

# THE U.S. ARMY'S ROOFTOP ANALYZER (RTA)

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**T**he U.S. Army Engineering & Housing Support Center (USAEHSC) is using its rooftop analyzer (RTA) to reduce the cost of implementing the ROOFER program by developing low cost roof plans that are used during the visual inspection of the roof area.

In March 1986, USAEHSC received a special grant from the U.S. Department of Defense to purchase an aerial infrared (IR) scanning system and to upgrade its image processor to meet the specific needs of the ROOFER program. The primary purpose for upgrading the image processor was to develop a computerized system that would assist the image analyst in evaluating and plotting the data that was being obtained from the nighttime aerial (IR) roof moisture scans. The secondary reason was to use the analyzer to assist in developing scalable roof plans from aerial photographs.

Because of the ease and economics associated with developing roof plans from aerial photos, the roles of the system have been reversed and the making of roof plans has become paramount. The availability of roof plans at most installations is very limited. Therefore, most plans used in the ROOFER program were being developed by the inspector prior to the inspection of the roof, resulting in a very time consuming and costly process. By using the RTA, the operator can rapidly develop a scaled outline of the roof area, plot and label all recognizable rooftop features, and plot any damaged areas that may be visible on the photograph. The computer does the calculations, i.e., determination of roof area, percent of roof area damaged, determination of scale, etc. The roof plan is then printed on the ROOFER inspection worksheet.

## KEYWORDS

Aerial infrared (IR) roof moisture scans, ROOFER inspection worksheets, ROOFER program, rooftop analyzer (RTA), rooftop features, scalable roof plans, videocassette recorder (VCR), vidicon camera.

## THE ROOFER PROGRAM

ROOFER is a U.S. Department of Defense developed computerized roof management program that uses standardized procedures to inspect and evaluate the flashing, membrane and insulation components of built-up roofs. The location of each roof defect is plotted on the roof inspection worksheet. Once the defects for each roof have been identified and the data entered into the computer, the ROOFER program analyzes the data and determines if it is more cost-effective to repair the defects or to replace the entire roof. (A detailed description of the ROOFER program is contained in References 1 and 2, and in "The U.S. Army's Implementation of the ROOFER Program.")

## RTA REQUIREMENTS

To meet the needs of the ROOFER program, it was determined that the RTA should provide the following capabilities:

- Produce scalable roof plans from aerial photographs, videotapes and/or graphic plots.
- Annotate text, rooftop features, damaged areas, scale, north orientation, etc.
- Maintain a graphic data base of standard roof plans.
- Perform area and linear calculations based on a standard engineering graphic scale.
- Edit graphic features.
- Print roof outline and rooftop features on the ROOFER inspection worksheet.

Based on the above requirements, the processor was returned to the original developer,<sup>4</sup> who made extensive modifications and additions to both the hardware and software components of the system. The performance of the upgraded system has exceeded expectations.

## COMPONENTS OF THE RTA

The rooftop analyzer is composed of the following components (Photo 1):

- A vidicon camera.
- A videocassette recorder (VCR).
- Portable computer with monitor.
- A separate high resolution black and white monitor.
- A separate central processing unit (CPU).
- A printer/plotter.

## OPERATION OF THE ANALYZER

The operation of the RTA requires the blending of the skills of a talented operator with the capabilities of the system's hardware and software components. The operator controls the development of the roof plan by analyzing the image received from one of the input devices. Once the data is entered in the computer, the computer does all the calculations.

Input into the analyzer can be from either a videotape using the VCR or from an aerial photo (Photo 2), sketch, plot, etc., by using the vidicon camera. The image is displayed on the screen of the high resolution monitor (Photo 3). The instructions that the operator can use to develop the roof outline and its features are displayed on the computer monitor (Photo 4).

Using the image that is shown on the high resolution monitor, the operator outlines the roof area and plots all the identifiable rooftop features. To establish a scale, the oper-

ator identifies three control coordinates on the roof and establishes a distance value between each point. If a subsequent measurement reveals the distances to be different, the new distances can be entered into the computer to adjust the scale of the plan.

Through the use of a screen cursor, the operator can readily trace the outline of the roof area. Rooftop features are plotted on the roof plan using standard engineering symbols or by tracing and labeling the nonstandard features that may occur, such as penthouses, equipment areas, solar collectors, etc.

If areas of ponded water or patches are identifiable on the photo, the operator can plot the affected area on the roof plan and the computer will determine the square feet and percentage of roof area affected.

Another unique feature of the RTA is that the operator has the capability to normalize the image derived from a slightly oblique photo by using the edit mode of the program.

When the operator has completed the roof plan, it is transmitted to the CPU, and eventually to the printer/plotter, where the roof plan is printed on the ROOFER inspection worksheet (Photo 5).

