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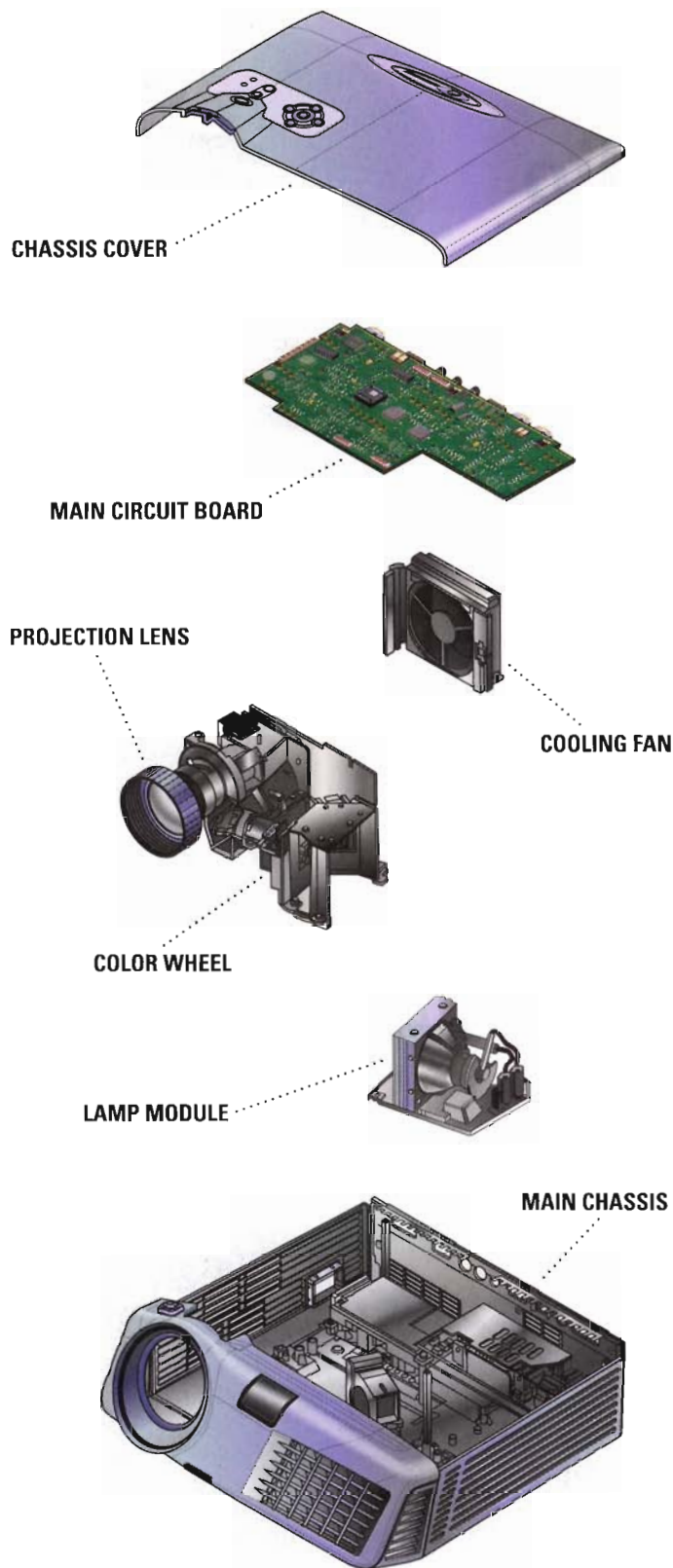
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James K. Willcox

Inside a front projector



With the prices of flat-panel HDTVs falling faster than the World Series hopes of a Kansas City Royals fan, it's not surprising that front projectors haven't been getting their fair share of attention. But prices for high-def front projectors have also been in a freefall and might be the best big-screen bargain available. With models now selling for under \$1,000 and with some 1080p models heading down toward the \$3,000 mark, a projector paired with a screen measured in feet instead of inches packs some serious, hard-to-beat home theater wallop.

While front projectors aren't ideal as everyday TVs — for one thing, their costly bulbs can burn out quickly with frequent use — models using the same DLP, LCoS, and LCD technologies found in rear-projection TVs are a big improvement over bulky, finicky CRT projectors. And digital projectors aren't just cheaper — they're also lighter and easier to set up and use, and they don't need the constant calibration that older tube-based models required.

Take, for example, Optoma's \$999 HD70, a single-chip DLP projector with 720p (1,280 x 720 pixel) resolution. Maybe its most important component is the DLP board, which holds a processor, memory, and a DMD (Digital Micromirror Device) chip covered with nearly a million mirrors. Since each mirror represents a single pixel, the total number of mirrors corresponds to the image's resolution. Other key components are the light source (typically a UHP lamp), a projection lens, and the projector's optics, which include a condensing lens, a light (or integrating) rod, and a relay lens. Colors are produced by passing light through a spinning "color wheel." (In more expensive, three-chip models, the light instead passes through a prism that splits it into red, green, and blue, and a separate DMD chip is used for each color.)

The projection lens dominates the HD70's front. All of the inputs — HDMI, component video, VGA, S-video, and composite video — are on the rear panel. The HD70 also has an RS-232 control jack, an IR receiver, and a 12-volt trigger relay, plus a fan and a power supply. Digital signals coming from a source, such as an HD DVD player or a receiver with HDMI outputs, are sent to an internal digital receiver. Analog component-video signals are sent to an analog-to-digital converter (ADC), while S- and composite-video signals go to a video decoder, which has a comb filter that separates the composite video into chrominance (color) and luminance (black and white) signals before an ADC digitizes them.

