Abstract
The Enhancing Visual Acuity (EVA) System (Dutch Ophthalmic Research Centre International B.V.) features a unique fluid control system – VacuFlow Valve Timing Intelligence (VTi®) – and represents the next-generation evolution of pump machines. VacuFlow VTi® overcomes the limitations of existing Venturi and peristaltic pumps and provides the potential to enable safer, faster, and more precise techniques. Alongside many other innovative and functional features, such as a light-emitting diode light source, integrated laser, high cutting speed with twin duty cycle cutting, automated infusion compensation, wireless foot pedal, phaco module with thresholding, and viscous fluid module, EVA could make a major contribution to advancing ophthalmology.

The Enhancing Visual Acuity System
The Enhancing Visual Acuity (EVA) system was developed by the Dutch Ophthalmic Research Centre International B.V. (fig. 1). It features a unique fluid control system – VacuFlow Valve Timing Intelligence (VTi®) – and represents the next-generation evolution of pump machines. EVA induces an aspiration flow effect by implementation of a displacement pump, providing precise flow and fast vacuum, eliminating the risk of unwanted pulsation or alterations in flow, and increasing the control that the surgeon has over the procedure. The system received CE approval on March 3, 2013 and became commercially available in June 2013.
EVA’s unique flow control system, the VacuFlow VTi®, was developed to overcome two main limitations of existing Venturi and peristaltic pumps. The first is the time lag created by dispelling large volumes of air from the (typically ≥250 ml) cartridge of many Venturi systems before the desired vacuum level is attained. VacuFlow VTi offers a significant improvement by combining a series of very precise computer-controlled operating pistons and valves working in very small flow chambers (volume: 6 ml). Secondly, the weaknesses of both the Venturi and peristaltic pumps have been compensated with EVA’s combined flow and vacuum system. Venturi pumps have never enabled precise, viscosity-independent flow control, whereas the peristaltic system characteristically produces mild flow fluctuations inherent to the rotary compression of flexible tubing. In addition, with advances in vitrectomy procedures, including peripheral vitrectomy and using smaller-gauge instrumentation, new options in vitrectomy systems were essential.

VacuFlow VTi® technology was introduced in 2012 by DORC with the prototype EVA platform and has since been used to perform vitrectomy, phaco procedures, and combined phaco-vitrectomy procedures. DORC made EVA available to a selected number of retina surgeons worldwide during its development and worked in close collaboration with them, incorporating their feedback to modify the final product design.

The EVA system allows the user to decide between two different modes: vacuum or flow control mode. In vacuum mode, the pistons work at high speed to build and maintain the desired vacuum value. In flow control mode, the valves operate at a precalculated speed to achieve the desired flow. The result is a perfectly synchronized system that enables exact control of aspiration and flow with a precision never achieved before. Moreover, a desired switch from vacuum to flow mode or vice versa is instantaneous since no mechanical changes are involved in this transition.

Features
Fluidics (fig. 2)
Better flow control allows for faster, more efficient cutting and a higher safety profile. In addition, with techniques, such as peripheral vitrectomy and smaller-gauge procedures on the rise, precise flow management is becoming even more critical to reduce the risks of this type of procedure.

The main limitation of the Venturi pump is the control of the depression generated by the pump that affects aspiration control. The Venturi pump can only create a depression of vacuum, increasing the gradient of pressure required to
maintain flow. A typical vacuum pump has a minimum outflow, based on the pressure gradient and the instrumentation size, which rules out the possibility to control the aspiration flow below. Since Venturi pumps cannot work with positive pressure at the pump level, many surgeons compensate by setting the cut rate as high as possible to provide partial compensation for this issue. Peristaltic systems generate a gradient of pressure so that flow remains stable independent of the fluid’s viscosity. The European Vitreoretinal Society (EVRS) Retinal Detachment Study, published in 2013, showed that retinal detachment surgery performed with vacuum-based venturi systems had a 2.9 times higher failure rate compared to the same surgery performed with flow-based peristaltic systems [1, 2]. A failure rate of 0.7% with 23-gauge surgery and 1.1% with 20-gauge surgery was achieved with peristaltic pumps, which rose to 1.4% with 23-gauge surgery and 2.5% with 20-gauge surgery when a Venturi system was used.

EVA’s unique flow control system eliminates the need for a conventional large-size cartridge. It is replaced with a microchamber system, in which computer-controlled pistons and valves work in harmony with high-precision pressure sensors. The two synchronized operating pistons compensate for changes in pressure, as recognized by the high-sensitivity pressure sensors. Two valves al-