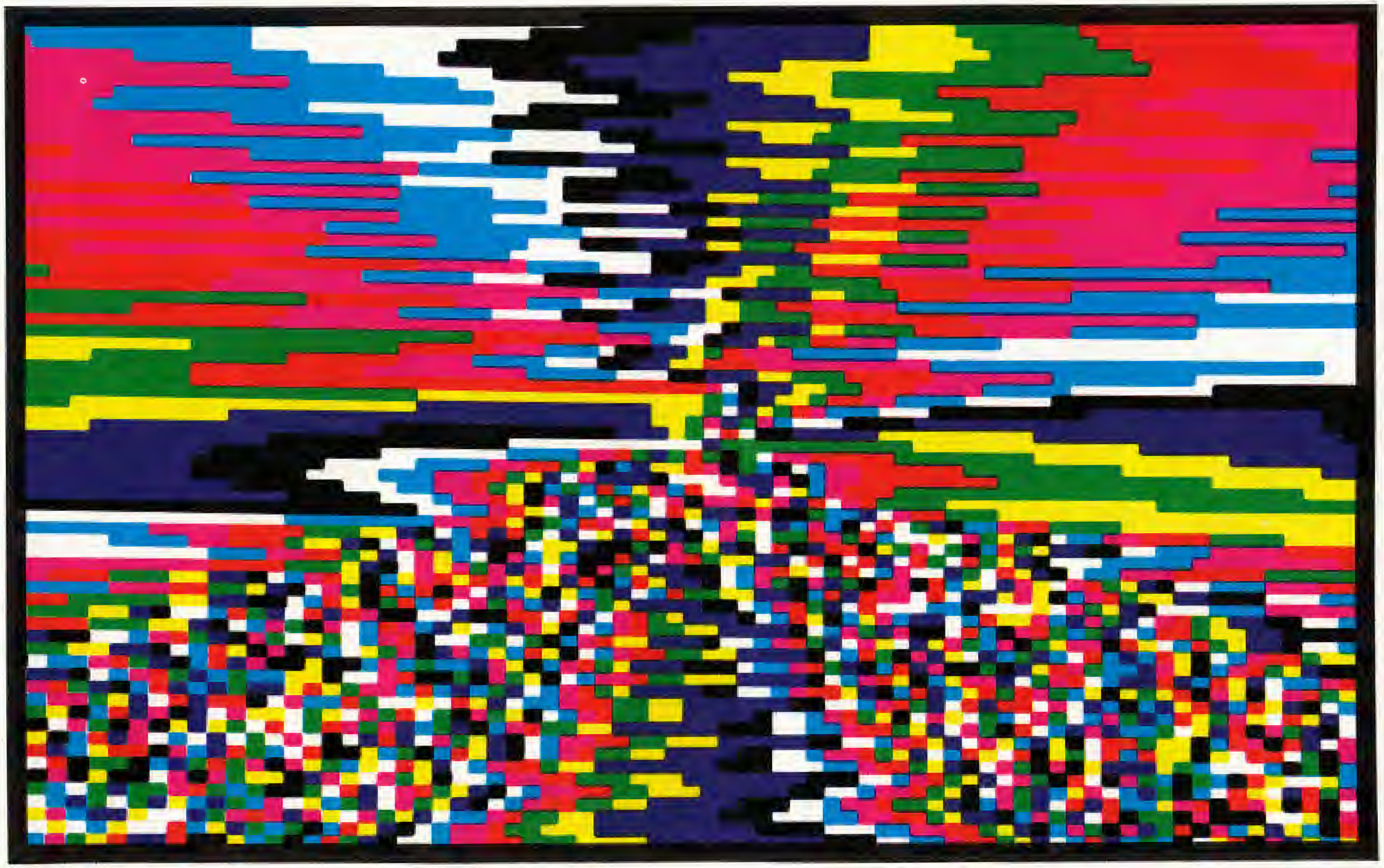
EXPANDING HEARTS

Miles Color Art, Slide A-45.

February ends its second week midst a wide distribution of those symbols of heartfelt love called valentines. You will perhaps be surprised that the nested hearts above represent a color block graph of the function: $z = ((y - (x^2)^{1/3}))^2 - (1 - x^2))/125$.