Because the various digitized signals can have different resolutions and frequencies, they're then sent to a scaler, which converts them to the DMD's native resolution. In the HD70, the scaler is part of the DLP chip set. Step-up models might have a separate scaling chip, and some have a separate deinterlacing chip to handle interlaced signals. Many high-end projectors are designed to be paired with a high-performance external scaler/processor. Optoma's \$7,999 HD81 package, for example, bundles a single-chip 1080p DLP processor with a high-quality Gennum VXP scaler and 10-bit motion-adaptive high-def deinterlacer. Along with all the scaling and deinterlacing being handled by a higher-

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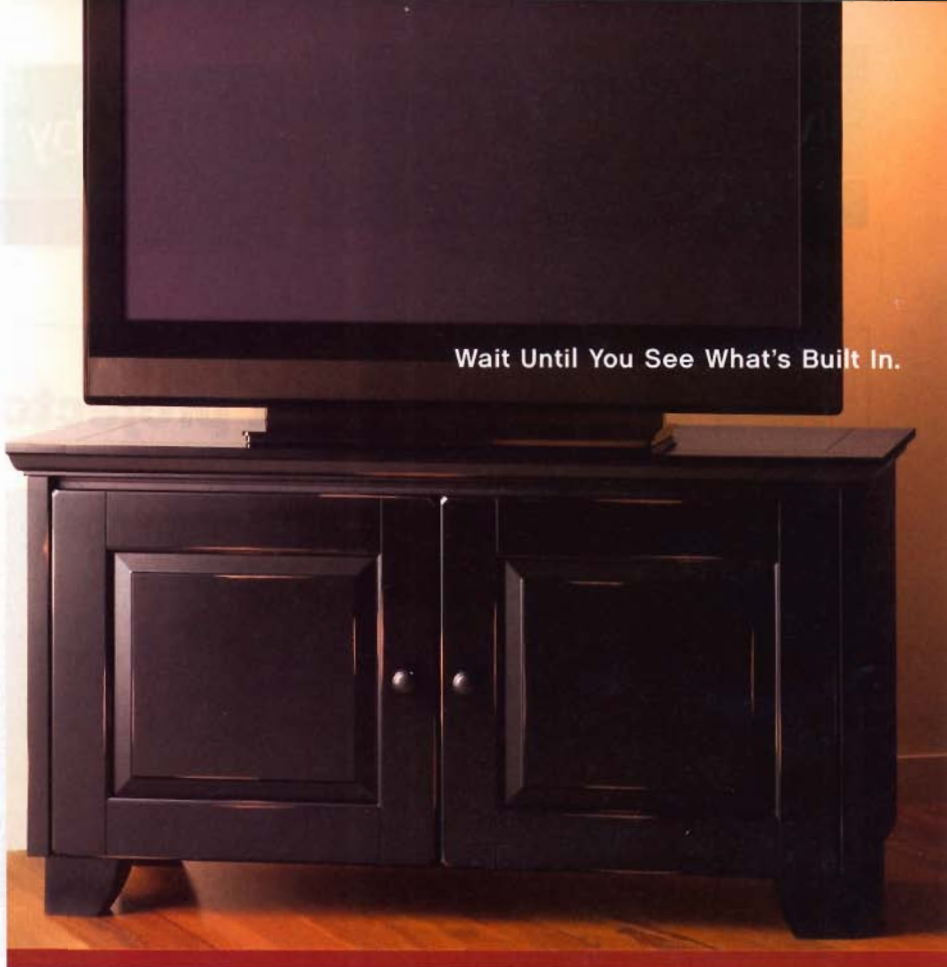
performance component, all of the inputs are located on the processor instead of the projector, making it easier to add or remove source components. This also means there's only one video cable (plus a control cable) running to the projector.

Because DLP is a reflective technology, the light source is in front, and to the side, of the DLP board, facing the rear of the projector, where the DMD chip is located. Light from the lamp is sent, via a reflector, through a filter (which screens out detrimental ultra-violet light) and then through a condensing lens before passing through the color wheel. The HD70 uses a seven-segment wheel — two segments each for red, green, and blue, plus one clear segment to help boost brightness. The colored light then goes through a light rod, which focuses it and disperses it evenly across the surface of the DMD. After it exits the rod, the light goes through a relay lens before striking the surface of the mirrors.

The DLP chip — essentially a sophisticated light switch — acts like a field general giving marching orders to a million-strong army of microscopic, hinge-mounted mirrors, which are switched on and off thousands of times a second. The mirrors face the light source when they're "on," and they tilt away from it when they're "off." By varying the duration and oscillation of the mirrors, the projector can create up to 1,024 shades of gray, and when used with a color wheel — which spins fast enough so that each of the colors is displayed 60 times per second — color is produced. The color wheel has to be accurately synchronized with the DMD chip so that the colors are displayed sequentially on the DMD at the proper time, creating images with up to 16.7 million colors.

The sequential colors are displayed so rapidly that our eyes see them as a single, full-color image. Sometimes, though, we can see the separate colors — typically as streaks when light-colored objects are displayed against a dark background. To help reduce this "rainbow effect," the wheel spins at a 4x speed (7,200 rpm), so colors are displayed 240 times per second. Since LCoS and LCD projectors don't use a color wheel, they're not subject to this effect. Each type of projector has its limitations, however, due to its respective technology. But that, as they say, is a subject for another "Inside" piece. **S&V**

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