# UTAH Range Database

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## Abstract

This document describes in detail the range database provided by the Department of Computer Science at the University of Utah. This document is intended for the person(s) involved in installing the database and those using the database.

The images are in four sets: the University of Utah images, SRI images, CCSP at NCSU images and the image of Victor Hugo. The scanning system is thoroughly described for the set of images scanned at Utah. The image formats for the other sets are also described.

The database contains 33 images which require 5.108 Megabytes of storage.

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# The Utah Range Database

## 1. Introduction

This document describes in detail the range database provided by the Department of Computer Science at the University of Utah. This document is intended for the person(s) involved in installing the database and those using the database.

The images are in four sets: the University of Utah images, SRI images, NCSU images and the image of Victor Hugo. The scanning system is thoroughly described for the set of images scanned at Utah. The image formats for the other sets are also described.

The 1600 bpi tape is prepared using the UNIX tar utility and can be read using the UNIX tar command:

```
tar -x
```

The database contains 33 images which require 5.108 Megabytes of storage.

## 2. Scanner

The images, with exception to the Renault piece, NCSU images and Victor Hugo's bust, were all scanned using a Technical Arts 3-D White Scanner Model 100-A. However, this section only describes the images scanned at Utah using the White Scanner.

The Technical Arts 3-D White Scanner Model 100-A is an active scanning system comprised of a laser, a beam spreading device, a camera and a proverbial *black box*. The laser projects a point of light which is spread into a plane by an oscillating mirror. This plane is reflected by another mirror onto the workspace. Where this plane of light intersects objects, a line of laser light is formed. This is sensed by the camera and the White Scanner system determines the Z-depth based on the laser angle and height, camera angle and height, and the position of the laser plane.

The scanned objects lie in a left-hand corrordinate system with the X-axis running toward the viewer (camera) and the Z-axis in the vertical direction. There are 240 pixels per scan line in the Y-direction and from 90 to 240 lines in the X-direction. The scanning system returns X, Y, Z, an intensity and a status word for each point in the scanline. These are in 1/1000 of an inch increments which are scaled up to integers (for X, Y, and Z). For example:

| White Scanner Value | True Value |
|---|---|
| 0254 | 0.254 |
| -9542 | -9.542 |
| 0001 | 0.001 |

The status word is encoded as hex-flags and the intensity is a 16-bit integer. A point on the scan line is considered *valid* if the result of ANDing the status word with 0x0044 (hex 44) is 4 (See Appendix I). We also reject any point with an intensity value less than 50.

Our scanner has two bad scanlines which are bad in every image scanned at Utah. These are lines 159 and 230 (See Appendix I). These lines contain erroneous data values and should be rejected. One possible solution is to perform a least squares fit for these data points based on the 6 local neighbors.

Each piece of information is contained in 2 8-bit bytes thus each point in a scanline requires 10 bytes (5 16-bit words) of data. Since there are 240 points per scanline, each scanline takes 2400 bytes. The format for a point in the scanline is:

| 16-bits | 16-bits | 16-bits | 16-bits | 16-bits |
|---|---|---|---|---|
| X | Y | Z | status | intensity |
| 2-bytes | 2-bytes | 2-bytes | 2-bytes | 2-bytes |

See Appendix I. for a sample C program for reading data.

For the set of images produced at Utah, the scanner was configured as follows. The laser was at a 21 degree from vertical angle and the camera was 51 degrees from vertical. The distance from the camera to the workspace surface (-2.5 average Z-depth) was 18.25 inches (see Figure 1).

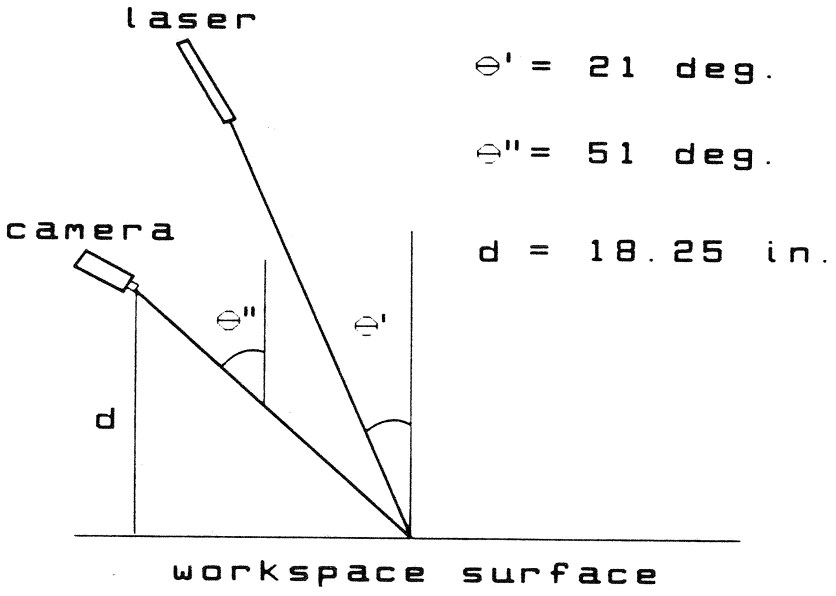



**Figure 1**

## 3. Objects

There are four sets of scanned images on the tape: University of Utah images, SRI images, NCSU images, and Victor Hugo's bust. Each set has a different encoding of Euclidian space. The following describes the different sets. Photographs of the objects scanned at Utah can be found in Appendix III. A summary of image names, formats and places scanned are in Appendix II.

University of Utah: This set is encoded in White Scanner format (see previous section). All the objects were scanned at the University of Utah with the exception of the Renault piece which was scanned at INRIA. We have converted the Renault piece scans to conform with the rest of Utah's images. That is, the Renault piece is also in White Scanner format though scanned with a different system.

SRI: This set is encoded as 240 X 240 X 16-bit images of Z-depth. That is the row and column indexes correspond to the X and Y locations and the Z value is the signed 16-bit number in the file. Bad data is represented as -1.

NCSU: This set is encoded as 8-bit images of Z-depth. That is the row and column indexes correspond to the X and Y locations and the Z value is the unsigned 8-bit number in the file. The sizes of the files are indicated by the file name extension, i.e. ledwire4.200x186 is an image with 200 pixels in the x dimension and 186 pixels in the y dimension.

Victor Hugo: This image was scanned by rotating Victor Hugo's bust in 1 degree increments. Thus the image is 360 X 283 X 8 bits of Z-depth. Where Z-depth is the distance from the center of the bust to the surface (surface of revolution).

## 4. Acknowledgments

We would like to thank Gerard Medioni of USC IPI for the images of the grapes and shuttle and for forwarding to us the image of Victor Hugo. We would like to thank Wes Snyder of the CCSP at NCSU for the images scanned at NCSU. We would also like to acknowldge Henri Maitre of ENST Paris for the image of Victor Hugo.

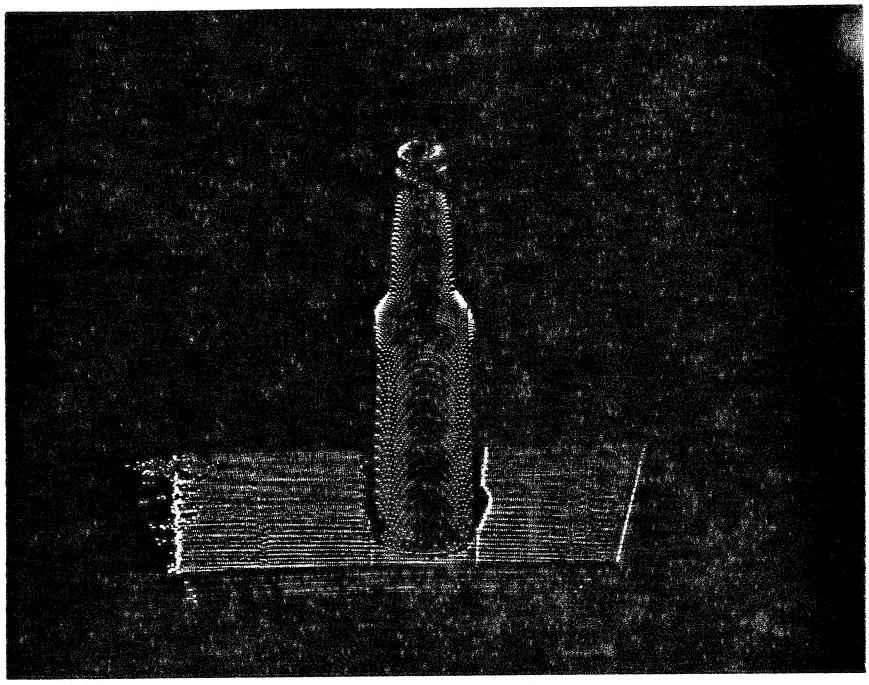
## I. Conversion Code for Utah Images

```
/*****************************************************************************
 *
 *      This program reads the file from the White Scanner (stdin)
 *      and writes the X Y Z INTENSITY and RASTER COLUMN to stdout
 *
 */
# include <stdio.h>

main()
{
        short int s1[240][5];
        float X,Y,Z;
        int INT,STATUS,i,lines;

        i=0;
        while((lines= read(0,s1,2400)) > 0){
          for(i=0;i<240;i++){
            X=s1[i][0] / 1000.0;
            Y=s1[i][1] / 1000.0;
            Z=s1[i][2] / 1000.0;
            STATUS=(s1[i][3] & 44);
            INT=s1[i][4];
            if( (STATUS == 4) && (INT > 50) && (i != 230) && (i !=159))
                printf("   %9.3f  %9.3f  %9.3f  %10d  %10d  \n",X,Y,Z,INT,i);
          }
        }
}
```

