

The Leica Dicomar Lens on the UX Cameras

The new AG-UX90 and AG-UX180 camcorders are large-sensor general-purpose professional camcorders, designed to deliver great footage regardless of the particular shooting scenario, whether the user is tasking it with shooting sports, or news, or live events, or concerts, or conventions, or speeches, or commercials, or corporate films, or weddings, or interviews, or any of the myriad other situations professional shooters find themselves in. An absolutely key component of being able to tackle so many different types of shooting environments, is the lens. While many shooters have come to rely on large-sensor cameras such as DSLRs, DSLMs, and digital cinema camcorders, the limitations of the lens for these large-sensor cameras has always introduced complications or limitations in shooting style as compared to the small-sensor all-in-one camcorder designs of professional handheld camcorders.

With the UX90 and UX180, Panasonic has set out to deliver a single-lens system that provides the quality, performance, and flexibility to let the camera excel in all these environments. Creating such a lens that could cover the relatively huge 1" sensor and 4K resolution was a significant task; getting it to do so with Leica Dicomar-certified performance was a significant accomplishment. Getting it to do so while actually delivering more capability, a wider field of view, better image stabilization, better autofocus, and a longer zoom range, is truly impressive. In this paper I'd like to explore what they've accomplished, how they approached it, and what these innovations mean for the typical shooter.

The Challenge of Making a Video Lens for a Large Sensor

Large sensors have taken over a substantial part of the professional videography marketplace. In the past, there were generally just two common sensor sizes: 1/3" for a handheld camera, and a big 2/3" sensor for a shoulder-mount camera. Nowadays Four Thirds and Super 35 sensors are becoming commonplace in digital cinema cameras and DSLRs used for video, all using sensors much larger than even the 2/3" sensor.

However, with those large sensors have come limitations in lens design, which impose corresponding limitations in how the videographer can use the camera and in what shooting situations that camera will allow the operator to get the shot.

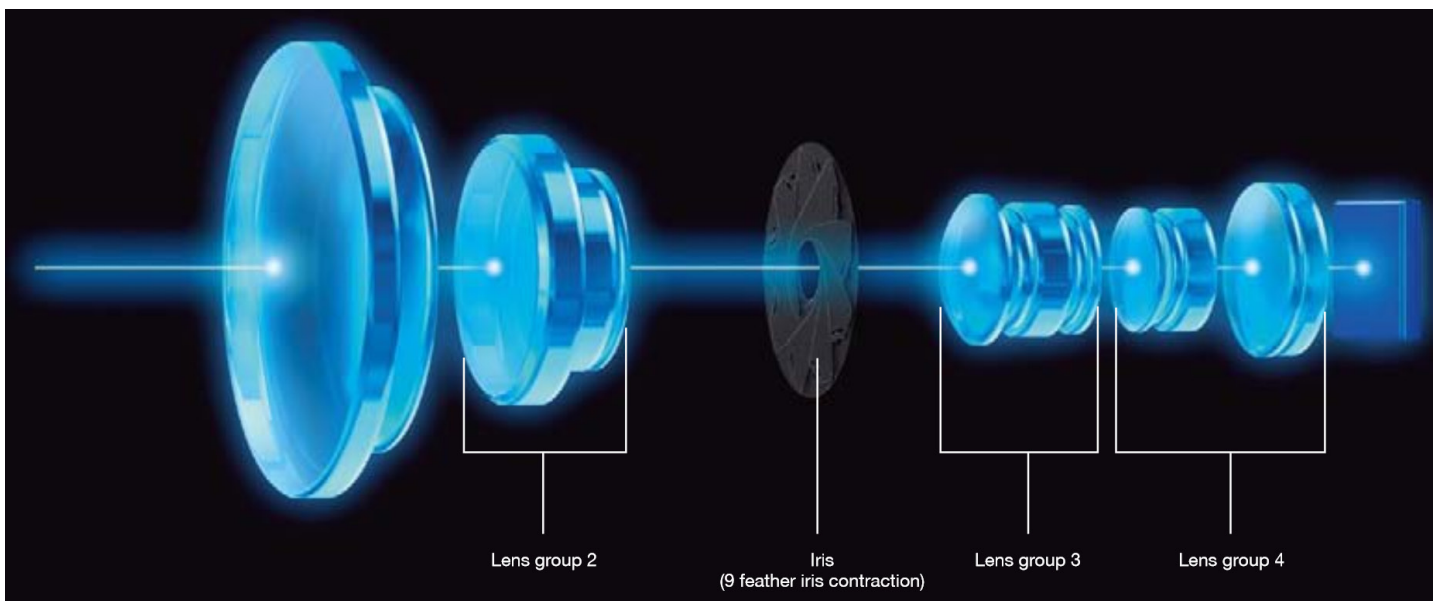
Generally the type of lenses used on large-sensor cameras are either movie camera lenses, or stills-camera lenses (such as Nikon F or Canon EF-mount lenses). While well-suited to cinema productions, movie camera lenses are not as practical to use in traditional news-gathering, sports coverage, live events or other scenarios where the benefits of a smooth power zoom, autofocus, or image stabilization would be useful. And prime lenses (by definition) don't zoom, so if you need a zoom lens, a large-sensor camera poses additional challenges. It's possible to mount genuine movie zoom lenses to these cameras, but movie lenses are (relatively) enormous, and (comparatively) extremely heavy, and (comparatively) astronomically expensive. As an example, the superb Fujinon 24-180 cinema lens offers a 7.5x zoom ratio, is 16" long,

