X-ray is the foundation of diagnosis for many diseases. Patients expect that their x-ray will be correctly analyzed to detect any abnormality. However we know that analysis of x-ray images is not perfect. There is a notable number of "false positive" readings of x-ray images that lead to unnecessary, time consuming and expensive procedures. How about "false negatives"? How many people suffer through an agonizing illness and even die simply because the radiologist did not see what was there? These are important issues in all x-ray applications, but critical in mammography where the objective is to detect the smallest artifact that could be cancerous. The dependability of film mammography became so suspect that Congress imposed the MQSA (Mammography Quality Standards Act) which calls for the imposition of severe penalties if film exposure and developing are not given a daily quality assurance checks.

Now the medical industry is in transition to digital image processing and presentation of the image on an electronic display device (so-called "soft copy"). The issue of reliability in image interpretation becomes more critical than ever before. There is no standard or common practice for quality assurance of these systems. It is a more critical issue for an electronic system than for film, since it is known that electronic displays will degrade, often in a manner that is not apparent to the viewer. Also monitors are likely to be located virtually anywhere, even though close control of the viewing environment is essential to provide the best possible visual analysis of an image. Incredibly, confirming that one can see all that the "soft copy" display provides is virtually ignored. Visual Information Institute has developed a new tool, VuCue, to assure that a radiologist can see what has to be seen for proper image interpretation and an appropriate diagnosis.

With this new tool, a quick and effective quality assurance check can be quickly performed at any time, therefore ensuring that false negatives and repeat procedures will be at a minimum. This exercise also provides an early indication that equipment needs attention prior to a catastrophic failure, therefore minimizing downtime and attendant loss of revenue. It is quite simple. The viewer must correctly discern a small symbol (such as a number) that is presented at minimal contrast and confirm to the system what that symbol is to pass the quality assurance test. If the viewer cannot correctly discern the symbol, they are notified that viewing conditions are not suitable for reliable image analysis and that adjustments must be made. Results are logged, pass or fail, so that a complete record of system performance is available to verify system integrity over a period of time. This instantly checks that the electronic system operation is adequate, that the viewing environment is correct, and that the viewer can perform at the required level.

Detail in an x-ray image is presented over a wide range of brightness with very small changes in contrast within the range from black to white. Interpretation of a monochrome image is dependent upon two factors, the ability to see fine detail and minimum contrast differences. What viewing conditions are required to see an appropriate amount of detail in an x-ray image? There are no concrete criteria. Eye performance is wide-ranging and extremely adaptable as viewing conditions change. There is reason to believe that visual performance from person to person is a notable contributing factor. X-ray image interpretation requires discernment of very fine detail, virtually shadows, at very low contrast and intensity levels, which is demanding in an area of limited visual performance. No standards or common practice have evolved, but could be established by a simple sampling of viewer response to VuCue.

For information to be discernible, it must be presented within capability of the eye in its state of adaptation. Visual acuity, essentially a form of brightness discrimination, varies as light intensity varies, is dependent upon diameter of the eye's pupil, and degrades dramatically when light level falls to the pint that eye operation shifts from cone vision (daytime) to rod vision (nighttime). Flicker, a common occurrence in video presentations, also affects eye performance. These variations may change from one person to another. These effects are so profound that it is impossible to expect to develop a "standard" viewing condition for effective analysis of x-ray images.

While eye performance is a fundamental and virtually ignored component of proper x-ray image analysis, electronic systems and displays also are far from perfect. Electronic technology has outpaced eye performance, and can present more "shades of gray" than can be discerned.

Information is presented on a monochrome display as changes in brightness at a density representing the fineness of detail. In an electronic display, fine detail usually is presented at lower contrast than coarse information. That is, the finer the detail the less contrast difference it will produce. As equipment ages, degradation will occur in this characteristic. As equipment ages, information will become defocused, especially in very bright areas, a phenomenon referred to as "blooming". Considerable research has been and is being applied to display performance, but is not addressing the issues of degradation and relationship of the displayed image to visual performance. It is difficult, and perhaps impossible to develop concrete standards for viewing medical images. In lieu of this, a method of verifying that, under prevailing conditions, a viewer is able to discern the necessary information is invaluable. VuCue provides this capability.

These problems also apply to other medical applications such as ultrasound and echo cardiology-wherever there is an electronic display used as the means to present critical images for diagnostic studies.

Experience teaches that electronic equipment, especially displays, can be built to present information in sufficient detail and with minimum contrast to provide the means for accurate diagnostic studies. Knowing that it does degrade, ongoing condition must be monitored closely. Displays can be adjusted for what appears to be a "good" image but may, in fact, be set so as to suppress information unknowingly. Experience teaches that the eye may not be in a condition so that all information can be discerned Experience teaches that the image may be defiled by extraneous light reflecting from the display surface, from clothing from windows, from light fixtures, etc. Display orientation is also important. Experience teaches that the eye,s capability is profoundly affected by the overall amount of light introduced to the retina, so viewing conditions must be carefully controlled. Discernment of information in the "near black" region is critical, especially in mammography. The ability to do so is quite dependent upon adjustment of the display devices, adaptive state of the eye, and fineness of detail. A person may be misled by being able to discern fine detail, low contrast information at a moderate intensity, but in fact not be able to discern similar information at a lower brightness level. Experience teaches that the viewer must have the means to confirm that information can be discerned at various brightness levels, especially at "near black" and "near white", and have a suitable visual cue to guide display adjustment to assure this condition.