PICTURE OF WARMTH

● Thermography is the technique of converting invisible infra-red radiation into visible heat pictures. Originally developed for military applications, the first infra-red images on a fluorescent screen were produced during the Second World War.

From those beginnings, rapid response detectors have developed to the point where they can produce television quality images from equipment very similar to portable video cameras. The ability to produce heat pictures from stationary or moving objects at any distance – without influencing the surface temperature in any way – makes thermography a vital tool in thermal assessment.

The technique has been used in the building industry since the 1960s, with much of the development work taking place in Scandinavia and North America. In Sweden the building code now requires that the standard and quality of insulation in new buildings is checked using thermography. In this country the technique has not yet attained such status. Nonetheless it is increasingly recognised and used, not only for heat loss surveys, but also for the investigation and diagnosis of building envelope deficiencies and failures. Thermography has the advantage of being able to scan large areas quickly and remotely without opening or disturbing the construction.

Building surveys

Perhaps the most commonly appreciated use of thermography in buildings is for heat loss surveys. These surveys are carried out during the heating season (a minimum inside to outside temperature differential of 10 °C is often quoted) and at night. Detailed criteria are given in an International Standard, ISO 6781:1983 *Thermal insulation – qualitative detection of thermal irregularities in building envelopes – infra-red method.*

Surveys of individual or small groups of buildings are usually done from ground level. Field of view, as in normal photography, is governed by the scanner lens and the distance from the building. The size of the building under investigation is therefore not generally a limiting factor. Modern equipment is light enough to be carried by the operator or mounted on a trolley and pushed around the site – consequently large areas of external fabric can be scanned in a comparatively short time.

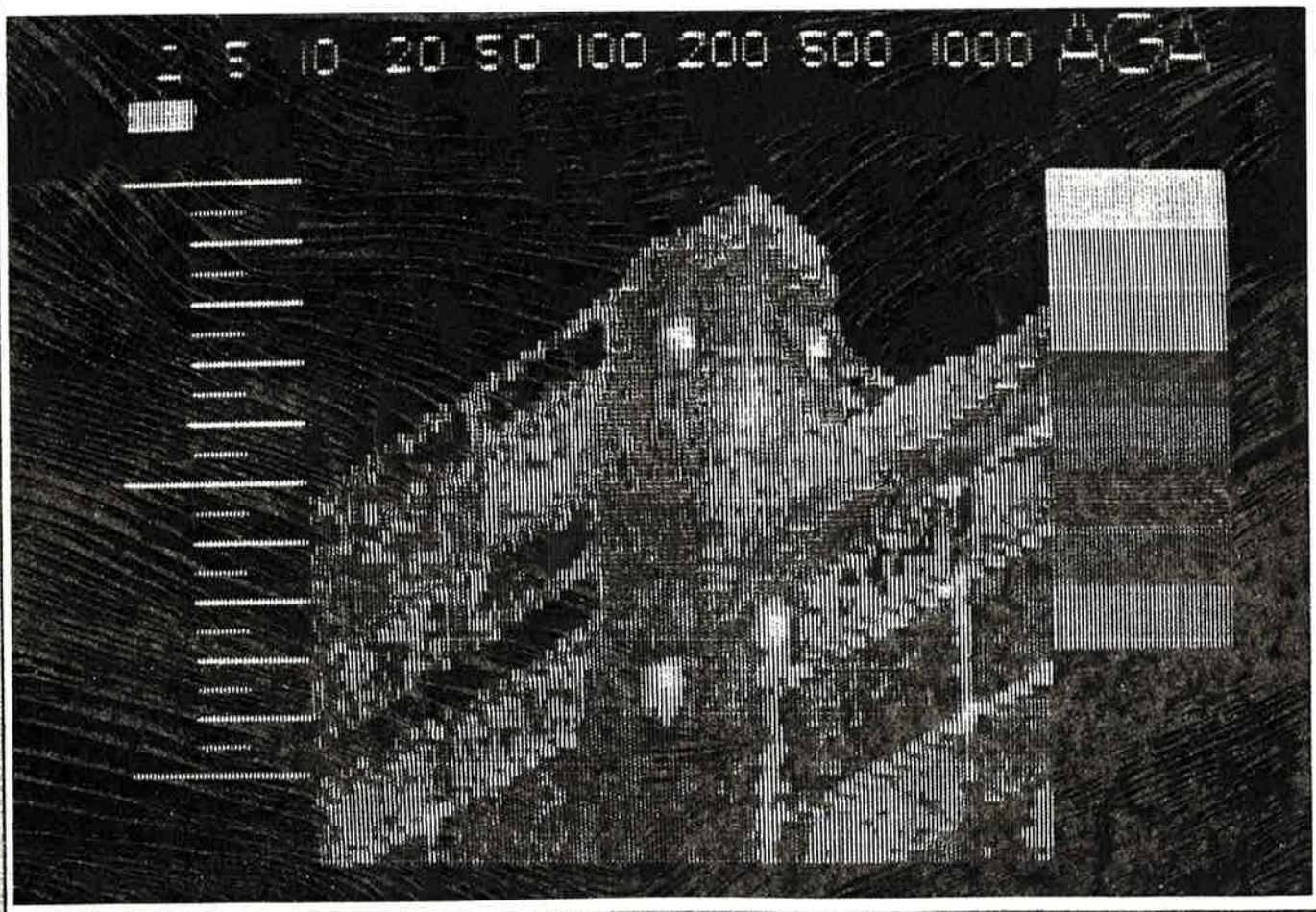
Analytical techniques can be employed to convert the measured levels of radiation to surface temperatures and calculations of total heat loss and effective U-values made. The thermograms provide "snapshots" of the pattern and extent of heat loss which can be an invaluable aid in an energy conservation programme.