weighs nearly 20 pounds(!), and carries a list price in excess of \$87,000 US (at the time of this writing). And movie camera lenses generally never offer image stabilization or autofocus. And it is highly uncommon to achieve typical video camera lens zoom ratios with either stills camera lenses or movie camera lenses.

A 1" sensor is about eight times as big as the 1/3" sensor that was traditionally used in handheld video cameras. The UX90 and UX180 were designed to be about the same size, same weight, and even lower cost than those 1/3" cameras, while providing all the flexibility they offered (and, of course, drastically outperforming them in terms of video quality, since they are large-sensor UHD cameras as compared to the 1/3" cameras which were generally limited to HD). Keeping the size and weight the same, while increasing the sensor size eightfold, presented serious challenges to the design team.

Advantages Of A Fixed Lens

By making the lens a dedicated, integrated part of the camera, the design engineers were able to employ several clever techniques that result in making the lens smaller than it would otherwise have to be, lighter than it would otherwise have to be, and less expensive than it would otherwise have to be. The UX180 achieves an outstanding 20:1 optical zoom ratio in a lens that's less than 6" long, and is so lightweight that the entire camcorder including lens weighs only 4 pounds. Compared to a dedicated cinema lens, this is a fantastic achievement; a 7.5:1 zoom ratio cinema lens like the Fujinon 24-180 is nearly three times as long (16" long) and ten times as heavy (the lens itself weighs approximately 20 pounds). By going with a fixed lens design, on a smaller sensor, the engineers were able to create a Leica-certified lens that is compact in size, light in weight, yet still provides an extreme zoom range that exceeds most traditional handheld camcorders -- while offering the smooth powered zooming, and optical image stabilization, and autofocus capability that are all missing from stills camera lenses and cinema lenses.



The lenses on the UX90 and UX180 are a complex system consisting of four groups of computer-controlled moving elements which work together to provide a 15x or 20x zoom range that covers a large sensor, while still remaining physically compact. The fact that the lens is integrat-

ed into the camera body, and that these four groups operate under internal computer control, allow the lens to be incredibly compact for its given zoom range, as the independently-moving groups provide zoom and focus capabilities that, if implemented in strictly optical terms, would have required a huge, long, and heavy lens that would have been impractical to fit into a handheld camcorder.

This lens is also an excellent performer, having passed the stringent quality standards of Leica in order to bear the Leica DICOMAR name. Low-dispersion glass and multicoating ensure crisp sharp images in 4K throughout the zoom range. And a nine-bladed iris provides soft, round bokeh.

