What to Look for in a Home Entertainment Projector

Jeffrey Hsieh  12.02.2014

This whitepaper looks at why users choose projection vs. flat-screen; reviews the differences between the traditional “home theater” and emerging “home entertainment” segments; and outlines what to keep in mind when shopping for a home entertainment projector.
What to Look for in a Home Entertainment Projector

Introduction

In today's Internet-fueled entertainment world, many in-home audiences are seeking to create a larger, more exciting viewing experience. Many are also looking beyond the familiar flat screen TV for their media room entertainment canvas. Offering the capability to deliver images of 100" or larger, projection systems provide a more realistic, big-screen environment with the added bonus of easy portability (when not ceiling mounted). Once primarily used by home theater enthusiasts with deep pockets and the desire to closely replicate a high-end theater experience, a newer class of “home entertainment” projectors offers the advantages of projection with a lower price tag.

Why a Projector?

Projectors and flat screen TVs can both offer a highly satisfying entertainment viewing experience. Each has differing features and benefits and some users simply have a strong personal preference for one over the other. The primary advantage of flat screen LCD TVs is their brightness, which can’t currently be matched by any projector. For rooms with a great deal of ambient light and no curtains, flat screen LCD TVs may be the best option. Some users also prefer the perceived simplicity of one device – the TV display – versus the use of a projector and screen. Hardcore home theater enthusiasts, on the other hand, have long favored projection for its more immersive, cinematic feel, along with the ability to deliver much larger image sizes.

- **Cost** – Projectors offer the best value in terms of cost per screen inch, even when factoring in the cost of replacement lamps and a projection screen. LCD TVs are considerably more expensive.
- **Image size** – Projectors deliver much larger images than possible with a flat screen TV and don’t limit users to one screen size. Depending on room size and lighting, many projectors are capable of projecting an HD image up to 300 inches diagonally, whereas HDTVs have a fixed screen size that currently maxes out at 80 inches.
• **Viewing angle** – Flat screen TVs look great when viewed from the “sweet spot,” but sit at an off angle and the image can be compromised. Projected images stay true regardless of the viewing angle.

• **Portability** – Projectors offer the option of ceiling mounting or freestanding use on a table. The advantage of the latter is the ability to easily take your entertainment elsewhere: to a backyard barbeque or a friend’s house for an epic game day.

• **Image quality** – Due to the constraints of human eyesight, many users won’t experience the visual clarity of Full HD 1080p content on an LCD TV. At the average viewing distance of 9 feet, the benefits of Full HD will only begin to become visible with a 55” screen, and the full visual benefits won’t be achieved until reaching a 75” screen. With a projection system achieving an image size at which high definition viewing can be fully enjoyed is both easier and more cost effective.

• **Entertainment experience** – Many users find that projectors deliver a truer, more cinema-like experience in the comfort of their own home.

• **Flexibility** – With HDMI connectivity, projectors let you easily connect to your PC to stream content and enjoy big-screen gaming.

• **Space-savings** – Paper-thin projector screens or a painted-on projection surface plus a portable or ceiling-mounted projector take up less space than an HDTV. Additionally, projector screens can be easily retracted, rolled up and stored away when you want them out of sight. Portable projectors can likewise be easily stashed away, while well color-matched ceiling-mounted projectors are discrete and camouflaged.

• **Durability** – Breakable LCD TVs and active children are often not a wise mix, especially when your media room doubles as a rec room or family room. Retractable screens paired with a ceiling mounted projector, on the other hand, are safely up and out of the way when the room is being used for other purposes.

• **Reduced eyestrain** – Small, bright focal points can cause eyestrain and visual fatigue and because flat screen TVs are smaller and brighter than projection, they tend to be harder on the eyes. Projected images, with their lower brightness and larger image sizes that fill a larger percentage of the visual field can help reduce both eyestrain and eye fatigue.  

---

1. Subsequent text.
2. Subsequent text.
Home Theater vs. Home Entertainment

When it comes to home use projectors, the wide range of available price points and specifications can be somewhat overwhelming. Understanding the projector landscape becomes easier when this full range of options is broken down into two main categories: home theater and home entertainment. Projectors that fall into these two areas are broadly designed to serve differing purposes and will offer different features and pricing.

