



Equipment - What, How and Why

What Equipment Are We Using, and What Do We Hope To Find

Para.Science gets a lot of emails every week from people asking about the equipment we use for par-anormal investigation. Some of the enquiries are from other groups or investigators, some are from school and higher education students researching an assignment that may involve the paranormal. Others are from researchers for media programmes and some are from people who are just plain curious.

Many of these enquiries require long involved answers and we find that we frequently repeat the same answers to different people.

In this article we have tried to provide answers to the most frequently asked questions that relate to the equipment we use in this research and investigation. It also discusses the things we are looking for with that equipment and why we are looking.

It is not meant to be exhaustive or overly technical in its content and is meant to be read and understood by all levels of interest regardless of any prior knowledge of the paranormal. It is also not meant to be read as a 'guidebook' to paranormal investigation methods. Each group or individual investigator will develop their own techniques that are suitable for them.

We have chosen to deliberately avoid endorsing any make or particular item of equipment. This is not meant to be an equipment review. Should anyone seek an opinion about any particular item make or model of equipment we would be happy to answer such enquiries separately.

Thermometers

Used simply to measure and record the temperature. Several types are available from the basic liquid in glass types through to hi-spec digital models with milli degree accuracy and computer interfacing.

The main types that we are concerned with are direct reading and indirect reading.

The direct reading type makes use of some form of sensor that is placed in contact with the medium being measured i.e. the air or a surface. There are several types of sensor that can be used including a probe that consists of two dissimilar metals - called a thermocouple. The probe is placed directly into an area where the temperature is to be measured - a room for example. Any change in temperature in the room causes a difference in the conductivity of the thermocouple and this can be read on a digital scale calibrated in degrees Celsius or Fahrenheit. Other types of sensor may use changes in resistance within the probe (a thermistor type) to measure the temperature.

Some models are able to record the maximum and minimum temperatures, other models even record the temperature many times every second and can either be read directly using a connected computer or stored within a solid state memory inside the unit for later downloading to a PC, where the recorded temperature over many hours can be displayed as a graph.

The indirect reading, more commonly called the non-contact type looks similar to a 'Star Wars' laser gun and in fact most models even shoot out a beam of laser light. The laser is simply there to act as a guide to what the thermometer is pointing at by conveniently placing a red laser spot or ring onto the surface being measured.

A special heat sensitive element similar to that used in PIR (Passive Infra Red) motion detectors 'looks' at the place where the gun is pointing and measures the temperature from the amount of reflected Infra Red energy being emitted. All objects emit heat in the form of IR energy which can be 'seen' in this way, although there may be some large variations in the amounts of IR that it emitted in some types of material. This is called the emissivity value and is expressed as a numeric value. Most non-contact thermometers are calibrated for an average emissivity of 0.95 which will give a fairly accurate temperature for most types of surface that one may wish to measure. Because the emissivity value is not a constant then non-contact thermometers may have varying degrees of accuracy depending upon the surface they are being used with. Some of the current models of non-contact thermometer available allow the user to manually select the emissivity calibration of the device prior to use. Tables are available from the equipment makers that give examples of the emissivity values of common materials.

Why measure temperature?

There is certainly a good deal of anecdotal evidence to link sudden changes in ambient temperature to reports of people experiencing unusual or possibly even paranormal events. Interestingly, there is even some (limited) objective data from calibrated thermometers that have recorded seemingly inexplicable large or sudden fluctuations of the temperature at some locations.

Many witnesses to alleged paranormal activity report that the ambient temperature changes suddenly, often dropping but in some cases rising, just before, during or just after an anomalous event took place. "The room went icy cold, then the ghost or spirit appeared" or "then the object moved" is for example often reported by witnesses to haunts, apparitions and at séances.

The reported temperature change may be a real event or it may be something that is only perceived by the witness. A witness may report feeling 'icy' cold and no temperature change can be objectively measured. This may be simply because the probe is in the wrong place or it may be that the wrong sort of thermometer is being used - we cannot for example measure the temperature of the air using an indirect reading thermometer as it will only give a reading for a solid or IR emitting surface.

Additionally, there are several physical mechanisms that can cause the temperature to change or be perceived to be changing and that are much harder to measure by conventional means. The 'Peltier effect' is one example; this uses the flow of electrons to effect cooling and is nowadays being increasingly used in cooling of computer components. Peltier cooling is difficult to measure with standard equipment.

Another mechanism, uses the flow of charged air ions, creating an 'ion wind' that can be felt as a gentle cool breeze by a person but cannot be measured by normal thermometers - place your hand close to a domestic air ioniser to try this out for yourself.

There are also many physiological and psychological reasons that may cause a person to feel cold when in fact the temperature has not changed. Fear, excitement or drugs all may cause the blood supply to the skin to alter and this may cause the witness to feel colder or hotter. Simply the belief that a location is haunted and that the temperature is 'supposed to drop' when ghosts appear may be enough for some people to report feelings of extreme cold.

The language that witnesses may use can also be highly misleading too - they often choose extreme descriptions - "It went ICY cold". "It was like walking into a freezer" are commonly encountered phrases in paranormal investigations. The reality, when measured may be a small temperature change of just

a degree or two, perhaps even no change at all. It is not unnatural for people when trying to deal with things that are beyond their normal range of comprehension to offer exaggerated accounts to try and convey the magnitude or fantastic nature of their experience.

Sound Recorders

In the past we made do with light and easily portable dictaphones and many investigators still do. They were not capable of producing high quality results that could later be played back and easily interpreted.

These days we use two main types of sound recorder, the analogue tape recorder and the digital recorder, using either tape, disc or solid state memory to store the recorded audio.

