Taking 'the 3D Way'

Independent consultant Simon Lambert describes the use of 3D computer-aided design to help end-users and suppliers.

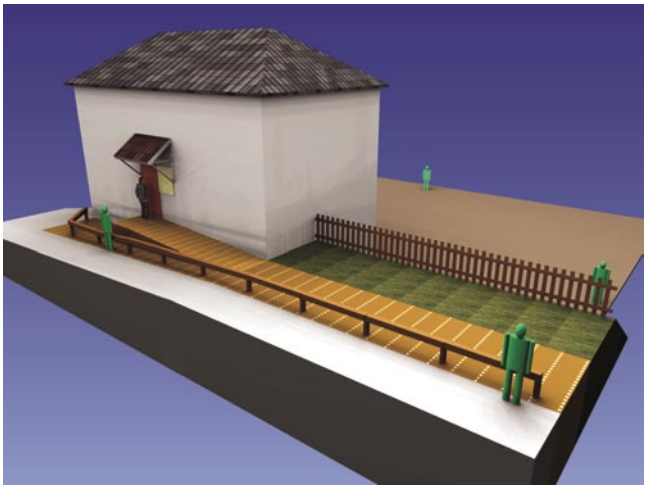
Unfortunately, it's not an uncommon cry in this business: "Why don't my CCTV pictures show me what I want to see?" We can fill pages writing about what happens to the images between leaving the camera and appearing before our eyes. Rather than concentrate here on picture quality or recording methods, we'll step back to square 1 and spend our time looking at innovative ways to solve a perennial problem: how to get the correct camera views in the first place.

Sowing the seeds of a disappointment

When a CCTV camera installation is sold there is an all too common risk lurking beneath the 'bonhomie' established between the customer and the salesman. Consider some familiar thoughts. In the customer's mind's-eye (or more worryingly, that of their boss/financier) the equipment that they've ordered will provide them with pictures showing the targets that they are interested in, over the territory that concerns them, in sufficient detail to be used for their intended purpose, e.g. identification of people, vehicles, etc. Unbeknown to the end-user this can differ from that in the mind's-eye of the salesman who created the canny sales pitch and helped design the 'keenly specified' system. The latter (possibly) knows that you can't use a wide-angle lens on the single car park camera and read vehicle index numbers 50 yards away, and he assumes that this is plain to any fool. Surely his new customer doesn't expect such obviously unreasonable capability? "Operational Requirement!" I hear you cry, but with many folks this goes in one ear and out of the other. Non-specialists only occasionally have sufficient self-awareness to ask the CCTV expert to educate them prior to the purchase in order to avoid buying a pig-in-a-poke. Let's not forget that the layman customer is a classic example of someone who 'doesn't know what he doesn't know' and in this way the seeds to a future bust-up are sown. These seeds will grow to bear fruit just after the customer suffers a loss that (forgive the pun) brings the inadequacies of the CCTV system into sharp focus. Now let's not forget the point of view of the salesman, who may be reluctant to design and quote a beautifully engineered system because he fears that a rival may compete by producing a cheap bid, with concealed inadequacies, using sufficient flim-flam to pull a purchase order out of the bag while trading on the customer's naivety. Any thoughts that the silly customer will eventually get his just desserts are of little consolation to a salesman whose income and job are threatened by his failure to gain the new contract. The salesman or sales support engineer are often under pressure to complete the design very quickly and it may lack sufficient attention to detail for such misunderstandings to be avoided. These last few issues are known only too well to me, as I spent several years early in my career as an engineer in a sales role.

A modern solution to an old problem

As an independent consultant (some have said poacher turned gamekeeper) concerns over these issues led me to develop ways that help avoid misunderstandings that can result in disappointment, mistrust, wasted time and money. The rest of this article will discuss methods developed in an attempt to avoid the problems described above, for the benefit of both the perplexed customer and the rushed sales engineer.



Survey measurements took less than 1 hour in order to create this site as a 3D computer model. The green figures are 1.6m human-sized 'markers' placed at the periphery of proposed camera views.

The techniques use computer generated 3D graphics to construct a model of the CCTV site so that the customer can *see* the virtual-reality views from the proposed cameras before they are agreed. A picture is so much easier for the non-expert to comprehend (let's not be fooled, experts too) than a tranche of technical jargon. They might carry this exercise out with their consultant and write the agreed design into the tender specification (including the images). The salesman and designer might use these methods when working directly with the customer to agree each field-of-view prior to signing a contract, so that future disputes between them on these issues may be avoided. Indeed, the smart salesman can use the methods to objectively demonstrate to his pro-

The same model predicts the view of a camera with 12mm lens mounted in the top right corner. Coverage and %R are clear.

spective customer the shortcomings of his rival's bid in a way that words could never do. So often, seeing is believing, and a salesman who can *show* that his proposal gives them what they want, and that his rival's clearly does not, can secure profitable business on its merits at any price. Some expensive mistakes during the installation might be avoided completely, to the advantage of all.

Bring life to a boring drawing

This can be especially useful when working on a new build that doesn't actually exist at the time of the CCTV procurement.

