



Alcon Laboratories, Inc.

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## Three-dimensional digital visualization for eye microsurgery

**Alcon, in partnership with TrueVision 3D Surgical, has launched NGENUITY 3D, a complete digital solution for vitreoretinal surgery that uses an ultra-fast high-definition digital camera to provide an unparalleled three-dimensional view of the retina. The system is designed to improve the visualization of anatomy and pathology, reduce light exposure to the eye, and improve surgeon ergonomics.**

Alcon, the global leader in eye care, has developed a platform for digitally assisted vitreoretinal surgery (DAVS) that provides a three-dimensional (3D) view of the back of the eye with excellent resolution, image depth of focus, clarity and color contrast. The system, trademarked as the NGENUITY 3D Visualization System, was developed in collaboration with TrueVision, a leader in digital 3D visualization and guidance for microsurgery, and affords a unique 3D view of the eye with the aim of improving patient surgical outcomes and surgeon experience.

Alcon, a division of Novartis, believes that the many benefits of the NGENUITY 3D Visualization System over traditional ocular devices—for example, increased depth of focus and working distance at the retina surface in high magnification; high-dynamic-range (HDR) imaging that reduces instrument glare and illuminates shadows; digital image filtering that provides useful color effects; and reduced light

exposure levels that may help minimize light toxicity—make it a truly disruptive technology in the vitreoretinal microsurgery space, and probably for other ophthalmic procedures as well.

The innovative NGENUITY 3D Visualization platform provides a unique partnering opportunity for companies developing digital imaging and/or digital diagnostic platforms for eye surgery that could benefit from this advanced visualization system.

### A digital vision for eye surgery

Over the past two decades, ophthalmological imaging and diagnostics have evolved rapidly, with technologies such as optical coherence tomography (OCT), fluorescein angiography and ultrasound imaging leveraging advanced digital platforms to produce ocular images of unprecedented resolution and quality. Strategically, in the operating room, machines such as those used for vitrectomies will rely

on digitization for improved results. However, the surgical microscope—arguably the most important tool for an eye surgeon—has not bridged the digital divide and has remained fundamentally unchanged for the past 50 years.

Paradoxically, this lag in digitization was created as the industry struggled to develop new high-definition and 3D digital imaging technologies that would rival the incumbent aging optical microscope. But digital imaging systems with incredible sensitivity have now made it possible to reach this threshold and are rapidly providing advantages over the optical microscope for surgeons.

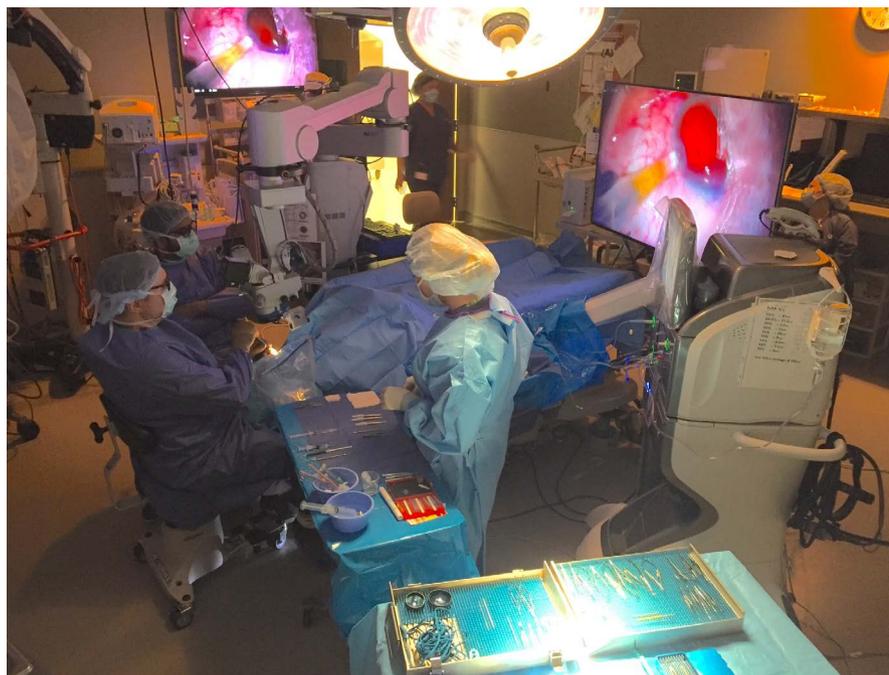
Among these is the NGENUITY 3D Visualization System, the first real-time platform to provide an integrated 3D, high-definition approach for digitally assisted vitreoretinal surgery (Fig. 1). According to Paul Hallen, global head of Alcon's surgical retina and glaucoma franchises, "the NGENUITY 3D Visualization System defines a new standard in ophthalmic visualization. An optimized HDR image results in an immersive intraocular view, which, coupled with augmented reality capability, enhances the surgeon's view. Surgical tasks may be simplified, which may help to improve patient outcomes."