Analogue types are the standard Cassette and micro cassette recorders that just about every investigator has in their toolkit. Simple and cheap to use they allow sounds to be recorded with varying degrees of quality. Many recorders have their own built in microphones that are not at all bad at recording something like a personal memo when the speaker's mouth is a couple of inches away from the microphone. The quality of the recorded audio can often be greatly improved by fitting an external microphone if you can. This has the added benefit of reducing the amount of mechanical and electrical noise that is picked up as the microphone can be positioned well away from the recorder. Specific types of microphones can also be used to best suit differing situations - Omni-directional microphones are great for general coverage and 'zoom', shotgun or cardioid types are best when one is trying to record sounds from a particular area without picking up too much from other sources.

Analogue machines do have some serious drawbacks - they are very prone to 'noise and hiss' on the recording that may mask what you are trying to record, particularly if it is a quiet sound. Using a higher quality machine improves this 'Signal to Noise' (S/N) ratio but like so many things the better the quality, the higher the price.

Many machines make use of specialised electronic circuits to remove this hiss and noise. Systems, such as those developed by the Dolby Labs are the most well known. Unfortunately use of these systems cannot be recommended for paranormal investigation work as they do alter the nature of the sounds being recorded and that could affect the quality of the evidence gathered.

Cassette tapes, whilst cheap have a very limited life and may not properly erase earlier recordings made, so it is possible to hear previous recordings underneath a newer one - this could easily fool an unwary investigator into thinking they have recorded some great EVP. To prevent that, the investigator should use each cassette only once on any investigation. However, once used a tape may be re-used for witness interviews a few more times. Cassette tapes are often available in bulk packs from some supermarkets and can work out less than 30p per tape.

Analogue machines have some advantages too; most digital recorders need to heavily compress the amount of information that is recorded in order to make effective use of the space available on the disc or memory. Most digital devices do this by chopping off the parts of the audio spectrum above and below the range we humans can hear.

That may be fine for listening to music and speech but not much use if you want to investigate the broadest part of the audio spectrum or use the recording later with some form of computer analysis software. If the audio information has been removed by the compression process in the recorder then it's gone forever. Analogue machines do not use audio data compression so the information recorded onto the tape is full-spectrum (within the already mentioned limits of noise) and may be a better choice in some investigation situations.

There is a final group of audio recorders that are commonly used by paranormal investigators - these

are the Dictation machines. These use the 'Micro-Cassette' tape format which means the machines themselves are often small and highly portable and most have a built-in microphone.

Such machines have their uses in paranormal investigations but they are specifically designed to be used to record speech from a nearby source - they are held close to the speaker's mouth and spoken into. One of the main problems with such machines is that they are frequently misused and deployed for location audio recording. The microphone is not designed to be sensitive enough to hear quieter sounds and so they may end up not being recorded properly or else buried in the general tape noise.

The small tape format also means that the signal to noise ratio is high, the smaller recording head size can also create further noise issues - any physical distortion or misalignment of the tape as it passes the head will cause additional audio problems that may fool some investigators into thinking they are hearing an anomalous event.

If you plan to use such machines, then if possible use an external microphone and the best quality tapes you can find ~ in fact that applies to all analogue recorders but is especially important with these dictation machines.

Digital recorders use digital sampling of the audio which is then recorded to one of a number of media - Tapes, MiniDiscs, CDs or Solid State memory chip, the latest even using small Hard Drives similar to those fitted to laptop PCs. The current trend is increasingly for using small digital recorders that use the MP3 (or similar) file format although many investigators make extensive use of the MiniDisc or MD recording format which uses small re-writable discs - not unlike mini CDs.

Digital recorders sample the sounds via the microphone thousands of times per second and many offer the user the option of changing the sample rate - the lower the sample rate, the more data can be stored on the media and so this is often simply expressed in terms of available recording time or in terms of a quality mode - HQ (High Quality), SP (Standard Play) and LP (Long Play). Before being written to the media, the data needs to be compressed as the amount of data is still huge, the compression rate is also something that the user can adjust in some models. Sony offer LP2 and LP4 recording modes on some models with claimed recording times of more than 10 hours for a single disc. This is done by progressively lowering the sample rate or increasing the data compression levels - the results are always a reduction in the quality of the audio and an increase in the noise levels often rendering the audio almost useless for later analysis (this may not really be initially noticed when one is simply listening to the playback through the supplied 'walkman' headphones).

The standard audio sample rate for CD audio is 44.1kHz (i.e. 44,100 samples per second) MiniDisc recorders use this same rate as their standard recording rate. MP3 audio recorders can exceed this - sample rates of more than 200kHz are possible on some machines fitted with small hard drives. Such rates can be used to make very high quality recordings although at the expense of much reduced recording times.

There are several different makers producing digital recorders and at the higher end of the market some are fitted with microphone sockets. Most digital recorders are small and light and can run on batteries for many hours, if a longer recording time is required then they may be plugged into the mains via an adaptor. Digital recording media can often be re-used many times too, meaning that it is a cost effective method.

MiniDiscs for example can be re-used thousands of times so they are very economical to use - in fact, the disc makers claim they can be used up to 2,000 times and still record as cleanly and clearly as on day one.

Sadly, the MiniDisc format is quickly disappearing from the high street but it is still possible to find hi-Spec machines available in some stores. Sony launched the Hi-MD format in 2004, which uses larger

capacity discs (1Gb) allowing the user a variety of very useful options. The Hi-MD recorders allow the user to select a very high quality audio mode known as PCM (Pulse Code Modulation), this mode is similar to that employed by Professional recording studios and has a lower compression rate than the standard methods employed in previous MiniDisc models.

Coupled with a high quality microphone the quality of the recording from a Minidisc is excellent and there is virtually no hiss or noise to mask the quietest sounds and as stores clear their stock at much reduced prices some excellent audio kit can be acquired.

