How To Design The Perfect CCTV System

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Introduction
With the serious changes that have taken place in society, the need for Security related products have risen to unheard of levels. Among the strongest demand is for CCTV Security Camera Systems. Large and small manufacturers have flooded the market with products to meet this demand.

In the past installation of security camera systems was relatively limited to professional installers. Now with the influx of products both in the retail market and through Internet sales, the use of a professional installer is less common.

You are seeing more “Do-it-yourselfers” installing their own camera systems. The idea is to save some money. However the reality is that many consumers end up choosing a camera system that doesn’t meet their needs. Worse yet, even if they do catch a criminal in the act, the video image is so poor that it can't be used for prosecutable evidence.

What was originally thought to be a good idea can turn into a total waste of your time and money.

About The Author
With more than 15 years in the security industry Steven Williams has seen the business from both ends as an installer as well as the owner of his own burglar alarm company.
The flood of security cameras on the internet has had both good and bad consequences for the consumer. The cost of owning a high quality camera system has gone down but without the proper knowledge consumers are spending too much money on systems that don’t meet their needs.

With this in mind he has put together this Guide so that you can design the perfect CCTV system. You can apply this knowledge whether you install it yourself or choose to use a professional installer.

Just imagine the look on their face when they try to sell you something you don’t need and you have the knowledge to set them straight. I am confident by the time you finish reading this guide you'll be able to design the perfect camera system.

**What Do I Want To See?**
One of the first things you need to decide before designing a camera system is "What do I want to see" It may seem obvious or even silly to ask but not having an answer will cost you money and cause hours of frustration.

The biggest mistake consumers make is to purchase their camera system from one of those wholesale clubs or from a "security company" that doesn't know what they’re doing! What ends up happening is that the system is designed around the number of cameras you want versus the number and types of cameras you need!

For example: Your car's being vandalized (50ft away) so you may think that you need only one camera to cover the whole front yard and to see your car. This application actually needs 2 cameras. Here's why: To see the whole yard you need a camera with a wide-angle lens. This produces a large field of view left to right but at distances beyond around 14 feet you won't be able to identify the vandals face.

The proper lens would for the second camera is a 16mm lens. This produces a close up view of the car but only a few feet to the left or right of the car. This simple example gives you an idea of how important it is know what you want to see before you determine the number of cameras you need.

**Here is a list of other questions you'll need to answer**
- How many cameras will be used indoor and how many used outdoor?
- How much light is available during the day and nighttime hours?
- Color or Black/White
- What will you be mounting the cameras to?
Ok so now that you have a general idea of what you want let's go into more specific detail. All cameras need light to operate properly. It can come in the form of sunlight or artificial light such as light poles or infrared light. If you look at the specifications of cameras you will notice a lux rating like .05 lux etc. Lux without getting to technical is used to measure available light.

Here are some common examples of Lux ratings:
- Direct sunlight 100,000 - 130,000 Lux
- Overcast day 1,000 Lux
- Deep twilight 1 Lux
- Full moon 0.1 Lux
- Quarter moon 0.01 Lux

Selecting A Camera For Your Needs
Security cameras can be organized into 4 major types

1. **Bank Style Cameras** are rectangular. They can be used indoors or outside, if used with a camera housing. Features such as back light compensation (BLC) are included. This is probably the most versatile camera style because of it's ability to change lenses and adapt to most lighting conditions.

2. **Color Day/Night Cameras** are mainly used for outdoor applications. Is color by day and automatically switches to B/W at night using infrared illuminators? Some do not use illuminators but switch to low Lux B/W mode at certain light levels. Produces clean clear picture

3. **Bullet Cameras** can be used in doors or outdoor. Has built-in weatherproof housing. General-purpose cameras with few bells and whistles. Cannot change lenses

4. **Nanny Cameras** for indoors use. Disguised in ordinary items such as alarm clock radios
**Color Vs Black/White Cameras**

Most consumers choose a Color or B/W camera based on cost alone. This is another area where a big mistake can be made. Although it’s easy to understand trying to stay within a set budget, the choice of camera should be made based on the available lighting level and what you want to "see"

Color cameras need more light to work than do black and white cameras. That's why you'll see the B/W camera with generally lower lux ratings.

In this next example a clerk is getting ready to close his store for the night. The parking lot is dimly lit and he is concerned about his safety while walking to his car. Since his main concern is whether or not someone is lurking around versus who it is, a B/W camera is better suited for this situation.

Using a low lux B/W camera will not only save him money but the video will be clearer than a color camera. If the parking lot is well lit then you may consider using color. You would still need to match the proper lens to take advantage of the details a color camera would provide.

Another option is to use a color day/night camera. This type of camera is color when there is adequate light available and produces a B/W image at night using infrared illuminators. These cameras are ideal when there is no light available.

