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Remembering the Landé-Edwards Membrane Oxygenator

The late Richard Jensen, a pioneer perfusionist from Minnesota, called it the “battery”. Others preferred the acronym “LEMO”. Offering an industrial design and block shape, the Landé-Edwards Membrane Oxygenator was arguably the first compact, totally disposable, commercially available membrane device manufactured on a large scale (see Figure 1).



*Figure 1. Landé-Edwards Membrane Oxygenator
(adult version 3.0 m2)*



*Figure 2. Dr. Arnold Lande
(photo taken June 2015)*

Kolff and Clowes are rightfully credited with conceptualizing membrane oxygenation in the 1950s. Subsequent trial and error with various hydrophobic plastics led investigators to discover the superior gas transfer properties of silicone rubber. In 1963, a young physician/inventor named Dr. Arnold Landé (see Figure 2) teamed up with Dr. C. Walton Lillehei at the University of Minnesota to build an efficient yet simple membrane lung. Progress came quickly, as the silicone fan-folded sheets aligned perfectly within the square molded housing to form precise parallel channels. A patent was filed in 1966 by Landé, and the results of numerous dog studies (perfused for up to 48 hours) were submitted and reviewed by the National Institute of Health’s Artificial Heart Program. In 1967, Lillehei introduced the prototype oxygenator to attendees at the 16th Annual American College of Cardiology meeting in Washington (see Figure 3). Later that same year, Lillehei left Minnesota for Cornell University in New York. To his credit, Landé accompanied Lillehei so as to continue the promising research of a truly workable membrane oxy-



Figure 3. Dr. C. Walton Lillehei at the American College of Cardiology meeting in Washington, D.C. in 1967 showing a prototype version of the Landé-Edwards Membrane Oxygenator

generator. To this point, the rudimentary device was known simply as the “Landé-Lillehei” lung.

At Cornell, refinements continued to be made. Most notably, the device would be fashioned in two sizes (1 sq. meter and 3 sq. meters) to appeal to both adult and pediatric users (see Figure 4)

A partnership with Edwards Laboratories, formalized in late 1968, prom-

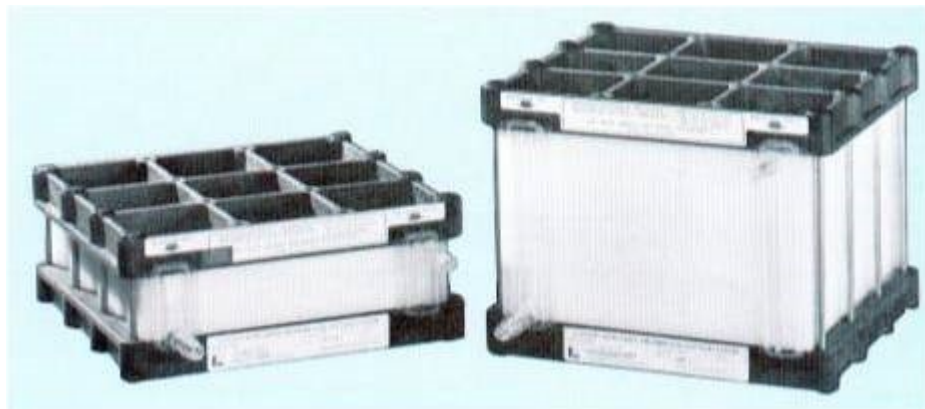


Figure 4. Adult (3.0 m²) and pediatric (1.0 m²) versions of the Landé-Edwards Membrane Oxygenator

ised quality control, sterilization, and distribution. In 1972, an article appeared in the *Journal of ExtraCorporeal Technology* touting the simplicity of the LEMO by reporting that six different surgeons and five different perfusionists successfully used the device to support 100 patients undergoing open-heart surgery. The remarkably low pressure drop afforded by the LEMO permitted gravity drainage through the device. This, in turn, allowed perfusionists to run a single-pump system. The device did not include an integral heat exchanger – an obvious inconvenience by today’s standards. In addition, during assembly the silicone sheets were dusted with dry sodium chloride to prevent the membrane channels from sticking. During setup, this powder would dissolve into the prime, thus producing a hypertonic solution which had to be rinsed from the circuit. For patients weighing less than 80 kilograms, two LEMOs were connected in parallel. Three or more LEMOs were commonly used for larger patients (see Figure 5).

The LEMO enjoyed nearly a decade of success, especially in children and long-term applications. In the mid-1970s, Dr. Landé relocated to the University of South Carolina to teach. He then joined the University of Texas Medical School in Houston to pursue artificial heart research. Along the way, he invented a wearable artificial kidney, and patented the idea of artificial gills to mitigate the bends during deep-water diving. Nowadays, at the age of 88, he is living in Michigan and pursuing an artificial pancreas that can be worn on a diabetic patient’s arm.

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Though the LEMO has been relegated to the dustbin of history, it was Professor Kenneth Taylor who stated in 1986 that "... it is most unfortunate that this excellent, well designed and popular device is no longer available ...".

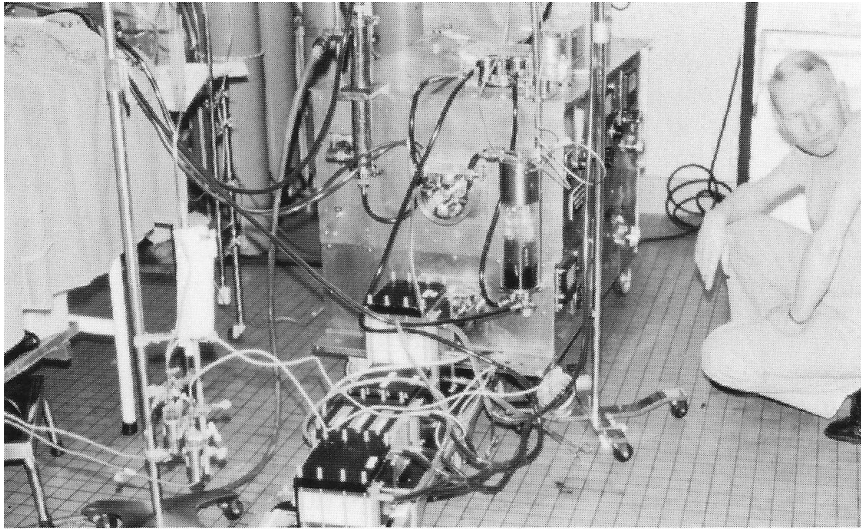


Figure 5. A young Jeri Dobbs conducting a laboratory evaluation of several Landé Edwards Membrane Oxygenators connected in parallel

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