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New TV Technology

as of January 2007

Once upon a time, when only analog, tube TVs were around, buying a new set used to be a whole lot less of a nerve-racking experience. Now, there are all sorts of questions. Do you go wide or not? Is LCD better than plasma? And what's the difference between rear-projection LCD, LCoS, and DLP HDTVs? If all the tech jargon has you confused, don't worry. Read our guide to the pros and cons of new, high-tech TVs, and you'll feel a whole lot more confident when you hit your local electronics store.

Direct-view (tube) TVs

Upside:	Relatively inexpensive; excellent picture quality; wide viewing angle.
Downside:	Bulky and heavy; limited screen size; lower resolution; usually not PC-compatible.
Forecast:	These sets are still going strong, and their low prices will keep them around in smaller screen sizes for years to come.

Direct view is how industry insiders refer to any television that doesn't use projection technology. Most of them are the familiar tube TVs you see everywhere--they're called *tubes* because the glass forms the business end of a cathode-ray tube (CRT). Direct-view tube TVs can be found in sizes up to 36 inches (diagonal), and as their screen sizes increase, so does their heft and depth. Sony's 34-inch KD-34XBR960, for example, tips the scales at nearly 200 pounds, measures 24 inches deep, and requires a minimum of two--and probably three--burly guys to lift it onto a stand. Because of size and weight issues, it doesn't pay for companies to make larger tube TVs; they simply aren't practical.

High-end tube TVs can give a great-looking picture. CRTs are still the kings of *black level*, a term used to describe the quality and the depth of black and other very dark colors. Direct-view tube sets look good from any angle, so unlike flat-panel LCDs and rear-projection sets, the picture quality doesn't change depending on where you sit. Compared to flat-panel and

microdisplay TVs (see the following sections), however, direct-view sets often look softer with high-definition material because they can't deliver as much detail. Most tubes won't accept high-resolution PC sources. Also, tubes suffer from more geometry errors than do flat-panel sets, which can make straight vertical and horizontal lines appear to bend onscreen.

New developments

Flat vs. curved screen: The traditional curved shape of the glass tube is giving way to completely flat glass. Sony introduced flat tubes first with its Wega televisions, but now, just about every manufacturer sells some kind of flat-tube TV. Flat glass not only looks more high-tech, it collects less ambient light from the room and, therefore, helps to reduce glare. But it's a myth that flat tubes result in straighter lines; they can have the same geometry problems as their curved counterparts, especially near the corners and the edges of the screen.

***Digital vs. analog*:** Many tubes are still entirely analog, meaning that they won't work with high-definition tuners or progressive-scan DVD players. An increasing number of direct-view tube TVs, however, can display high-def. These sets still use the tube, an inherently analog display technology (unlike plasma, LCD, DLP, and the rest; see the following sections), but if they can accept and display high-def and progressive-scan images, they qualify as honest-to-goodness HDTVs.

***Wide-screen 16:9 vs. standard-screen 4:3*:** For the strongest theatrical impact, the majority of movies are filmed in the wide-screen format, where the screen is much wider than it is tall. Regular televisions and most TV programs use a narrow-screen, 4:3 aspect ratio, which refers to the width of the screen compared to its height. Newer TVs--especially HDTVs--often have screens with a much wider ratio: 16 units of width for every 9 units of height, which translates to a 16:9 aspect ratio. Wide-screen, direct-view TVs cost more than 4:3 models for the same amount of screen real estate, but they're great if you watch a lot of DVDs or HDTV.

Thin tubes: Some TV makers are coming out with so-called thinner tubes that are much shallower than standard tubes of the same size. Samsung's TX-R3079WH is a good example: its depth measures just 16 inches, which is about 6 inches shallower than a typical 30-inch wide-screen tube TV. While that depth is definitely thinner than usual, it's certainly not flat.

Flat-panel TVs: plasma and LCD

The biggest television-technology revolution since color, flat-panel TVs will eventually replace tubes as the direct-view televisions of choice. You can hang flat sets on the wall, on the ceiling, or above the mantle in place of a trophy buck. The two major players in the flat-panel game are plasma and LCD, so we'll go over each type separately.

Plasma

Upside:	As little as 3 inches thick; very good home-theater image quality in best examples; wide viewing angle.
Downside:	Relatively expensive; slight potential for burn-in; generally lower native resolution than similarly sized LCDs.
Forecast:	Prices have fallen, and pictures have improved dramatically, perpetuating plasma's place as king of the flat-panel home-theater hill.