1983 FEBRUARY 1983

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JANUARY 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	MARCH 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	1	2	3	4	5
6	7	8	9	10	11	Lincoln's Birthday 12
13	Valentine's Day 14	15	Ash Wednesday 16	17	18	19
20	Legal Holiday Washington's Birthday 21	Washington's Birthday 22	23	24	25	26
27	28					



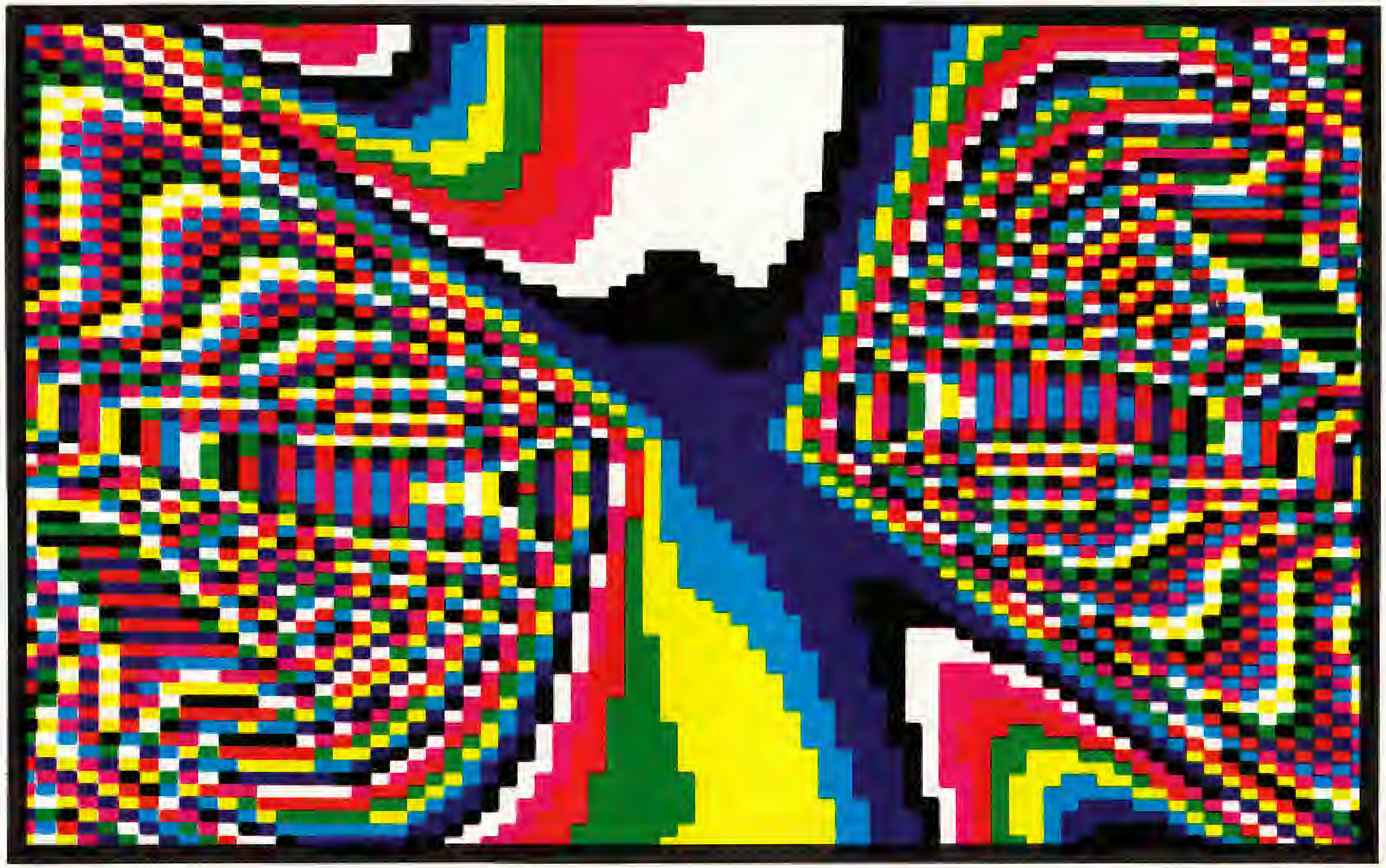
BLACK LIGHTNING HITS FANTASY ISLAND

Miles Color Art, Slide A-8.

March marks the transition from winter to spring, frequently with displays of violent weather. Our generating function has a denominator near zero on the lower halves of $y=x$ and $y=-x$ causing its values and their associated colors to change rapidly near those rays. The function graphed is: $z = 4(2x + 7\sin((x-y^2)/12))/(\text{abs}(x) + y + .001)$.