Stabilization

Getting sharp, crisp images over a wide zoom range is important, of course, but hardly the only factor in delivering professional images in a wide variety of situations. Tripod-based work can provide clean, stable images, but tripods are not always available, nor is it always desirable to lug a heavy tripod everywhere. In recognition of these facts, Panasonic developed and expanded upon an excellent optical image stabilization system. For the UX cameras, Panasonic expanded the area that it evaluates for image stabilization to be approximately 9x larger than the area it used in previous cameras like the AG-AC160A. Additionally, they've mounted the focus unit using tiny ball bearings that provide smoother motion than before, which especially helps the optical image stabilizer to counter tiny movements.

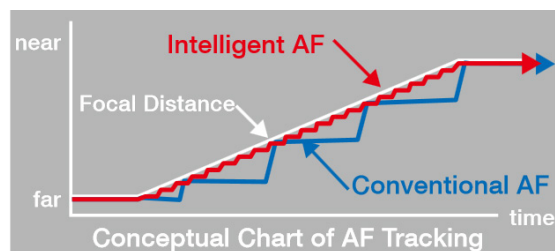
The result is high-quality, stable image stabilization that, in many instances, could even render a tripod unnecessary. Man-on-the-street interviews at reasonable distances can be shot with surprising steadiness in Full HD with the Hybrid Image Stabilizer enabled. And while you'll still prefer a tripod for extreme telephoto work, the new image stabilization makes it much easier to get usable handheld footage even at the longer end of the lens, than it was on previous camcorders.

Not only is the image stabilization itself inherently improved, but it is also programmable. The camera operator has the ability to customize the stabilization for the type of shooting scenario she expects to encounter; you can fine-tune the image stabilization for high-frequency vibration or low-frequency motion, and you can fine-tune it for minor movements (like hand twitching) or for big sweeping movements (like when walking with the camera).

Autofocus

Effective autofocus has always been a challenge for the handheld camera operator, but the challenge grows several degrees more difficult when utilizing a large sensor, because the inherently shallower depth of field of the large sensor makes focus tolerances tighter than ever, and Ultra High Definition and 4K mean that focus errors are more noticeable than ever before. Panasonic has addressed this by creating a new Micro-Drive Focus Unit. They've made it far more sensitive and precise, able to move in tiny increments at speeds that greatly exceed the focus units in the older 1/3" camcorders. This gives the autofocus system the capability of coping with changes

in focus caused by the shallow depth of field of the large sensor; a subject moving closer to (or further from) the lens can be tracked far more effectively with the new Micro Drive Focus Unit.



Just as a high-resolution sensor renders crisper images, the high precision of the Micro Drive Focus Unit allows it to render faster and more stable autofocus. Compared to previous cameras, the level of precision of the Micro Drive Focus Unit's movements, and the speed at which it can make those movements, make autofocus in 4K not only possible but practical.

Now, autofocus will never be perfect, but on the UX180 and UX90 it is faster and more precise than it was on previous cameras. And, like the Optical Image Stabilization, the focus unit is also programmable. You can adjust its parameters to provide the type of focus response you expect to need for your shooting situation. For example: if you're filming a sit-down interview, it's likely that the person will not be moving much; as such, you can program the autofocus to respond gently and slowly, which would minimize the appearance of "focus hunting" that causes so many shooters to curse autofocus. On the other hand, if you're shooting a quickly-changing scene (such as a football game) you might want the autofocus to strictly track the current object and to respond at maximum speed. You can adjust the autofocus speed and sensitivity to make it respond quickly to little changes, or have it respond more slowly and require bigger changes, depending on how you expect the scene to play out.