There are drawbacks to these digital recorders though, they are fairly expensive - even the cheapest are approaching £100 and for a machine with a good build quality and good battery life you need to spend more than £250. Some shops sell small MP3 players that offer a 'Voice Recording' option usually via a small built-in microphone. Prices vary but can be as low as £20. They may seem to be an attractive option until you hear the awful sound quality - it is very heavily compressed and the tiny microphone is not very sensitive. Such models should be avoided and have no place in the serious investigators kit. Currently, there are no solid state or hard drive digital recorders that offer a good quality built-in microphone (Sony do offer a MiniDisc dictation machine that has an excellent microphone built-in). Most of these recorders also do not have a microphone socket, recording only via a 'Line level' socket, so choose carefully and check out the features before you buy.

Another potential drawback is that the recording quality is so good that unless you have a very quality microphone your recordings will show up the weaknesses of the microphone. A good budget microphone can be found for around £40 and rise in price with specification to many hundreds or even thousands of pounds. It is best to avoid 'Dynamic' types of microphone as they need high input levels to work efficiently and are not great for recording quieter sounds. Electret - sometimes called condenser microphones are better for 'area' recordings and offer better sound quality, they do require some form of power, either from an internal battery or from the recorder - this is not an issue as most devices support such microphones.

A key consideration with all forms of digital audio recorder - except a few very high spec and outrageously expensive studio types is sample compression. Compression is needed to 'squeeze' the vast amounts of data onto the recording media to allow for reasonable recording times. Most compression methods remove unnecessary parts of the data such as all the audio frequencies above and below the normal range of human hearing i.e. 20Hz~20kHz - that's not a major problem if your recording something you can hear. Anything the witnesses report hearing so can the Minidisc. However, recent advances in paranormal research mean that we now want to listen for sounds that are outside this range (see below) and for that the Minidisc is useless.

There is another form of digital audio recorder that offers the very best of both analogue and digital techniques. The Digital Audio Tape or DAT recorder uses digital recording techniques and utilises a cassette tape similar to an 8mm video cassette. The use of tape and the method of digitising the audio result in a recording that has the full range of frequencies available without the removal of parts of the audio like Minidisc. The use of a tape recording medium does mean that for the highest quality each tape can only be used a couple of times and must be properly erased between each use. These DAT recorders are unfortunately very expensive, retailing at more than £2,500. They also have a limited lifespan before the recording heads need to be replaced.

A final mention in this section must be for the video camcorders. These will be dealt with later on but many of the models use a digitally recorded audio track, the data being recorded to an audio track on the videotape.

We look at sound very carefully in all investigations as it is a frequently reported component of many cases. Witnesses report that the 'apparition' may speak for example. Doors may be heard to open and close when in reality no door moves. If a witness or an investigator hears a sound then in some circum-

stances it may be said that they are imagining it. If the same sound is recorded by a machine then it is clearly not the result of any form of hallucination or imagination but that does not mean it is paranormal, however unusual it may at first seem.

Locations can and do have unusual acoustic properties, sounds may appear to come from unexpected sources or perhaps change in nature so that they sound strange. Infrasound, that is sound considered to be below 20Hz and therefore below our hearing threshold is also a factor that needs to be considered. Aside from any direct effects on the body of the experient it may also cause parts of a location's structure of objects within it to vibrate and produce sounds that are within the hearing range - above 20Hz.

A recording of a sound event may appear to have good evidential qualities but in reality it may not be. As an example, a recording of footsteps in an empty corridor, the recording cannot demonstrate that the corridor was actually empty at the time of the recording so the value of the evidence is diminished to others when you present your evidence later.

Sound recorders can allow the investigator to do more than simply record the sounds at a location; it is also possible with computer assistance and accurate positioning of microphones to triangulate and 'map' the position that a sound or sounds was coming from.

The method is relatively easy; At least 3 Stereo microphones are placed at several carefully marked locations throughout a building. This knowledge of the microphone placement is crucial. When they are played back it is possible to measure the difference in the time that it takes the sound to reach each microphone using a computer. This minute difference - often milliseconds - can then be used to indicate the direction from which the sound was coming from. By then comparing the different directions indicated from the already known microphone locations it is easy to triangulate the source of the sound. In some locations, such as those with long corridors or locations with unusual acoustic properties this method may only give you a rough guide as to the location of the sound event.

Sound that is above and below the normal range for our hearing is also of extreme interest to paranormal investigators as laboratory studies have shown that very low frequency sounds can cause some subjects to have 'paranormal' type experiences. A frequency of just below 19Hz for example is the frequency at which normal human eyeballs will vibrate imperceptibly. In some people this may cause a disruption to the peripheral vision and the feeling that they are being watched or that there is someone else in the room with them. Just a bit lower ~ between 14Hz and 8Hz is the frequency at which the bowel and organs, including the brain will vibrate and this can cause the victim to experience real physical discomfort and in some severe mental states such as fear and anxiety and in others feelings that strongly resemble 'paranormal' phenomena.

Very low frequency sound is very difficult to measure and requires some specialised items of equipment. Ordinary microphones are useless, even specialised microphones are unlikely to perform well enough in this 'Infrasound' region. One approach is to use a large plate or diaphragm and an accelerometer - a transducer that measures the speed and changes in vibrations within the diaphragm plate. The signal from this transducer can then be taken to a spectrum analyser to display a read out of the frequencies that are present.

Very high frequency audio has also been suggested to be a component of some paranormal cases. There are a number of cases where the alleged ghost seems to exist in a speeded up time frame. Sounds have also been recorded that are much higher in pitch or at frequencies that are above our normal human range. Many animals including rodents, dogs can hear these frequencies, some animals can even produce them - Bats use very high frequency (Ultrasound) to hunt prey in the dark. It is worthy of investigation to discover any anomalies in the part of the electro-magnetic spectrum that is in the audio ranges. It is these anomalies that may give us valuable clues that may lead to further developments in paranormal research.

Pictures and Images

This is potentially the most interesting part of paranormal investigation - at least in the eyes of the media and the general public. Everyone likes to see a good ghost picture. After all seeing is believing and the camera never lies!