Starting at the high end of the price-performance range, home theater projectors are designed to be used in environments that replicate the movie theater experience, that is, very dark, loud and immersive. These environments typically include high-fidelity surround-sound systems and high-end projectors designed to throw as large an image possible in a room with virtually no ambient light. Home theater rooms often lack windows or use light-darkening shades, and ceilings and walls are frequently painted a dark color to further reduce ambient light. Components are chosen to maximize image and sound quality and some may include 3D capabilities. Because the intention is theater-dark viewing, home theater projectors don’t need to be particularly bright and typically range from 1,000-2,000 lumens. Contrast ratio, which is conversely related to brightness, tends to be maximized in these high-end projectors.

Home entertainment projectors, as the name implies, are designed to support a wider variety of home entertainment content in a range of lighting and room conditions. These projectors are ideal for those who value in-home entertainment but don’t want to dedicate the time, money or darkened room space for a formal home theater.

A perfect choice for movies, television, sports programming, gaming and Internet browsing, home entertainment projectors offer big, bold images and built-in sound systems. They are generally used in multi-purpose spaces such as living rooms and family rooms. Because these rooms tend to have a good deal of ambient light, home entertainment projectors tend to be brighter than their home theater counterparts, with
output in the range of 2,000-3,500 lumens. Designed for more casual use, home entertainment projector image quality tends to be somewhat lower than high-end home theater projectors, while still being generally quite good and offering a viable substitute for HDTVs.³

Projectors in the home entertainment category also offer added features that are important for their more versatile use. These include a shorter throw ratio for maximizing the potential of smaller spaces and low input lag (the delay in getting the picture to the screen inherent in all projectors), which is key for satisfying big screen gaming. Home entertainment projectors also tend to be lighter and more portable than home theater models.

Home Entertainment Projector Basics

Home entertainment projectors are designed to meet the needs of those looking to enjoy a wide variety of content on a large screen in a multi-purpose area of their home, as well as to bypass the costs and complexities of a high-end home theater. Within the home entertainment category a range of options exists to meet individual user needs.

The main factors to consider when shopping for a home entertainment projector include:

- Cost
- Projection technology
- Color processing technology
- Picture quality
- Resolution
- Contrast ratio
- Brightness
- Ease of set up and use

Cost

For many, budget is the bottom line. Each of the factors discussed below will affect cost to some degree. In general, the higher the brightness and resolution, and the more connectivity and design features, the higher the cost. Many entry-level home entertainment projectors, however, will offer a combination of these features at an outstanding value.
What to Look for in a Home Entertainment Projector

**Projection Technology**
Most home entertainment projectors are based on one of two technologies: DLP (digital light processing) or LCD (liquid crystal display). A more recent technology, LCoS (liquid crystal on silicon), is mainly used with high- and ultra high-end projectors. DLP is the most commonly used projector technology in all categories, from home entertainment to commercial theaters. DLP offers an outstanding long-term TCO (total cost of ownership) thanks to filter-free designs that eliminate the need to clean and replace filters, and the rarity of light engine failures more common to other technologies.

**Color Processing Technology**
Most projectors in the home entertainment category will include some type of technology designed to enhance color performance. One of the better known, BrilliantColor™ by Texas Instruments, is integrated in many projector brands. Some individual projector manufacturers offer proprietary technology designed to expand upon the familiar benefits of BrilliantColor. Among the benefits to look for are:

- Consistent color performance in both bright and dark environments
- Advanced color wheel design
- Expanded color range
- Dynamic lamp control capabilities
- Automatic or one-touch color/brightness adjustments
- Enhanced gray scale accuracy
- Minimized brightness fluctuations

**Picture Quality**
The three main specifications that affect the quality of the picture thrown by a projector are resolution (along with the resolution of your source material), contrast ratio, and brightness. Determining the best projector for your needs and budget isn’t a simple matter of choosing the “highest” specs. This is because the ultimate picture quality will be determined by the relationship among these factors, along with room conditions, image size and source material. For example, both image size and contrast ratio are conversely related to brightness; as either of these increase, perceived overall brightness will decrease.
Resolution
The term “native resolution” (typically shortened to just “resolution”) refers to the number of pixels a projector has available to create an image. The first number represents the number of pixels in each horizontal row; the second is the number of pixels in each vertical column. Multiplying the two delivers the total number of pixels the projector can display; therefore, the higher the resolution, the more pixels. Higher resolution projectors can display a greater degree of detail and will reduce or eliminate visible pixilation, which delivers crisper viewing at a closer range; they also offer better compatibility with high-definition source content. For the most part, as resolution increases, so does cost.

