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EMD RISING

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ENM

Under a new owner, and facing rigorous new regulations for controlling emissions, Electro-Motive might have a secret weapon to reclaim its place as the world's dominant locomotive builder

by David Lustig and Fred W. Frailey

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Distinctive Electro-Motive-built faces take the lead of two BNSF coal trains at Ashby, Neb., on June 27, 2009. Craig Williams

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Tectonic shifts in business are rare. Seldom does a Toyota overtake a General Motors, or a little Nokia rise up to slay a giant Motorola. But it does happen, as when a determined, never-give-up General Electric became the go-to maker of diesel locomotives in the late 1980s, ultimately reducing GM's Electro-Motive Division, which had styled itself "The Home of the Diesel Locomotive," almost to irrelevancy. Normally that would be the end of it; once decisively beaten, it's hard to rise up again and retake leadership of an industry. Just look at Baldwin and Alco.

Except that these days, you can feel that rumble of the earth again. In less than six years, EMD (now called Electro-Motive Diesel) has undergone an extreme makeover. Sold by GM, it was re-energized by two private-equity companies that saw its great potential in both product and name

recognition. They brought in a chief executive who convinced employees and customers alike that the new owners were not interested in pulling EMD apart, but instead wanted to make it again a profitable company impossible to pass up by the right suitor and at the right price. And that's exactly what happened. In 2010, EMD became the new child of Caterpillar, a giant, world-class manufacturing company that also knows a thing or two about diesel engines. Moreover, diesel mavens at the big railroads say EMD locomotives are again the equals, if not better, than anything else in the industry.

To date, these changes haven't altered market shares. EMD remains stuck in distant second place. So what is the portent of that trembling beneath our feet? Rumbles reflect changes you cannot yet see. And the biggest rumble of all, it turns out, heralds an event that won't occur for another four years. Yet

that event uniquely works to the advantage of Electro-Motive while leaving General Electric in what could be a serious quandary. This is the story of how it all came about.

GENERAL MOTORS SURRENDERS

When John Hamilton first peered inside the cavernous factory in La Grange, Ill.,



Billy Ainsworth.

TRAINS: Jim Wrinn



John Hamilton.

David Lustig



Montana Rail Link's SD70ACes and SD45s represent the new and the old of EMD's catalog. Between their construction, the builder lost its top spot. TRAINS: Tom Danneman

where EMD makes its diesel engines, alternators, and electrical cabinets, it appeared to him "like Gotham City in a Batman movie": old and underused. Hamilton, an experienced manufacturing executive, had been hired in 2003 by Greenbriar Equity Group and Berkshire Partners to run Electro-Motive should they become its owners. Electro-Motive was losing money, he knew, and owner

General Motors was investing little capital.

"That's a bad endgame," Hamilton says. "GM was in trouble and holding everything back to preserve itself. If the company did not become standalone, it would be like Pontiac and Oldsmobile: great history, no future."

From the 1940s through the 1970s, omnipotent EMD ruled the locomotive world. The 567-cubic-inch (per cylinder) engine first used in 1938 was a classic. The 567 worked so well inside the FT road-freight locomotive that it endured for nearly 30 years, down the locomotive lineage to the 2,500-hp GP35, SD35, and double-diesel, 5,000-hp DD35. The 567's replacement in 1965, with 645 cubic inches of displacement, went into the hugely successful GP and SD38, GP and SD39, GP and SD40, and SD45, then their Dash 2 successors. EMD sold nearly 10,000 copies in North America.

Then, about 1980, Electro-Motive be-

gan backfiring, setting the stage for that tectonic shift. It pushed the 645 engine past its limits in the GP and SD50, and introduced a finicky new electrical control system. Reliability sank. On delivery of SD50s, field engineers wrote up as many as 20 defects per unit. Vibrations affected wheel adhesion and led to component failures.