1983 MARCH 1983

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
FEBRUARY 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28	APRIL 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	St. Patrick's Day 17	18	19
20	21	22	23	24	25	26
27	28	Passover 29	30	31		



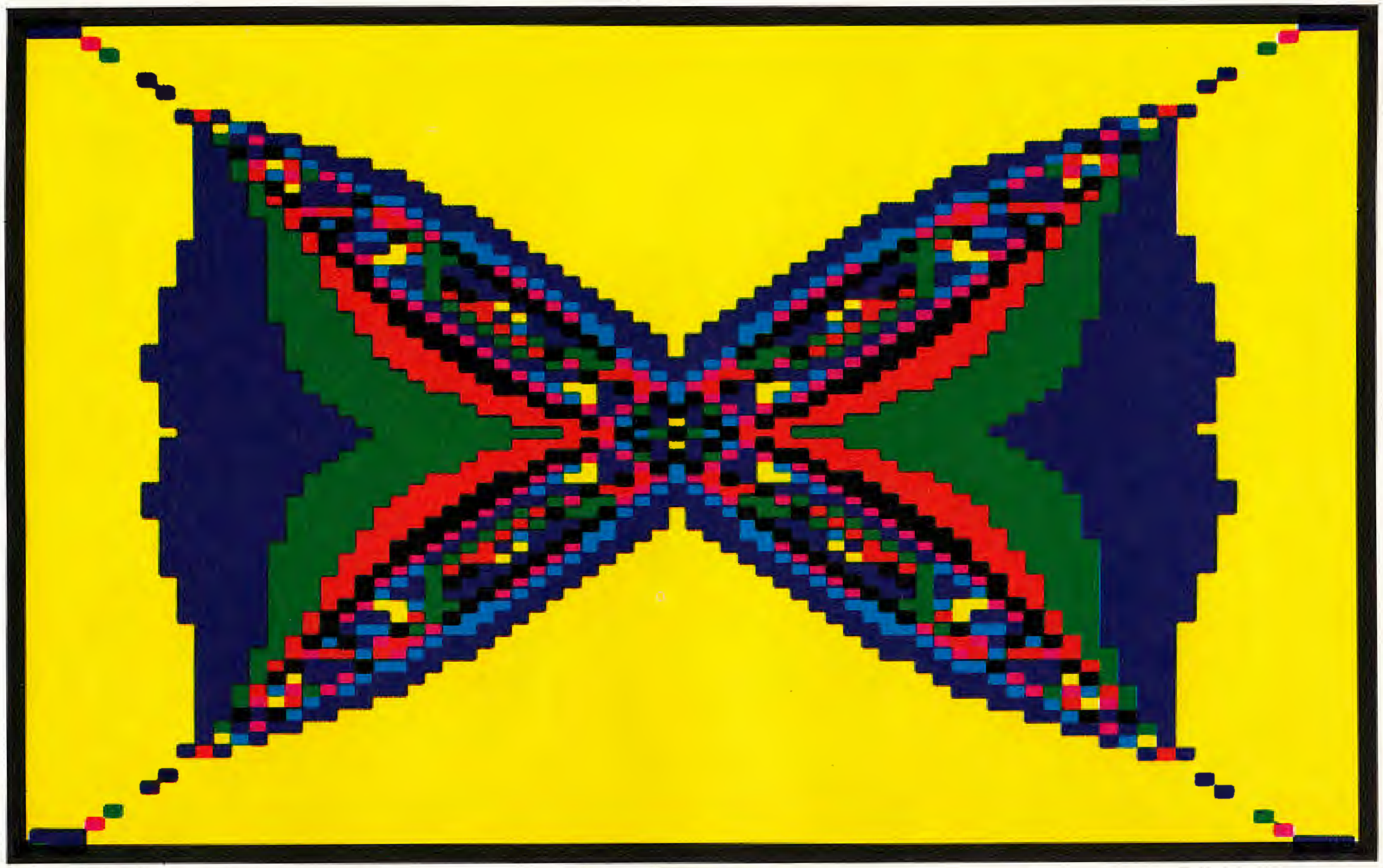
BLUE LADY DANCING

Miles Color Art, Slide A-39.

April is filled with Spring in the air, a time to rehearse for the dances on May Day ahead. This leaping dancer first attracted national attention on the cover of the May 1982 issue of IEEE Computer Graphics and Applications. Her choreographic function is: $z = 3(x^3 - y^2)\sin((x + y)/20)/(x^2 + y^2 + .3)$.

1983 APRIL 1983

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
MARCH 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	MAY 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31				Good Friday **1**	**2**
Easter Sunday **3**	**4**	**5**	**6**	**7**	**8**	**9**
10	**11**	**12**	**13**	**14**	**15**	**16**
17	**18**	**19**	**20**	**21**	**22**	**23**
24	**25**	**26**	**27**	**28**	**29**	**30**



BELLIGERENT BOUND BUTTERFLY

Miles Color Art, Slide A-26.

May buds and blossoms bring buzzing bees and beautiful butterflies about. This bound specimen first appeared in the cover story of the May 1982 issue of IEEE Computer Graphics and Applications. A derivative will be published as a poster size art print by Primrose Press in late 1982. The function graphed is: $z = ((3\sin(\mathrm{abs}(x/13)) + 3\cos(y/13))^2)/(\mathrm{abs}(x) - \mathrm{abs}(y) + .03)$.

