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THE USE OF COMPUTER MODULATED DRAWING  
IN THE TEACHING OF ART

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## Abstract

A hardware-software process is described which automatically creates computer modulated drawings from an artist's own works. The process allows a drawing to act as a constant source of data for a series of renditions of it in widely varying styles. As a result a student of art can study the effects of line structure, line quality, and pen stroking style in rendering truly constant subject material.

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The figures shown in this paper are examples of "Computer Modulated Drawings". They were derived from a single source drawing and were produced by software developed by Williams [1] to allow artists to use a computer as a tool in rendering their own work. The process uses a Visicon Automatic Digitizer [2] to convert a hardcopy drawing into digits which are then manipulated by graphic collation software [3,4] into data structures which isolate and mathematically describe the geometry of the various lines which compose it. These data structures may be used as a direct source of commands for a digital plotter. Modulation occurs when the mathematical descriptions themselves are dynamically perturbed at the time of plot generation.

The simplest form of modulated art is no modulation at all, and the results are a faithful pen and ink reproduction of the original drawing. Heavier modulation, results in a work which retains the general holistic form of the original but which has been rendered in a completely different style. The process is totally automatic and rapid, requiring (for the figures shown) roughly two minutes for digitizing, four minutes for graphic collation (on an IBM 370/158) and twenty minutes for plotting. Graphic collation times are roughly linearly proportional to the amount of line data present, and plotting times vary with the complexity of modulation. The entire system is parameterized and does not require a knowledge of computer programming. Each type of modulation is coded by number, and the degree of perturbation is specified by such variables as amplitude and spatial frequency.

The value of computer modulated drawing to the teacher of art is derived from a capability for allowing a drawing to serve as a single and constant source of data for an indefinite number of variants to it. This permits the detailed

and parameterized study of the visual effects achieved by varying line structure, line texture, pen stroking style, etc. in rendering truly constant subject material. Such renditions are not possible by hand, for subtle localized changes in style will inevitably be introduced by the human while redrawing subjective material.

In essence the computer modulated drawing process provides the art teacher with the facilities of a computer darkroom with which to study the effects of different drawing styles on various subject matter. The source data for these studies may be carefully chosen archival works or they may be spontaneously selected drawings from the class itself. The speed of the computer based process insures that results will rapidly be forthcoming even in the case of the most complex and tediously structured design patterns.

The times required by computer modulation are currently largely a function of plotter speeds. Consequently the substitution of a display scope for a mechanical plotter can yield faster, though perhaps visually degraded, results. The plotter, of course, can manually be controlled in its employment of ink color and pen widths. The same data may be repeatedly plotted to yield high quality results on differing grades of paper.