Infra-red heat loss surveys have been carried out simply to educate building users and promote good housekeeping practices, such as closing doors, securing windows and turning down thermostats, as well as demonstrating the effects of good insulation.

Aerial heat loss surveys of larger sites are often carried out when a general overview is required. Line-scan systems mounted in fixed wing aircraft can be used to overfly entire cities and towns, but the result is restricted to a rooftop view.

In view of this, Wimpey Laboratories has developed an aerial thermographic survey system using a helium-filled balloon. The Skyscan system uses an 1100 ft^3 capacity helium-filled balloon which is tethered to the ground vehicle and carries the infra-red scanner on a purpose-designed platform beneath the balloon. This platform is remote-controlled from the ground vehicle, enabling the scanner to be directed at particular buildings or areas of special interest.

Infra-red images are displayed on monitors in the ground vehicle where they can be immediately assessed by the engineer and building owner. The location of any hotspots can be followed up by a more detailed appraisal from the ground. The altitude of the



Thermography provides pictures that can pinpoint poor insulation and condensation problems in buildings.

Infra-red thermography has become widely recognised as a valuable tool for assessing the thermal performance of buildings. During the past few years systems have advanced rapidly in response to the industry's needs. *Philip Johnson* takes a close look at the technique and its uses.

balloon is varied by electric winch up to a maximum of 60 m – so the majority of buildings on a given site can be covered.

This method of aerial surveying has several advantages. The balloon is silent in operation and can remain airborne for long periods with no environmental disturbance. This is particularly important because most surveys are carried out at night over built-up or sensitive areas. Unlike the use of helicopters, there is no restriction on minimum night flying heights giving greater accuracy and definition. Furthermore the oblique scanning angle gives views of both roofs and wall elevations.

Heat loss surveys are not restricted to existing buildings, but are also carried out on new and refurbished buildings to check the quality of the insulation. Areas of missing cavity wall insulation, for instance, are readily detected as is missing or poorly installed insulation behind cladding panels on roof sheets.

However, it is not yet common practice to survey buildings thermographically on completion. The exception is the specialised case of cold stores, where breakdowns in the vapour seals and insulation can lead to progressive ice build-up and the danger of structural collapse.

Modern infra-red equipment is sensitive to temperature changes of just a few tenths of a degree. Thermography can therefore be used to investigate building envelope deficiencies where they result in, or are caused by, extremely small changes in surface temperature.

Condensation problem

One example is the all too common problem of condensation. Using thermography it is possible to provide an evaluation of its cause and extent.