They do have a down side though, infrared illuminators produce a light that is invisible to the naked eye but to a camera it's like shining a spotlight in the area the camera is looking in. This spot light effect tends to "ghost" objects that get close to the camera.

So the bottom line is, it is better to use B/W cameras outside such as a super low lux .0003 camera if the primary application is for night time use. Use color cameras for indoor use or where you have good lighting conditions.

**Proper Camera Placement**

This is an often looked but very important element of CCTV design. If you are installing outside security cameras keep in mind where the sun rises and sets. The sun can create glare on the lens that would make your video image useless during these times.

If at all possible avoid positioning you camera in the direct path of the sun and choose a mounting height that will let you look slightly downward at your viewing area. In addition look for cameras that have built-in sun
shields. The combination of preplanning and mounting height will eliminate most of the problems you will face but sometimes there is nothing you can do.

There is a different set of problems for interior cameras. Because ceiling heights average around 8 feet high there is a limited amount of angle you can create to avoid direct sunlight. This is especially problematic for cameras facing windows.

The sun creates an excessive amount of background light, which causes a silhouetting effect. A person standing in front of the window would very hard to recognize. To combat the sun in this situation look for a camera with a feature called backlight compensation and use an auto iris lens.

For the most part you don't have to worry about the size of outside cameras but with interior cameras this can be a major concern. No one wants a huge camera hanging on his or her living room wall.

Here you have a couple of options. You could use a miniature pinhole lens camera or even a hidden camera such as a motion detector camera. These discrete cameras can easily blend in with the surroundings.

Since a standard wide-angle lens has about a 90-degree field of view you should place most interior cameras in the corner of the room. This placement will give you the maximum viewing area.

**Choosing The Proper Lens**
The one size fits all approach to lens selection leads to big mistake #3. Most out of the box camera systems that are sold by "wholesale clubs" use wide-angle lenses. Usually a 3.6mm or 4mm lens. Don't get me wrong there are many times that these lenses will work for your application. The problem is that when you need application specific lenses they either won't know what you'll need or it's simply not sold that way.

There are several styles of CCTV Lens available on the market such as fixed focus, manual iris lens, vari-focal, DC auto iris and zoom lens to name a few. They can be further divided into 2 categories.

C mount lens and CS mount lenses. To the naked eye a C and CS mount lens look identical. The only real difference between them is how far the lens is from the camera chip. There aren't any performance differences. A CS mount lens is 5mm closer than a C mount. You can use a C mount lens using an adapter ring on a CS mount camera but not the other way around.
Don't worry too much about CS and C mount lenses. CS mount lenses are pretty much the standard used today, but just double check the camera specs to see which one it requires.

The best way to determine the lens size you need is to use a viewfinder. You simply look through it; adjust the viewing ring until you are satisfied with the view. Then read off the number on the side to get the size lens you need.

These viewfinders are a bit pricey but well worth it if you have a large number of cameras to purchase. If you are looking for prosecutable evidence then a good rule of thumb to use is for every mm of lens multiply that by 4. So a 4mm lens will give you facial features of someone about 16 feet away.

If you can't justify spending the money on a viewfinder then there are many online lens calculators available. I like using this free [Lens Calculator](#). It not only gives you a numerical value for your field of view but also some example pictures to visualize what each lens size will look like.

Next we'll determine the type of lens you need. If your camera location has adequate and constant light then a fixed iris lens will work. For placements that will be subject to variable lighting conditions you'll want to use auto iris lenses. These types of lenses automatically adjust the opening and closing of the cameras iris and lighting conditions change. This keeps your images from being too bright or too dark.

One way to take all the guesswork out of selecting a lens is to use vari-focal auto iris lenses. This saves you time and hassle because the lens does all the work. Once the camera is installed simply adjust the field of view to what you want. The auto iris is good in all lighting conditions.

**Monitors**

When choosing a monitor for your system you should try to purchase one that has at a minimum the same lines of resolution as your cameras. A line of resolution is the total number of horizontal lines a camera or monitor produces. The more lines of resolution the clearer the picture will be.

In an attempt to save money you might be tempted to use a regular TV. A TV will work using the right video connectors but you'll actually be wasting money if you purchase high resolutions cameras.

CCTV monitors are designed to show the video in higher resolution than a TV. Why buy spend your time and money designing a camera system.
expecting to identify a thief only to be disappointed at the quality of the picture. If you put what you learned so far into practice you can’t blame the camera or the recording device it will be the TV you hooked up.

Many low-end camera systems use a "Quad Monitor". They combine a quad processor and a CCTV monitor. A quad processor let's you display 1 camera at a time, switch between cameras on a timed interval or display all 4 cameras at once. In theory this sounds like a good idea. In reality there are multiple problems associated with these systems.