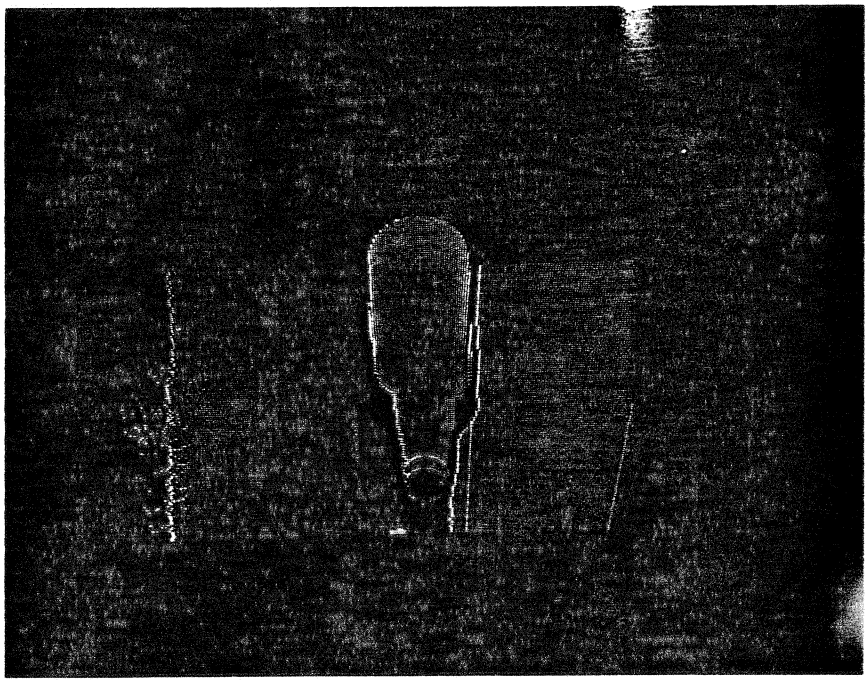
## II. Summary of Images

| file name | place scanned | data format |
|---|---|---|
| bottle | Univ. of Utah | White Scanner format |
| bottle_1 | Univ. of Utah | White Scanner format |
| cylinder | Univ. of Utah | White Scanner format |
| cylinder_1 | Univ. of Utah | White Scanner format |
| garg_front | Univ. of Utah | White Scanner format |
| part_1 | Univ. of Utah | White Scanner format |
| part_2 | Univ. of Utah | White Scanner format |
| part_2 | Univ. of Utah | White Scanner format |
| poly_1 | Univ. of Utah | White Scanner format |
| poly_2 | Univ. of Utah | White Scanner format |
| poly_3 | Univ. of Utah | White Scanner format |
| poly_4 | Univ. of Utah | White Scanner format |
| poly_5 | Univ. of Utah | White Scanner format |
| poly_6 | Univ. of Utah | White Scanner format |
| poly_7 | Univ. of Utah | White Scanner format |
| poly_8 | Univ. of Utah | White Scanner format |
| poly_9 | Univ. of Utah | White Scanner format |
| scene_1 | Univ. of Utah | White Scanner format |
| scene_2 | Univ. of Utah | White Scanner format |
| scene_3 | Univ. of Utah | White Scanner format |
| renault_1 | INRIA | White Scanner format |
| renault_2 | INRIA | White Scanner format |
| sri_grapes1 | SRI | Z-depth format (16-bits) |
| sri_grapes2 | SRI | Z-depth format (16-bits) |
| sri_shuttle1 | SRI | Z-depth format (16-bits) |
| sri_shuttle2 | SRI | Z-depth format (16-bits) |
| v_hugo | ENST | 360-deg X 284 (8-bits) |
| refrig.128x128 | NCSU | Z-depth format (8-bits) |
| minihi.202x166 | NCSU | Z-depth format (8-bits) |
| minihi1.250x186 | NCSU | Z-depth format (8-bits) |
| ledwire4.200x100 | NCSU | Z-depth format (8-bits) |
| ledwire7.250x250 | NCSU | Z-depth format (8-bits) |
| pcboard.350x250 | NCSU | Z-depth format (8-bits) |

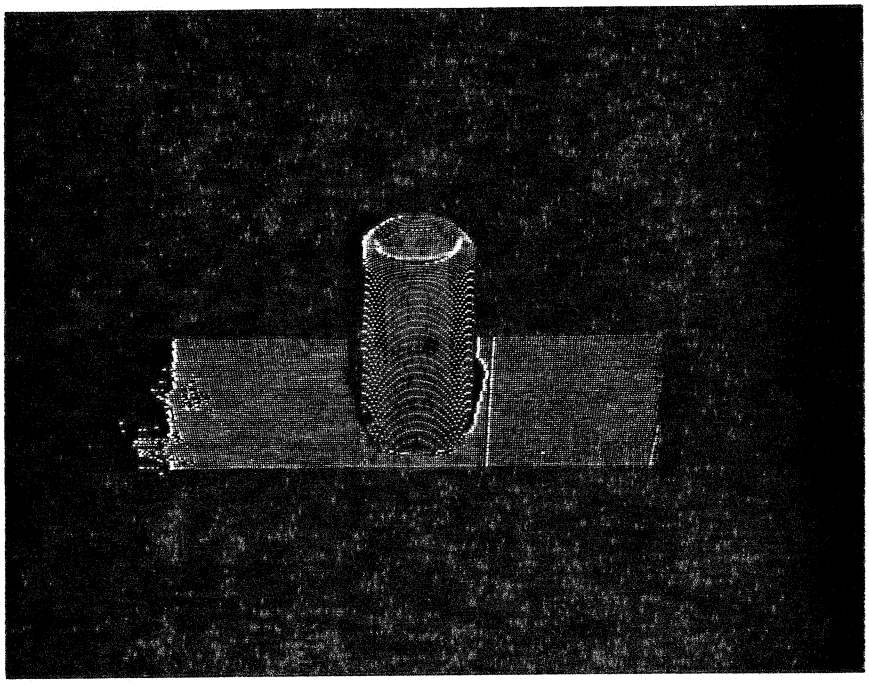
## III. Photographs of Objects Scanned at Utah