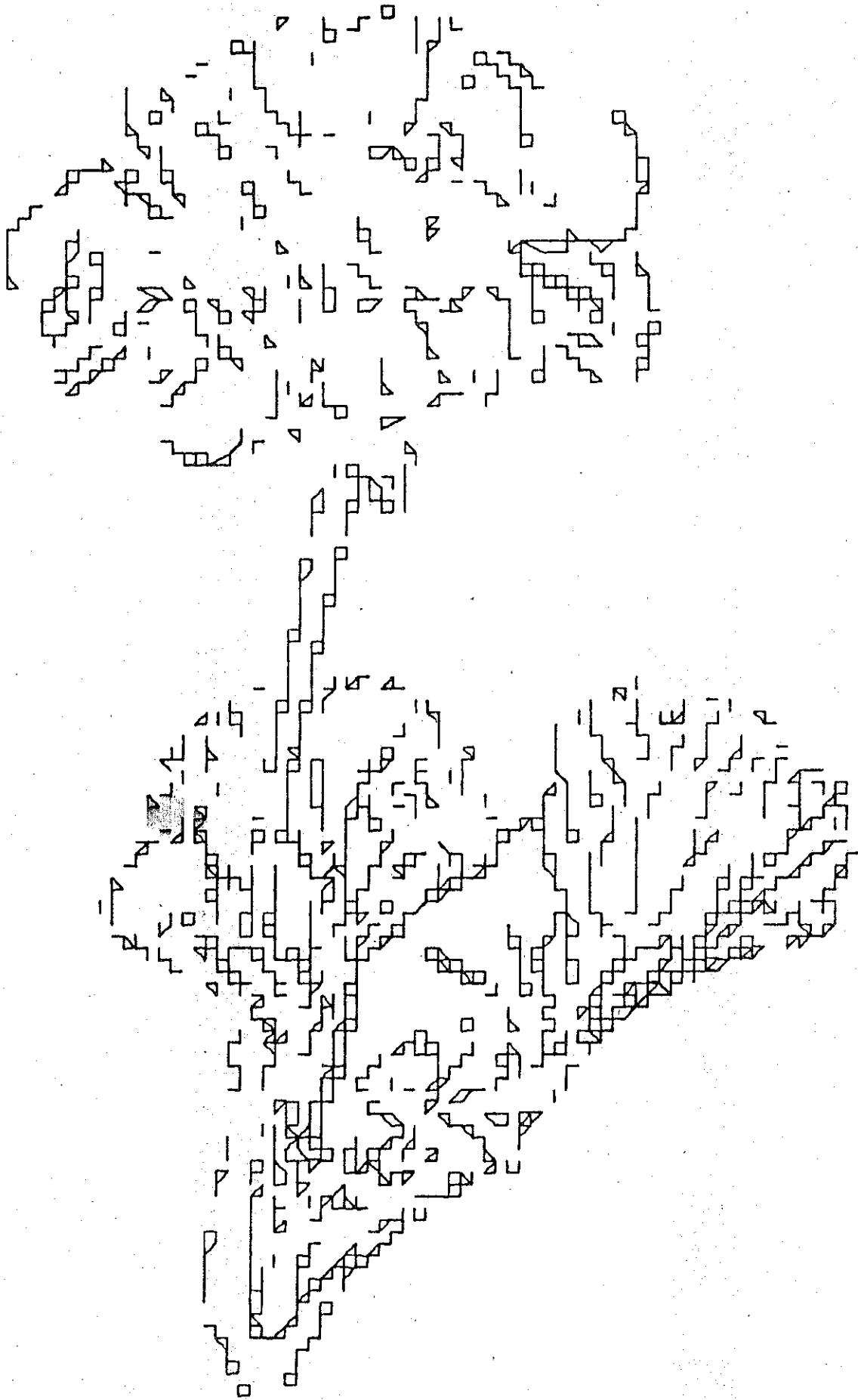
The computer modulation process was expressly designed to give the artist the benefits of a computer while allowing him to perform much of his work in his accustomed environment unfettered by the mechanical and electronic constraints often associated with machines. He prepares his work at his leisure using standard art supplies of his choice. When he has finished he secures his drawing to the surface of a drum which is mechanically rotated past an optical sensing mechanism which records black and white decisions based on the amount of light reflected from the document. Placement of the drawing on the drum requires roughly one half minute and needs no special mechanical aptitude. Digitization proceeds automatically and is completed in at most two minutes.

The digitizer output is fed to a computer which then creates the geometrically descriptive data structures. Modulation begins when the modulation parameters have been specified. The results are plotted mechanically on paper or electronically on the face of a cathode ray tube.

