Systematic Improvement

With AGVs, a primary bottleneck on productivity is battery life. But when looking at an AGV as a full system, there are plenty of ways this bottleneck can be widened.

Alex Cannella, Associate Editor

No matter what industry you work in, productivity will always be a concern. No matter how good a product or factory line's uptime might be, it can always be better — until the day everything runs entirely on automated machines 24/7, anyway. Which means that there will always be a perpetual mission to find whatever productivity bottleneck is most hampering production and chip away at it.

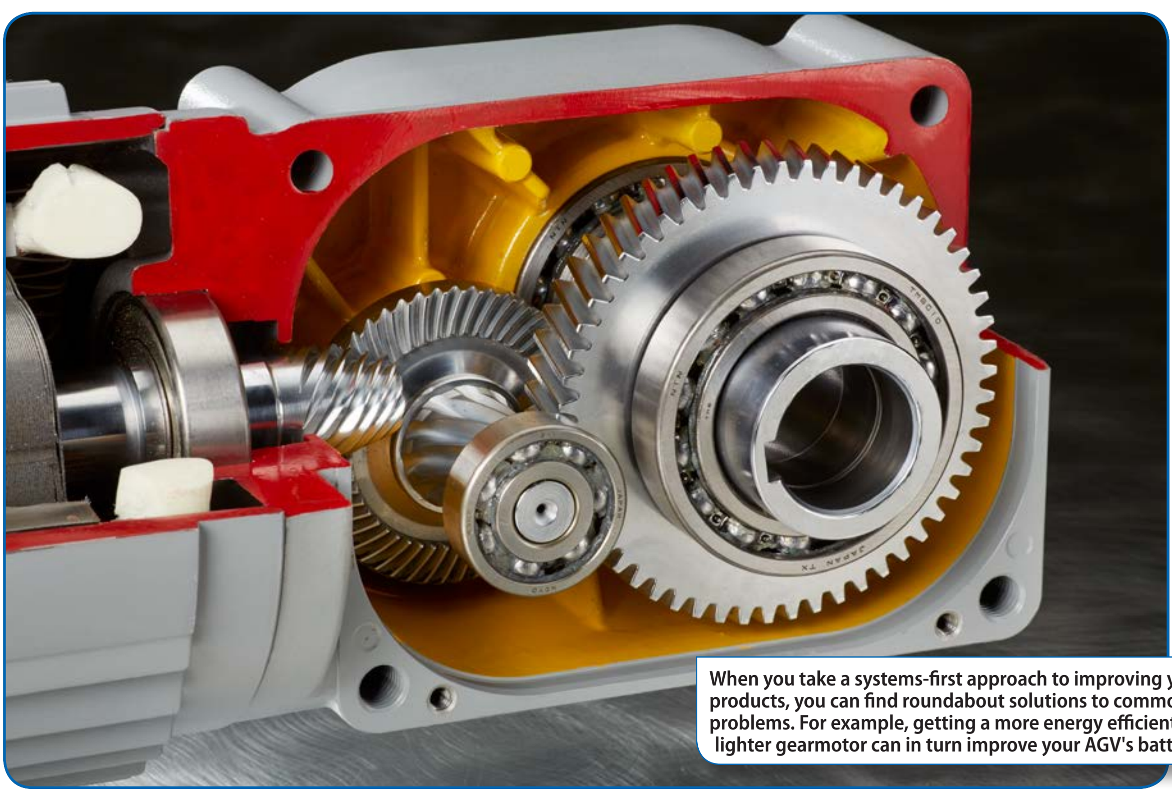
And for automated guided vehicles (AGVs), the primary productivity bottleneck of the day is battery life. Every trip back to the dock to recharge is lost productivity, and so the clear target is to reduce the amount of time spent charging, either by reducing how long it takes to charge or how many trips to the charging station need to be taken. And the obvious first step would be to just make a bigger, better battery, or a faster charging one — solutions that target the battery and directly affect our two limiting factors.

Or is it? There's a whole host of other, largely straightforward ways you can improve battery life if you just shift your approach a bit and look at the issue not as an isolated battery problem, but as a systems problem.

For example, take lightweighting. Basic physics declares that the heavier something is, the more energy it takes to make it move, so if you lighten the load, you'll require less energy to move the same distance. You already see this concept readily embraced in plenty of places, particularly automotive fields, but it also applies to AGVs and battery life. Since a battery's primary limitation is that it can only hold a limited amount of energy, it stands to reason that by lowering the vehicle's overall weight, it will draw less from the battery and the battery will last longer, improving productivity.

The benefits of lightweighting apply doubly for AGVs, as starting to move something draws more energy than keeping it in motion, and many automated machines, including AGVs, frequently start and stop. It becomes all the more important, then, to reduce the amount of power required to make the AGV move and consider weight when picking or making components.