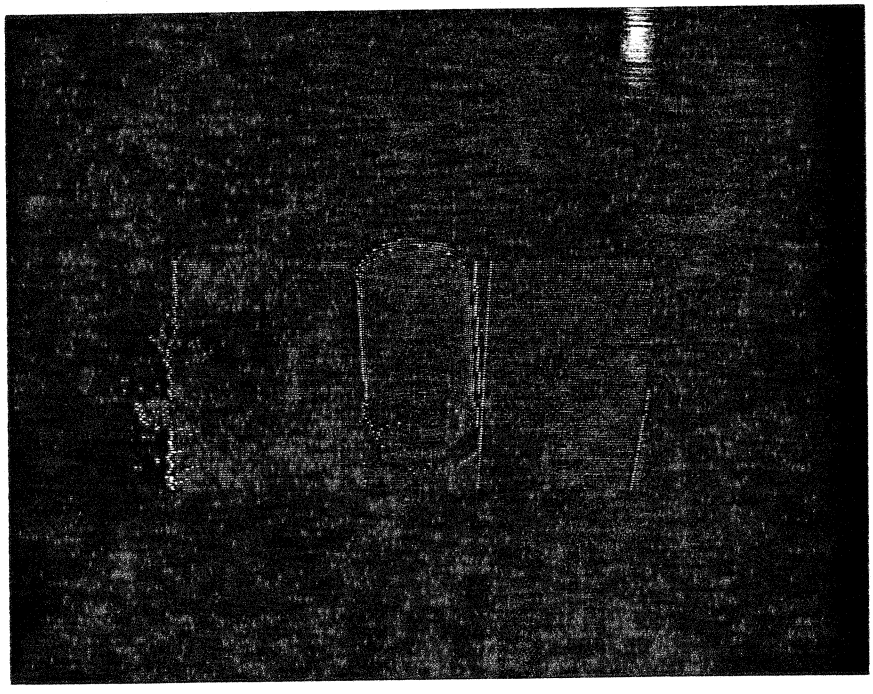
bottle



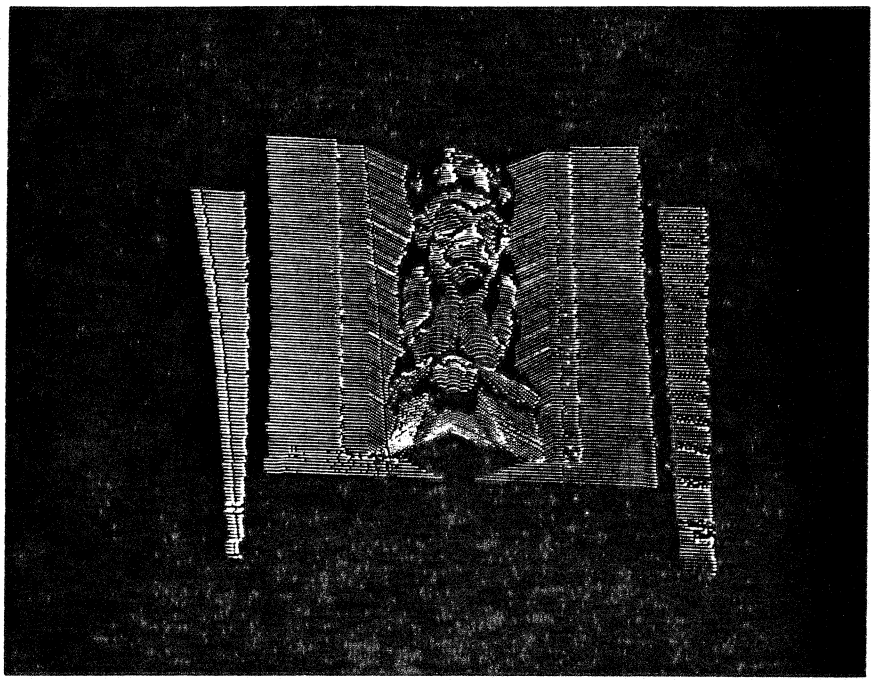
bottle_1



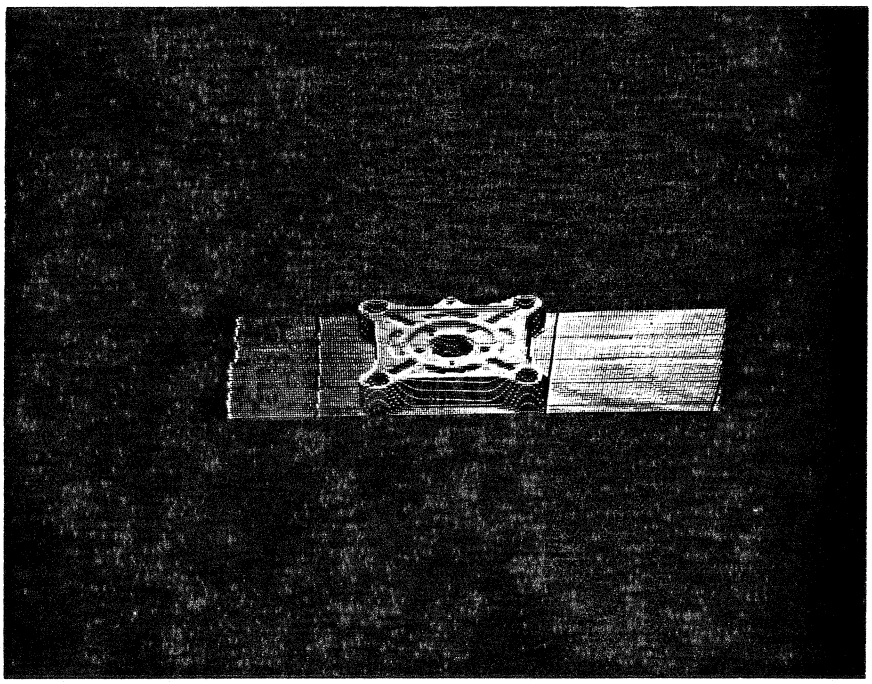
cylinder



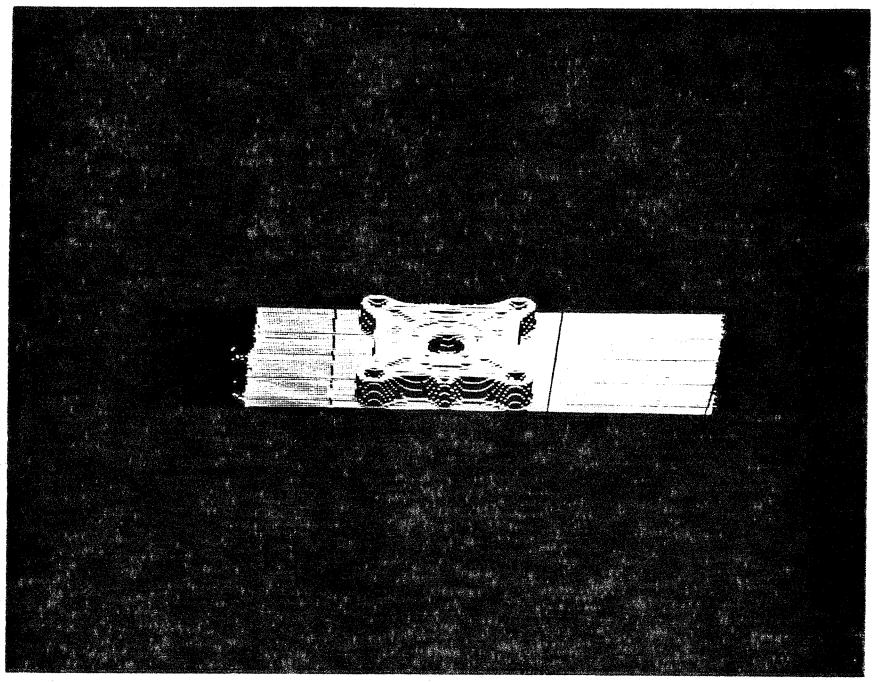
cylinder_1



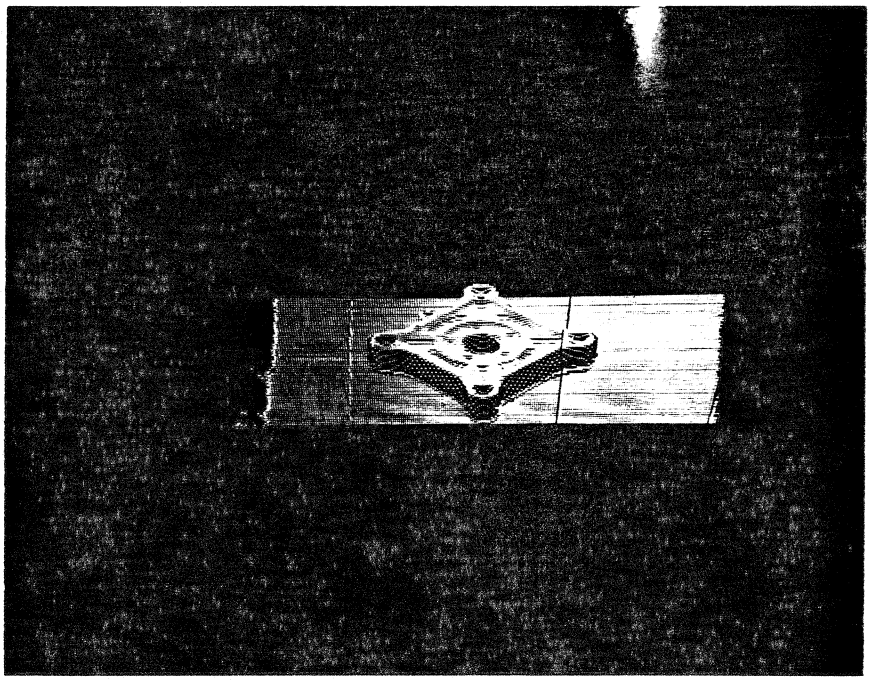
garg_front



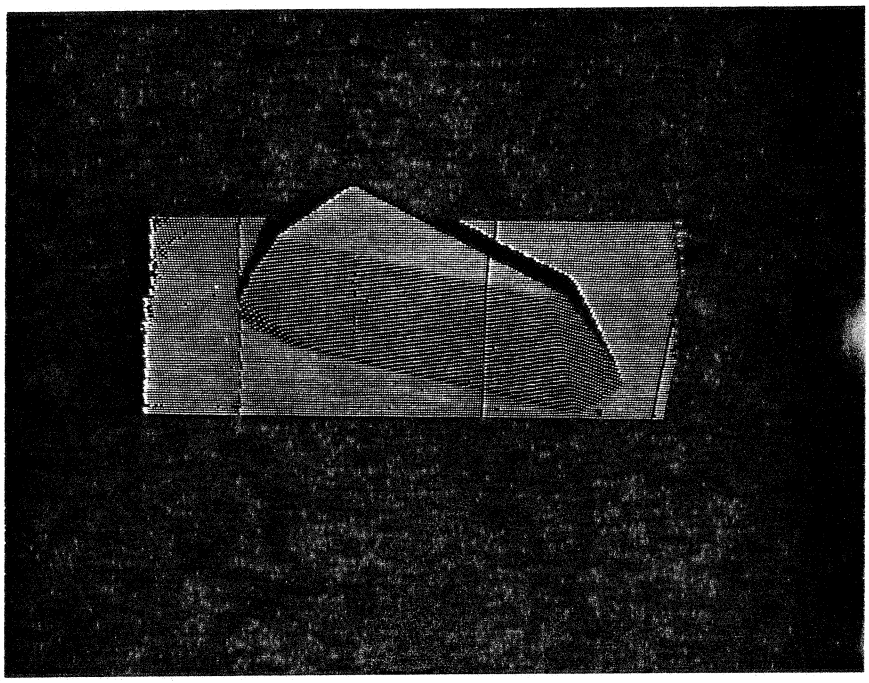
