FAREWELL TO THE METERING EDGE

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Out at sea, hydraulics often power motion compensation systems onboard ships. By using a new generation of Electrohydrostatic Actuators, such systems can be signi cantly optimized. In this particular gangway application the following improvements were achieved:

- Higher energy ef ciency enabled a 90 % reduction in input power
- The amount of hydraulic uid was reduced by 80 %
- The total system footprint was cut by 30 %

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In many applications hydraulic cylinders remain irreplaceable as no other actuator can produce linear movements, while subjected to such large forces, so easily and cost effectively. The cylinder's motion is usually controlled using valves, which regulate the ow of oil to and from the cylinder by opening and closing specially designed metering edges. Such valve-controlled cylinder solutions enable precise and dynamic actuation but suffer from one major problem, poor energy ef ciency. To ensure a sustainable future for uid power it is necessary to design systems that exploit the distinct advantages of hydraulic cylinders while delivering improved ef ciency. This was exactly the challenge facing the Dutch company Ampelmann three years ago.

As a leading supplier of Motion Compensated Gangways, the Rotterdam based company has come to appreciate the performance of valve-controlled circuits during the past ten years. On the other hand, they always regretted that a system that in principle only lifts and lowers a mass and on average practically performs no work, still consumes so much energy. Together with Moog, they decided to develop a new architecture based on an Electrohydrostatic Actuation System (EAS). The new solution is signi cantly lighter and more compact, requires less than a fth of the amount of hydraulic uid previously needed, lowers energy consumption and reduces the gangway's input power demand by 90 %.

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In sea states with signi cant wave heights of up to three meters, the Ampelmann A-Type Gangway allows 20 people to be transported from a vessel to a xed or oating object in less than ve minutes. The heart of the system is a valve-controlled hydraulic hexapod that counteracts the ship's wave motion and provides full motion compensation. A traditional centralized hydraulic power unit supplies the valves with pressure and ow. This design offers two major advantages. First, all six actuators can be supplied with power from one common motor-pump unit,

Fig. 1: New Ampelmann A-Type Gangway with EAS

and second, this unit only has to cover the average ow rate demand, since hydraulic accumulators, used to cover peaks in ow demand, can be integrated with relative ease in the supply line. In the event of a power failure, these same accumulators perform the function of an emergency pressure supply and ensure that passengers can be safely brought back on board even if electric power from the ship's generator is lost.

Unfortunately, from an energy point of view, this setup is not optimal. To allow ow to pass through the inlet metering edges the supply pressure must always be greater than the highest load pressure in the system. This mismatch between the supply and load pressure levels leads to unnecessarily high pressure drops across the valves. A loss-free transformation of the supply pressure down to the currently prevailing load pressure in each cylinder, similar to a buck converter used in power electronics, is not possible using valves. A variable supply pressure can reduce these losses, but as mentioned previously in these types of applications hydraulic accumulators are needed. Consequently, the supply pressure level is xed and cannot be adjusted. These pressure losses, also called throttling losses, occur not only across the inlet edges, but also across the outlet edges, since oil owing back from the cylinder always ends up in the pressure-less tank. This means that any power returning from the actuator is throttled across the outlet edge and turned into heat, i.e. no mechanical energy can be recovered from the process.

In the case of a Motion Compensated Gangway, conditions are particularly unfavorable as the hexapod is continuously delivering and absorbing energy as it lifts and lowers the gangway. Ideally, the actuators would store energy from the waves during each retraction motion and reuse it during extension, meaning that the average power consumption would be close to zero. During the retraction motion in a valve-controlled system, not only is the energy absorbed from the waves lost across the outlet metering edge, the cylinder’s inlet side is simultaneously being supplied with oil from the accumulators. Consequently, the actuators consume power during both extension as well as retraction. Since the system’s average mechanical output power is close to zero, this means that all the hydraulic energy supplied from the accumulators is