With prices starting around $2,000 for high-resolution models, a coveted plasma TV is within reach of most shoppers. But now that you can get a 40-inch LCD for about the same chunk of change, plasmas have to depend on factors other than price to remain competitive against their flat-panel nemeses.

Picture quality varies greatly between different makes of plasma, so be sure to read reviews before you plunk down your cash. Despite significant advances, plasma panels still can't quite replicate the deep blacks that tubes can. Otherwise, the best plasmas can produce nearly CRT-quality images, with excellent color and viewing angles, and high-resolution models (as opposed to EDTVs) appear demonstrably sharper than most CRTs when showing high-def sources. LCDs generally have higher resolution at similar screen sizes, however, which affects visible detail with HD and computer sources.

Burn-in: You may have heard that plasma has a couple of drawbacks. One such downside is burn-in, which occurs when an image--such as a stock ticker, a network logo, or letterbox bars--gets etched permanently onto the screen because it sits in one place too long. In our experience, the danger of burn-in has been greatly exaggerated, and people with normal viewing habits have nothing to worry about. The potential for burn-in is greatest during the first 100 or so hours of use, during which time you should keep contrast low (less than 50 percent) and avoid showing static images or letterbox bars on the screen for hours at a time. After this initial phase, plasma should be as durable as any television technology. Many panels also have burn-in-reduction features, such as screensavers and pixel orbiting, or settings to treat burn-in once it occurs, such as causing the screen to go all white.

Plasma life span: The life span of plasma TVs is another area that's improved dramatically over the last few generations of the technology. Partly in response to claims made by LCD TV makers, plasma manufacturers now claim their panels last an extremely long time. Most plasma makers today claim that their 2005 models have a life span of 60,000 hours before the panel fades to half brightness. According to a 2005 Nielsen study the average household watches 8 hours, 11 minutes of TV every day. Even if the real figure is closer to 30,000 hours, and the plasma is the only TV in the house, that works out to more than 10 years before the set reaches half-brightness--about what you'd expect from a direct-view CRT.

LCD

Upside:	Higher resolution than comparably sized plasmas; no danger of burn-in;

	available in a range of sizes.
***Downside*:**	Relatively expensive; home-theater image quality generally not as good as plasma; relatively narrow viewing angle.
***Forecast*:**	Flat-panel LCD will continue to be the most popular HDTV technology, thanks to falling prices and plenty of choice.

Flat LCDs are extremely popular in screen sizes below 37 inches, thanks to their stylish looks and the fact they can fit just about anywhere. Larger LCDs--as high as 65 inches--remain more expensive than plasma and rear-projection models, but in the critical 40- to 42-inch size range, LCD prices have dropped precipitously. As of spring 2006, flat-panel LCDs in this size range can be had for around $2,000--pretty much the same as plasmas.

The picture quality of LCD has historically suffered from poor black levels, but the latest versions are much improved, if not quite up to the best plasmas. That's because LCDs cannot achieve a true black since there's always some light leaking through the pixels. Color saturation is also generally inferior to plasma, again as a result of the inability to completely blacken (turn off) the pixels. Light leakage affects the purity of the color.

Viewing angle is another weakness of LCD compared to plasma. On every LCD we've reviewed, we witnessed some brightness and color shift visible when we watched from an angle that's far from the sweet spot right in front of the TV (to either side, and especially above or below). Plasmas look equally good from very wide angles.

On the other hand, LCDs will generally have higher native resolution than plasmas of the same size, leading to slightly better detail with HD and computer sources--although high-resolution plasmas have plenty of detail for most viewers. LCD spec sheets often talk about response time, but in our experience, almost all newer LCDs have adequate response time to deal with fast motion. LCDs also have a reputation for being brighter than plasmas, and while that's technically true, plasmas are generally plenty bright for even the most demanding high-ambient-light viewing.

Plasma vs. LCD

In terms of picture quality, plasmas and LCDs are becoming more and more equal, although we still generally recommend the best plasmas over the best LCDs for critical home-theater viewing. Most people will be perfectly happy with either technology, however, especially with high-def sources. For screen sizes between 37 and 42 inches, the buying decision generally boils down to price, the performance of individual models, and the perception of plasma's fragility, a perception that, again, is largely mistaken.

When it comes to flat-panel TVs, you have a choice between two types: **plasma** and **LCD** (liquid crystal display). Which is better? That depends. You'll get a great picture either way, but there are factors you may want to consider.

See the chart below for a quick comparison of plasma and LCD TVs.