1983 MAY 1983

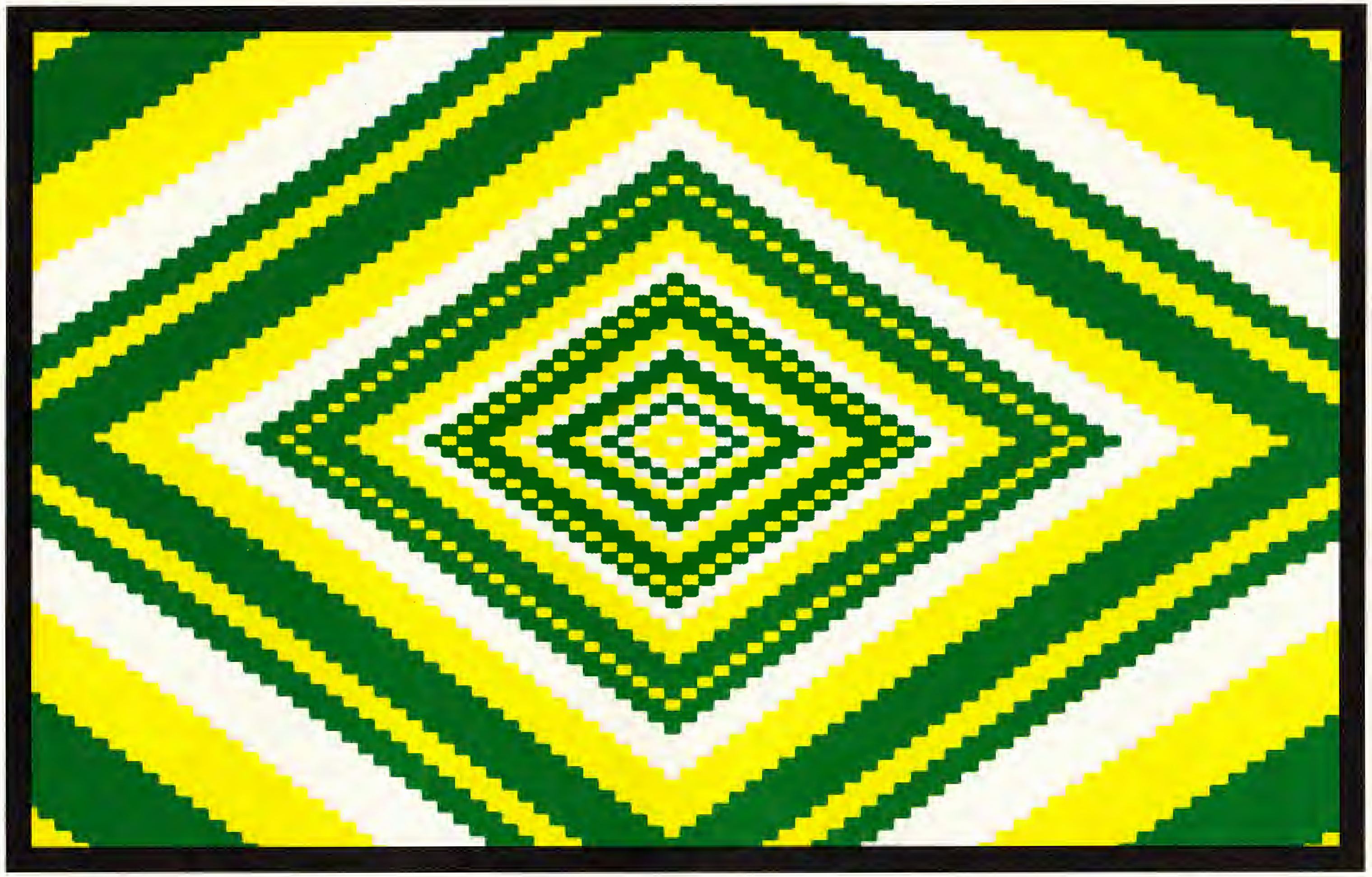
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
Mother's Day 8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	Memorial Day 30	31				

APRIL 1983

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

JUNE 1983

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		



NESTED DIAMONDS

Miles Color Art, Slide B-33-VI.

June is a month for brides and baseball, both of which bring diamonds to mind. Color block graphs of any function of (abs(x) + abs(y)) lead to diamond shaped equicolor bands. Here we see: $z = 7\mathrm{Ln}(x^2 + y^2 + 2\mathrm{abs}(xy) + .001)$.