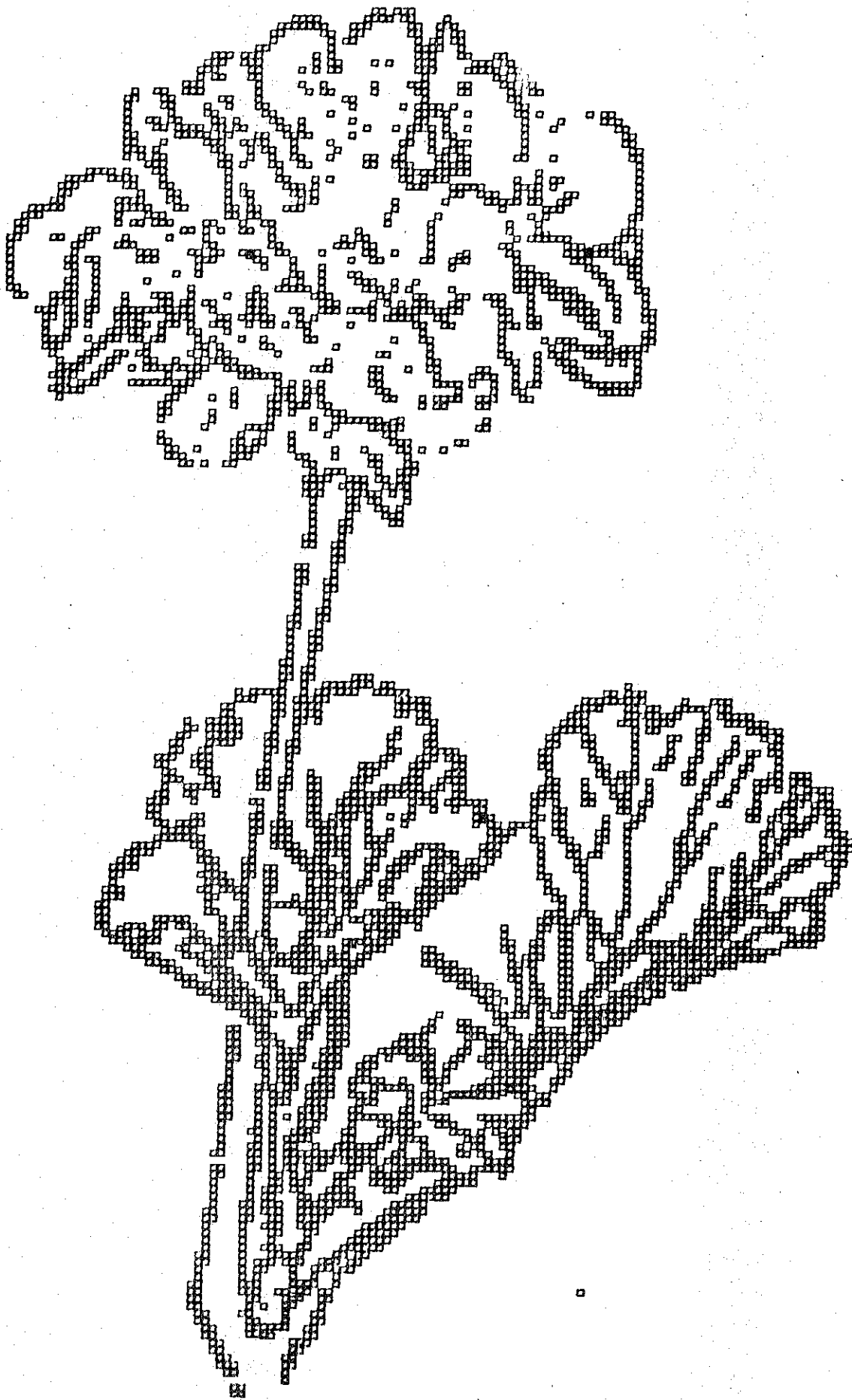
A typical hardware configuration may include a digitizer, incremental plotter, and display scope connected to a minicomputer which can communicate with a larger general purpose computer. The current graphic collation and modulated drawing software system resides in 160K bytes of IBM 370/158 memory but hopefully future systems will totally be resident within the minicomputer itself. It is envisioned that future systems will incorporate computer graphics facilities which will allow an artist to manipulate and modify his drawing interactively.

The art teacher can employ such equipment throughout his domain of expertise in attacking problems in drawing and, hence, in the photomechanical print (etching, lithograph, and silk screen). Beginning students can study the effects of style on rendering simple subjects, and advanced ones can selectively incorporate widely varying modulation techniques in creating arbitrarily complex works. The full power of computer graphics can be invoked to assure that pleasing localized effects on a drawing are not destroyed while others are being developed elsewhere.