### The NGENUITY 3D Visualization System

Alcon's NGENUITY 3D Visualization System comprises four key elements:

- an HDR 3D digital camera that provides superb resolution, image depth, clarity and color contrast;
- a high-speed graphics processing unit (GPU) computer that processes and optimizes stereoscopic images of anatomy and pathology during microsurgery;
- a 55-inch immersive 3D display that renders real-time images with 4K organic light-emitting diode (OLED) ultra-high-definition (UHD; 3,840 × 2,160-pixel resolution) technology; and
- passive, circularly polarized 3D glasses that provide the surgeon with a 3D view featuring a level of depth perception that was not previously available.

As a result, the surgeon may increase magnification while maintaining a wide field of view and use digital filters to customize his or her view during each procedure, thereby highlighting ocular structures and tissue layers so as to better visualize the back of the eye (Fig. 2).



**Figure 1: Panoramic view of the NGENUITY 3D system in action in an operating room.** The NGENUITY 3D Visualization System is an integrated platform for real-time, digitally assisted vitreoretinal surgery that provides a 3D view of the back of the eye with excellent resolution, image depth, clarity and color contrast. The system offers an expansive panoramic surgical view that provides full access to the operating view to everyone in the operating room, and facilitates improved posture for the surgeon.

## Reducing light exposure

The NGENUITY 3D Visualization System has been engineered with the specific goal of minimizing light exposure to the patient's eye. Proper illumination is essential for visualizing the dark micro-environment at the back of the eye during vitreoretinal surgery, but overexposure during prolonged procedures can lead to iatrogenic phototoxicity.

Despite the development of novel light sources and more efficient endoillumination systems, surgery-induced phototoxicity remains a concern for surgeons and patients because of its potentially significant adverse effects on visual acuity.

The digital technology underpinning the NGENUITY 3D system features very high light sensitivity, which allows surgery to be conducted at photon streams five to ten times lower than those typically employed with a standard optical microscope.

"The ultra-HDR sensors of NGENUITY allow surgeons to deliver less total lumens to the patient's eye," said Hallen. "This is significant in that light intensity is a square function of the distance from the retina, and the fiber optic illuminator is only millimeters away from the delicate, highly sensitive retina tissue."

## Improved accuracy

The UHD digital camera of the NGENUITY system augments stereopsis and depth perception to levels that surpass those of observation through the binoculars of an optical microscope. For procedures that include macular surgery and difficult diabetic dissections, this is a particularly helpful feature, because it greatly simplifies the axial identification of fine tissue planes.