1983 JUNE 1983

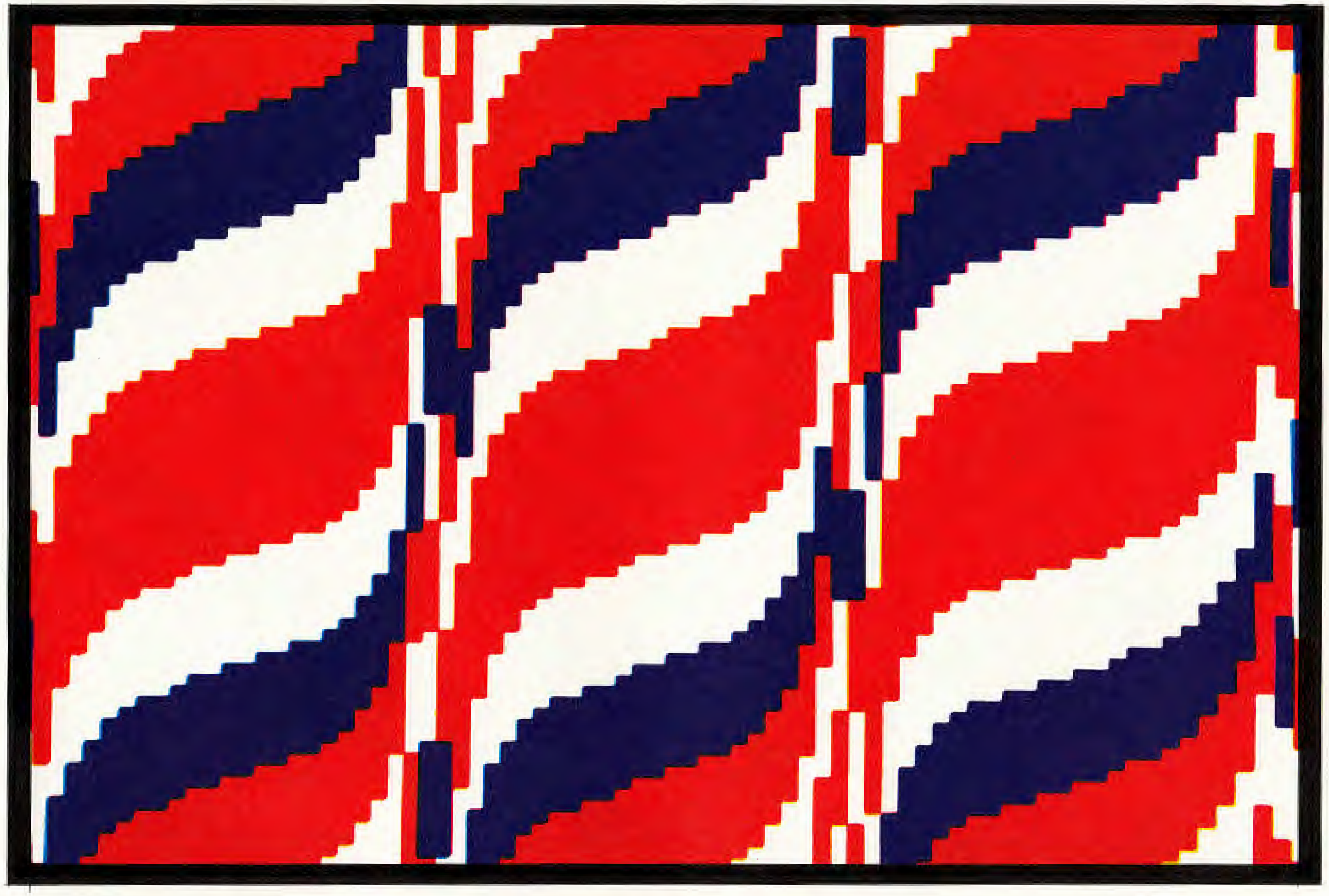
MAY 1983

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

JULY 1983

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
Father's Day 19	20	21	22	23	24	25
26	27	28	29	30		



TANGENTIAL FLAGS

Miles Color Art, Slide A-32-VI.