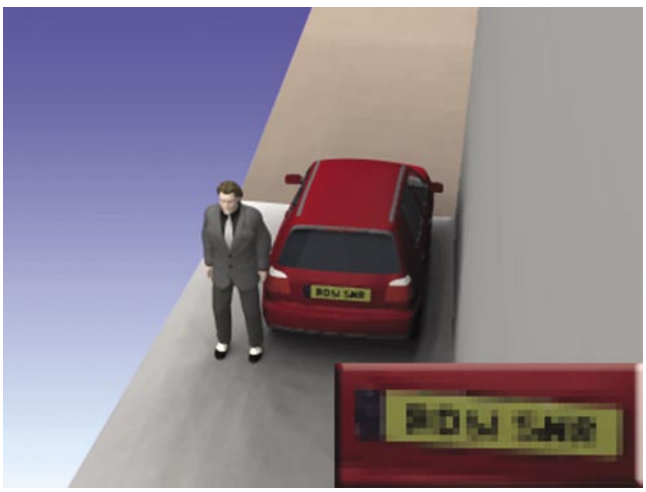
Architect's plans can be adapted to create a virtual world where 3D CAD drawings have virtual cameras inserted so that the fields-of-view can be calculated by the software and displayed as frames approximating the real-world views. Rapid experimentation with camera locations, heights, orientations, pan/tilt sweeps, and lenses can quickly and easily be performed on a laptop computer in the presence of many members of the design team. This can produce optimum CCTV layouts that are clear to everyone involved. They can be altered with ease if requirements change as the project develops.

This building didn't exist when designing the CCTV. The architect allowed one camera. Could it achieve facial 'Recognition' for people along the length of the Reception desk? Yes, with a 6mm lens.

Where the site already exists it is not uncommon for mobile CCTV cameras to be deployed, e.g. van with telescopic mast, to check camera coverage. This has the advantages that particular equipment can be performance tested in a range of lighting situations. However, limitations of time, expense, weather and dangerous or difficult physical access mean that experimentation in the 3D virtual world may be a welcome approach too. This may also be true when important stakeholders cannot attend the tests, or particular targets are not physically available such as Rotakin, moving vehicles, walking/running people.

Dispelling Myths

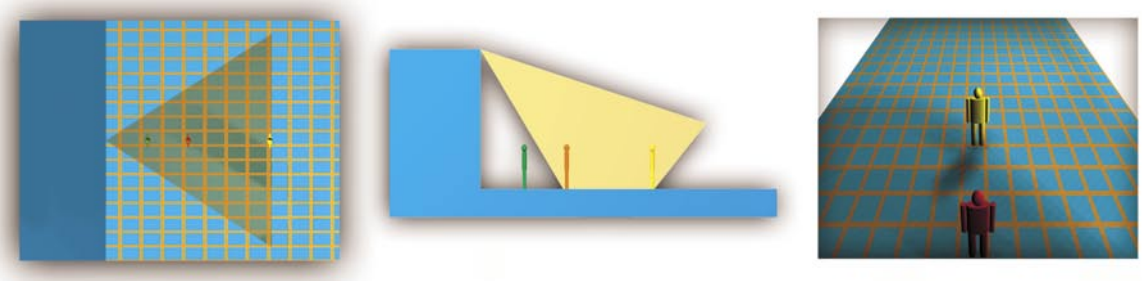
Non-specialist stakeholders can appreciate camera siting and fields-of-view, and can also be helped to understand the limitations of picture resolution by generating camera images with the same number of pixels as a typical DVR recording. Many customers genuinely believe that the police and NASA can enhance their inadequate pictures when required. After all, such marvels are frequently reported on the TV news. If spy satellites in space can read newspapers, and a computer technician in an episode of 'Spooks' can enhance a small fuzzy blob on a CCTV image then surely modern technology has no limitations in their mind. Using these virtual environments the clarity of number plates and peoples faces from *their* proposed cameras can be demonstrated, the limitations clearly seen and the possibility of disappointment reduced.



A supplier says that their proposal will identify vehicles. With this distance & lens a 288x384 pixel image is computed (DVR or VHS playback). The number plate is magnified in the bottom right (inset)

The right way to look at the problem

For many years CCTV systems have been designed by using a lens calculator and drawing triangles on site plans. However, these 2D methods can take no account of the effects of mounting the camera several metres



A two-dimensional plan (above, left) shows that the camera's triangular field-of-view covers the three people satisfactorily, but when we take the rare step of looking at a side elevation (above, centre) the blind spot is revealed. The actual view from the proposed camera is generated by the computer (above, right) so that even non-technical contributors can comment on its suitability.

above the ground or the vertical tilt and the inevitable blind-spot beneath. In addition, the designer has no information about the height of any features that block a camera's clear line of sight, especially trees. So how do we proceed when 3-dimensional details are not available from the customer? Simple surveying skills can quickly provide the necessary measurements for recreation in the 3D CAD environment. We currently use a hand-held laser range finder, Abney level (similar to a sextant for sighting vertical angles), magnetic compass and a tape. For larger, more complex sites we use our theodolite, and may hire a fully equipped surveying team when economically astute. Alternatively, modern 'photogrammetry' software can create 3D models from carefully aligned 2D photographs, or 3D laser-scanners can capture every nook & cranny of complex scenes and are becoming more commonplace.

Moving on

For many years these techniques have been used in the AEC business (architecture, engineering, construction). The world of CCTV has always had 3 dimensions but often designers have chosen to work in 2D as the calculations are simpler! Modern technology offers the tools to do the job properly, and we have actually used these to good effect on a number of projects. There is an indisputable 'wow' factor with the client. We have progressed to the 4th dimension of Time (according to Albert Einstein) and animated the transit of targets through cameras' fields-of-view as this is vital where the gaps in time-lapse recording are such a common feature of CCTV footage.

Incidentally, another interesting use of the technology involves superimposing lifelike computer generated images of proposed equipment onto photographs to help with applications for planning permission (above), and to photo-realistically visualize and plan installations such as control rooms (below).

A stitch in time saves nine

It's my belief that time spent using these new techniques at the beginning of a project can help to minimise problems further down the track. End-users know what they are getting, and the installers know that it can be done. The business management gurus would be proud. We're taking the '3D way'. [•]

This article first appeared in CCTV Image, the journal of the CCTV User Group, in November 2003. It is reproduced with their kind permission.www.cctvusergroup.com

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