Comparison	Plasma	LCD
Screen Size	Generally larger than LCD. Screen sizes up to 60″ or larger.	Wide range of sizes, topping out around 45″.
Viewing Angle (Refers to how far you can sit to the side of the screen without losing picture quality)	Typically has a wider viewing angle than LCD.	Newer LCD displays with wider viewing angles are making this less of an issue.
Comparison	**Plasma**	**LCD**
Brightness/Contrast	Very Good	Very Good
Motion Tracking	Very Good	Good to Very Good
Thickness	About 4 inches deep	About 3 inches deep
Screen Burn-In	Moderate Risk	No Risk
High-Altitude Performance	May be affected by high altitudes. However, some plasmas specifically designed for high altitudes.	Not affected by high altitudes
Product Lifespan (Time it takes the light source to fade to half its original brightness)	30,000 — 60,000 hours. Once the light source in the cells is gone, generally not repairable.	50,000 — 60,000 hours When bulb burns out, it can be replaced, but it may be expensive.
Advantages	Available in larger sizes Truer, natural color Superior brightness & contrast (in darkened room) Sharp motion tracking Lower cost per square inch	Lighter & more durable Superior brightness & contrast (in bright room) Easily wall-mountable No burn-in Excellent for use as a TV & PC display
Disadvantages	Susceptible to burn-in Heavier, so may need additional supports to mount on a wall	Picture slightly less natural than top plasma TVs Slower response time: motion not as sharp

Rear-projection TVs: CRT, DLP, LCD, and LCoS

Thinking of going big? Sure, you could buy a 65-inch plasma, but most people who want to maintain a good credit rating will opt for a rear-projection television (RPTV) instead. These sets start at 42 inches (diagonal), and almost all have a 16:9 aspect ratio and are HDTV-compatible. Their big screens hide two basic varieties of display technology: old-fashioned CRT tubes, and microdisplays that use DLP, LCD, or LCoS technology. Here's an introduction to the choices.

CRT

Upside:	Relatively inexpensive.
Downside:	Deep cabinets; need periodic maintenance; not ideal for bright rooms; narrow viewing angle; softer image than microdisplays; most cannot display computer signals.
Forecast:	These dinosaurs are quickly being phased out in favor of lighter, lamp-driven microdisplays, and their demise in clearly in sight.

Tube-based RPTVs used to rule the big-screen roost, but unless you're really strapped for cash or willing to get professional calibration to achieve the best home-theater image quality, we recommend skipping the tube in favor of a microdisplay. Tubes are not as bright as microdisplays and require careful setup and regular convergence adjustments to achieve sharp focus and maintain alignment of the red, green, and blue CRTs.

Low prices will keep CRT-based big screens in the game for another year or two, and videophiles may indeed point out that the best examples of this technology still provide superior image quality in many ways. They still have better black levels than any microdisplay; they generally have deep, well-saturated color; and they can achieve a sharp picture if adjusted properly. Truly good-quality CRT-based big-screens are basically nonexistent now, however, and the product category as a whole is destined to die off sooner rather than later.

Microdisplays

A new generation of rear-projection televisions has effectively succeeded CRT-based RPTVs by now. These sets are called ***microdisplays*** because they're based on one or more microchips that contain thousands or millions of pixels. DLP, LCD, and LCoS are all competing types of chips. All current microdisplay rear-projection TVs contain a lamp that bounces light off of (DLP and LCoS) or through (LCD) the chip and onto the big screen. Below is a brief look at how microdisplays differ from standard televisions, as well as a cheat sheet to give you a quick grasp of the many abbreviations and terms in this category. More in-depth explanations of each technology follow.

The lamps inside these sets, which cost $200 and more, must be replaced every 3,000 to 10,000 hours, depending on technology and conditions of use. You can replace most lamp assemblies yourself.

The bulbs take from 20 seconds to a minute to warm up and cool down.

The TVs are generally lighter and slimmer than CRTs, and you almost always need a stand to get them to eye level.

Most can display computer, as well as high-def and standard TV, and usually look better when fed a digital (DVI, HDMI, or FireWire) rather than an analog connection.

Unlike rear-projection CRT sets, all microdisplays can get quite bright without losing detail, so they're perfectly watchable in brightly lit rooms.

