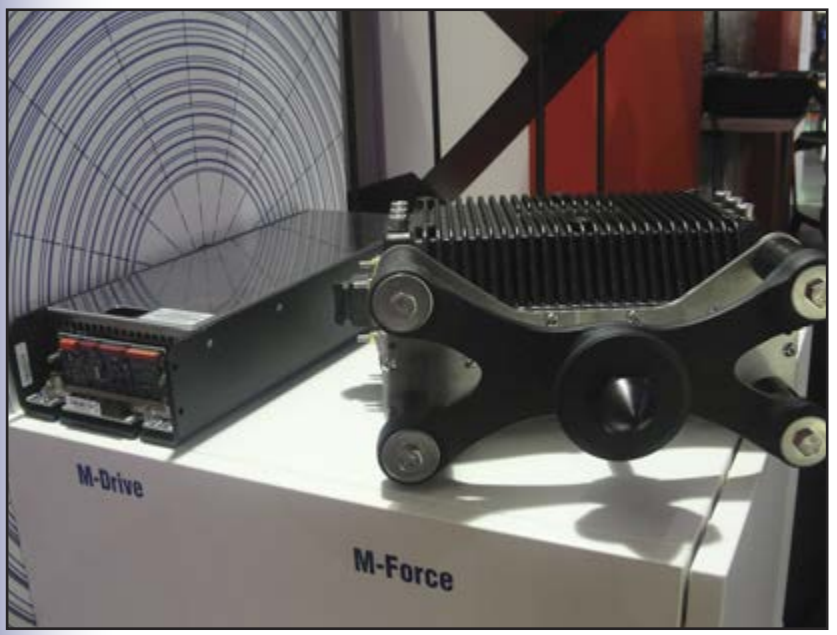
As co-founder and R&D Development Director of Powersoft, Claudio Lastrucci's fields of expertise include electric power, audio amplification, signal processing, acoustic design, and other areas. (Photo courtesy of Powersoft)



Powersoft's M-System combines the M-Force motor transducer and M-Drive switching-mode amp module, taking advantage of Differential Pressure Control (DPC) technology to establish a global feedback between the electrical and the acoustic domains. The Zero Latency DSP performs real-time processing of the differential pressure control signal to adaptively correct the diaphragm displacement.

Applications of a Closed Feedback Loop Transducer System Equipped with Differential Pressure Control." The paper was co-authored by Fabio Blasizzo (then a freelance transducer engineer who conducted practical measurements in the early stages of the project), Mario Di Cola, Paolo Desii, and Claudio Lastrucci. Desii is one of Powersoft's R&D engineers, responsible for embedded systems development and software. Lastrucci is Powersoft's co-founder, President, and Research & Development Director—he is also the driving force of the company's technologies. According to Lastrucci, Di Cola was involved in the evaluation of the first prototypes "as soon as there was something to test," which means about three years after the project started.

Basically, the paper described a closed feedback loop transducer system dedicated to very low frequency reproduction. As stated, "The use of a feedback control loop can be very helpful to overcome some of the well known transducer limitations and to improve some of the acoustical performances of most subwoofer systems. The feedback control of this system is based on a differential pressure control sensor. The entire system control is performed by a 'Zero Latency DSP' application, specifically designed for this purpose in order to be able to process the system with real-time performances."

The M-Drive, used in conjunction with DPC was the technology at the core of IPAL systems, with a specifically designed transducer to implement the novel approach of a closed feedback loop for direct control over the system's acoustical output.

The first amp module—equipped with DPC and a PFC-equipped power supply—delivered up to 8,500 W and was tested by several speaker manufacturers. Italian company B&C Speakers was among the first companies to introduce two IPAL high-efficiency transducers. B&C Speakers developed two different IPAL compatible speakers, the 21IPAL (21") and the 18IPAL (18"). The 21IPAL was intended for use with single speaker applications and the 18IPAL was recommended for 2x18" configurations. Eighteen Sound, another Italian speaker manufacturer, also developed its own design with IPAL-compatible products.

The original AES paper introduced the concept of Virtual Speaker Modeling, again leveraging the company's expertise in software and DSP control to take advantage of the DPC concept and create a so called "Virtual transducer." This powerful software tool makes the real transducer behave as a "user defined" transducer, synthesized by the speaker designer with a dashboard to manage the desired driver's Thiele–Small (T-S) or electromechanical

parameters, based on a mathematical model.

Previous attempts at motor-driven speakers had some elements of Powersoft's concept, but lacked much of the refinement. Some readers may remember Tom Danley's motor driven speakers and their distance cousin, the Phoenix Gold Cyclone. Moving magnet shakers include the Bodysonic, the Clark, the Earthquake, and others.