Those sentiments are about as wrong as it is possible to be - every camera tells lies and everyone usually sees what they want to see!

There are two types of image recording equipment - still and moving. Both are available in analogue and digital formats.

The digital stills cameras are becoming the most common type of camera these days as they offer an easy and cheap method of producing large numbers of pictures almost instantaneously. However, they have a number of problems associated with their use. The images they produce are in the form of a computer compatible file so they are very easy and simple to manipulate. Anyone with a simple cheap digital camera and a PC can produce very plausible pictures of ghosts, UFOs and a host of other paranormal phenomena, the internet is full of such fakes and frauds.

The image is also produced using a microchip - mostly known as a CCD (Charge Coupled Device). A 2nd type of image chip is called a CMOS (Complimentary Metal Oxide Semiconductor). Both have a limited number of light gathering points known as pixels. Broadly speaking, the more pixels the more detailed the final picture will be. Currently most digital cameras have about 1 - 8 million pixels per chip. This is actually quite poor compared to the most basic film camera which has more than 35 million pixels for each 35mm frame and the human eye which has nearly 60 million pixels!

The camera then uses some very clever software that 'paints' in the gaps between the pixels to produce the final image. The drawback is of course that the camera is lying very badly as it makes an educated guess as to what actually lies in the areas of the image it cannot see. For example - a pin point of light may well appear as a disc of gradually decreasing brightness and much larger than the original point source. This may be one of several causes of the plethora of 'orb' images that have recently exploded onto the paranormal scene.

CCD and CMOS chips also see the light quite differently than the human eye, they are more sensitive to Infra Red light for example and colours are also perceived differently depending upon the type of lighting being used

This has both advantages and disadvantages, for example the IR sensitivity can be used to great effect in allowing the camera to see better in the dark. Using an IR light source, such as I.R. LED's in the front of the camera can permit photographs to be taken when no other visible light photography is possible. In daylight, the chip cannot actually determine colour directly and respond to light passing through a coloured filter in front of the chip in order for colour images to be obtained. The image that is recorded is merely a representation of what was actually in front of the camera, it is the result of a combination of the CCD sensitivity to light, and the camera's internal software that writes the final image.

Digital photography is however, a very useful tool for the investigator as it allows an almost unlimited ability to take photographs with little regard to cost or waiting for the pictures to be developed. For a visual notebook of a location it is unsurpassed. With very careful protocols in place that acknowledge the limitations and appropriate safeguards against later tampering with the image it can be used successfully as an investigation tool too.

Digital photographs can be downloaded to an analysis PC far more quickly and simply than for a picture taken using film and with fewer steps in between the taking and the viewing.

Any investigator using digital photography must deal with these limitations and show that they have dealt with them before any images they produce can be accepted as evidence.

Film photography is also popular as an investigative tool - film has been around for more than 150 years and has produced many apparently stunning images of ghostly apparitions and other phenomena. The very longevity of the medium also has the advantage that is very well understood and so fraud is normally easily detected. The format is also that bit harder to manipulate to produce frauds and although a competent photographer can produce a very effective fake it requires a degree of understanding and some expertise to achieve. There have been a number of photographs produced that apparently show paranormal phenomena and that have stood up well to close scrutiny by the experts.

Film is not without its problems and drawbacks - It is a chemical based process that requires a precise amount of light to produce a good quality image. Many times, photographs are taken in less than ideal conditions where the image is not correctly exposed and thus open to problems with the resultant image.

Film also 'sees' light differently than the human eye and different types of light will produce different colour casts and shades. There are specific types of film that are made for many lighting conditions such as daylight, tungsten light or fluorescent light. For those using standard 'daylight balanced' film then there are a wide range of filters that can be fitted over the lens to compensate for the variations in the lighting conditions.

Another difference with film photography that needs to be taken into account is that it is a multi-stage operation before a final image is produced.

The light hitting the film surface causes a chemical change in the emulsion of the film. This change cannot be seen until the film is processed using chemicals that remove the parts of the emulsion that were not exposed to the light. These stages need to be carried out in total darkness to prevent alteration to the 'latent' image. Further chemicals are required to 'fix' the changes and prevent further changes taking place when the film is exposed again to light.

Unless it is a slide or reversal film, in order to see the proper picture the film (negative) has to have a light shone through it and onto photographic paper. This is an identical process to that which the original image was taken and again requires darkness and several chemical stages to reach the final photograph that we can hold in our hands.

At any one of these stages problems with the chemistry can and do take place and every one of these will affect the final photograph. Even small changes in the temperature or strength of the chemical solutions that are used will impact upon the photograph and alter it from the original. Slide (reversal) films are normally the least affected as they undergo the least number of chemical steps. For this reason they are often the preferred medium of the serious paranormal investigator.

For the best analysis results it is preferable to work from the negative rather than the print. Like a slide film it has been through a lower number of chemical changes. Also it is far harder to produce a hoax directly onto the negative and for that reason most photographic hoaxes tend to be carried out at the printing stage.

Any subsequent computer analysis must also take into consideration the alterations to the image that are made by the image scanner at the digitising stage. Unless the investigator has a very expensive scanner with an extremely high resolution much of the original image information and detail will be lost at this stage. Also many of the problems associated with digital photography apply - after all a scanner is simply a digital camera that slides along in a glass-topped box!

Specialist films are available too that permit photography to be carried out in extremes of lighting such

as Infra red and Ultra violet and also at very long and very fast exposures, all variables being of potential interest to the paranormal investigator. The use of such films is highly specialised and may not work with some camera models, anyone interested in such techniques are advised to seek additional assistance from a photographic specialist.

Moving Images - Video

With video photography many of the criteria that apply to digital photography also apply - a video camera uses either a CCD or a CMOS image chip, the output is then recorded by either analogue (tape media only) or digital techniques to the recording media - most likely tape, although recent models can record to DVD, Hard disk or solid state memory cards. In effect then, a video camcorder is little more than a stills camera that records a continuous series of stills - 25 frames per second for mini DV.