Furthermore, you can instruct the autofocus system as to how much area you'd like it to evaluate for focus; you can restrict it to evaluating only a small box in the center of the screen (for tight focus tracking), or you can widen that box to encompass a large swath of the screen. Finally, you can also enable touchscreen focus so that the autofocus system will focus on exactly the area of the screen you want it to. This programmability is made possible by the high-speed, highly-sensitive Micro Drive Focus Unit, which provides the sensitivity and the quick response necessary to enable high-speed tracking focus.

Wide Angle

One of the most important developments on the AG-UX90 and AG-UX180 is the expansion of the wide end of the zoom range. Veteran shooters are well aware that it's easy to get a lot of telephoto, but what you really need is more on the wide end. Shooting in cramped quarters or small rooms, it's frequently been difficult to frame up the shot and include all the people and scenery that you'd like. And there's only so far you can back up, when in a small room! Panasonic has responded by giving the UX90 and UX180 the widest wide angle field of view of any professional handheld camcorder.

Typical handheld camcorder have a wide-angle field of view that is approximately the equivalent of using about a 30mm lens on a full-frame 35mm stills camera. Sometimes they'd be a little wider (like 29mm), sometimes a little tighter (a popular handheld ENG camcorder from a com-

petitor offered a 31.4mm wide-angle equivalent). On these cameras, it was fairly common to use an add-on wide-angle conversion lens, usually providing about a 0.8x magnification, in order to get an appropriately-usable field of view in tight quarters. On the UX90 and UX180, Panasonic's given it a wider wide-angle field of view, which is about the same as what that 0.8x wide-angle converter used to offer!



Above, this scene was shot at the 31.4mm equivalent wide angle of a common and popular ENG camera.



Above, this scene was shot on the AG-UX90 at its widest wide-angle view, 24.5mm equivalent.

The standard lens on the UX90 provides an equivalent of a 24.5mm lens's field of view, and the UX180 in Cinema 4K has the equivalent of a 24.0mm lens's field of view. This is a great advantage for the videographer; not only can they now get the shot, but they can do so without having to buy an expensive add-on wide-angle conversion lens. Nor will the videographer have to deal with the potential image artifacts that could sometimes accompany such accessory lenses, like chromatic aberrations or distorted perspective, because the wide-angle field of view is part and parcel of the built-in Leica-certified Dicomar lens.

Zoom Control

Another practical aspect for the videographer is the controllability of the power zoom feature. In cameras of the past, there was limited controllability; Panasonic's own AG-160A, for example, had only three speeds the lens could zoom at: slow-ish, medium, and fast-ish. With the UX90 and UX180, the lens control has been greatly expanded. The power zoom is capable of incredibly smooth, extremely slow zooms; at minimum speed it can take as long as two and a half minutes to traverse the zoom range from wide angle to full telephoto. On the other hand, you can execute a high-speed zoom from wide-angle to full telephoto in as little as about two seconds. The slow-speed zoom eases in extremely gently, so you can now feather in the start of a zoom move that should be undetectable by the viewer. Or, you can set it on Fast Zoom and rocket from the wide angle to telephoto extremely quickly. With the pressure-sensitive main zoom rocker, you can modulate the zoom speed on the fly; pressing harder results in faster speed, pressing more gently results in slower zoom speed, so a skilled operator can feather into a fast move gently, and ease out of the zoom move to a very nice ramp-off when reaching the desired focal length. The zoom control possible on the UX90 and UX180 far exceeds the previous cameras, while still maintaining compatibility with external zoom controllers or even providing for entirely wireless remote control operation with the use of an optional wi-fi adapter and the free AG ROP remote-control app for Apple iPad tablets.

Summary

Large sensors on video cameras have traditionally required compromises involving little automatic control over the lens, loss of autofocus and image stabilization, and requiring many expensive lenses just to have sufficient options for field of view. The engineering in the UX180 and UX90 lens has made it not only possible but entirely practical to employ a large 1” sensor in a camcorder that is tasked with covering all the types of tasks that a practical, go-anywhere, do-anything professional handheld camcorder might be asked to do. The UX180 and UX90 cameras’ lenses are operational improvements that make the videographer’s job easier and more practical than before, with more creative control due to the large sensor.