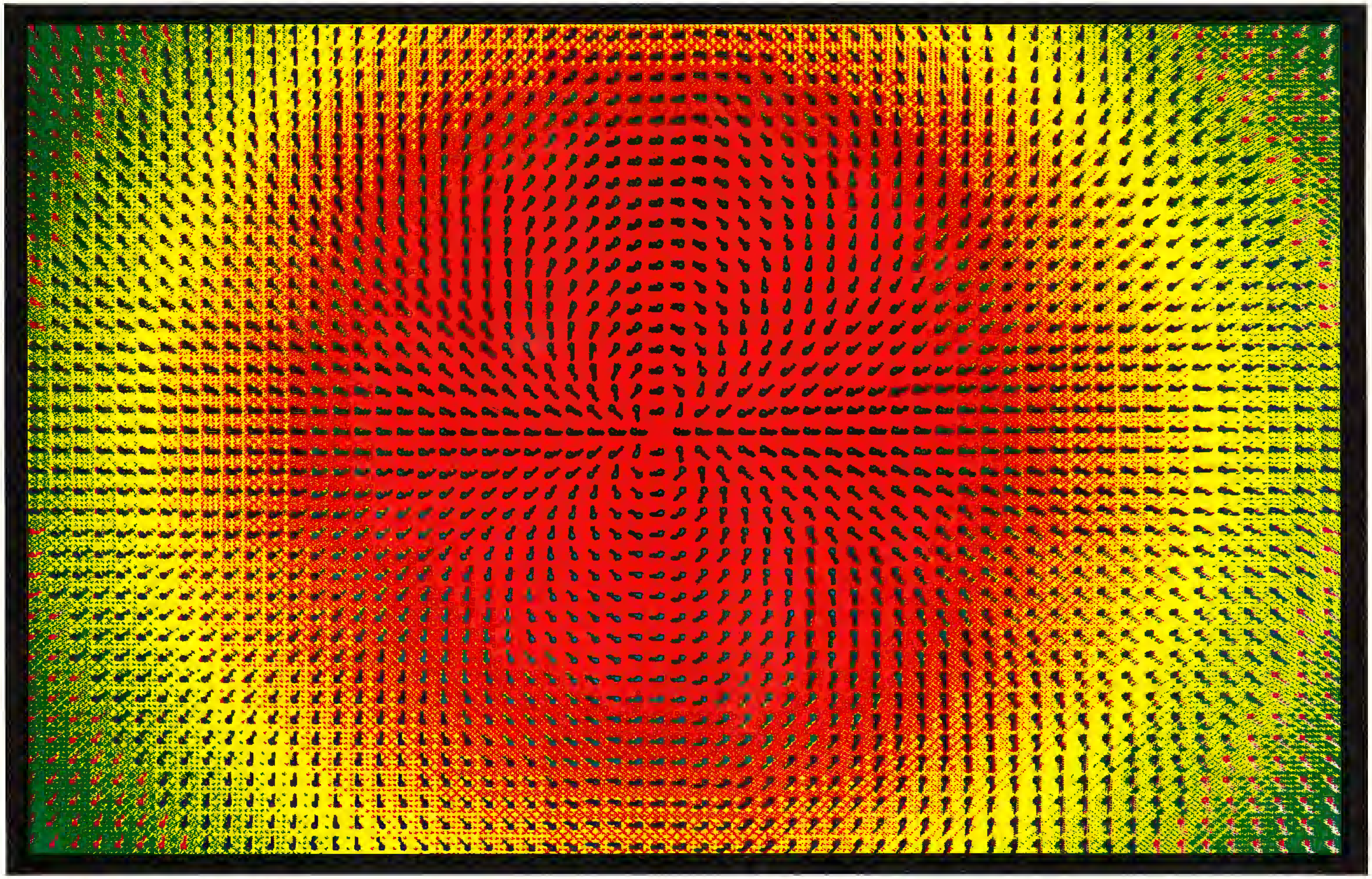
July is the time to say Hurrah for the Red, White and Blue. This tangential triptych is a patriotic variant of one first published on the cover of the ACMSE 80 Proceedings. The irrational singularities of the generating function $z = (y - 4\tan(x/8))/10$ are straddled in the block graph.

1983 JULY 1983

JUNE 1983						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

AUGUST 1983						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	Independence Day 4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24 31	25	26	27	28	29	30



SEMINOLE SUNBURST

Miles Color Art, Slide E-1.

August, as a month of extreme heat, is symbolized by this high resolution color block graph of the complex function $f(z) = z^2/36$. The warm colors from red to yellow in nested circles represent the absolute value of f(z) at a point z and the directed line the polar angle for f(z). This illustrates DeMoivre's rule which says the angle for z^2 is twice the angle for z.

1983 AUGUST 1983

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	JULY 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	SEPTEMBER 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	

RED FRAMED BLACK HOLE IN BLUE SKY

Miles Color Art, Slide A-18.

September is back to school month, perhaps to study those mysterious "black holes" in outer space. Here is one framed for you using a diamond in the sky function: z = (((abs(x))mod 37 + (abs(y))mod37)/4)mod2 + (abs(x/37)mod2 + abs(y/37)mod2)2.

