BRAKING TOWARD THE FUTURE

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When assessing the future of a given industry, particularly one where technology plays a key role, it's typical to hear talk of the future being "here" or "now." Setting aside all metaphysical discussion of what constitutes a changeover from the present to whatever comes next, these conversations tend to take place in the context of what's currently possible. Sure, some ideas may be legitimately futuristic, but most are firmly rooted in present-day knowledge and capabilities. With this in mind, it would be incredibly underwhelming to simply say that the future of off-highway vehicle braking technology has arrived. It's more apt to say the present is always evolving, with new advancements constantly being developed. Ultimately, however, the changing world of braking has far less to do with *when*, and everything to do with *what*. That is because the braking industry has actually moved beyond the niche of brakes and related components, and is now focused on how brakes can become more integrally connected with the operation of a vehicle as a whole.

Getting Brakes Connected

In the past decade, electrohydraulic braking systems—including ABS and traction control—have grown increasingly popular, due largely to the vehicle design flexibility and performance advantages they offer. The industry has seen several other instances of intelligent machine controls, unrelated to braking, over the years as well. But what all of these technologies have typically had in common is that they've existed as standalone, point-to-point functions that have not been integrated together. The present and future of braking is all about taking the next logical step—getting fully connected and finding ways to embed intelligence throughout a machine so that vehicle systems are totally integrated and optimized.

ABS is a good example to examine. Historically, ABS has worked through a relatively simple form of connectivity. An ABS fault might send a message through a CAN bus, perhaps activating an ABS fault light on the vehicle dashboard. No interaction with other vehicle functions would take place. Everything occurring with the ABS would basically be self-contained.

Now, ABS can be programmed to exchange information with other vehicle systems, such as a hydrostatic drive. If one or more wheels start to lock up, the brake system can tell the hydrostat that an ABS event is occurring by delivering a message for the transmission to disengage, thereby increasing ABS performance and preventing the engine from stalling. The vehicle controllers can also use other status information like vehicle speed for interlocking and other safety features.

There are multiple benefits to machine integration. The first and most obvious is improved vehicle performance. Lower cost is another. Although it is unusual for a technology improvement to result in a cost reduction, using just one electronic system—instead of several—to collect and share all vehicle function information often results in cost savings. Fewer components and reduced weight also provide a tangible benefit.

Innovate to Integrate

In addition to enhancing integration for existing brake system technologies, engineers are branching out from their traditional areas of expertise. For example, rather than focusing solely on brake systems and components, manufacturers like Mico are expanding their services to cover the full gamut of vehicle stability control in order to better support their OEM customers.

The basic goal of designing a brake system is to achieve a specific stopping distance based on vehicle weight and other parameters. When looking at electronic stability control, more factors have to be taken into account. Stability control may be utilized to help a driver keep a vehicle under control

Components in Mico's electrohydraulic brake system (all photos courtesy of Mico).

in extreme driving situations like over- and under-steering. This requires an evaluation of a vehicle's dynamic capabilities through the use of accelerometers, gyroscopes and other sensors that aren't typically found on an off-highway vehicle. Manufacturers also prefer to perform a vehicle computer simulation to evaluate stability control performance prior to deploying the technology to a vehicle.

From there, integration can occur just as it does with technologies that are related strictly to braking. An electronic stability control system may communicate with a vehicle's electronic suspension system. It might apply a single brake or multiple brakes depending on whether the machine is following the driver's intention to move in a certain direction. Many other systems and information can also be utilized to assist with stability control.

Regenerative braking is another popular technology that is helping to make vehicles more energy- and fuel-efficient by storing energy generated during the braking process, and later re-using the stored energy for driving. The technology is an additional example of the need for vehicle integration and system communication, as regenerative brakes will encounter situations where standard service brakes must take over.

More Involvement

One side effect of the proliferation of total machine integration is that brake manufacturers must be willing and able to become involved earlier in the overall vehicle development, rather than entering the picture at a later point to implement a standalone braking system. Even for independently operating functions, controls and components usually need some degree of tuning along the way. Those tweaks can be related to actual performance or simply be a packaging modification to ensure that a component physically fits where it belongs. When these same components are required in an integrated scenario, it is clearly a more efficient design process to figure out how every vehicle system will work together from the start and then engineer those systems accordingly.

The move toward integration also means that in many cases, an "off-the-shelf" braking component will not be a viable solution for an intended application. But for companies that have spent decades providing specialized, custom braking components, the learning curve promises to be much shorter than for manufacturers who have historically delivered high-volume, generic options.

Rooted In Safety

Braking is inherently all about safety—mitigating risk to primarily prevent accidents, loss of life and injury, and to help avoid damage to expensive vehicles and equipment. Safety has been and always will be of the utmost importance, but for decades most off-highway vehicle industries were exempt from a large number of vehicle safety standards because machines simply didn't move quickly enough for certain braking guidelines to apply. With new technology advancements, off-highway vehicles are becoming faster. Clearly this fact has the attention of braking component providers, as increased speeds are creating new challenges for vehicle design Faster vehicles must conform to certain Safety Integrity Levels (SIL) and other safety standards that are not new, but are more critical for faster equipment.

Because such standards didn't previously apply when off-highway vehicles were slower, braking manufacturers actually have to educate their OEM customers about certain requirements. Things get even more interesting when factoring in the high degree of integrated software and other electronic capability built into an optimized vehicle. In essence, integrated vehicle design has created a two-way street where both brak-

J.H. Fletcher's Prime Mover diesel tractor features a Mico electrohydraulic braking system.

Mico's full-power brake system with ABS and traction control.

ing and equipment manufacturers need to become schooled in the other's traditional area of expertise.

Tomorrow Keeps Arriving

The off-highway equipment industry is extremely dynamic. Environmental pressures like Tier 4 requirements and wildly fluctuating markets can create daily challenges. Given the degree of difficulty in many cases, it's quite simple to see how decisions might be made because a particular solution is the easiest or cheapest available.

Fortunately it is also an industry that is full of problem solvers—engineers and other leaders who are driven to deliver a new wave of technology to improve vehicle safety and performance. Braking manufacturers are very much at the forefront of the current wave and will play a big role in what comes next. Upon seeing how far technology has come with electrohydraulics and other advances, it's ironic that even braking experts might have to admit that there's just no stopping what's coming tomorrow.

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Great Lakes Power's ST35 straddle carrier also utilizes a Mico electrohydraulic braking system.