Currently, Wide XGA (1280 x 800) and HD 1080p (1920 x 1080) are the most common resolutions for home entertainment use. HD 720p (1280 x 720) has been a popular lower-cost alternative; however at present WXGA projectors offer higher resolution in the same price range. As expected, image quality will improve as you move from HD720 to WXGA to HD1080.

Maximum Resolution
A related spec is a projector’s “maximum resolution.” While native resolution refers to the total physical number of pixels displayed by a given resolution, maximum resolution has nothing to do with the projector’s physical display. Instead, maximum resolution refers to which content signal resolutions the projector is able to display. Because content is available in many different signals, each projector is programmed to recognize and process a number of these signals, based on their popularity in a given market. Maximum resolution is the highest signal resolution that the projector is programmed to process and display.

The process of converting signal resolutions that differ from a projector’s native resolution is referred to as “scaling.” When a projector receives a signal that has a higher resolution than its native resolution, the image will be compressed into fewer pixels; when a signal with a lower resolution is received the projector must expand the signal in order to display a full frame image. When source material is scaled there will always be a loss of signal quality, resulting in a somewhat softer image when compared to the same material displayed at its
native resolution. This is particularly an issue with data projection, such as text, Internet content, or financial information, which suffers the most from being scaled.

**Source Content**

It is important to be aware that the resolution capabilities of any projector will be constrained by the native resolution of your source material. Low-quality signals will result in lower-quality images, regardless of the projector’s native resolution. The larger the screen, the more noticeable this will be. The best possible image quality will always be achieved when the projector’s native resolution is matched to the native resolution of your source material.

When it comes to scaling video images, today’s technology can producing images nearly as crisp and clear as they would be displayed in native format. Because of this, projectors capable of delivering solid home entertainment image quality are available at various resolutions and price-points to meet a range of budgets and needs.

As we near the end of 2014, the most popular resolutions for home entertainment projectors include:

- **1280x720** – Also referred to as 720p, this resolution is the lowest considered viable for a home entertainment system. This resolution will generally deliver reasonable image quality for DVD video and 1080p Blu-Ray content and 1080i HD broadcast content via scaling. The visibility of any displayed pixel structure can be virtually eliminated by situating seating farther from the screen. These projectors vary in price from around $449- $649.

- **1280x800** – This hybrid resolution can natively display 720p high definition video as well as XGA (1024x768) and WXGA (1280x800) standard computer resolutions without scaling. For viewing goals that include computer data or web pages as well as video, this format will most clearly display the computer-based data signals. However, the trade off for this capability is the 16:10 aspect ratio (rather than 16:9), which means that 16:9 video content will be displayed with black bars at the top and bottom of the projected image. Pricing for
home entertainment projectors in this category ranges from around $449- $649. 1280x800 projectors priced above this will include commercial-oriented features such as additional HDMI ports and networking capabilities.

• **1920x1080** – Offering the greatest total pixel count, 1080p resolution delivers the sharpest-looking, most detailed images as well as better compatibility with high-definition content sources. With Full HD 1080p resolution, HDTV 1080i signals and 1080i and 1080p signals from Blu-ray disc players are displayed in their native format without requiring scaling. This gives you the sharpest and most detailed images available from most common sources of HD material. Due to the high pixel density, visible pixel structure is greatly reduced for crisp, clear up-close viewing. Prices for 1080p home entertainment projectors begin around $700 and can be as much as $1499. Again, 1080p projectors at higher price points than this will include features designed to support commercial use.

**Contrast Ratio**
Contrast ratio is a measure of the difference between an image’s white and black components. For example, a contrast ratio of 1000:1 indicates that the black levels will be 1000 times darker than the white. Therefore, the larger a projector’s contrast ratio, the greater the difference between the brightest whites and the darkest blacks it can display. In general, as contrast ratios increase, so does a projector’s ability to create greater depth of image. While some high-end home theater projectors offer contrast ratios of 200,000:1 or more, the home entertainment buyer should not assume that anywhere close to this level is necessary for his or her needs.