part_1



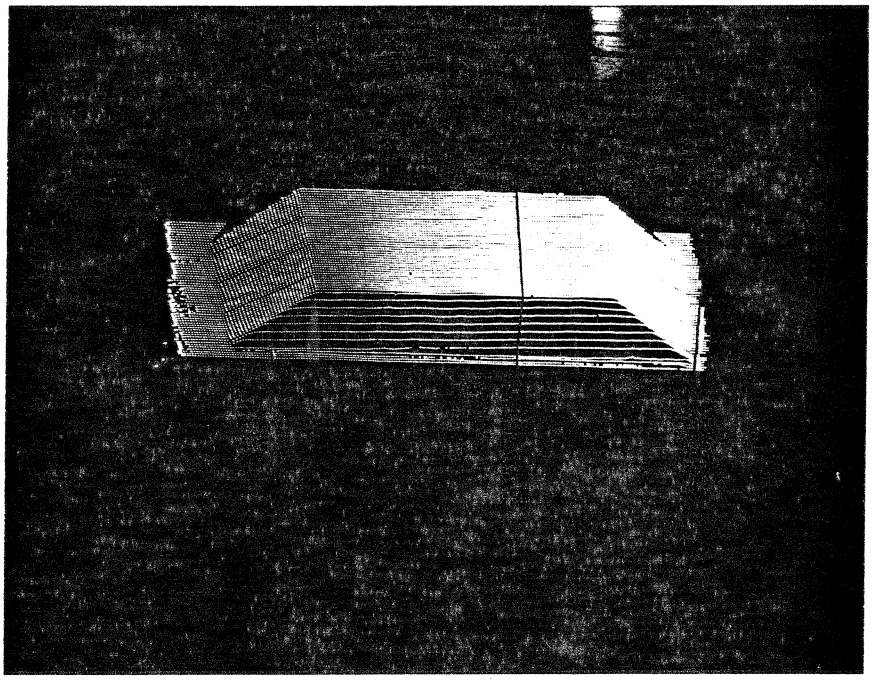
part_2



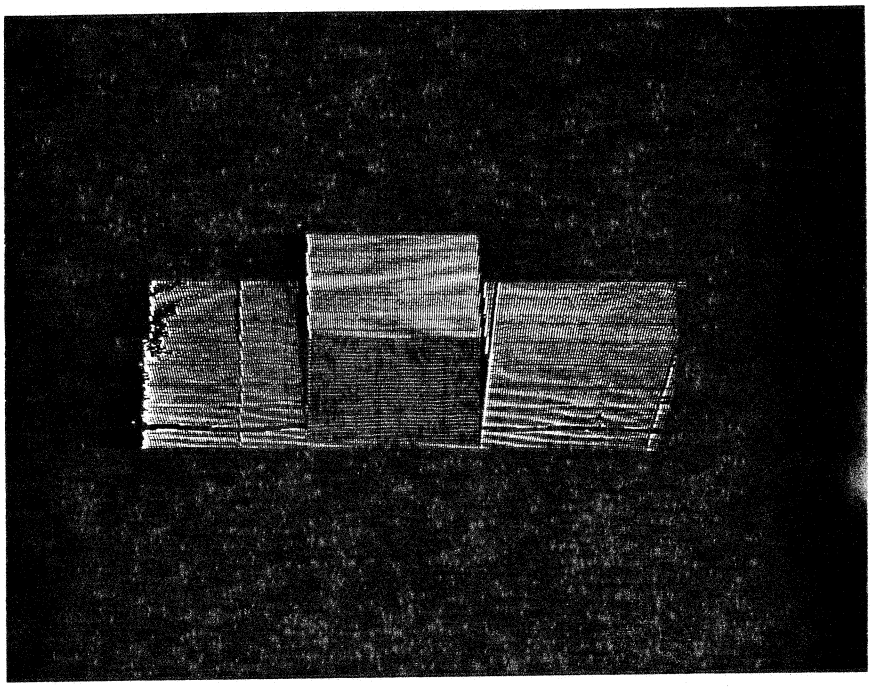
part_3



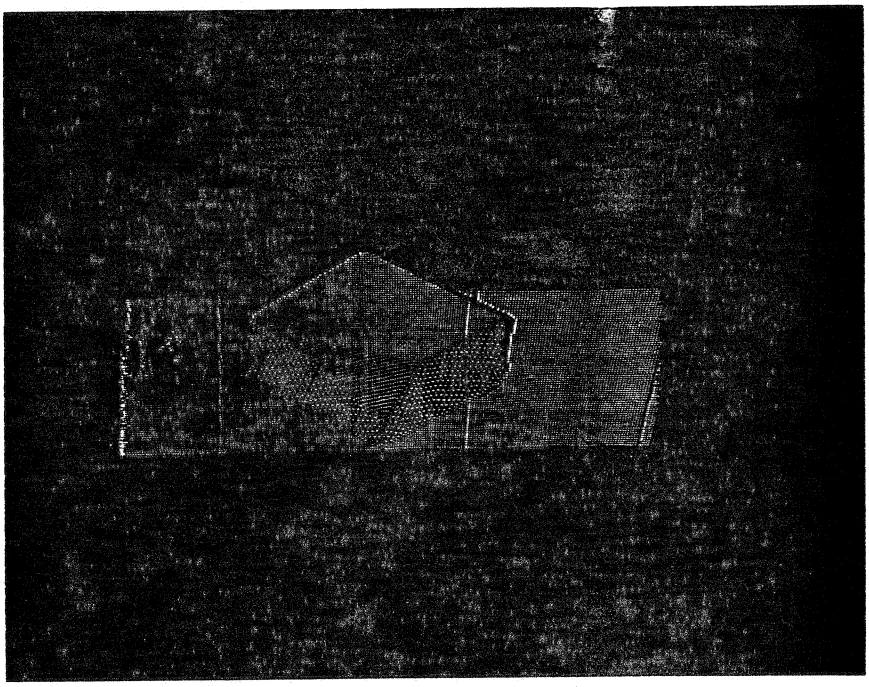
poly_1



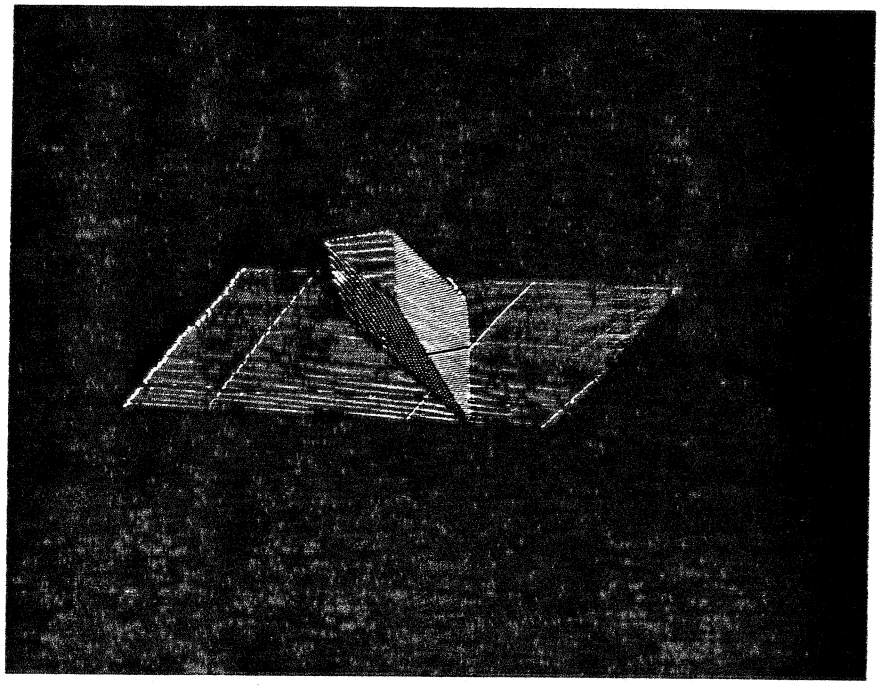
poly_2



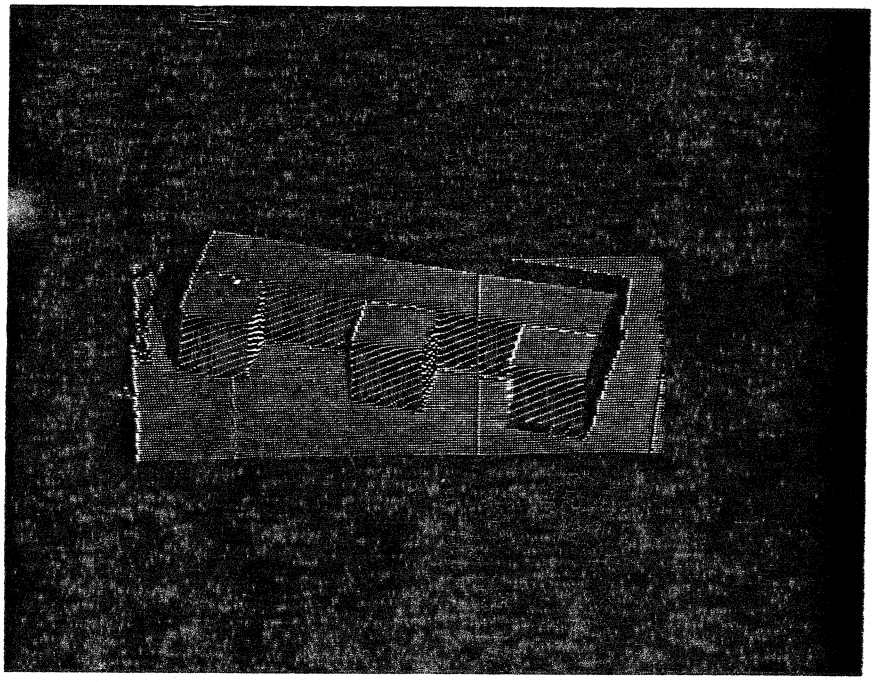
poly_3



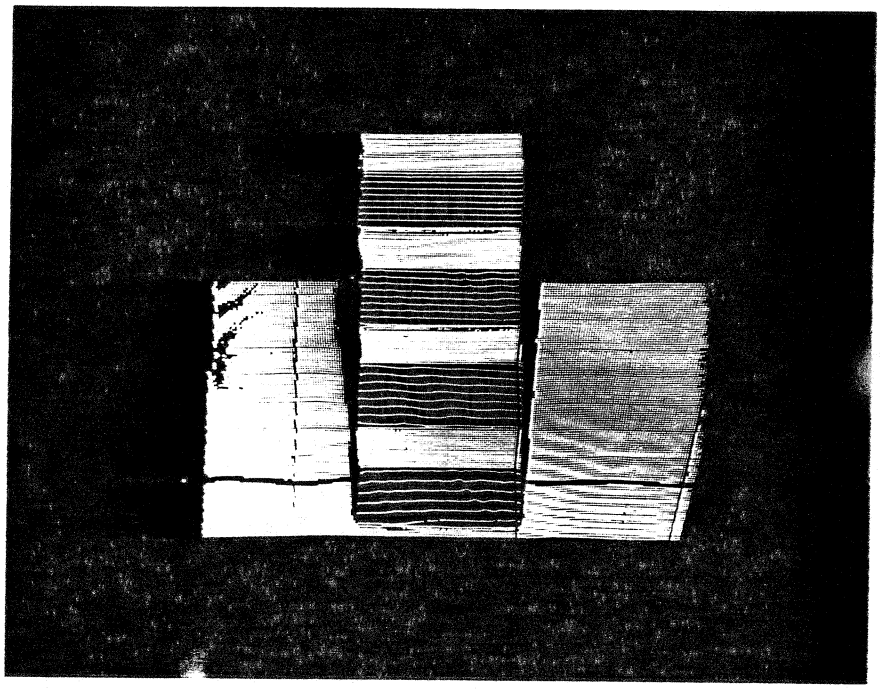