1. With multifunction products, the manufacturer combines two middle of the road products. Instead of you choosing the level of quality for each component.

2. If one of the products goes bad the entire system is down.

3. You can't expand the system. You only would have to replace the quad processor to accommodate more cameras

4. They use "telephone type" wire and connectors instead of the industry standard BNC connector or RCA connectors. This really limits the type and quality cameras that can be used.

Monitor Size
The size of your monitor is not only a matter of preference but will determine how well you see your video images. For a single camera system, just about any monitor will work. However if you’re smart you will plan ahead and purchase a larger monitor. This is so you can expand later without having to buy another one.

The reason you need a large monitor for 4 or more cameras is you'll be looking at more than one camera at once. Your screen will be divided into smaller sections. The more cameras you have the smaller each section is.

You still can pull up an individual camera in full screen in live mode. The type of video processor will determine if you can pull up an individual camera to full screen of recorded images.
Recording Devices
There are 2 basic types of Digital Video Recorders (DVR’s). The first is a PC based system with a special video capture card and the second type is a stand-alone non-PC based system.

DVR’s have advanced features such as motion detection recording and the ability to remotely view your property from anywhere in the world. This is an absolute must have feature. If a DVR doesn’t have it, DON’T buy it.

PC Based Systems offer the most features but require an enormous amount of processing power, memory, and operating system resources. PC based DVR’s are much more expensive than stand alone DVR’s so be sure that your needs merit the extra cost.

Stand Alone Systems offer many of the same features of its PC based cousin like motion activated recording and remote viewing but at a much more reasonable price.

Shop diligently. Lower cost DVR’s exclude full multiplexing, which does not allow you to view an image in full screen mode after a recording in its original quality. They take a quad recorded image and "digitally" zoom one of the cameras to give you the illusion it is multiplexed.

As with any digitally zoomed image, you lose image quality. You can identify a DVR that does full multiplexing by checking to see if it offers both "quad" and "field" modes.  

The amount of hours a DVR will record is dictated by frame rate you record and the size of the hard drive. You will need to factor in how long you need to keep the recordings.

Although motion detection recording helps limit amount of “dead time you record, you may still need to record 6-8 hours a day. When the capacity of the hard drive is used up it starts recording over old recordings. Be sure to pay close attention to the specs of the DVR and ask whether you can export the recordings to an external device.
**Installation Tools & Techniques**

All cameras need to be powered and have a way to get the video signal back to the monitor and recorder. The most reliable way to achieve this is to "hardwire" your camera system. Some camera locations may require wireless transmission of the video signal but you should avoid using wireless if possible. Wireless is best suited for temporary surveillance applications.

Video / Power cable can be purchase pre-made in specific lengths like 25', 50' etc. It can also be purchased in bulk rolls of 500’ or 1000’ that can be made to custom lengths.

Although using pre made cables is perfectly acceptable there are drawbacks over making your own. With pre made cables, the connectors are already on the wire so you have to drill a larger hole to pull the wire through an opening.

You may also have excess wire to deal with. This is especially bad when it's on the monitor end. Making custom cables makes for a neater installation and costs less per foot.

If you decide to make your own cables you will need some specialized tools. One is a wire stripper, the other is a crimper You will use these to prepare your cable for "BNC" connectors. Using these industry standard connectors will insure that your wiring is compatible with most cameras on the market. It also allows you to replace or upgrade your cameras at a later date without having to rewire your system.

Most installations require that you hide your wiring as much as possible. You can do so by "fishing" the wire through your walls and ceilings. We first drill a 3/4 inch hole in the top wall plate as well as where you will be mounting the camera. This size hole will allow you to use the pre-made cables or the custom made cables.

We insert small flexible fiberglass rods into one hole and try to push it out the other end. They come in 6' lengths and can be combined with other rods. This is especially helpful when pulling wire over long distances like a drop ceiling.

Once the rod is sticking out the other end, attach your video cable to it and pull the wire out until about 18" is sticking out. You'll have plenty of wire to work with.
Another type of wall fishing tool is called a fish tape. It is a long metal wire that is wound onto a spool. You simply pull out a small amount and feed it into your hole. Keep pulling and feeding it until you can attach your video cable to it.

**Power Supplies**
Individual transformers or a [power distribution panel](https://example.com) can power your camera system. For neater installations especially for systems with more than 4 for cameras, use a power distribution panel. A power strip with 8 outlets fills up rather quickly when you also plug in the monitor, recorder and 4 transformers.

I hope that you have enjoyed this report. The knowledge you have learned will save you money and hours of aggravation

Best of Luck
Steven Williams