While desirable for true theater-like conditions, the benefit of high contrast ratios will only be noticeable in highly light-controlled, pitch-black rooms. For the typical multi-use home entertainment room, where the projector will often be used with some degree of ambient light, contrast ratios in the range of 4,000:1 – 10,000:1 will be more than sufficient to deliver a satisfying visual experience. It is also important to note that contrast ratio does not indicate how well a projector will
display the shades of gray falling between black and white. These finer details are adjusted by a projector’s control settings, with multi-color processing technology such as BrilliantColor and sRGM modes enhancing this fine tuning capability.

**Brightness**

Projector brightness is measured in ANSI lumens (or simply, lumens), with brightness ranging from a lumens output of anywhere from 500 – 10,000. While it may seem counterintuitive, brighter is not always better. For one thing, brighter also means more costly; for another, not every environment will require an ultra-bright projector to achieve satisfying results. Factors to consider when determining your brightness needs include:

**Ambient lighting**

Ambient lighting is the most critical factor to consider in determining the appropriate brightness level for your application need. The more light you have, or want, during viewing, the higher brightness you’ll need to deliver a sharp image. Think carefully about the typical viewing conditions in your media room. If the room will always be darkened, or always be lit, you’ll want to choose a projector on either end of the brightness spectrum. A projector bright enough to shine through a great deal of ambient light will be hard on the eyes in a dark room, whereas a low level of brightness will look washed out in a room with lots of ambient light. However, many home entertainment users want the flexibility of using their projector in a range of lighting conditions; for these users a mid-range of brightness will ensure satisfying viewing whether the lights are on or off.

**Audience size/screen size**

The larger the projected image, the lower the perceived brightness of any projector, due to the distribution of light over a larger area. The number of people in a room is a helpful guideline for determining the optimal projected image size for comfortable viewing. As a general rule, the more people in the room, the larger the ideal screen size.
What to Look for in a Home Entertainment Projector

**Type of projection screen**
The amount of light reflected from a projection surface can significantly affect image brightness and quality. Projection directly onto walls will require a brighter projector as walls are generally poor light reflectors. Most purchased projection screens, however, provide a reasonable level of reflection; however this can get tricky and will again be based on your specific needs and environment. According to CNET tech writer Geoffrey Morrison, “Mating a projector with the right screen is crucial to get the best image possible from it. Figuring out what to spend is the real trick.”

Projectors can be grouped by ANSI lumen output as follows:

- **Under 2,000 lumens** – Used in low-lighting environments, these projectors are not typically used for multipurpose home entertainment viewing as they require tightly controlled lighting to eliminate ambient light. Typical uses for these projectors include: home theater, classrooms and small-medium sized meeting rooms.

- **From 2000-3000 lumens** – Representing the mid-range of projectors, these are the typical brightness levels for home entertainment use. Users will generally want to keep lighting at least somewhat dim to achieve a vibrant image. Uses include entry-level home entertainment, conference rooms and classrooms.

- **3000-4500 lumens** – These are the high-performance portable and semi-portable projectors, most commonly used for large conference rooms and classrooms as well as high-end home entertainment settings. With this level of brightness it is not necessary to dim lights, and a crisp, clear image can be expected with standard room lighting, even on larger screens, which enables ease of viewing with larger audience sizes. Projectors with brightness ratings higher than 4500 lumens are considered “ultra bright” and are intended for high-end commercial use.

Mating a projector with the right screen is crucial to get the best image possible from it. Figuring out what to spend is the real trick.
What to Look for in a Home Entertainment Projector

Aspect Ratio
Aspect ratio defines the relationship between the width and the height of an image. It is used to describe projection screens and content sources as well as projectors. For example, a 16:9 projector, projection screen or content source will have 16 units of width for every 9 units of height, resulting in a rectangular shape. Projectors, screens, and content sources with a 4:3 aspect ratio will have 4 units of width for every 3 units of height, for an image that more closely resembles a square. While a projector’s aspect ratio doesn’t directly impact the quality of the projected image, it is an important spec to be aware of as it will determine the image’s shape and space occupied on the screen.