poly_4



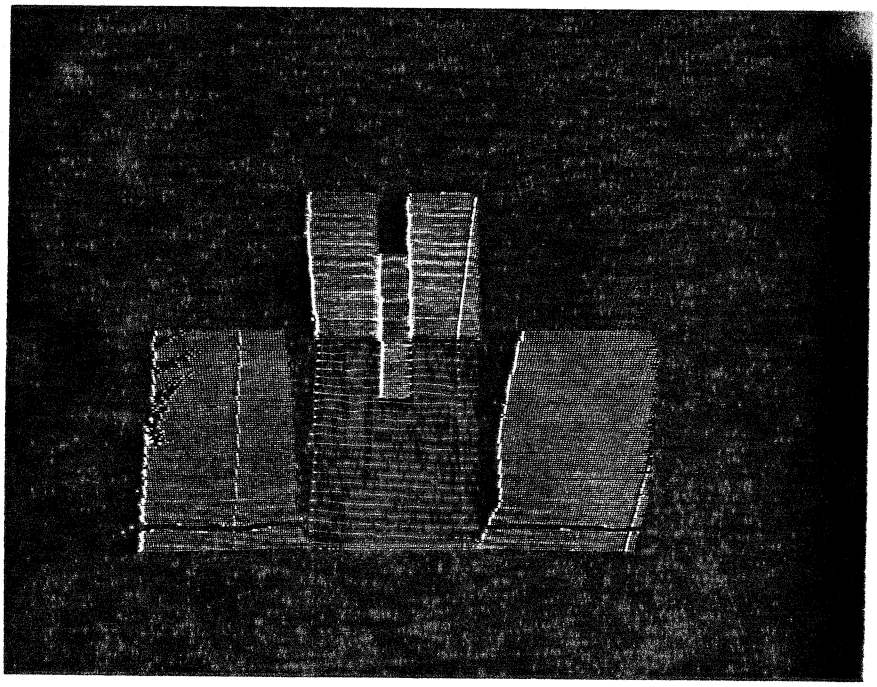
poly_5



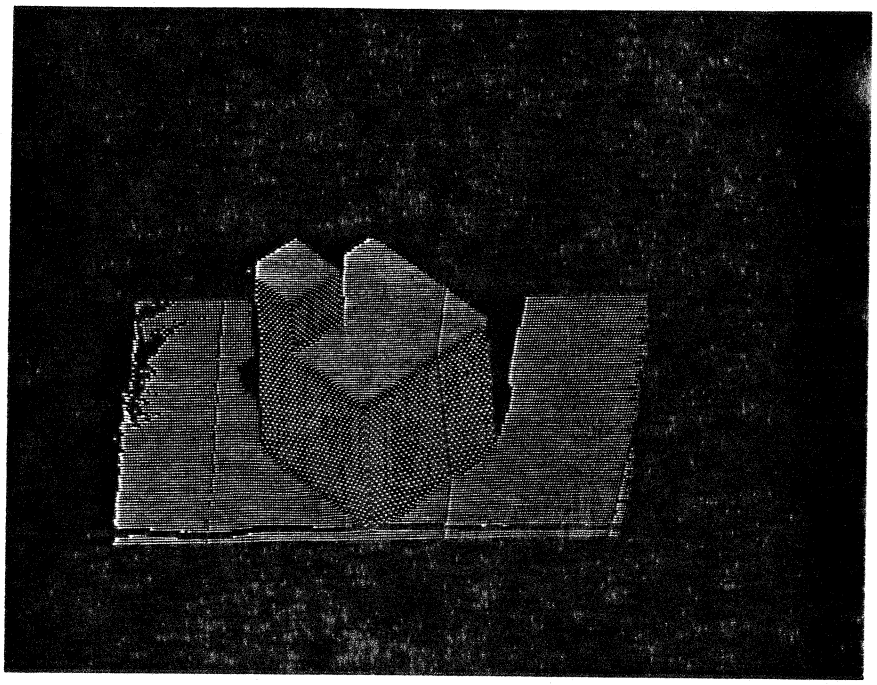
poly_6



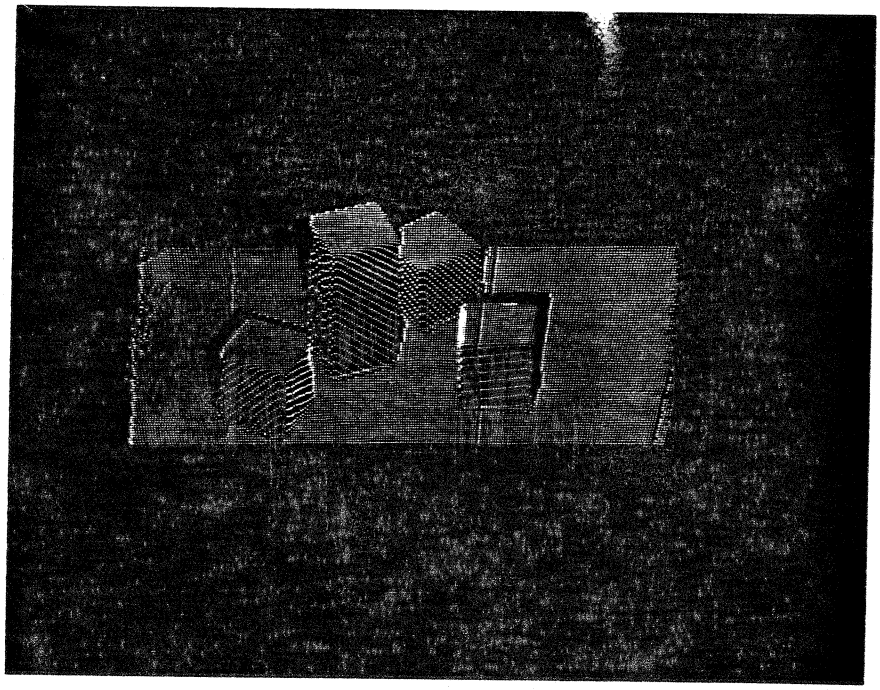
poly_7



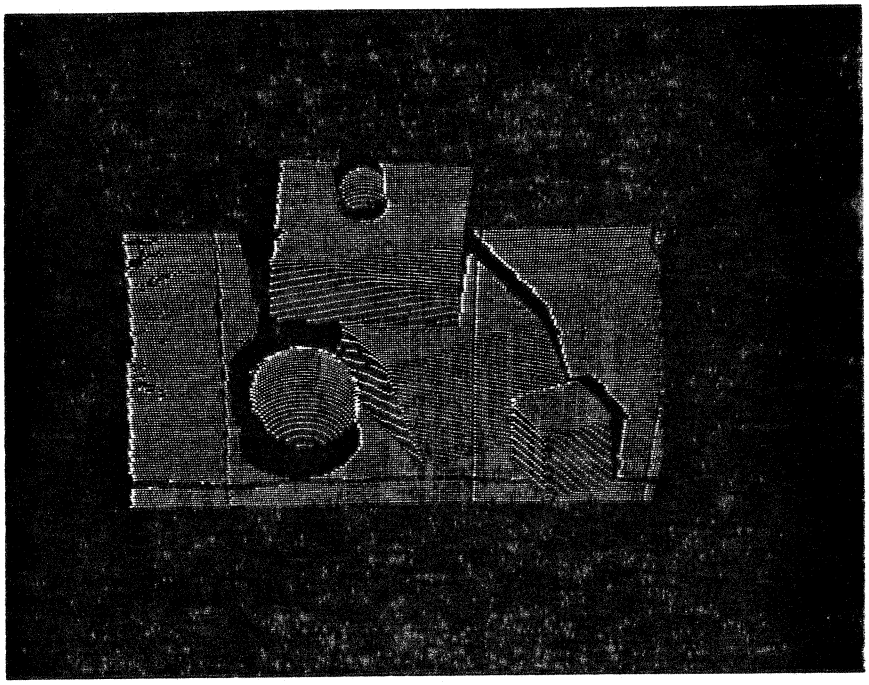
poly_8



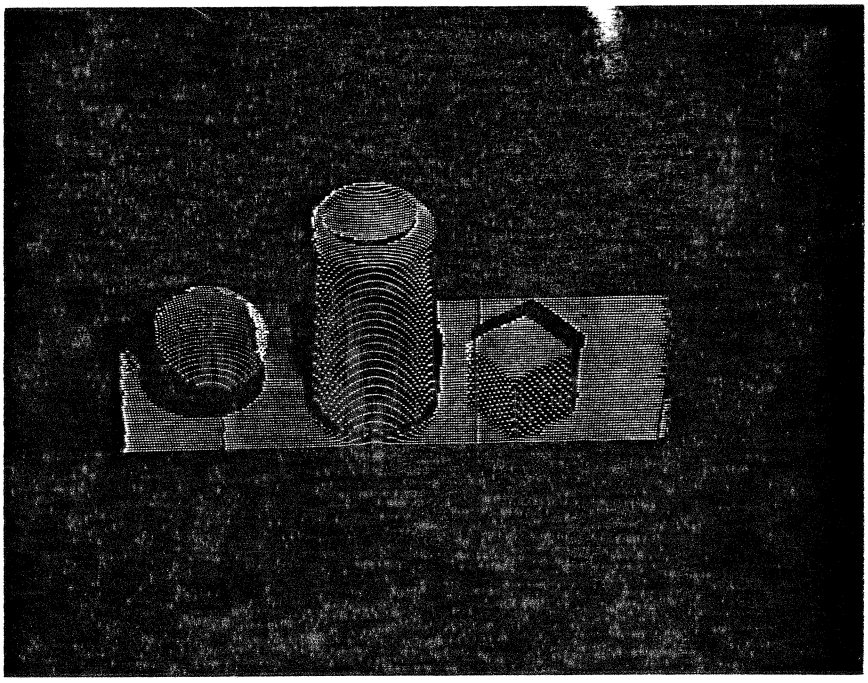
poly_9



scene_1

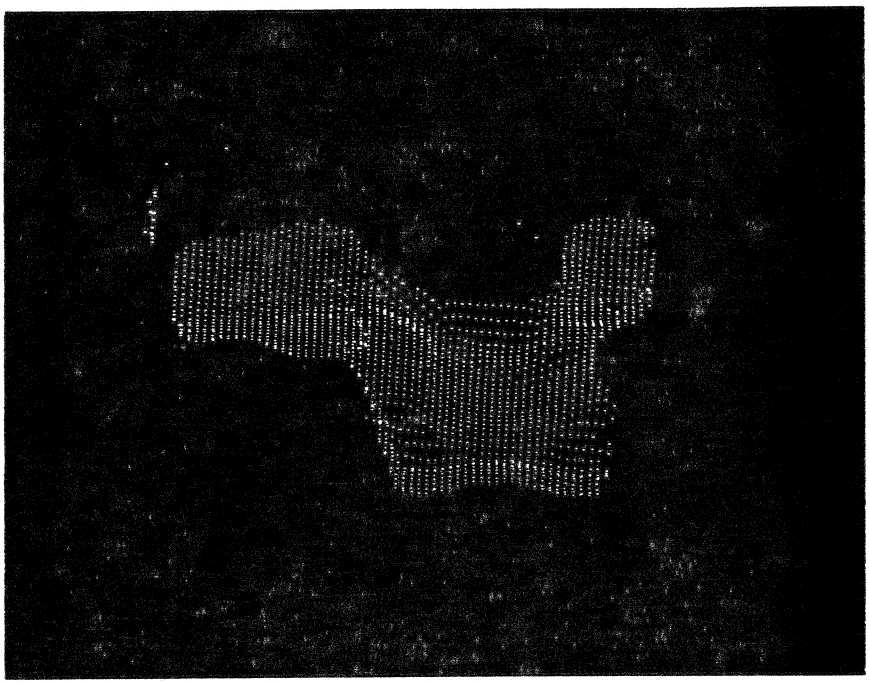