The image-processing capabilities further allow digital enhancement of tissue planes via adjustment of the light balance and contrast and the application of digital color filters, which helps to reduce factors such as the concentration of vital dye or the amount of light needed during surgery. For example, in some situations in which the surgeon has to identify transparent tissues such as the vitreous, he or she can manipulate the image by enhancing the blue color to improve visualization. In other instances, such as with the peeling of an epiretinal membrane, use of a red filter can ease the procedure. Ultimately, minimizing or completely eliminating the use of certain vital dyes during vitreoretinal surgery can reduce the risk of potential toxic side effects of the dyes.

The level of customization of the surgical view afforded by the NGENUITY system uniquely assists surgeons in visualizing ocular structures, pathology and tissue layers, which results in more precise and faster surgical procedures.

# the NGENUITY 3D Visualization System defines a new standard in ophthalmic visualization

Paul Hallen, Global Head,  
Surgical Retina & Glaucoma



**Figure 2: Image manipulation for improved surgical outcomes.** The NGENUITY 3D Visualization System supports the completion of surgical tasks through the customization of surgical views during a procedure, which can facilitate the visualization of ocular structures and tissue layers. The system offers 20% greater magnification, extended depth of field and amplified stereopsis compared to the standard visual microscope.

## A broad vision

Beyond the sheer technological and clinical advances that the NGENUITY system represents for the ophthalmological surgery space, the platform has some characteristics that make it very valuable from a practical and didactical perspective inside the operating room.

Eye surgeons have a high incidence (>50%) of neck, upper-extremity and lower-extremity pain, because they have to look through the binoculars of a standard optical microscope for extended periods of time during surgical procedures. The only alternative to this state of affairs is a system that frees the physician from having to look through the microscope's eyepiece. The NGENUITY system achieves this through its superb digital camera and image processing capabilities, which allow the surgeon and everyone else in the operating room to view the surgical field on a large UHD monitor. As a result, the surgeon does not have to rigidly constrain their head position to the microscope oculars anymore and instead can lean back in a relaxed and unconstrained position during surgery.

The large display also affords others in the operating room—from the operating assistants to residents and medical students—the chance to have the same view of the surgical field as the surgeon. For surgical assistants, this eliminates the traditionally inferior view of an assistant scope, thus reducing the potential for error. In addition, the large display enhances the surgeon's ability to direct and teach surgical staff and trainees.

"NGENUITY also has potential benefits for surgeon ergonomics, improved collaboration with OR staff, and enhanced student participation during surgery. I believe these benefits make NGENUITY an essential tool for teaching institutions," said Hallen.

According to George Williams, chair of ophthalmology at the Oakland University William Beaumont School of Medicine, "it's an absolute game changer, the fact that I can now see exactly what the fellows are doing. They can see exactly what I'm doing with excellent depth. It gives me more confidence to allow them to go further and further into the case. It gives me more confidence that I know exactly that they are accomplishing our surgical goals."

Finally, the platform allows the generation of high-quality recorded surgical videos and intraoperative image integration. NGENUITY has the ability to display preoperative images such as OCT scans and fluorescein angiograms during any portion of the operation. Such multimodal surgeon interaction streamlines some of the processes during surgery by allowing the surgeon to contrast images in real time without having to look away from the actual surgical field. The image processing capabilities of the NGENUITY also allow for integration with other emerging digital intraoperative viewing and diagnostic technologies.

## Collaborative vision

NGENUITY is the result of a collaborative partnership between Alcon and TrueVision, a leader in digital 3D visualization for eye microsurgery. The partnership's goal is to further develop the product to improve its performance and capabilities, and thus enable ophthalmic surgeons to make more informed surgical decisions aimed at improving patient outcomes.

Alcon's main partnering interest would be in companies in the digital imaging and/or digital diagnostics space with technologies that could be added to the NGENUITY platform via original equipment manufacturer (OEM) agreements.

According to Hallen, "NGENUITY is becoming a disruptive force within ophthalmic visualization. It is a great platform for integration of multiple diagnostic technologies and alternative views to enable the surgeon to make more informed surgical decisions aimed at better patient outcomes, also representing a unique partnering opportunity in the digital imaging space."

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