As with resolution, challenges arise when a projector’s aspect ratio doesn’t match up with the aspect ratio of the source content. Most home entertainment projectors today offer the popular 16:9 aspect ratio, which corresponds to the HDTV standard, and is also represented as 1.78:1 (16 divided by 9 = 1.78). However, movies and other video content come in many different aspect ratio formats. For example, TV programs and videos intended for standard (non HD) TV are developed in the legacy 4:3 format, which is often denoted as “1.33:1” (4 divided by 3 = 1.33). Making matters even more complicated, content delivered on DVD comes in a wide range of formats, including 1.33, 1.78, 1.85, 2.00, 2.35, 2.4, 2.5, and more. Blu-Ray disc content, which is natively high-definition, is typically 1.78:1 or wider, with additional popular aspect ratios such as 2.35:1 or 2.4:1.

When the aspect ratio of the projector, projection surface, and content source are aligned, the image will fully cover the screen. When the viewing material does not match the native resolution of the projector, for example when watching 4:3 content on a 16:9 display, a portion of the screen will remain unused, resulting in black bars along the top and bottom or sides of the screen.

Given the lack of universal standard for video content, it is highly unlikely that the aspect ratio of your projector will match up with all of the content you’ll want to watch. With no one perfect solution, the choice once again comes down to personal preference. Users who like to watch films made prior to 1953 and older, DVD-based TV programming may want to
What to Look for in a Home Entertainment Projector

select a 4:3 projector (and screen); those more interested in the latest high-definition programming will most likely be happiest with a 16:9 configuration. A newer option, super-widescreen 2.35:1, has also been gaining in popularity.

To summarize, the benefits and downsides of the most prevalent projector aspect ratios include:

4:3
- Native large-screen display of classic films, DVD-based television series, and IMAX specials
- Scaled display of all other video content formats
- Electronic masking to block off top/bottom of screen for viewing 16:9 or 2.35:1 is available, but costly
- Not as prevalent; may be difficult to find desired combination of features

16:9
- Native display of HDTV programming, widescreen DVD, and Blu-Ray content
- Scaled display of other video content formats
- Many 16:9 projectors available to choose from
- 4:3 material can appear quite small centered on a 16:9 screen with black columns on each side
- Movies wider than 16:9 will have black bars above and below the image
- Electronic masking to block back bars is available, but costly

Ease of Set Up and Use
Beyond brightness, resolution, and contrast ratio are the added features that make installing and operating a projector easier and more enjoyable. Among the things to look for are:

- **Type of lens** – Projectors equipped with a high-quality short throw lens will enable stunning, big screen results even in small rooms. By projecting large images from short distances, short throw lenses will also reduce shadowing on the projected image and spare the audience from the distraction of blinding lights.
What to Look for in a Home Entertainment Projector

- **Connectivity options** – While one HDMI port is a must for enabling source content connectivity, dual HDMI inputs offer added flexibility for easy setup and installation, with fewer cabling concerns. Enabling simultaneous connection of two HDMI-enabled video sources, such as game consoles, digital cameras, smart phones, laptops, satellite boxes, and Blu-ray/DVD players, projectors with dual HDMI inputs minimize time spent switching between inputs.

- **USB power port** – Featured on some models of home entertainment projectors, an added USB power port offers the ability to use wireless HDMI dongles like Google Chromecast to enjoy wireless streaming of content from Netflix, Hulu+, and others.

- **3D Blu-ray ready** – Projectors with the latest HDMI technology deliver the highest picture and sound quality without degradation and can display 3D images directly from 3D Blu-ray players, for the ability to enjoy 3D visual effects cost-effectively in the comfort of your own home.

- **Remote control features** – Look for options like single button controls that enable preset preferences for brightness and other settings. One-button controls that dim screen brightness when your content is paused (along with automatic dimming when the projector is idle) will reduce power consumption and extend the life of the projector’s lamp – for an energy- and cost-saving enhancement that’s good for the environment as well as your budget.
Conclusion

In contrast to home theater enthusiasts willing to go to great lengths to black out windows and darken walls, floors and ceilings of a dedicated viewing room in the pursuit of the perfect cinematic experience, many home audiences seek more casual viewing. Home entertainment projectors offer a versatile, cost-effective option for those users who want to enjoy a wide variety of content types in a multi-purpose room within varied lighting conditions. Among the factors to consider when purchasing a home entertainment system are how a projector’s brightness, resolution and contrast ratio match up with your personal space and viewing needs. Beyond these key specifications, a projector’s cost and convenience features will shape each user’s purchase decision.

3 http://www.pcmag.com/article2/0,2817,2412448,00.asp
4 http://www.cnet.com/how-to/the-big-picture-projection-screen-basics/