scene_2

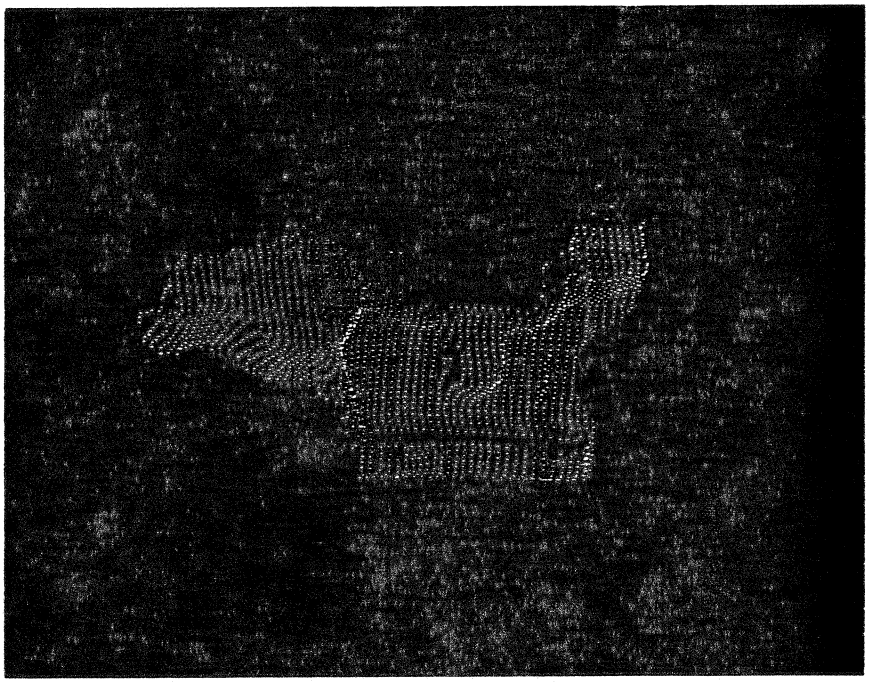


scene_3

## IV. Photographs of Objects Scanned at INRIA

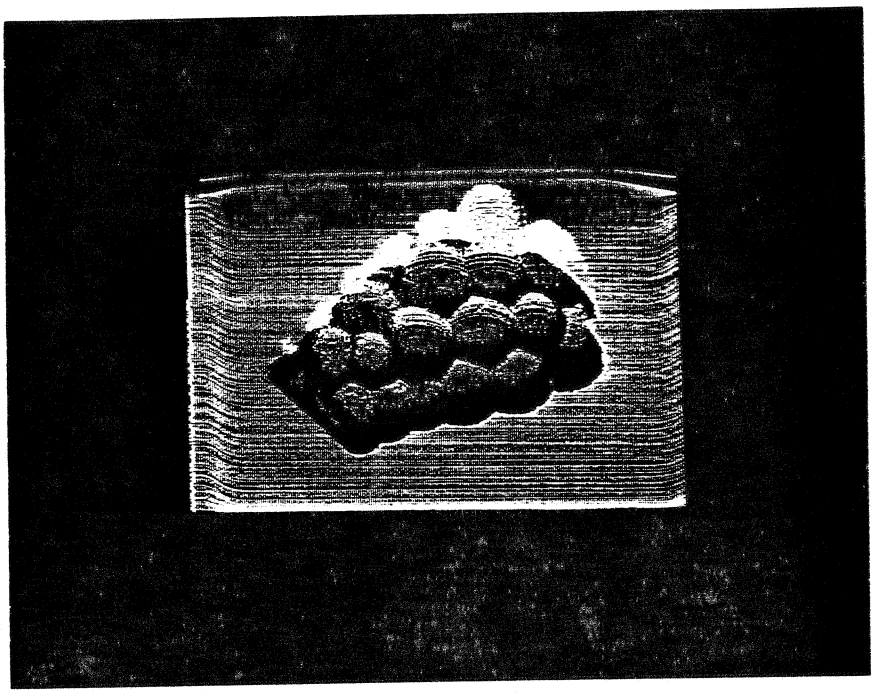


renault_1

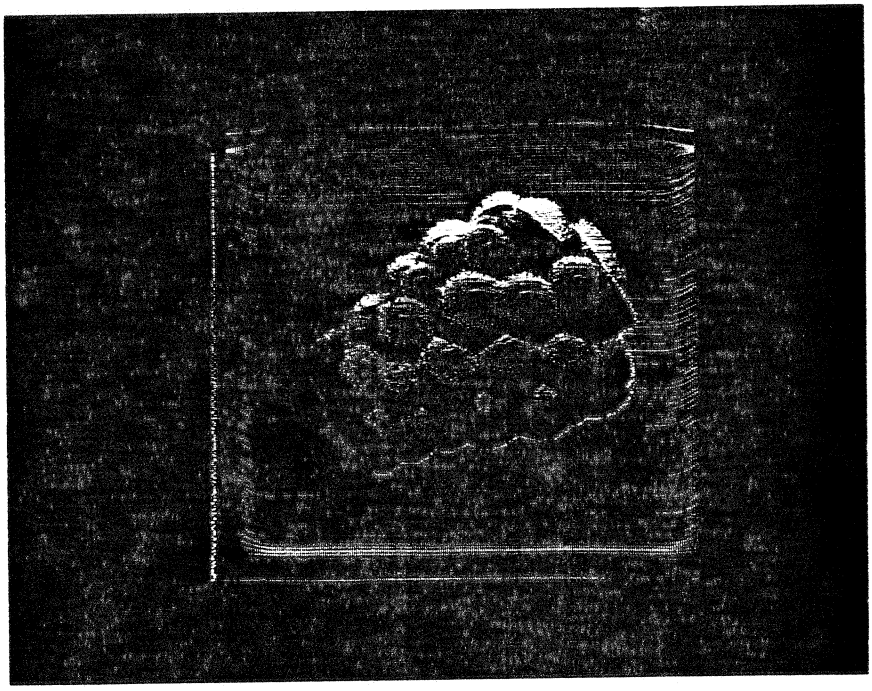


renault_2

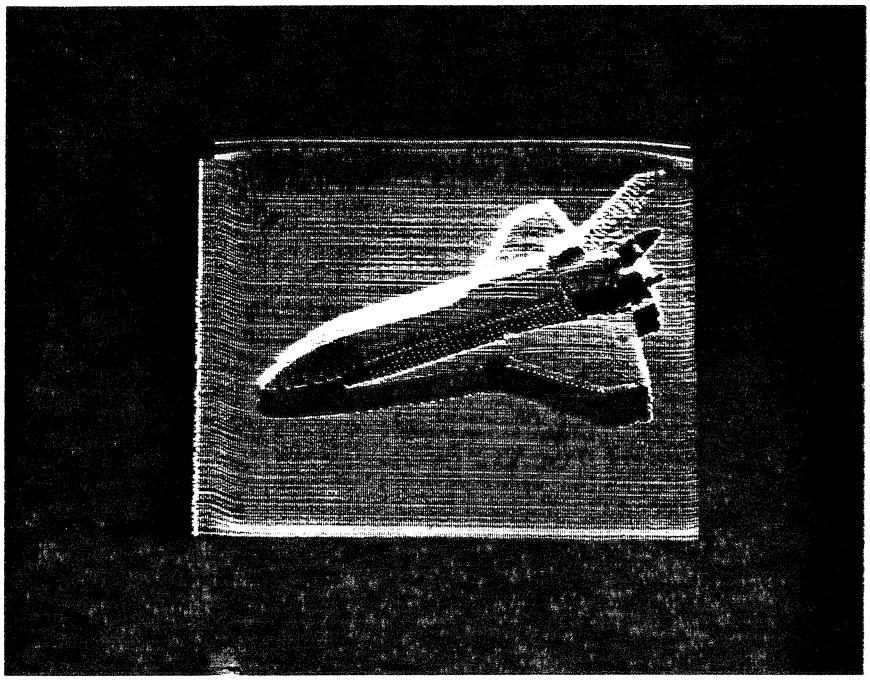
## V. Photographs of Objects Scanned at SRI