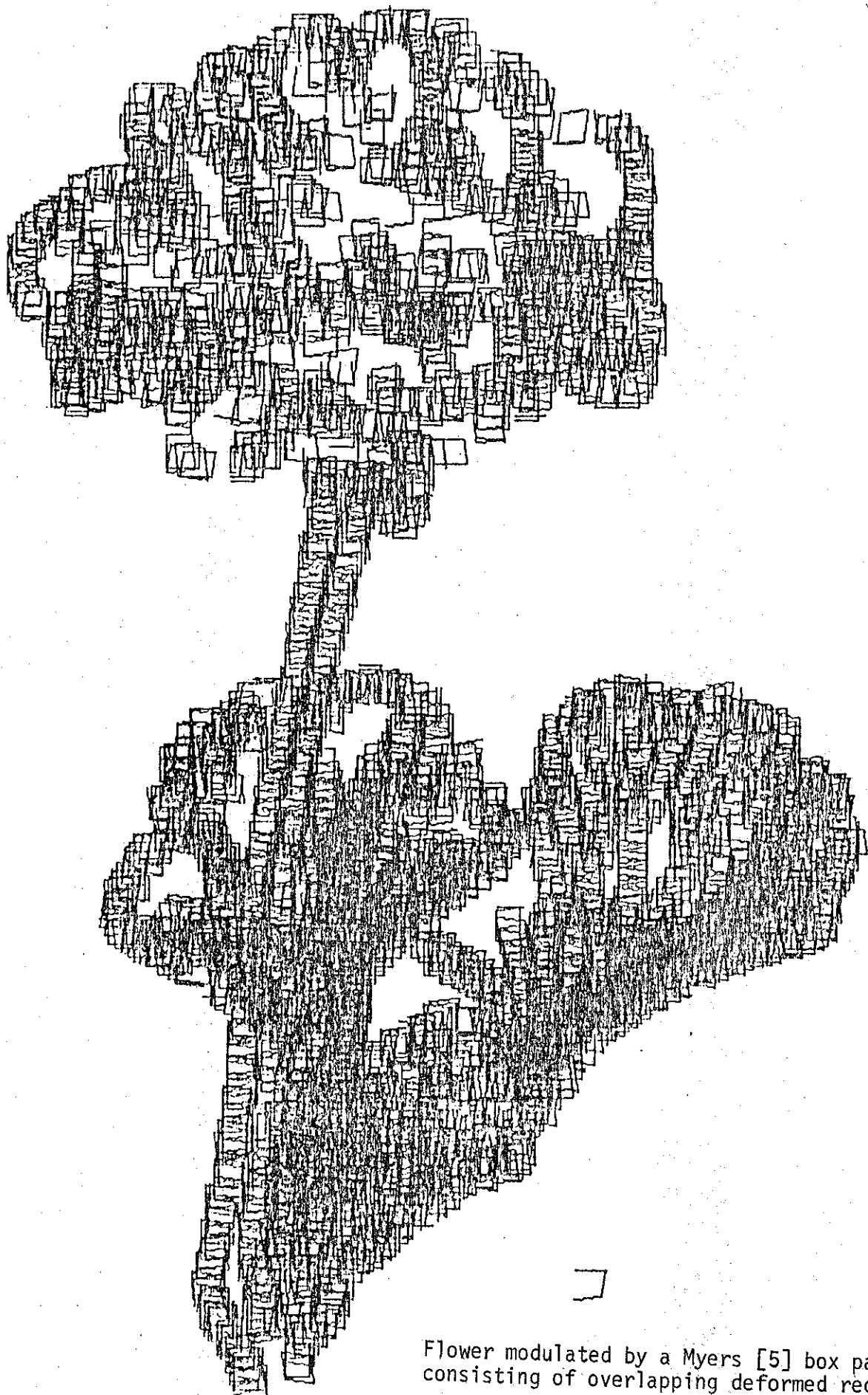
In short the computer modulated drawing process provides the teacher of art with a new and exciting tool with which to work. The computer is involved in its appropriate domain of tedium, and the artist retains his dominance in creativity. Though the system is mechanical, the results need not have a mechanical appearance.