That's all a pretty straightforward and simple concept when you think about it, but it's also a solution that requires you to look past the battery itself, consider the entire AGV as a system, and think about how components affect each other. A sort of forest versus trees solution. And it's just one of a number of potential ways you can improve your machine's battery life.



When you take a systems-first approach to improving your products, you can find roundabout solutions to common problems. For example, getting a more energy efficient or lighter gearmotor can in turn improve your AGV's battery life.

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Power density falls into a similar vein as lightweighting, but comes from a different angle. Any given application only needs so much torque to work, and at that point, you can compare components such as motors for their power density, essentially shopping around for the component that can do the same job with the smallest footprint.

Possibly the greatest systems-based change you can make, however, is to use more energy efficient components. It's the reverse concept of lightweighting. Energy efficiency is primarily a concern of energy conversion, of how much power is lost during the process of converting electricity to actual force. The more efficient a component is, the less energy is lost during that process, and the less overall electricity is drawn from the battery.

Again, nothing about either of these concepts is anything *new*, per se. They come up everywhere. Making increasingly compact motors is always a priority in a number of fields. Similarly, energy efficiency has been popping in and out of the news every time a new regulation milestone gets mandated, and companies that push the efficiency of their components even beyond those regulations are quick to point out the cost benefits over time of doing so. But it requires you to look outside the battery for solutions to a battery-based problem and take a systems-first approach to design, something that doesn't always happen from the start when developing new products.

It's also worth pointing out how all these different methods all synergize with each other. With a lighter AGV, you don't necessarily need as much torque to get it moving, and thus can use a smaller motor, which in turn leads to a lighter AGV, and both of the above can help improve a system's overall energy efficiency.

However, this still leaves us with a question: How exactly do you accomplish all those things? They may be simple solutions, but the actual steps to accomplish them are less so. It's not as if you can just walk outside and find more lightweight but equally durable components, or just decide you're going to make your motor 20% more efficient. These things take hard work and a dedicated engineering team to figure out, and even once you do, it's just back to the drawing board to see how you can do it again. So I sat down with the VP of Brother's Gearmotor Division, Matthew Roberson, to get a few examples of how component manufacturers are working to hit those goals.

"It's all about the systems," Roberson said. "So we're taking it from the systems approach, where if you're trying to get efficiency, you don't just look at the battery. You have to go through the components. And our components, we're on the drive train."

Roberson's primary answer for Brother was to move from using worm gearsets in their gearmotors to hypoid gearing, and the primary benefit here was in the field of energy efficiency. Brother's testing found that gearmotors with worm gear sets often only had an efficiency of 40–85%, depending on the gear ratio of the motor, compared to hypoid gearing's 95-99% efficiency. Depending on the application, that is a significant gain. At a 10:1 ratio, a 10% improvement is still significant, but when you look at the other side of the scale where Brother tested, where a worm gearset with a 60:1 ratio only averaged 40% efficiency while a hypoid still managed 95, the difference is night and day.

According to Roberson, the primary reason for the massive leap in efficiency primarily was due to friction between the gears, or rather, how a hypoid set had significantly less of it. Worm gears undergo significantly more friction as the gears slide along each other compared to hypoids' meshing movement.

And this is where we come back to an earlier statement of mine. AGVs start and stop fairly often, which already antagonizes those differences in efficiency. But here again, Brother found the worm gear lost out even worse compared to hypoids due to the friction that had to be overcome to get the worm gears moving again. The result is that Brother found hypoid gears more efficient across the board and capable of handling higher initial inertia loads than a worm gear set, meaning better power density and thus less energy consumed every time that AGV starts moving.

That's not the end of the benefits Brother found, either. There's also the concern about where all that lost energy from less efficient gearing goes—aka the heat it produces and disperses to the rest of the system.

"Usually energy losses mean less amperage," Roberson said. "It's being transferred to heat instead versus transferred to power on the wheel...What that also means is that the gearmotor runs hotter. It's more challenging. It's more challenging for the seals, it's more challenging for the bearings, it's more challenging for the system."

Speaking of productivity killers, waiting for replacement components after something fails can be one of the worst, a constant bane of almost any machinery line. Finding a way to reduce wear and stave off eventual failure is pretty up there when it comes to convenient side perks.

Brother also offers some of the usual suite of value-added services that come with custom-built components such as "plug and play" designs. Continuing their systems-centric focus, there's an emphasis on designing components that fit inside the larger system of the product the components are being designed for. This also leads to other design decisions such as making their gearmotors grease-lubricated, which allows for the motors to be mounted in more configurations than their oil-lubricated counterparts.

When it comes to improving battery life, Brother's gearset swap is only one example of the overall process, but hopefully it illustrates how taking a full systems-wide approach to a project can open up more avenues to tackle it from compared to honing solely in on the primary component involved, and can help you better choose what to include in your AGVs once you adopt that approach.

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