There are essentially two methods of writing that image to the recording media - Analogue methods such as 8mm, Hi8, compact VHS and compact SVHS.

These work in a manner similar to audio cassette recorders and record the full bandwidth of the original image to the tape. They also have the video equivalent of hiss and noise that prevent the quality of the image reaching those required for true TV like definition. There are still a few Hi8 camcorders on the market at very reasonable prices, and offering very useful features for the paranormal investigator including NightShot® and Interval Recording.

Digital camcorders provide a higher overall image quality and as the video information is recorded in the form of digital data then the resulting video is immediately compatible with computer analysis software. Digital recording produces a lot of data and this must be compressed so that a decent amount of recording time can be obtained from a single tape cassette or DVD. This is done in a way that does not remove any parts of the image. Instead, the software, samples the image information once every 14 frames to make a 'reference' image - the next series of images are compared against this. The imaging software simply removes those parts of the image that do not change from one reference frame to the next. This is perhaps a simplistic explanation but serves to illustrate the technique. The resultant image is still an accurate representation of what was before the lens. The 'cleaner' less noisy signal means a far higher quality of image with a higher definition when viewed afterwards. Many commercial broadcasters are now using video cameras that are quite affordable by the enthusiastic amateur - indeed ghost hunting programmes and some nature and news broadcasts are done on the same machines that are sold by the high street retailers.

All of the same cautions that apply to still photographs apply equally to moving pictures. The same ease of hoax and mistake and the same need for protocols for management and use as evidence.

Video cameras have another major benefit too - this is also to some extent now shared by a number of the digital stills cameras; they have an ability to record digital quality stereo sound coincidentally with the pictures that are recorded.

Although the 'on board' microphones rarely match the full quality capability of the recording medium, when used with a decent microphone they are every bit as good as a Minidisc and in some circumstances better as the compression method used may be less severe on the audio bandwidth.

The key benefit for a paranormal investigator is that the sound of the door opening can now be heard at the same time as the image of it opening is seen - this offers a double opportunity for the event to be examined and assessed. If the sound recorder is separate from the camera it requires a great deal more work to show that the two events took place at the same moment.

Very recently, digital camcorders have started to appear on the market that use hard drives, small versions of the ones used in a PC to record large amounts of video data. This allows very long recording

times to be achieved. The video data then needs to be downloaded to a PC before the disc can be re-used.

There is a small number of manufacturers also offering camcorders that store the video on solid state memory cards, the same as used in digital still cameras. This is a brand new technology and it is still not clear how effective this method of recording video will be.

Another way of recording moving images is with a Closed Circuit Television CCTV camera. This is actually nothing more than a video camera that is separated from the recorder often by a long cable or wireless link. An advantage of CCTV cameras is that the pictures from several cameras can be viewed and recorded at a central place and onto one or more recorders. Some CCTV models have microphones fitted but these are generally of a low quality that is useful in some circumstances but is a feature that has little benefit to paranormal investigators. Some advanced CCTV systems have the ability to 'stamp' the recordings with the date and time it was made. Indeed this ability is shared by all the forms of camera and video that we have discussed in this article - in many cases though they do require the internal clocks and calendars to be set correctly beforehand!

Most paranormal investigators use all forms of the above photography and a few others including that instant type film cameras.

The pictures are used to support every investigation but it is important to remember the limitations of each and to deal with all the issues highlighted above. In order to use a photograph or piece of video footage as evidence it is important that the correct procedures are put into place for all subsequent handling and viewing. We have only touched upon the major problems that pictures present and as every potential problem is identified proper methods to ensure that they are minimised need to be put into place. Failure to make use of these procedures and protocols may completely ruin the potential evidence value of any picture or moving image that is obtained.

Although, it is not strictly the right time to talk about video analysis, many investigators do make use of software to examine their video footage. There are specific programs that may be used for video analysis but these cost several thousands of pounds. Many investigators therefore use a standard video editing package which can provide some basic image enhancements that may assist with determining what is actually on the footage. The risk with such methods is that they may inadvertently add or subtract information, thereby changing the image in some way and may even create further anomalies. The use of such software must be with extreme caution and work should only ever be carried out on a copy of the original footage - never on the original itself.

That said, it has to be remembered that the software can not perform the actual analysis, it is merely a tool to aid the investigator in interpreting what may be going on in a picture or video tape to try and obtain the most detailed information possible from a picture. Ultimately, based on that information, the person conducting the analysis must use their own judgement to make the final determination of what, if anything the footage or picture shows.

Direct Vision Devices

These are the group of optical devices that require an operator to look into. The results from such techniques will always be subjective. Some devices may however be attached to a camcorder or stills camera by some means.

Items such as Binoculars and Telescopes are very useful for making distant objects appear closer or larger and allow us to obtain more detail from them.

They are used in many types of case but mainly in support of skywatches and other outdoor activities such as Battlefield haunting investigations.

The Light intensifier or Night vision scope is a useful tool as it permits us to see into the dark. This is achieved by electronically amplifying the available light many thousands of times so that the observer is able to see things that under normal circumstances he would not be able to. The 'Nightscope' is used in many types of case and although it is a very useful item of equipment, when used without some recording device attached it is merely as aid to normal vision and a support tool.

The usefulness as an evidence gathering instrument of direct vision devices is severely restricted, by the fact that the image produced by all of them can only be seen by the operator using them at the time, and we are then reliant upon their description and interpretation of what they are seeing.