1983 SEPTEMBER 1983

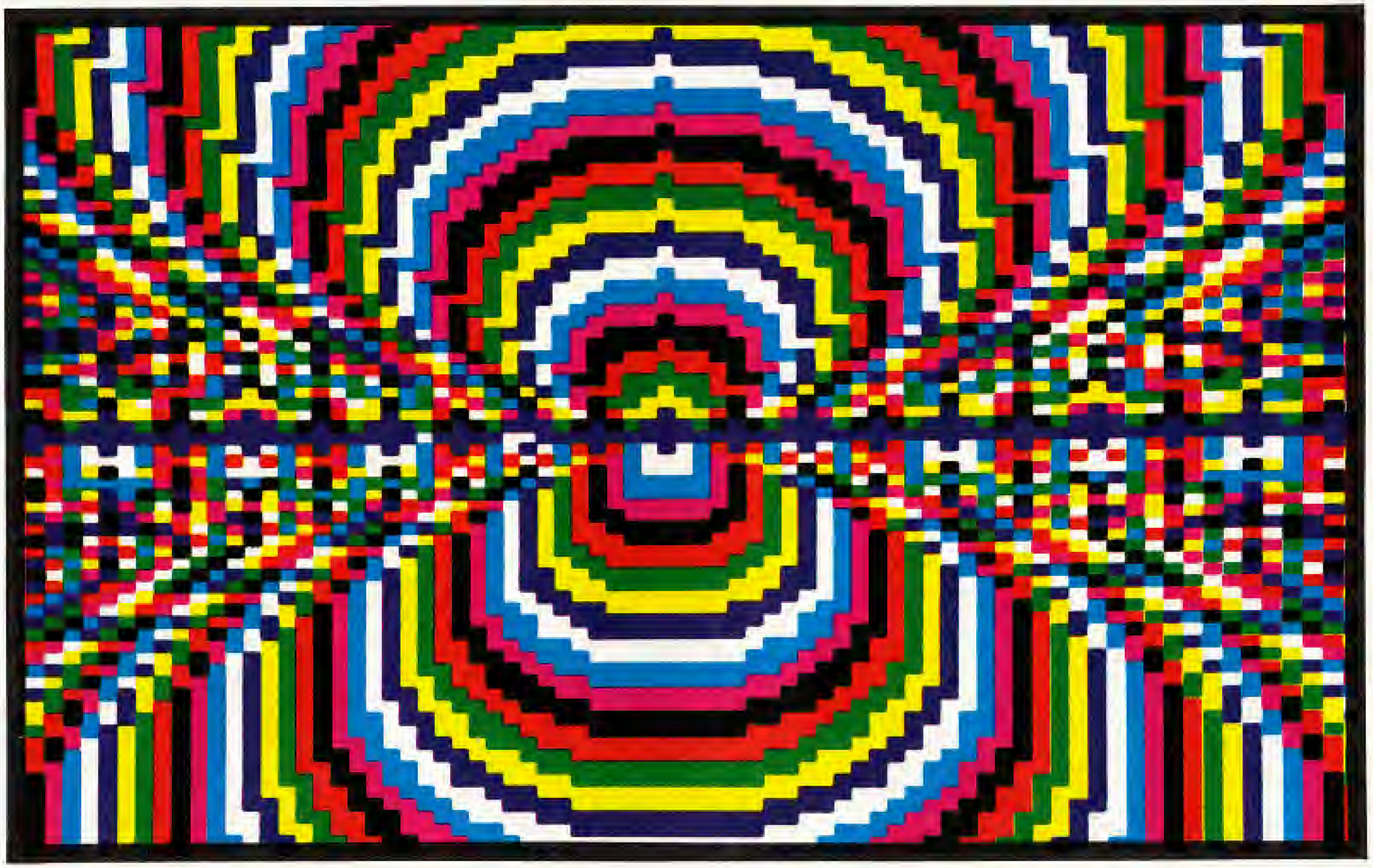
AUGUST 1983

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

OCTOBER 1983

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1	2	3
4	Labor Day 5	6	7	Jewish New Year 8	9	10
11	12	13	14	15	16	Yom Kippur 17
18	19	20	21	22	23	24
25	26	27	28	29	30	



OCTAGONAL OCULARITY

Miles Color Art, Slide A-40.

October was originally the 8th month of the Roman Year. We salute it with this pattern of nested "8 s" which appears to be made with tangential octagonal halves. The generating function is: $z = (x^2 + y^2)/(2y + .001)$. The equi-color bands are bounded by circles tangent to the x axis at the origin.