By 1987, the more-powerful 710-cubic-inch replacement went into production on the new model SD60. But the damage with customers had been done. EMD in 1989 began moving all final assembly of locomotives to London, Ont., which had previously assembled engines mainly for Canadian customers. The shift did not go smoothly. General Electric, meanwhile, never waver-



EMD powered the SD90MAC with its 265H engine. Most are now retired. John C. Benson

GREATEST HITS

These are the locomotives that put EMD on top and kept railroads' motive power departments coming back for more.



FT: Famously introduced in 1939, this sleek model proved diesels could go axle to axle with steam. *Trains: Jim Wrinn*



GP7: This 1949 EMD design set the standard. Yards, branch lines, and main lines; the GP7 could do it all. *Jim Hediger*



GP38: In 1966, EMD engineers took the GP7's flexibility and made it more modern and powerful with the 645. *John C. Benson*



SD40-2: This 1972 design revolutionized dieseldom. Nearly four decades later, all seven Class 1s still roster them. *Jim Hediger*



SD70MAC: EMD is the first to bring A.C. traction into the mainstream with this innovative 1994 design. *Robert S. McGonigal*



ing in its goal of upending EMD, steadily improved its products, starting with the Dash 7 and Dash 8 locomotive lines. GE seemed to be the horsepower and quality leader, with EMD playing catch-up.

General Electric first surpassed EMD in total unit sales in 1983, and by 1990 the war was over, with GE the seemingly uncatchable victor [see chart, page 31]. Since 1930, GM's deep pockets and array of engineering talent had worked to Electro-Motive's advantage. Now GM seemed to have no stomach for staying in the fight. By the end of the 1990s, it was trying to sell its subsidiary.

On April 4, 2005, the sale of EMD to Greenbriar and Berkshire closed, and John Hamilton had a new title: chief executive officer and president of the newly renamed Electro-Motive Diesel. The company was on its own. Asked later whether he felt fear at the prospect of competing against one of the world's biggest and most successful companies, the 51-year-old Hamilton replied: "Not an ounce. Maybe I'm stupid, but not an ounce."

RESTARTING THE ENGINES

"With three models and six customers, we should be able to run this company on QuickBooks," Hamilton joked to some accountants before the deal closed. He'd had nearly two years to hone a business plan. One was surely needed by spring 2005. Electro-Motive Division had been kept viable by one customer, Union Pacific, which in 1999 ordered 1,000 SD70M locomotives and kept coming back for hundreds more. The first 1,000 units for UP were delivered during 2000-2002, giving EMD a deceptively healthy glow; in 2002, it came within four locomotives of matching General Electric's output. But aside from the 416 locomotives sent to UP in 2002, only 52 others left the factory, and none went to another Class I railroad.

EMD's global market share among U.S. builders plunged from the 41-49 percent range during 2000-2002 to the 26-30 percent range the following three years. Its only steady U.S. customers in the first half of the decade were UP and, after 2002, CSX and Norfolk Southern. BNSF Railway had



EMD has transitioned from an “Americans on airplanes” sales staff to an international model; its overseas sales have risen. A BHP Iron Ore SD70ACe passes Munjina, Western Australia, in 2009. Phil Melling

not taken a delivery from EMD since 2000, both Canadian railroads gave GE all their business, and Kansas City Southern wasn't in the market. Overseas deliveries declined all but one year in the first half of the decade, to just 21 units in 2004.

Hamilton says his first priority was to align himself with EMD's 2,400 employees, two-thirds of them union members. “All turnarounds require the buy-in and energy of the employees,” he says. “Your strategies go nowhere if you don't have people excited at the possibilities. We had to create a vision that makes people say, ‘You know what, this could be good.’”

Five-foot-11 and bespectacled with a runner's slender build and a warm grin, Hamilton set about winning over his workforce. “You gain trust,” he says, “by laying out a strategy that makes sense.” He talked

to employee groups about becoming cost-competitive, making capital investments, and restoring EMD's footprint in the world. Hamilton continues: “Every company has a mission statement that's posted somewhere and then ignored. We take ours quite seriously, because it says our mission is to recapture our position as market leaders. Think about that: an admission that we weren't the leader anymore and that someone out there is better than us and we need to catch up.”