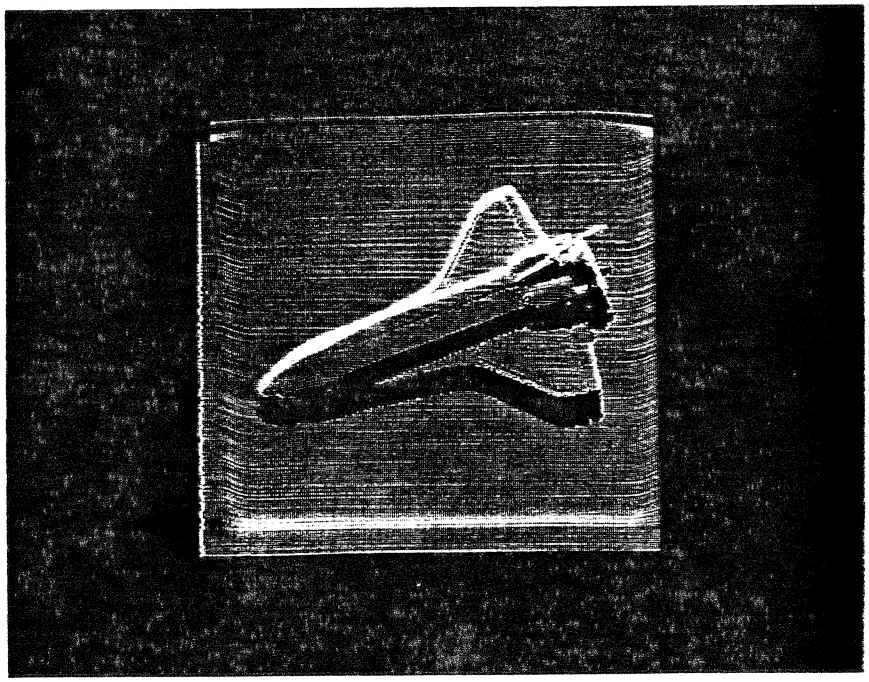
sri_grapes1



sri_grapes2

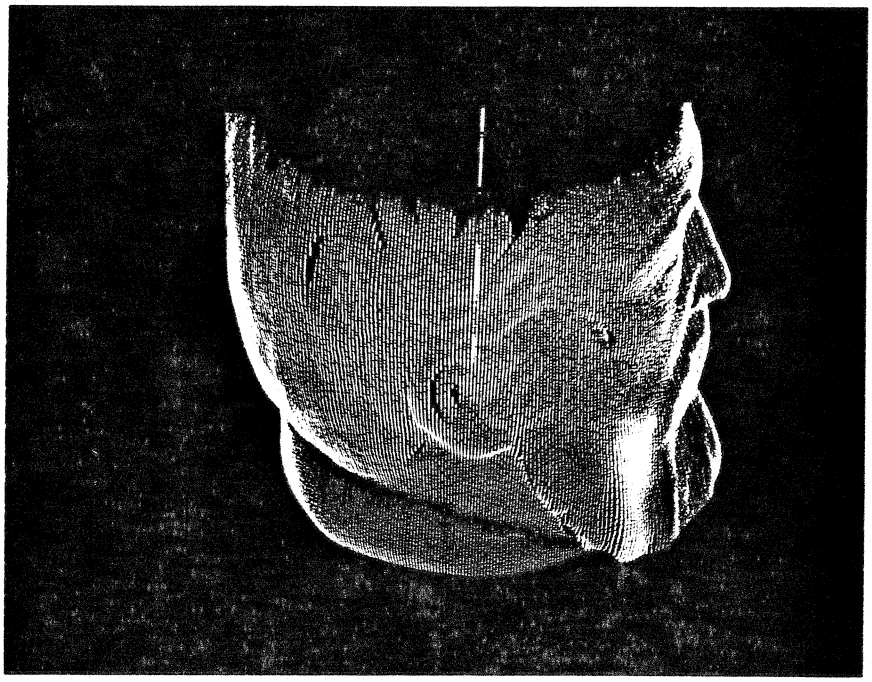


sri_shuttle1



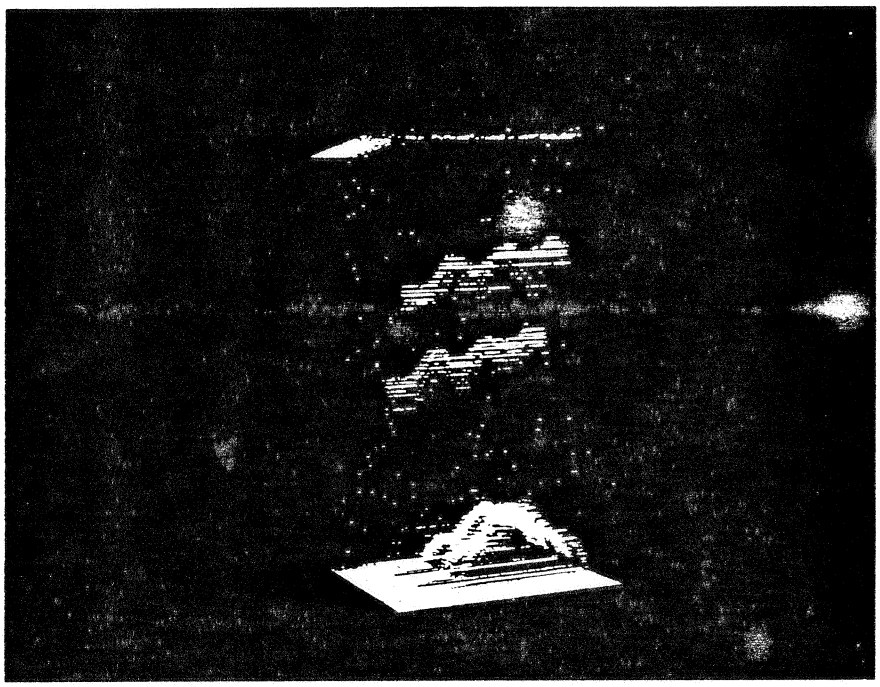
sri_shuttle2

## VI. Photograph of Object Scanned at ENST

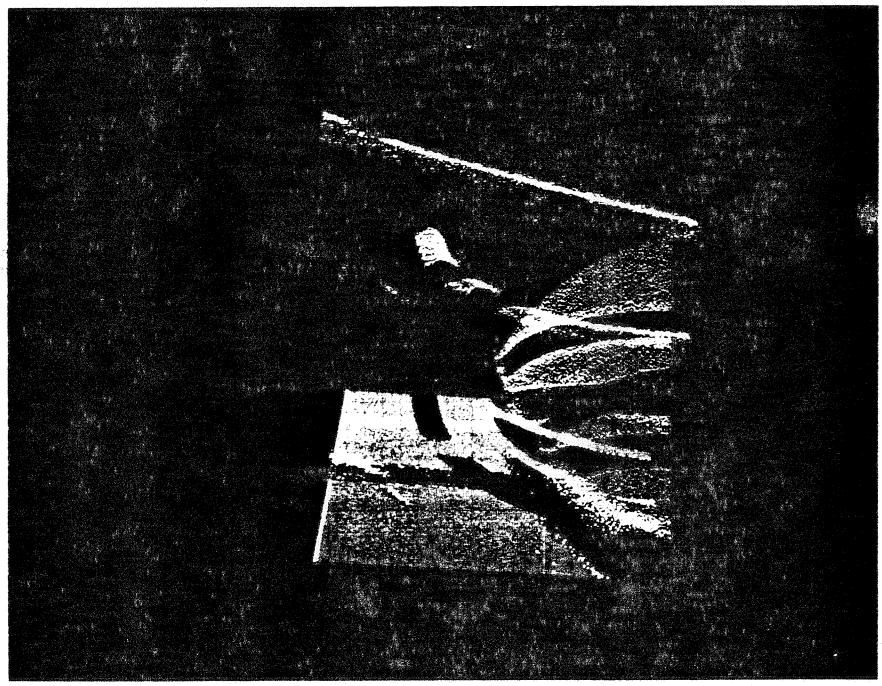


v_hugo

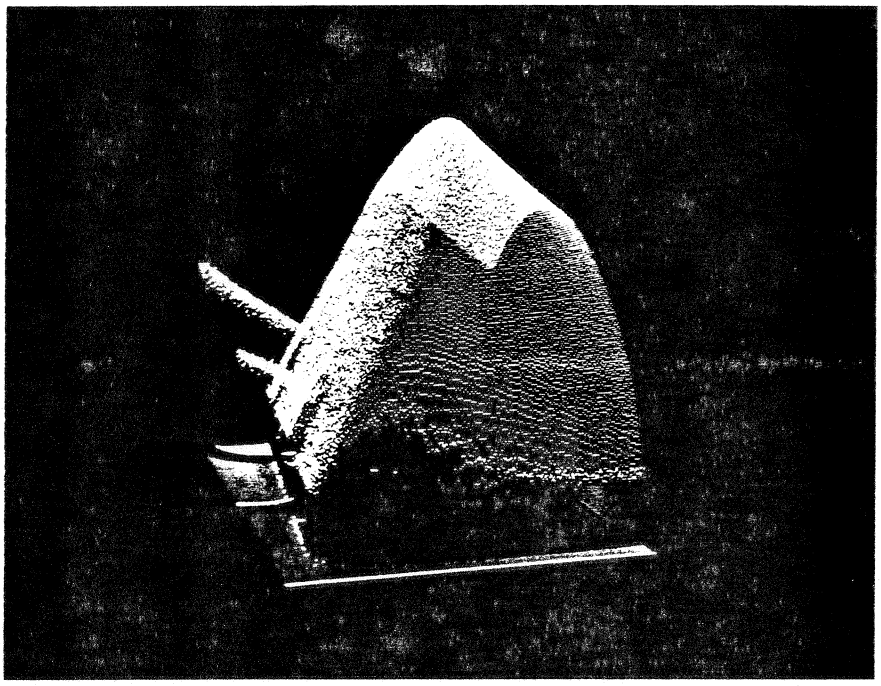