Electromagnetic Field (EMF) Detectors

Any Electro-Magnetic Field is actually made up from two separate component fields. The Electric Field and the Magnetic Field. EMF - the term we all commonly use to describe these fields is actually wrong. In Physics an EMF refers to an Electro-Motive Force and is a term describing the electrical potential between two points of an electrical circuit. However in recent years it has become a universally accepted abbreviation for Electro-Magnetic Fields. An EMF is the Invisible lines of force produced by voltage and current that surround any electrical device or electrical power line. They can also exist separately from each other, Electric fields are produced by most living and many non-living organisms and objects. Magnetic fields are only produced by materials that are naturally magnetic - Ferrous metals and some minerals for example or whenever an electrical current flows through a conducting body, such emissions always have an associated electric field too.

There are two types of radiating electro-magnetic emissions that are of interest to paranormal investigators. The Non-Ionising and the Ionising. The Electromagnetic spectrum extends from the ultra short wave lengths that comprise ionising radiation and x-rays down into the non-ionising portion of the spectrum such as the visible light, radio waves and finally into the Earth's own Geo magnetic field, often described as being DC, i.e. without any frequency. Sound waves are not part of this spectrum as they are produced by the movement of acoustic waves through a physical medium such as air or water.

Researchers have been extending their search into many areas of the EM spectrum in the desire to try and obtain answers to the puzzles of the paranormal. Most recent research has concentrated upon the lower regions of the EM spectrum with research into magnetic and what are termed electro-magnetic fields. These studies have centred on lab based research by Parapsychologists and Physicists in several countries.

Magnetic fields from the Earth have been suggested as possible explanations for many unusual reports including UFO related events, Poltergeists and Hauntings. The current research seems to show that some people's brains may be more susceptible than others to these emissions, creating electrical activity within the brain that may then be interpreted as being of a paranormal origin. Of course, we have developed to use and trust our 5 senses and the brain can only interpret this interference in a sensory manner - therefore, they may see, hear, taste, touch or smell something and believe it to be anomalous. EM radiation does seem to affect PSI abilities too, for example; it has been noticed that success in PSI tests and reports of spontaneous PSI experiences have appeared to decrease at times when there are high fluctuations in the local geomagnetic field.

The geomagnetic field strength is normally between 20,000 and 50,000 nano-Tesla (nT) - 200~500 milli Gauss (mG) depending upon where in the world it is measured. Other factors including local geology and the presence of both Ferrous and non-Ferrous metals for example in the construction of a building metal, all affect the precise level as does changes to the amount of solar radiation that is received on Earth.

Electro-magnetic fields at 50Hz and 60 Hz are produced by the mains electric supply. These frequencies are very close to those naturally produced by the human body (less than 100Hz) and by the brain

itself, which operates at frequencies below 50Hz. It is perhaps therefore not too surprising to learn that exposure to some types of EMF can have a measurable effect on human physiology and behaviour. Some research has suggested that exposure may even be harmful and is the main reason why there are so many EMF detectors available in this increasingly health conscious world.

So far, Lab based studies have included placing subjects into fluctuating random magnetic fields generated by two large coils that the subject sits in between or have had low amplitude EMFs directed into the brain. Much of the pioneering work has been carried out in Canada by Professor M.A. Persinger. Many test subjects reported experiences that were suggestive of paranormal experiences, such as feelings of being watched and touched, a presence in the room with them and the hearing of voices. At a range of specific frequencies the subjects even reported experiences that were remarkably similar to the Near Death Experience (NDE).

Following on from this research it was postulated that a person in the everyday environment might also have these same experiences if they are subjected to similar EM fields. Many similar EM fields have been measured in the real world - power cables, computers, TVs and mobile phones have all been found to have a similar EMF to those used in the lab experiments. If these people then went on to have an experience that was 'induced' by the EMF without being aware of the EMF being the cause then they might then go on to say that they had experienced the 'paranormal'. For example they may see a ghost or be abducted by Aliens.

So far all of this research has been confined to the lab with some limited studies carried out in the field, where it seems that the environmental EMFs are indeed linked to anomalous personal experiences. In one experiment in a haunted part of Edinburgh test volunteers reported a higher number of feelings of being watched or uncomfortable in particular areas where the EMF was higher than in areas where no 'paranormal' activity had been reported.

Many ghosthunters carry an EMF detector. In fact the EMF detector is the current number 1 'must have' tool for any self respecting ghosthunter and to an extent Ufologists as well. Most of the devices that are marketed and affordable by the average paranormal investigator are designed purely to measure the amount of EMF that is given off by domestic appliances at 50Hz . Even worse, are the ones made for the American market that are calibrated at 60Hz. These devices simply measure too high a frequency to be of any use. Laboratory experiments have indicated that the critical frequencies that affect the mind are much lower, in the 0.5Hz - 30Hz range.

Brain activity is seen typically in ranges referred to by Greek letters: Delta (0.5-4Hz), Theta (5-7Hz), Alpha (8-12Hz), Beta (18-30Hz) and Gamma (30-50Hz).

It is the lower ranges - Delta - Beta that typically cause the subject to experience events that they may describe as being paranormal. Equipment to measure EMF in these ranges is rare and almost without exception very expensive. Most paranormal Investigators simply do not possess such tools but some recent field work has suggested that the affects of amplitude and frequency changes within the main electrical supply may also be linked to some anomalous reports.

There is a disturbing trend seen in recent years and one that seems to be spreading rapidly! That is shown by groups who possess Electro-Magnetic field measuring instruments without any knowledge whatsoever what they are looking for or even why. Many also believe that ghosts emit or give off EMF radiation and that when their EMF detector 'goes off' then it has detected the presence of a ghost. As far as is known ghosts are not known for their ability to radiate Electro-magnetic energy and so such an idea is counter-productive and unlikely to further our knowledge. Most of this poor information comes from the Internet, and may be further compounded by a number of TV shows that claim to be investigating the paranormal and appear to be using these EMF detectors as 'Ghost Detectors'. Many paranormal groups have recently sprung up, their enthusiasm fired by such shows, they invariably rush out to buy their own 'EMF' meter and without a backward glance at the research material suddenly

have the means to detect ghosts and ghostly activity. To make matters worse still, these 'investigators' then go on to encounter perfectly normal EMF levels that trigger their detector and after a quick sweep over the mains wiring to pronounce it not the cause they happily declare the location haunted and have proved it to be so!