He says it took about two years to really win people over, to convince them the new owners weren't going to cut and run. By then EMD was reinvesting internally generated cash in robotics to speed the creation of power assembly components. Hamilton helped his cause by going onto the factory floor to spend time with individual workers — even learning how to operate their machines, in some cases. One United Auto Workers leader said to him: “I see what you're doing here, but you're still just perfuming the pig.” Now, Hamilton says, “No-body talks about perfumed pigs anymore.”

THE CATALOG

EMD's worldwide catalog goes beyond the locomotives Americans and Canadians are most familiar with. Check these out:



SD70M-2: EMD's base D.C. traction motor 710 diesel has sold well at Canadian National and Norfolk Southern. Mike Williams



SD70ACe: Like the M-2 but with A.C. motors, this model has sold well in North America and internationally. Andrew Robb



SD70ACS: This variant of the SD70ACe (bound for Saudi Railways) includes add-on air filters for desert service. Geoff Williams



JT56ACe: This Chinese-built EMD contains the powerful 265H prime mover; China Railways ordered 300. EMD



Class 66: These dual-cab 12-cylinder 710 diesels rate 3,200 hp, and have become common across Europe. Kim McLaggan



Kansas City Southern's EMD repowers enable the railroad to meet Texas's clean air standards. A pair of GP22ECOs pass Metro Junction, Texas, in April. Roger Bee



The SD50, introduced in 1981, was EMD's first major stumble. TRAINS: Matt Van Hatten

THE NEW EMD

Winning back its traditional North American customers would take time. While the company worked on that, it also pursued other strategies. Hamilton wanted to move EMD from what he described as an "Americans on airplanes" approach to international sales to become a truly global company. To that end, he hired foreign nationals to represent EMD in Australia, Brazil, China, and Europe. For a chief operating officer, he installed Egyptian-born Ossama Hassan, 66, who came to the U.S. to earn four college degrees, beginning with one in mechanical engineering, and went on to work for International Harvester, FMC, General Electric, Allied Signal, and Honeywell.

The first international challenge occurred immediately. GE had won two previous competitions to build high-horsepower locomotives for China Railways. In mid-2005, an-

other 400-unit order went out for bid.

"We wanted to win this one," Hamilton recalls. The spec was for a 6,000-hp engine, and EMD had just the thing in its 16V-265H prime mover, a 16-cylinder monster developed in the 1990s for the 6,000-hp SD90MAC-H. That September, EMD was awarded a contract to supply kits for 300 of the locomotives, to be assembled in China by its partner, Dalian Locomotive Works.

"It's going to sound awfully simple," Hamilton says, "but we did it by going over there, meeting the customer, listening to what its needs were, and being much more flexible than GM would have been in similar circumstances. Plus, they wanted us there."

Dalian delivered the first batch of Chinese locomotives in April 2009. As the order progressed, more and more of the components, up to 80 percent, were to be made in China. Hamilton dismisses the notion that

the Chinese can ultimately reverse-engineer this product and cut out EMD.

"There are a lot of critical elements in one of these designs that are not obvious," he says. "We make very subtle changes, and small changes can have a big impact on how the locomotives operate. Nobody can make an exact copy. Someone may think so, but it won't work out well if they try."

From just 21 locomotives made in Ontario and shipped overseas in 2004, Electro-Motive steadily grew the number to 118 by 2008, for such customers as mining company BHP Billiton for service in Australia (56 SD70ACe units during 2005-2009, with 18 more going out the door in 2010), Egyptian National Railways (40 3,300-hp units with a 12-cylinder version of the 710 engine), and an array of diesels for freight rail companies in Europe. Not included in the head count are locomotives assembled overseas, such as in China and South Africa.