Flower modulated by a "needlepoint" technique involving gridding on a coarse mesh

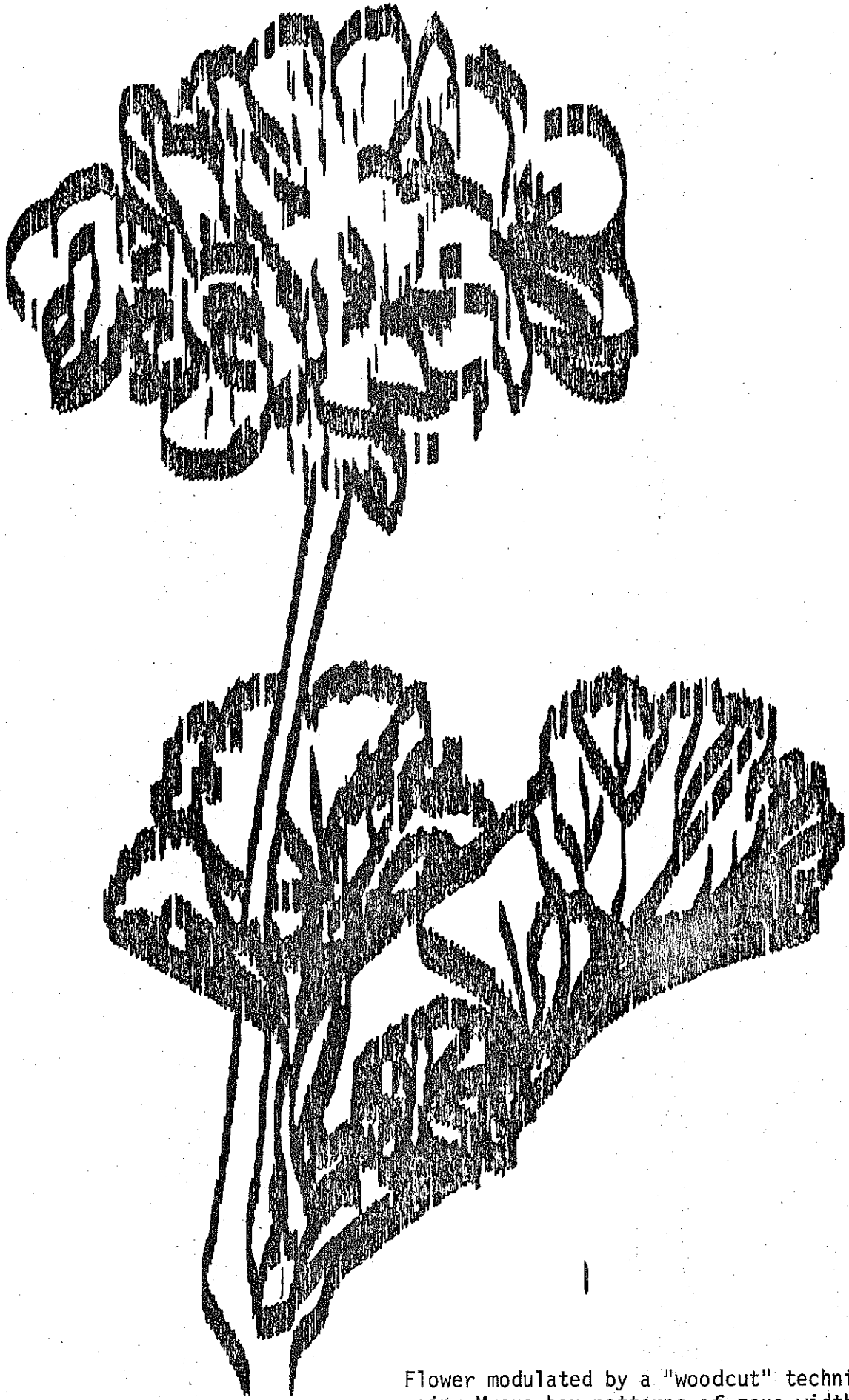


Flower modulated by a beaded pattern  
created by a mosaic of small squares



Flower modulated by a Myers [5] box pattern consisting of overlapping deformed rectangles





Flower modulated by a "woodcut" technique using Myers box patterns of zero width

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