In truth, EMF's are to be found within most environments and locations and with a huge variation in their amplitude too. It is therefore wrong to simply assume that any EMF that is detected is of an anomalous or paranormal origin without extensive testing. Even then, the tools that are available may simply be the wrong item of equipment and may not be capable of detecting the causal emissions. As an example, consider a single-axis EMF meter, which is the most commonly found type of meter in the ghost hunters kit box. This is only capable of measuring an EMF radiation in one direction. EMF's are present in the form of a circular or spherical field surrounding the source. Moreover the two components of the EMF - the Electric Field and the Magnetic Field are at right-angles to one another. Therefore, if the alignment of the EMF meter sensor is not directly in line with the emission direction the meter will give a misleading reading or may not even be able to 'see' the field at all.

It must also be remembered that EMF meters are also specifically designed to measure within a specific range of frequencies (commonly 50 or 60Hz) and that outside that range they cannot produce reliable measurements. They also cannot indicate what the frequency of the EMF they are measuring is and so the information they supply can only ever be treated as a guide to the actual emission levels, rather than as a definitive measurement and even then only within a defined range of frequencies. Despite the claims, to the best of our current knowledge no such Ghost Detection device exists.

Looking at those EMF meters that are available to the amateur paranormal investigator one sees a very wide range of usefulness. Basic meters costing just a few tens of pounds - like the CellSensor® and the Dr. Gauss® may just be sufficient for an experienced investigator to estimate the levels of EM radiation from sources such as man-made electrical appliances and cables. In actual fact they are not strictly EMF meters at all - they only measure and display the magnetic field component, hence they display the results in units of magnetic measurement i.e. milli Gauss (mG). Moving up to the single-axis digital or higher specification meters including the Aaronia MultiDetektor II Profi and the standard AlphaLabs TriField® meter, permits more accurate measurements to be obtainable in 1 or more axes. These meters also provide the opportunity to make separate measurement of the two-parts of the EMF - the Electric field and the Magnetic field, units of measurement are mG for the magnetic field and Volts/ metre (V/m) for the electric field. Towards the top of the amateur price-range are the digital 3-axis meters that have the ability to measure both types of field, simultaneously and separately.

Beyond this are some expensive items of equipment that are capable of directly measuring the Earth's DC local magnetic field and also emissions at a broad range of AC frequencies above that. Traditionally used in laboratory research, recently some investigators have shared resources to acquire these pieces of equipment so they are now being used to explore haunted locations for the first time.

Regardless of the type of EMF meter you may have, provided it is used correctly and wisely they are all capable of providing the paranormal investigator with useful and potentially helpful information. However, even the most expensive and accurate meter if used incorrectly or without genuine knowledge of what the presented information may mean will only result in wasted effort and meaningless data being collected.

There is a further type of EMF meter that is extensively used by Paranormal Investigators that needs to be considered here too. The Natural EM TriField® meter made by AlphaLab is designed to measure only changes within an Electromagnetic field - i.e. it only gives a reading when it detects that the level of the either the magnetic field or the electric field is changing, the meter reads Zero in a stable and unchanging field. It is also a true 3-axis meter unlike the Standard TriField® models.

Changing fields are important within paranormal research as the lab studies carried out so far by

Professor M.A. Persinger have indicated that the brain may also be affected by fluctuations within the overall field strength rather than just simply changes within its overall amplitude. The Natural EM Tri-Field® is currently the only hand-held stand-alone device that allows paranormal investigators to look at changes within the field strength. Other meters, such as the Model 1394 Tri-axial digital meter that can be linked to a PC for either real-time or data-logging of the EM field strength can be used for greater degrees of accuracy and at a slightly higher cost.

Other Meters and Equipment That Can Be Used to Aid A Paranormal Investigation

Perhaps one of the more frequently seen items of equipment in the modern investigators kit is the Negative Ion Detector (NID) .

This may be used in two ways - to detect the presence of a strong negative ion count within the location and also to detect high levels of Electro-Static charge in the environment.

Negative Ions have been indicated to be a factor for some time in the possibility of a ghost being present. Researchers have found a correlation between the appearance or manifestation of paranormal and Poltergeist type activity and a high level of negative ions being present, although such a link remains rather vague and a lot more work needs to be carried to establish this correlation fully. The problem being that if there are large numbers of negative ions then there may also be a large number of positively charged ions available too.

Air ions are simply charged air molecules and can carry either a Negative or Positive charge. Negative ions come from a variety of natural sources such as after a thunder storm or on a windy day. They may also have man made causes such as ionisers and air pollution reducing devices. They are sometimes described as being beneficial to health and well-being and many devices that create and pump-out negative ions are sold for such purposes. It is not within the scope of this article to discuss the relative health benefits or otherwise of air ions however, but for those researchers interested in experiments involving negative or positive air ions then the alternative health 'industry' is a good place to look for items of equipment!

One example of 'reverse engineering' the research has been carried out by some investigation groups who use either domestic or even 'industrial' strength ionisers to produce a huge quantity of negative ions in the hope that by creating an environment that may be more conducive to paranormal activity occurring within a given location they may increase their chances of capturing it. Positive air ions are created by either radioactive decay or as a product normally or 'glowing' heat i.e. flames, radiant heaters and cigarettes.