Other new income flowed from after-market products, such as rebuilt traction motors from a factory opened in Mexico in 2010. But the most ambitious idea is the 710ECO Repower project. EMD puts an 8- or 12-cylinder 710 engine and a microprocessor control system inside the bodies of old locomotives, thereby extending their service lives. The company claims savings of 25 percent on fuel and 50 percent on lube oil consumption, plus a 70 percent reduction in greenhouse gas emissions.

In 2009, EMD delivered the first of 21 710ECO Repower locomotives to Kansas City Southern inside GP40 and SD40 car-bodies. In 2010, Union Pacific followed with 10 SD59M-2s rebuilt from SD60Ms. ECO

repowered locomotives are also starting to “clean up” in the commuter rail market, with F59PH rebuilds for both the California Department of Transportation’s Amtrak California and Metrolink in Los Angeles.

But Electro-Motive’s bread-and-butter business, new locomotives for North American freight railroads, limped along in the closing years of the decade. Whereas GE could count on building 800-900 locomotives per year for this continent, EMD was delivering only about 250 annually. BNSF came back with orders, as did Canadian National and Kansas City Southern. But CSX got its last delivery in 2004 and NS in 2006, while Canadian Pacific has bought only GE road engines since a 1998-99 order for SD90s.

EMD became glad it emphasized overseas and aftermarket sales, because the Great Recession murdered the locomotive market on these shores. EMD delivered a mere 46 domestically in 2009, 35 of them to BNSF. For the first time, overseas sales (66 units) exceeded those in North America. GE was hurt, too, delivering less than half its usual number of new locomotives.

“I knew the industry was cyclical,” Hamilton says, “but when it goes down, it goes down hard.”

Going into 2010, Electro-Motive had orders from Canadian National, BHP Billiton, and Saudi Railways, among others. Locomotive expert Sean Graham-White said in autumn 2010 that EMD was headed toward about 115 deliveries for the year, no improvement at all from 2009. Graham-White figured General Electric would ship about 250 locomotives, one-third its pre-recession output. For all of that, Hamilton says, Electro-Motive was again profitable, even in the lousy markets of 2009-10.

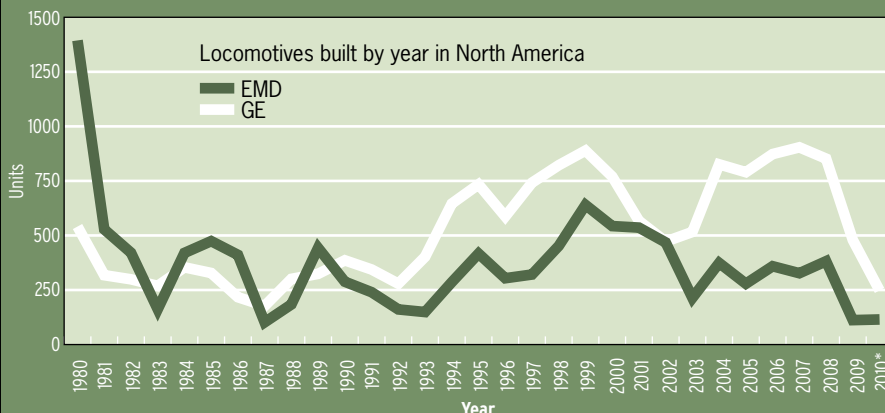
DEADLINE 2015

“We are going to make that burst of black smoke that erupts from diesels a thing of the past,” said the Environmental Protection Agency’s administrator, Mike Leavitt, in May 2004, announcing the Tier 4 Rule. Previously announced Tier 2 regulations on nitrogen oxide emissions took effect in 2005, and were tough enough that GE designed an entirely new 12-cylinder engine, the GEVO, and started its new Evolution line of locomotives, the ES44DC and AC. EMD discovered that it could modify its 710 engine to meet the new rule, and put 4,300-hp 710G3C-T2 engines inside the newly designated SD70M-2 and SD70ACe models, both of which remain in production.