## VII. Photographs of Objects Scanned at NCSU



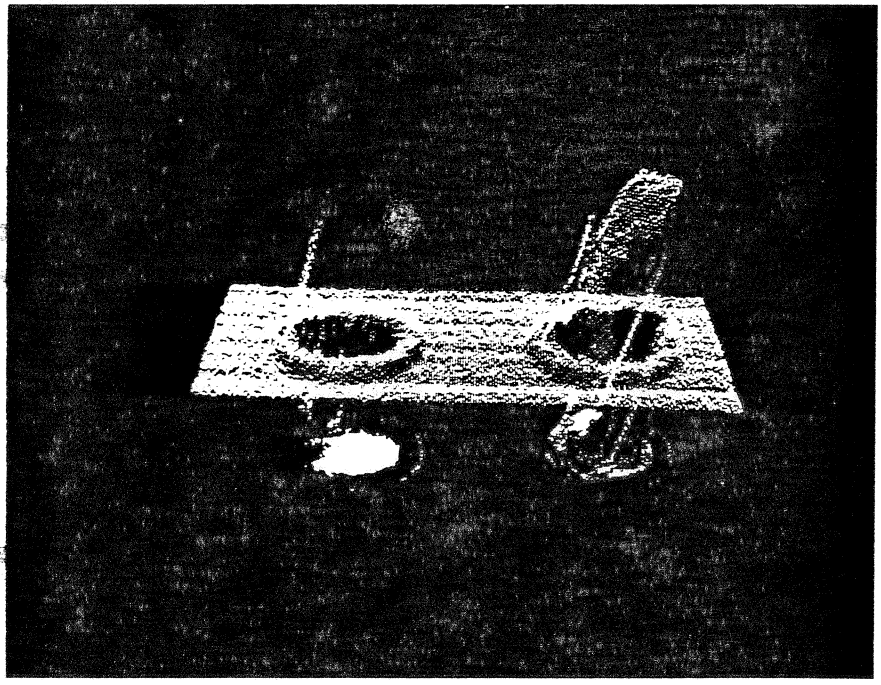
refrig.128x128



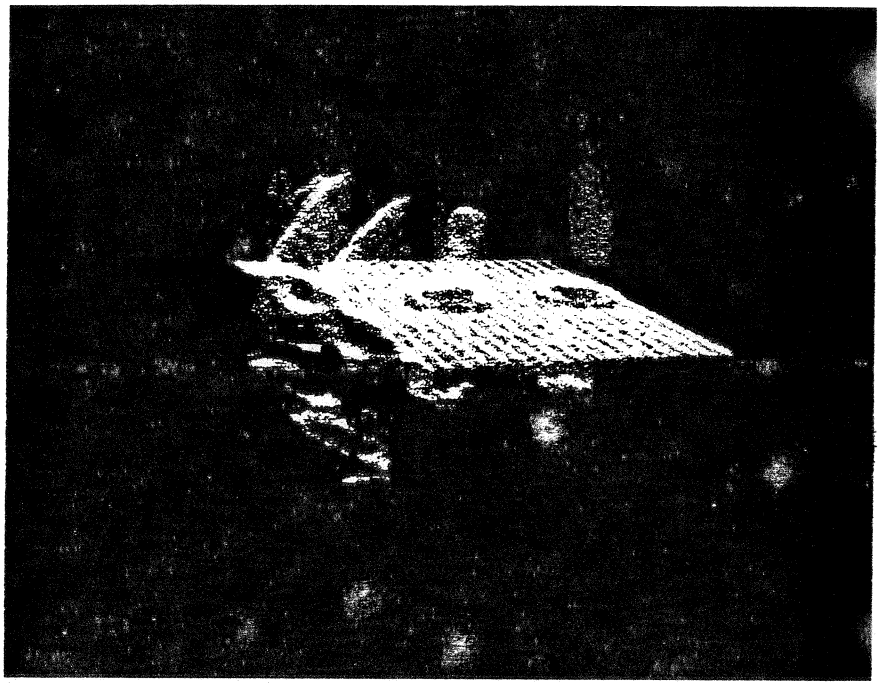
minihi.202x166



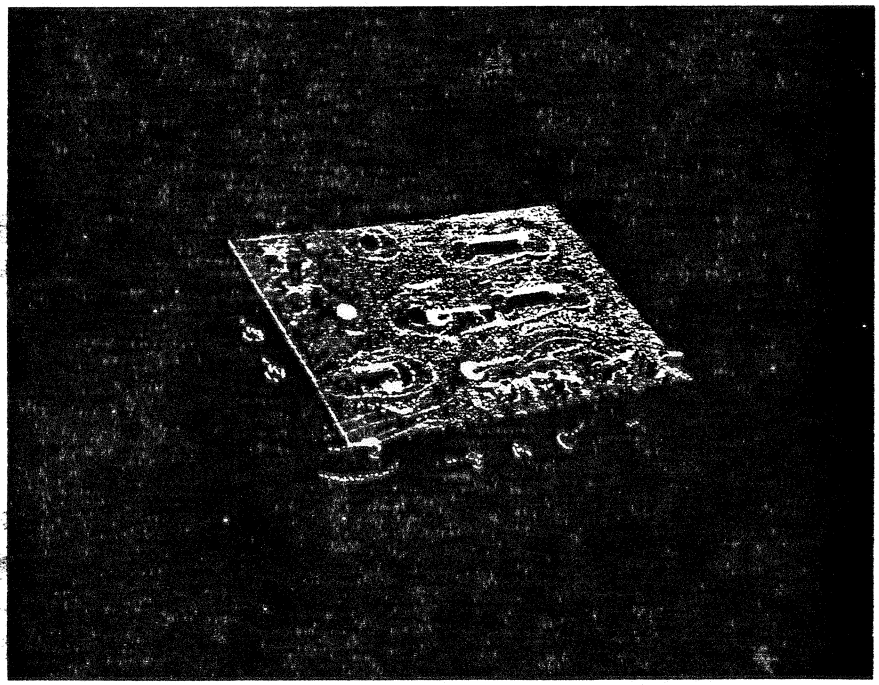
minihi1.250x186



ledwire4.200x100



ledwire7.250x250



pcboard.350x250