Unless the operator provides different instructions, the CPU automatically plots the roof plan on the inspection worksheet using established parameters (Figure 1). The processor will rotate the roof plan until the long axis of the plan is parallel to the long axis of the roof plan area on the worksheet. It also will enlarge the roof plan until it fills the roof plan area, based upon a standard engineering scale. As the plan is rotated, the north orientation is also corrected. Faint background grid reference points are imprinted on the plan, so the inspector can more easily plot any defects that are noted during the visual inspection.

#### USE OF THE RTA TO ANALYZE AERIAL INFRARED (IR) ROOF MOISTURE SCANS

The RTA is also a valuable tool for analyzing the data developed during the aerial infrared (IR) roof moisture scans. Using the videotape that was made during the scan, the operator develops an outline of the roof and plots all areas suspected of containing wet roof insulation. Once the data is entered into the computer, the computer determines the roof area, calculates the area and percent of wet roof insulation, and plots the data on the roof plan.

#### OTHER USES

As the analyzer is used and demonstrated, other applications become apparent, i.e., it can be used to develop scaled plans of parking lots, building elevations, including historical buildings, and any other feature that is contained on a videotape, photograph, sketch, plot, etc. Basically, the use and application of the system is limited only by the imagination, knowledge and talents of the user.

#### SUMMARY

It is estimated that by using the rooftop analyzer, the U.S. Army will save about \$60 to \$80 for each roof plan that is used in the ROOFER program. When considering that each installation has 350 to 500 built-up roofs, a tremendous savings will be realized at each installation. The savings will continue to mount as more uses are identified.

#### REFERENCES

- <sup>1</sup> Shahin, M.Y., Bailey, D.M. and Brotherson, D.E., "Membrane and Flashing Indexes for Built-up Roofs, Volume II: Inspection and Distress Manual," Technical Report M-87/13, U.S. Army Construction Engineering Research Laboratory (USACERL), Champaign, Ill.
- <sup>2</sup> Bailey, D.M., Brotherson, D.W. and Tobiasson, W., "ROOFER: A Management Tool for Maintaining Built-up Roofs," NIST/NRCA Paper, 9th Conference on Roofing Technology, May 1989.
- <sup>3</sup> Tobiasson, W. and Korhonen, C., "Roof Moisture Surveys: Yesterday, Today and Tomorrow," U.S. Army Cold Regions Research and Engineering Laboratory (USACRREL), Hanover, N.H.
- <sup>4</sup> Reference Manual for using the Rooftop Analyzer 1.0, dated June 28, 1989, Eutecnic, Acton, Mass.

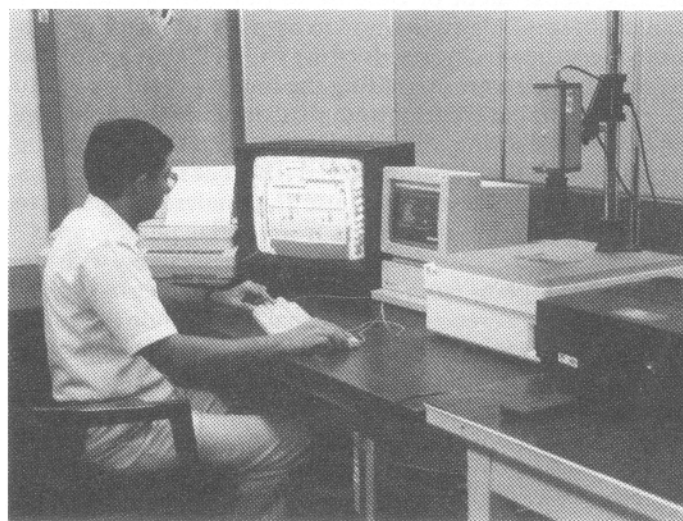
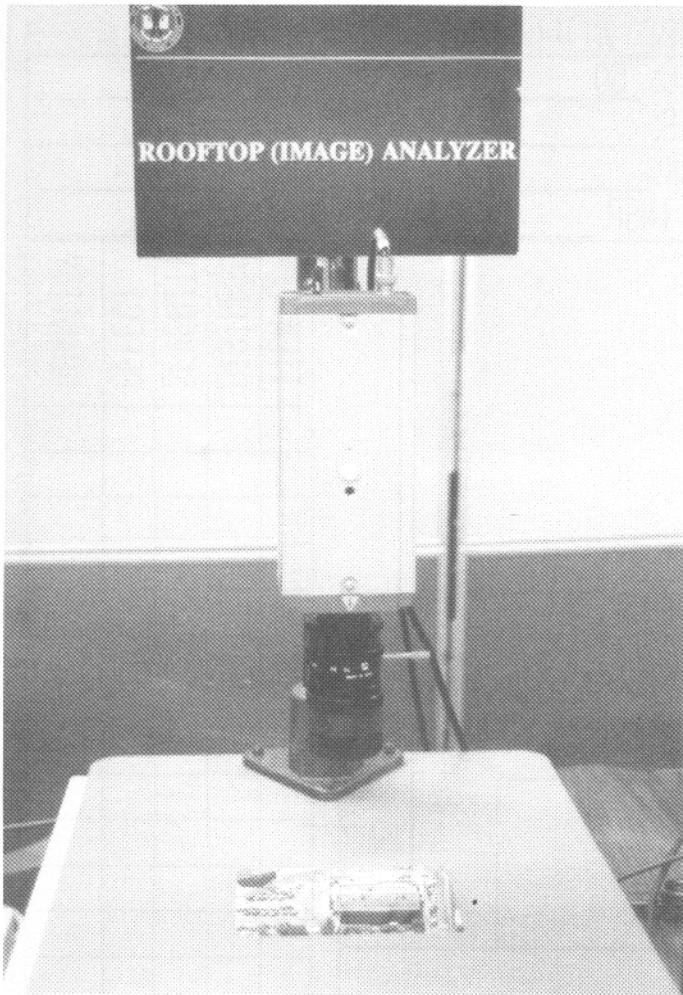
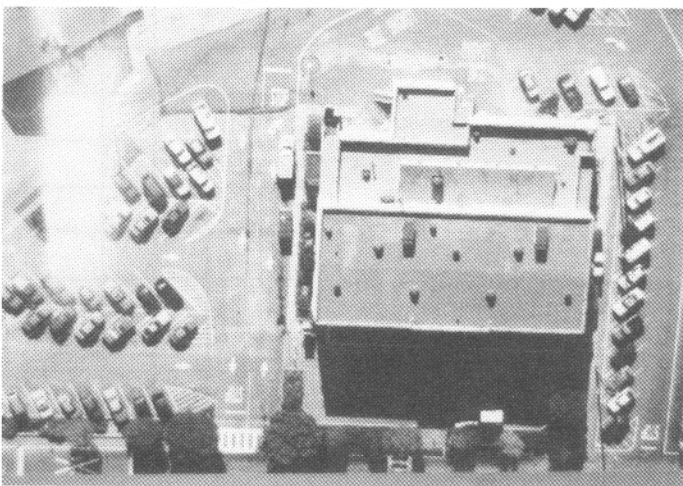