Tier 2 took out some nitrogen oxide and particulates. Tier 4’s goal is to finish the job, removing almost all of those contaminants, effective at the start of 2015. Complying with this rule is a potential nightmare, both chemically and physically. At EMD, the responsibility falls on lifer Martha (Marti)

EMD vs. GE: The leadership changes sides

At the start of the 1980, the Electro-Motive Division of General Motors was the undisputed king of locomotive manufacturers in North America. A decade later, General Electric usurped that role and retains it to this day.



*Estimates

Note: EMD production numbers for 1981 and 1982 assume that an 80-unit order for Egyptian National Railways was evenly split between those two years. Source: Sean Graham-White



Welders shape export SD70ACes at EMD’s sole assembly plant in London, Ont. David Lustig



Marti Lenz (left) and Ossama Hassan visit the shop floor at La Grange. David Lustig



A two-cycle 710 prime mover takes shape at EMD's London, Ont., plant. David Lustig

EMD'S PRIME MOVERS: 710 VS. 265H

	710	265H
Horsepower	4,300 (16 cylinder); 2,150 (12 cylinder)	6,000
Cycles	2	4
Displacement	710 cubic inches per cylinder	1,010 cubic inches per cylinder
Bore	215.9 mm	265 mm
Locomotive application	SD70M-2, SD70ACe, and variants	SD90 and JT56ACe

Lenz, a self-professed "shop rat" who joined EMD right out of Northwestern University's school of engineering. She's in charge of designing and making diesel engines.

First of all, where to put everything? After-combustion treatment to remove nitrogen oxide and particulates requires hardware almost as sizable as the engines themselves. Let's start with particulates. Lenz figures they can be gotten out by sending exhaust first through a diesel-oxidation catalyst to deal with lube oil and fuel carry-over, then through a diesel particulate filter to capture the rest. She calls finding a place to put these components in the engine compartment "a real challenge" that may alter the appearance of the SD70ACe carbody.

As for nitrogen oxide, the ease with which the 710 could be made to meet Tier 2 requirements opened the eyes of Electro-Motive's people. They tested a single-cylinder version of the 710 at Argonne National Laboratory and made a remarkable discovery: If you recirculate exhaust gases back into the combustion process, the effect is to make the engine compliant to Tier 4 for nitrogen oxide. This is possible because the 710, almost alone among the world's locomotive prime movers, operates under a two-cycle rather than a four-cycle process.

"Our engine runs cooler," Lenz says, "and the cooler the engine, the less nitrous

oxide is produced." Add exhaust gas recirculation, and bingo, you're in compliance on nitrogen oxide. Or so EMD hopes.

"We've gotten to Tier 4 levels in a research environment," she says, "so our next step is to see if we can do it on a locomotive." A "mule," a stationary 710 engine inside the La Grange plant, was being tested to prove the point. Moreover, early indications are that such tinkering with the 710 can be done without impinging on its fuel economy.

So EMD's secret weapon turns out to be that quarter-century-old 710 engine, honed over the years from a fickle machine that customers complained about to an engine that, in Lenz's words, "is easy to work on, pretty tolerant of all kinds of abuse, and good for applications in all different types of equipment because of its rate of load pickup. We achieved world-class reliability numbers."

The nitrogen oxide solution for General Electric and other makers of large four-cycle diesel engines may not be as elegant. "If there's a magic fix out there," Lenz says, "I don't know it." Four-cycle engines run hotter than their two-cycle cousins, producing more nitrogen oxide. So far, no maker of high-horsepower, four-cycle diesels has revealed a Tier 4 solution that does not involve spraying urea, or perhaps some other liquid such as ethanol, on the exhaust to marry with the nitrous oxide particles and

create a different, harmless substance.

That's right, urea, the same product railroads frequently move in covered hoppers for use as fertilizer. It's a nontoxic chemical, but it can be an irritant if spilled or improperly controlled. And it freezes. So in addition to buying stores of urea and installing urea tanks and urea-pumping stations at refueling points, railroads would have to prevent urea from freezing both in the ground and on the locomotive.