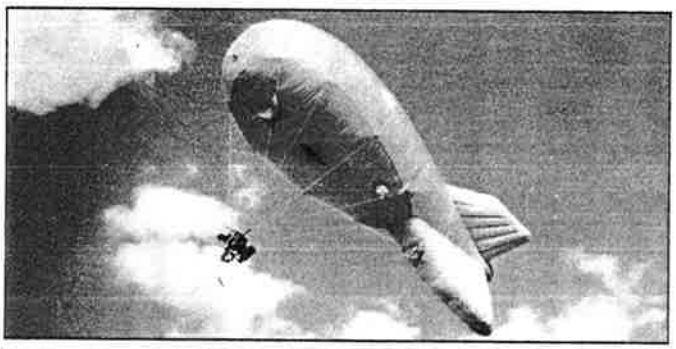
Often associated with older, poorly insulated and heated buildings, the problem does not seem to have significantly diminished with better insulated and more airtight constructions. The unsightly results of surface condensation mean sophisticated equipment is not necessary to locate its extent. However, its cause is another matter. Thermography can be used to show whether condensation is due to a failure of the building envelope, or by excessive internal moisture production and inadequate ventilation. By comparing the surface temperature of the affected section with adjacent areas it is possible to highlight structural cold bridges, missing insulation of the local ingress of outside air.

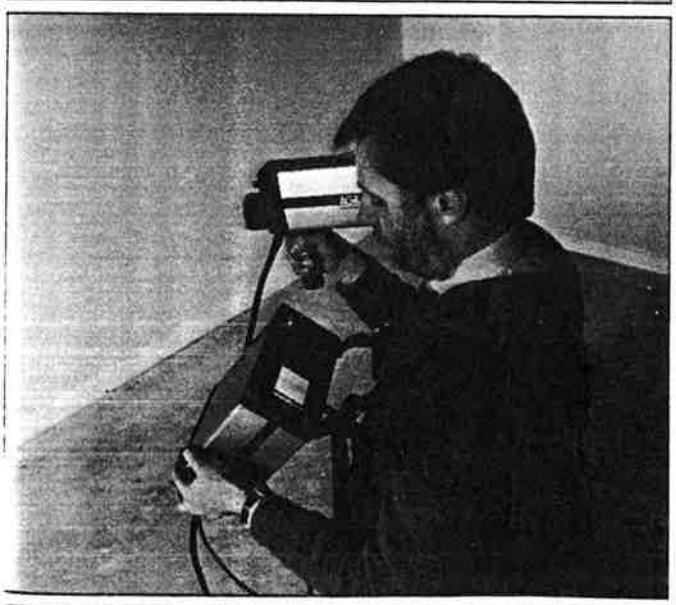
Interstitial condensation is much more difficult to track down as the condensate often appears away from the place of deposition. Interstitial condensation in roofs is a particular problem where the source and extent of moisture can be difficult to ascertain. Moisture dripping from the underside of roofs often appears instead to be the result of a leak in the waterproofing.

Moisture is soaked up by thermal insulation – meaning the resultant heat loss can be detected thermographically. The pattern of moisture deposition can be determined from the pattern of increased heat loss and correlated with joints, openings, structural members and so on, to show more clearly where moisture enters.

In summary, the development of modern thermal imaging systems and of techniques for building evaluation has meant a wider application of thermography for building surveys. The main advantages of thermography are its versatility, its speed and its comparatively low survey cost. It is non-destructive and non-intrusive and combines simplicity with a high degree of detail. With the emphasis on energy conservation, building refurbishment and upgrading of existing stock, thermography in the building industry in this country is set to increase in forthcoming years ■

Philip Johnson is principal scientist in the environment department at Wimpey Laboratories.





Aerial pictures of buildings from many angles are possible using Wimpey's balloon survey system.

DRAWING BY DEGREES

The principle of operation is straightforward. The amount of infra-red radiation emitted from a building surface increases at higher temperatures.

This creates a greater electrical output from the detectors in the infra-red scanning system giving a brighter image on the monitor screen.

The resultant heat picture or thermogram thus shows higher temperatures as lighter areas and lower temperatures as darker areas.

The thermograms can also be colour coded so that discrete temperature steps are depicted as different colour bands. This pictorial representation of surface temperatures and the resemblance of the infra-red image to the actual visual appearance of the building means that thermograms are easily understood.

Images can be recorded on either video or photographed for a permanent record and can therefore be used as documentary evidence, precisely locating and recording areas of failure or special interest.

Caution is necessary in the interpretation of building thermal images. At a given point in time the surface temperature profile over the building surface, whether internal or external, is the result of a complex interaction of a number of parameters. These include the prevailing and previous day's weather conditions – notably wind temperatures and sun the pattern of heating, the dynamic thermal properties of the component elements and the influence of any interstitial moisture or air movement.

It is precisely because these material properties influence surface temperatures that thermography can be used in their evaluation. However, a thermographic survey can only be successful if carried out under conditions which minimise adverse environmental effects, and interpreted with due regard to the fundamentals of heat transfer.