1983 OCTOBER 1983

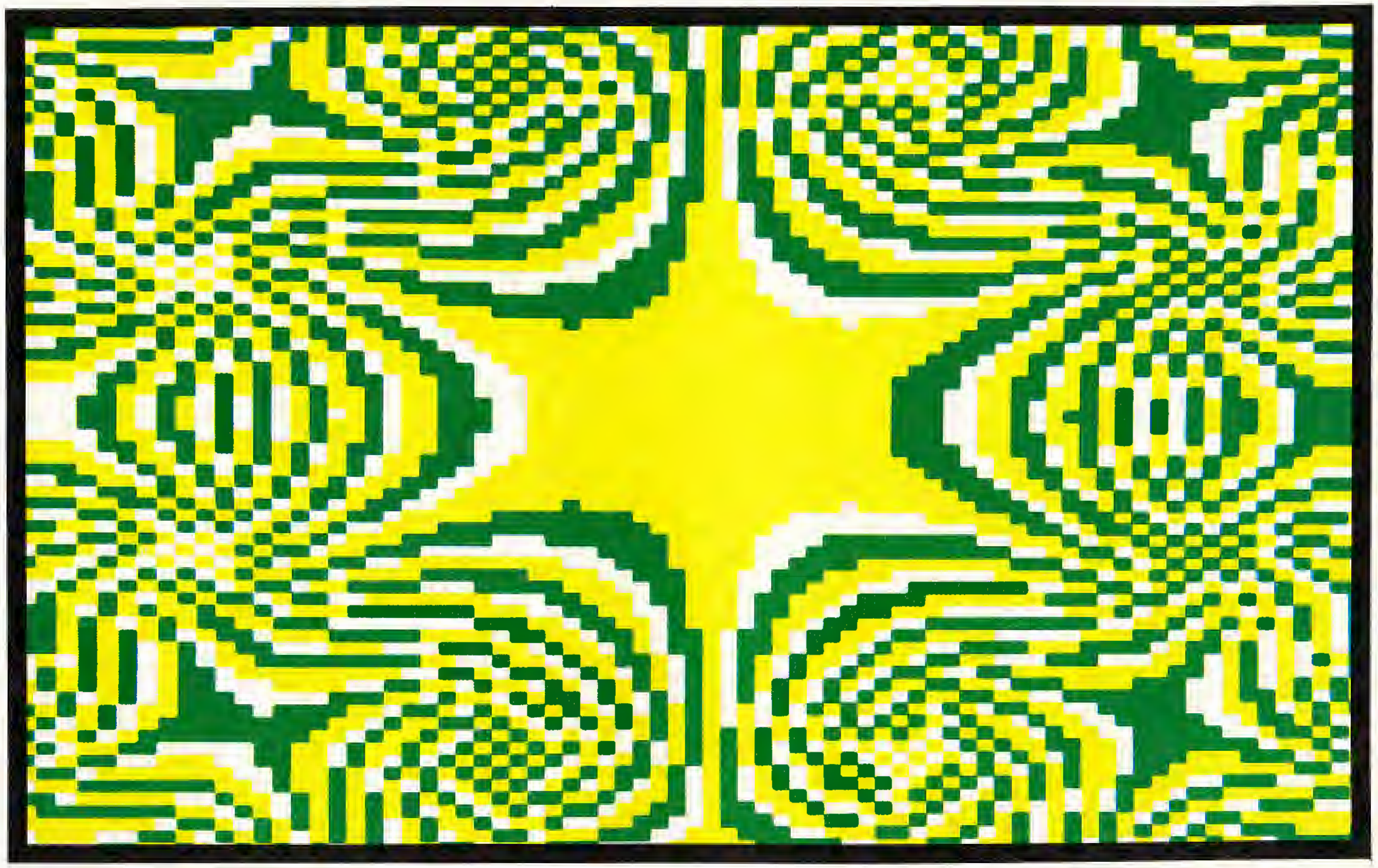
SEPTEMBER 1983

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

NOVEMBER 1983

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
						1
2	3	4	5	6	7	8
9	Columbus Day 10	11	12	13	14	15
16	17	18	19	20	21	22
23 30	24 Halloween 31	25	26	27	28	29



KZ^3 REAL PART, VICKI'S VERSION

Miles Color Art, Slide A-39.

November is the birth month for Vicki Miles. The real part of Z^3 is the harmonic function $x^3 - 3xy^2$. The color block graph of that function reveals 120° symmetry inherent in its polar form $R^3COS(3\Theta)$. The eight colors available when this design was created could produce more than 16,000,000 permutations of this pattern depending upon the assignment of color to number ranges. This particular three-color pattern was generated using $k = 1/512$ to match the decor of the Miles family room.

1983 NOVEMBER 1983

OCTOBER 1983

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

DECEMBER 1983

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1	2	3	4	5
6	7	Election Day 8	9	10	Veteran's Day 11	12
13	14	15	16	17	18	19
20	21	22	23	Thanksgiving Day 24	25	26
27	28	29	30			

THE SUBTRACTIVE (PIGMENT) MODEL

VENN DIAGRAM FOR SUBTRACTIVE PIGMENT MODEL

Miles Color Art, Slide A-45.

December ends our year. The model shows how our additive light patterns end up in print. The pigments used to print our beauties of the month are magenta, yellow and cyan, the traditional printers' primary colors. They mix, in pairs, to produce the additive light primary colors red, green, and blue as shown in this diagram. The January additive model and the one above are duals which provided the key to recreate printed color versions of computer screen images.

1983 DECEMBER 1983

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
NOVEMBER 1983 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	JANUARY 1984 S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31			Hanukkah 1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
Christmas Day 25	26	27	28	29	30	31

Intelligent Systems℠

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