The Negative Ion Detector simply uses a simple circuit that is pre-set to 'trip an alarm' when the local negative air charge reaches a pre-determined value. The device typically uses an metal antenna or plate as the detector. This is given a pre-determined positive charge by the electronics inside the device and thus attracts negative ions onto the detector from the surrounding air - opposite charges always attract one another. If there are sufficient numbers of negative ions available they may be able to cancel out the positive charge of the detector and thus trigger an alarm. The level is pre-set and arbitrary and on the most commonly available models is not able to be adjusted by the user - as there is little information about how many negative (or positive) air ions may be significant (if at all) then such a device may be of limited value to most investigators.

Another point to bear in mind when one is using such a device is that the information you obtain may indicate that other states are occurring within a location. For example, if the NID shows a high level of negatively charged air ions present then it is also highly likely to be the case that the surfaces within the location such as walls or items of furniture and even the investigators themselves will start to become Positively charged - unless they are properly earthed (grounded). Currently, there is no established link between high numbers of positive ions present and reporting of anomalous activity although such a link

cannot be totally ruled out.

Most Negative Ion Detectors also function as Electro-Static detectors - this can be easily shown when one is using a basic model NID. Whilst carrying such a device, that is not connected to a suitable Earth (Ground) the investigator may discover that the device alarm will sound frequently especially if they are walking on a man-made carpet or similar material. In fact they are generating a static-electrical charge as their feet move over the carpet which in turn is sensed by the NID setting of the detection alarm - if the investigator is unaware of this feature of basic NID models they may well interpret the alarms as an indication of high amounts of negative air ions.

Stand-alone Electro-Static detectors are rare and only manufactured by a handful of makers - they can also be expensive and difficult to use in some indoor locations. However, they are used by some advanced paranormal investigators as research by several respected researchers has also shown that paranormal activity is linked to the presence of high Static-Electricity levels in the environment. Static-Electrical energy can be naturally found following a lightning strike or close to many electrical devices such as a TV set. It can also be created by something as simple as pulling a garment of man made fibres over the head! Charges created can be extremely high and in the order of tens of thousands of volts which is high enough for the electricity to leap across the air creating the tell-tale sparks to appear as blue flashes.

For those who are interested in pursuing such research then perhaps the most useful of all the devices available is the Air Ion Counter. This device draws air into a special chamber inside the device, that can be charged both positively or negatively. By this means it is possible to obtain a reasonably accurate count of the numbers of both Positive and Negative air ions (measured in quantity per cubic centimetre). By using such a device it is possible to determine accurately the numbers of air ions present and their charge.

Much of this research is very much of a speculative nature and any results may not have any subsequent relevance to paranormal activity. Indeed those groups conducting similar studies have found results that seem to indicate the exact opposite of what was to be expected. i.e. that ghosts seem to shy away from negative ion areas and that Static-Electricity fields may also diminish the amount of reported paranormal activity within a given location.

Recently paranormal investigators have been able to obtain perhaps one of the most useful new tools to support their investigations. This is the Hot-Wire Anemometer.

This small device uses a ultra-thin wire (less than the thickness of a human hair) to measure the movement of air through a room or other space. The Hot-Wire Anemometer can measure draughts of less than 0.2 metres per second (m/s), which is barely detectable by the average person. Such low velocity air movements may be responsible for many apparent paranormal events - such as movement of curtains, suspended light fittings and candle flames. The actual speed of the air flow may be very slow, almost imperceptibly so, but if sufficient volume of air is being moved and it is acting upon a large surface area such as a door for example even heavy doors may start to move apparently paranormally.

In this same category of new tools for the investigator one may include Barometers - there are now many accurate digital models available for low cost. Barometers measure changes in the air pressure. Air pressure is rarely truly static and changes may often be quite rapid - for example during periods of changeable or bad weather. These changes in air pressure can also create unusual and apparently paranormal events to occur including sudden knocking and rapping sounds, popping of the ears and in some cases movement of objects.

Despite all the High technology that is often employed by today's paranormal investigator there is still a lot of useful information that may be obtained from using some of the good old tried and trusted methods and equipment from the past including:

Candles which are a frequently used tool that offer a very quick check for slight drafts and air currents -candles are cheap and easy to use. Almost the slightest movement of the air will cause a candle flame to flicker but caution has to be exercised as a candle will frequently flicker as a result of the irregularities of combustion. To guard against this we always have the candles in pairs and look for both candles flickering at the same time. Of course there is also the ever present risk of fire with this method and candles should never be left unattended.

Pencils and sticky tape - many cases involve doors that are said to move and it is often difficult to see a slight slow movement with the eye or even a video camera. A good trick is to watch the footage speeded up as small movements become easier to see at the higher speed. However, by simply taping a pencil to the bottom of the door in question and taping a sheet of paper to the floor beneath the movement and distance of movement can be traced by the line upon paper drawn by the pencil.

Flour - Rarely used as it's messy but still a good standby for some investigations. Not as you may imagine to detect ghostly footsteps in the flour but rather to catch human subjects who are somewhere they shouldn't be. Very useful in a 'trigger object' experiment to ensure nobody goes near to it or tampers with it.

Plastic dome - an upturned clear or opaque plastic dome makes an ideal cover for trigger object experiments -again mainly to prevent tampering and also when the trigger object is light and easily moved, like a feather for example, the dome prevents the wind or draughts blowing and moving the object.

And Finally!

There are many items that we use in the course of investigations that are not covered in this article. Some of them are the everyday common sense items that every ghosthunter should already carry about their person and need no discussion and barely even need listing, though for the sake of completeness they are:

A wristwatch

A notebook and pen/s

A torch - ideally with a red filter over the lens.

A third generation multi tasking nightvision scope with 3-D target plotting and tracking

Walkie-Talkie radios are a useful addition to the personal inventory of each member. They provide instant and effective communications between all the team members and also a extra level of safety for each member.

A first aid kit should also always carried.

Each member of the team on any investigation is also aware of the need for appropriate clothing and food and drink to make sure we survive the night!

If you have any further specific questions relating to an item of equipment that Para.Science are using then please email your questions to us and we will try and provide you with an appropriate answer.