From Concept to M-Force

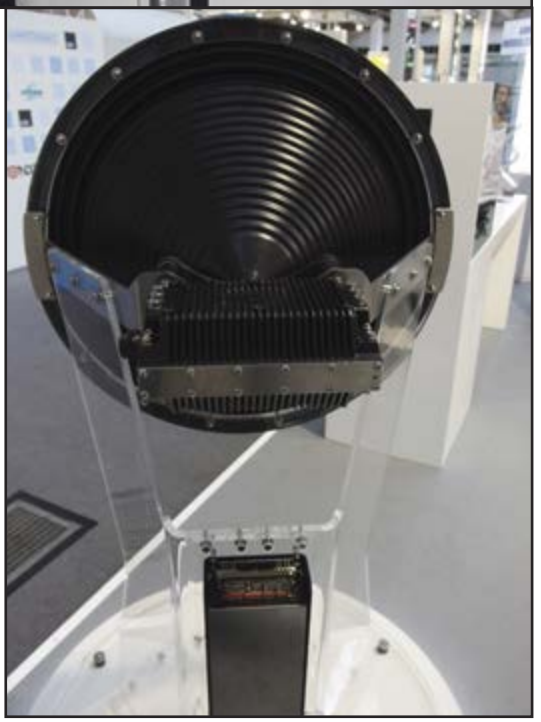
We specifically asked Lastrucci about the "genesis" for the whole M-Force project. And, Lastrucci admitted this was a "eureka moment." "The moment we imagined something not axisymmetric but 'planar' in the magnetic design. However, the move for a different transducer technology came from the knowledge of switch-mode amplifiers, their native properties and the desire to fully exploit the real benefits of the native energy recycling capabilities. No switch-mode amplifier, no M-Force…"

As previously described, the M-Force evolved from the earlier efforts to optimize a transducer for subwoofers. As Matteo Bianchini's stated to

"We don't like to use too big words, but M-System really 'risks' to be one of the few big things happened in audio transduction in the past decades," says Matteo Bianchini, Powersoft's OEM Account Manager.

audioXpress, "In our R&D efforts, we always tried to take into account the interaction of our technology with "adjacent domains," especially the world of transducers and the actual effects of this interaction in the acoustical domain. As a consequence, some of the technologies are more complex than the simple amp, and involve many perspectives, from processing to transduction, as well as acoustic design and, of course, high power electronics."

He adds, "The first things you might notice are the very high output figures (310 V_{PEAK}, 200 A_{PEAK}), making it able to drive lower-than-1-Ω loads, but there's much more than that: The M-Drive, despite compatible with applications using traditional transducers, was designed in order to fully drive the M-Force, an innovative low frequency transducer (a linear motor based on a moving magnet approach) that no other amplifier would be able to push to the limits."



The complete M-System was presented at the 2014 Prolight+Sound show, when several manufacturers were already working on practical implementations.

After showing it at multiple shows and providing samples to some exclusive partners, Powersoft decided to make it available for OEM projects.

The M-Force was the second stage of Powersoft's R&D efforts, following the M-Drive amp module and the IPAL concept. In 2014, Powersoft presented another paper at the 136th AES convention in Berlin, Germany, explaining how the company designed "A Novel Moving Magnet Linear Motor." The paper, presented by Lastrucci describes how the company explored a new "electrical to acoustic conversion approach" combining "new technologies in the electronic amplification domain and latest magnetic materials." The new transducer is presented as a "new electrodynamic device that considerably improves electrical to acoustical conversion efficiency, sound quality, robustness and power handling," based on a "fully balanced and symmetrical moving magnet motor design, along with anisotropic magnetic compound integration," to deliver substantial performance improvements in terms of "acceleration, linearity and efficiency, providing additional degrees of freedom in high quality professional speaker design," different from the "ubiquitous moving coil approach."

The topology is closer to a bass shaker than a conventional subwoofer. In crude terms, the M-Force is a bass shaker coupled to a spider, a cone, and a surround. However, the response is far more linear than a shaker with some benefit from the servo-control feedback circuitry.

The new transducer leverages a specific radiating element developed to cope with the high force and displacement provided by the motor "using large-size vacuum-formed conical polymeric diaphragms that embeds in a single material piece, the piston, the connecting elements, and the outer surround as the load for the motor and the coupling device to the acoustical domain."

This paper describes the M-Force system introduced at the 2013 Prolight+Sound and InfoComm shows. It features an impressive 40" diaphragm, as well as 22" and 30" variations. The 40" unit reportedly is able to generate a maximum radiating surface up to 6,500 cm^2, or the equivalent radiating surface of four 21" drivers.

Powered by the powerful new "pistonic" motor, the system effectively opened the way for powerful low-frequency cabinets with "a much smaller form factor for a given SPL performance and low-end extension."