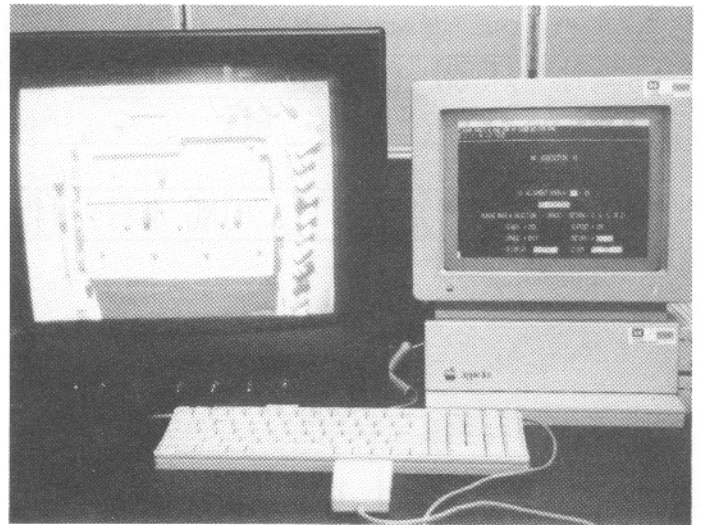
Photo 1 Components of the rooftop analyzer.



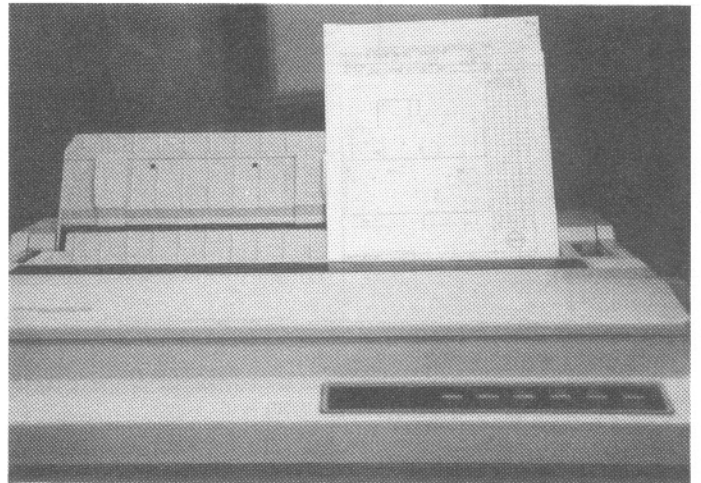
**Photo 2** The vidicon camera is used to transmit the image of the aerial photograph to the computer.



**Photo 3** Image of the aerial photo is displayed on the high resolution monitor.



**Photo 4** A menu showing some of the instructions that the operator can use to develop the roof outline and plot the rooftop features.



**Photo 5** Printer/plotter developing the ROOFER inspection worksheet, along with the roof plan.

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**Figure 1** *Roof Inspection Worksheet.*