Microdisplay cheat sheet Full name

DLP	Digital Light Processing
LCD	Liquid crystal display
LCoS	Liquid Crystal on Silicon

Chipsets, variations, and brandings HD2, HD2+, HD3, xHD3, 3-LCD, H-LCD, HD-ILA, SXRD

Main picture-quality advantage(s)	Good pixel fill and uniformity; deep blacks in better models
	Lack of rainbow effect
	Excellent pixel fill; lack of rainbow effect; deep blacks in better models; 1080p chips have all 1,920x1,080 pixels
Main picture-quality disadvantage(s)	***Rainbow effect; low-level noise; wobulated resolution on many chips***
	Black level; screen door effect; uniformity; no 1080p chips
	Uniformity
Pervasive myth	***Causes headaches***
	Degrades over time faster than other microdisplays
	Subject to burn-in

DLP

***Upside*:**	Very good black-level performance on the best models; excellent uniformity.
Downside:	Rainbow effects; some low-level video noise; currently no nonwobulated 1080p models.
Forecast:	DLP is getting only cheaper and more popular, although it has some catching up to do to equal the best LCoS sets' picture quality.

DLP was developed by Texas Instruments, and the company sells many types of DLP chips to numerous traditional and not-so-traditional TV makers, making DLP the most widespread and popular technology of the three.

A tremendous range of DLP-based sets are available today, and their image quality varies greatly according to price and manufacturer. Entry-level models, among the least-expensive microdisplays you can buy, generally have 720p native resolution (1,280x720), although naturally they can also accept and display 1080i HDTV signals. Step-up models have 1080p resolution (1,920x1,080), which can deliver sharper images with 1080i HD and computer sources.

Both 1080p and some 720p DLP televisions use a technique called *wobulation* to achieve their stated native resolutions. With wobulation, which Samsung calls SmoothPicture, the DLP chips have half as many physical pixels (a 1080p chip has 960x1,080 pixels). A tiny mirror or lens moves rapidly back and forth to alternately create the first and second halves of the image and achieve 1,920x1,080 resolution. Wobulation can produce good results, and on some 1080p TVs, it can technically deliver all 1,920 lines of horizontal resolution; on other sets, it makes the image look softer. As usual, performance varies from model to model.

One potential problem with DLP sets is known as the *rainbow effect.* Some people can see brief streaks of color on these TVs, especially in images with black fields and some bright features (such as a spaceship). This is caused by the fact that the single DLP chip uses a color wheel to create red, green, and blue, and hence all colors. The occurrence of these rainbows has been significantly reduced with the advent of newer, faster color wheels, and most people who watch a DLP never see rainbows at all (and the few who do usually see them only occasionally). DLP HDTVs do introduce a bit more low-level video noise, which can look like tiny dancing pixels or specks in shadowy areas, than other microdisplay TVs.

Upcoming DLP technologies address a few of these issues. At the 2006 Consumer Electronic Show, Samsung announced a DLP set with an LED light source (as opposed to a traditional lamp), which the company says will reduce rainbows and have other benefits. A few other companies will also offer LED DLPs this year. Mitsubishi demonstrated a laser-powered DLP HDTV at its 2006 line show but doesn't expect to ship one until late 2007. Nonwobulated 1080p DLP chips have also been developed for front projectors, and we expect them appear in high-end DLP RPTVs by 2007.

LCD

Upside:	No rainbow effect.
Downside:	Blacks not as deep as the best LCoS or DLP sets; not as bright as DLPs; some uniformity issues; visible screen-door effect; no 1080p versions.
Forecast:	LCD will continue to challenge DLP among entry-level sets, but it needs a 1080p version to compete against high-end models.

While less popular than DLP models, LCD-based rear-projection sets should continue to do well as long as the Big *s* stays in the game. Sony has developed a better chip than LCD, however, which it calls SXRD (see below) and puts in its higher-end rear-projection HDTVs.

Until LCD makers bring a true 1080p microdisplay to market, the technology will remain the province of entry-level sets.

The best DLP and LCoS sets still hold the lead in producing the deepest blacks, but LCD chips have made serious improvements. Translation: Unless you have them side by side, you probably won't be able to tell which of the two delivers the deepest blacks. Prices for similarly sized DLP and LCD TVs will likely remain close as big-brand behemoths face off and try to outdo one another.

Another area where DLP and LCoS have an image-quality advantage is something called the *screen-door effect.* If you sit close to an LCD, you may notice a faint grid of pixels, much like a screen door, overlaid atop the image. You're seeing the space between the pixels, which is more visible on LCD than on the other two microdisplay technologies. It's generally not noticeable even on LCDs unless you sit closer than twice the diagonal measurement of the screen.

LCD and LCoS also generally have more white-field uniformity issues than DLP. With expansive flat fields, such as the ice in a hockey rink, some LCD and LCoS sets introduce slight discoloration into some areas of the screen. This effect varies widely from model to model, but DLP sets are generally immune. DLP sets are also generally capable of producing brighter images than LCDs.