Brett BeGole, GE's general manager of global locomotive operations, says his company expects to avoid needing urea for its GEVO engine by recirculating exhaust gases, just like Electro-Motive. "We're right on track," he says. But getting the desired result without surrendering fuel economy and creating other unintended effects is harder to do with the hotter four-cycle engine, and fuel economy is the name of the game in the locomotive business today.

EMD's Hassan is convinced GE will find a non-urea solution. "There has to be one," he says. "The distinction is, who is going to get there first with minimum impact on fuel efficiency?" You'll begin to know the answer by 2013 or 2014, when alpha and beta versions of Tier 4 locomotives begin tests on the rails.

THE CAT PURRS

Even with revenues of a reported \$1.8 billion in pre-recession 2008, Electro-Motive Diesel is a mouse beside Caterpillar, the world's largest maker of construction and mining equipment (and diesel engines, it might be added). Cat is widely believed to have tried to buy EMD from General Motors in 2005. The rumor is that the United Auto Workers persuaded GM not to strike a deal with the equipment-maker. At the time, bad blood remained between the union and Caterpillar over an eight-year labor dispute that the company clearly won despite two lengthy strikes.

Denied EMD, Cat instead bought Progress Rail Services in 2007 for \$1 billion and made it a subsidiary. Progress sells a line of genset locomotives powered by Caterpillar's four-cycle C18 engines, but has been more active repowering old units and in selling aftermarket parts and maintenance services.

It turns out that Cat never really took its eyes off that mouse, Electro-Motive. Douglas Oberhelman, who became Caterpillar's chief executive in mid 2010, had been a big advocate of entering the locomotive business. And on June 1, 2010, Caterpillar announced that it would buy EMD from Greenbriar and Berkshire for \$928 million in cash and assumption of debt. The sale closed in early August, with EMD becoming a subsidiary of Progress and Hamilton reporting to Billy Ainsworth, the president and chief executive of Progress.

Within a month, Hamilton resigned, despite in an earlier interview having ex-



Canadian National has been a strong North American EMD buyer, with more than 100 SD70M-2s. Competitor CP hasn't bought an EMD for 10 years. Jeff Robertson

pressed a strong desire to remain with EMD. "I felt the need to get out of the way," he said afterward. "I like Billy; he likes me. But this combined company is too small to have two CEOs." He continues to believe that meeting the Tier 4 requirements without massive re-engineering could give his former employer a competitive advantage over General Electric, and that EMD's biggest challenge will be "to get that done." But it will be Ainsworth's responsibility. The Progress Rail leader told EMD employees he will assume Hamilton's job "for the foreseeable future."

How will EMD change under Caterpillar? Two key answers have already come to light.

At the InnoTrans 2010 show in Berlin, Ainsworth said the company would seek to land the next order for passenger diesels by Amtrak. But "Buy American" provisions for government contracts mean such diesels can't be assembled at London.

That's why the second revelation is particularly interesting. In October, Progress announced a new locomotive plant in an unused 740,000-square-foot building in Muncie, Ind. At press time, details were few, but it gives EMD a standing to make a bid.

Ainsworth also revealed in Berlin that



Two Norfolk Southern SD70M-2s lead freight past Sunbury, Pa., on Aug. 18, 2010. NS recently announced it will purchase 100 new SD70ACes. Michael S. Murray

Norfolk Southern has ordered 100 SD70ACe locomotives, by itself a number almost equal to London's entire 2010 output.

This much seems obvious: As an independent company, Electro-Motive lacked the resources available to General Electric. Overtaking its larger rival seemed a distant long shot. But so it must have been for General Electric in the 1970s, when EMD deci-

sively ruled the locomotive business. Caterpillar, even after being pummeled by the Great Recession in 2009, was a \$32 billion company in sales (versus GE's \$156 billion) and is fully able to bankroll whatever ambitions Ainsworth has for EMD. So against all odds, Electro-Motive has some momentum going as it makes another run to become the biggest and the best in its business. **I**