LCD's big advantage over DLP, and one that it shares with LCoS, is lack of the rainbow effect--a big deal if you see rainbows on DLP sets and a moot point if you don't. Don't put too much stock in the slightly higher native resolution afforded by some LCD chips; in the big scheme of things, 1,386x788 doesn't provide much of a sharpness boost over 1,280x720. DLP makers have also claimed that the organic compounds in LCD chips degrade over time, while DLP chips do not. Though this is essentially true, it has little impact on real-world product life span because LCD chips still last very long time under normal working conditions. While LCoS and DLP makers tout the "inorganic" nature of their chips, we don't consider that a major reason to choose one technology over another.

LCoS

Upside:	Excellent black levels on the best models; great interpixel fill; no rainbow effect; true 1,920x 1,080-pixel chips on 1080p models.
Downside:	Some uniformity issues.
Forecast:	In terms of pure picture quality, LCoS has the potential to be the best, although these sets can cost more than their LCD and DLP counterparts.

LCoS has been through some trying times, and Philips, Toshiba, and Mitsubishi are among the heavy hitters that produced early-generation models, then decided to abandon the technology. Intel even floated a rumor that it would enter the LCoS stakes, which has since proven untrue. In the second half of 2004, JVC and Sony introduced variations on LCoS chips, but 2005 was LCoS's breakout year, with both companies introducing high-end 1080p models that offer

excellent performance. It remains to be seen whether other manufacturers will jump on the LCoS bandwagon, although chipmaker Brillian has recently introduced an expensive LCoS line of its own. Since JVC and Sony are pretty much the only games in town, we'll deal with them individually.

Front-projection TVs

At the top of the screen-size ladder, you'll find displays that don't really qualify as TVs: front projectors. These light cannons can easily fill 100-inch screens, but they're not for everybody since they require a light-controlled environment and plenty of room. Plus, for optimal picture quality, you'll want to buy a dedicated screen, although you can use a white wall in a pinch. Screen makers such as Da-Lite and Stewart have special, low-gain screens designed to improve black-level performance for LCD and DLP projectors.

CRTs are also used in front-projectors; think of those three-tube monstrosities that hang from the ceiling in the coach compartments of older airplanes. We won't discuss them here, however, namely because CRT projectors are quite expensive and are generally reserved for high-end, custom installations, where they put the local cineplex to shame. We'll forgo a discussion on LCoS front projectors, which are also generally quite expensive, until we review one.

DLP and LCD projectors, on the other hand, often cost much less than their rear-projection cousins and sometimes much more. Both technologies project the kind of huge picture--from units as small as a shoebox--that you enjoy at the theater.

DLP

Upside:	Can get extremely bright; decent uniformity; generally better black-level performance than LCD.
***Downside*:**	More expensive than similar-resolution DLP models; rainbow effect.
Forecast:	Already the most popular technology for home-theater projection, new less-expensive 720p versions will make DLP even more desirable.

DLP-based projectors come in all prices, resolutions, and picture qualities, so it's tougher than usual to generalize about them. That won't stop us from saying, in general, that DLP projectors can produce a brighter image than their LCD counterparts, and their black-level performance is also usually slightly better. DLPs suffer from the same rainbow effect as their rear-projection brethren, although very expensive three-chip models do not.

Historically, true HD-resolution--1,270x720 or more--DLP units have cost significantly more than the 720p LCD competition, but very recently, a slew of more affordable 720p DLP projectors have begun hitting the market. They still cost a bit more than the LCDs and usually don't offer features such as lens shift, but nonetheless, they're destined to seriously increase the popularity of HDTV-resolution DLP models. At the other end of the spectrum, true 1080p resolution DLP projectors are coming out this year, which should offer excellent image quality and will definitely cost a bundle.

LCD

Upside:	Usually less expensive with more features than DLP models of the same resolution.
Downside:	Some screen-door effects; often not as bright as DLP models.
Forecast:	The advent of cheap DLP models is forcing LCD to improve in every regard, as well as drop in price.

LCD and DLP are very close in terms of performance, and even LCD's ability to produce good blacks has improved quite a bit. DLP still enjoys a slight edge in contrast ratio, however, mainly because its projectors can get a bit brighter than those of LCDs. The screen-door effect, which appears as a fine grid of pixels overlaying the screen, is also more noticeable on most LCD projectors. As we mentioned above, however, 720p LCD projectors still enjoy more features than their budget 720p DLP competition, including highly desirable items such as horizontal and vertical lens shift. Otherwise, LCD offers a similar selection of resolutions as DLP models

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