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Interview



PART 2

Source: AM Batteries

Powder instead of coating: How AM Batteries in cooperation with Lebbing are reinventing electrode manufacturing

In the previous issue, we explored how the collaboration between AM Batteries (AMB) and Lebbing automation & drives GmbH evolved from an initial control system project into a strategic partnership. This time, we take a closer look at the technology behind that journey and the automation and control systems required to scale a disruptive dry-coating process to industrial production speeds.

Isabell Lebbing and Thomas Lebbing discuss the technical challenges, key engineering decisions, and lessons learned with Lie Shi of AM Batteries, and Charles Garris, Vice President of Engineering, who leads automation and controls integration at AMB.

Mr. Shi, AMB's process eliminates entire steps from conventional electrode manufacturing: slurry mixing, wet coating, drying, solvent recovery. What does that mean in terms of how the plant itself is laid out?

Lie Shi: It gives battery manufacturers tremendous flexibility, because the space required is only about a fifth of what a wet process needs. A wet-process line, with its dryer and recovery system, can take up something close to a football field. Our coating process fits into the end zone, roughly twenty meters.

That sounds almost too good to be true and like everybody should be doing it in the way AMB does. So there has to be a catch somewhere. What's the real bottleneck?

Lie Shi: There are three, really. The first is the material itself: our particles are highly engineered, and getting the shape, size and binder ratio right takes deep electrochemistry and physics know-how. The second is the deposition step, controlling particles from one to twenty microns so they land evenly. The third is compression i.e., finding the calendering parameters that turn all of that into a uniform electrode. None of the three is trivial on its own.



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>
> **Lie Shi**

We're naturally interested in automation and controls from our side. How does that technology harmonize with the overall system supplied by another company within Jagenberg Group, Jagenberg Converting Solutions GmbH?

Lie Shi: This is a big question because automation shows up at almost every point in our process. Our real competitor is the wet process, which runs at 50 to 70 meters per minute. When I joined AMB three years ago, we didn't even have equipment yet. Two years ago, we were running at one meter per minute, and customers were understandably unimpressed. Getting faster is simply not possible without automation and controls, and that's the first role it plays.

The second is managing very fine particles. We use an online uniformity gauge to check thickness in real time and feed that information back to the deposition and calendering stages. The third is on the mechanical side: roll pressure, calendering, web tension. Without automation, you'd need a small army just to run the line, and the whole cost advantage would disappear.

Thomas Lebbing: Very true because the web tension, calendering, compression – that's precisely why accuracy and uniformity across the whole web can't be an afterthought. That's the part we, as your partner, take that seriously: making sure that precision holds, every single time.

Can you explain more about the specific functions automation performs on the calendering line itself?

Charles Garris: For us, closed-loop feedback is essential, especially in production. Battery tolerances are extremely tight, and customers expect minimal human intervention on the line. Detecting a defect is one thing, but by the time you've detected it, you've often already produced a lot of scrap. So, the ability to detect and correct immediately is critical. Gap control is a good example: uniformity coming out of the spraying process should feed back from the thickness gauge to the spraying nozzles themselves automatically. These closed-loop functions matter because, however skilled your people are, at production speed you can't rely on manual correction alone.

Which performance metrics are most significantly influenced by automation, then?

Charles Garris: There are many, but a few stand out. There's a balance between the rate of material flow into the machine, our powder electrostatic deposition process, and the various web-handling controls. Web tension is essential, particularly in foil-based electrode processes, and the relationship between web velocity and the coating system must be very tightly controlled. Gap control is essential and making sure we achieve the correct final loading uniformity is another part of that same picture.

Let's talk about process stability and quality, then. What inline measurement methods matter most for quality control, and which ones are essential for preventing scrap?

Charles Garris: The basics are standard across the industry: making sure the material isn't contaminated and making sure it's arriving and leaving the process in the right amounts. Thickness gauges are standard practice, and we rely on them too, for equivalency purposes. There are a few measurements that are somewhat unique to our process which we're not able to go into in detail.

But broadly speaking, we still validate and control the machinery with instrumentation consistent with standard electrode-making practice, thickness gauges and flow meters among them.

And how sensitive is your process to material variation, particle size or distribution, when it comes to these measuring and quality systems?

Charles Garris: I'd compare it to a Pareto chart. A handful of parameters are very sensitive, maybe twenty percent of them account for eighty percent of the overall sensitivity, and the rest matter much less. So, there's a long list of parameters to keep an eye on, but the system and its controls are largely robust. The ones that really demand attention sit in the particle-engineering portion of the process, which, as Lie mentioned, is a highly engineered system in itself.

That robustness doesn't happen on its own, of course. It must be built in deliberately as a line scales up which is exactly where standardized automation justifies its existence. What role does standardized automation play during the ramp-up phase, as you move from pilot lines toward stable mass production?

Charles Garris: A very important one. You must understand and invent the process first, and anything genuinely new tends to start out as manual as possible. Automation is the stairway from that manual beginning to a fully industrialized technology. It's an enabler for speed, uniformity, and quality, but it's very much hand in hand: to program the equipment well, you also have to understand the process well. It's part of a shared development path between the process engineers and the automation engineers.

Let's stay with the plant floor for a moment. You reduce the footprint roughly five times and eliminate infrastructure like solvent recovery entirely. Does anything new take its place? Dust management, for instance, given that you're now handling powder rather than liquid?

Charles Garris: In theory: yes. Part of the process now manages powder instead of liquid slurry. But from the start the equipment is designed with that in mind, so we don't expect many specialized new requirements at full-scale production. If anything, we've removed more infrastructure than the NMP solvent handling and recovery being the best example. The one real difference is that a portion of the process now handles powder, and we want to prevent direct human contact with it through our design almost entirely. Today, in the lab, some access is still useful, always with the right safety measures in place.

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That's a reassuring picture for anyone integrating this into an existing plant. Looking further ahead, where do you currently see the biggest gaps in existing automation solutions? And do you see a future role for AI in this kind of process?

Charles Garris: I think we'll see AI show up in laboratory and development settings well before we see it widely in the field. The main reason is regulatory. Harmonizing machinery safety standards between the US and Europe has been a slow process for years, and the litigation environment in the US creates natural barriers to rapid adoption in production. In a controlled, highly technical lab environment, it's already possible to use AI to tune and optimize a process in ways that could later be replicated in more traditional PLC and control logic.

Thomas Lebbing: I think that's fair, and it corresponds to what we're seeing too. But I'd add that companies like us have to help pave the road here. Standards won't change on their own. They shift once enough companies can show that the risks have genuinely been addressed, and we're already working with a team on exactly that internally, self-learning systems that improve quality over time using sensor data. It's slower going in regulated industries like energy or pharma, but it's coming.

What hasn't been industrialized yet, even though it already works in your lab?

Lie Shi: Tandem, double-sided powder coating is the clearest example, mainly a question of cost and sequencing rather than feasibility. As a start-up, you can't be good at everything on day one. So, being selective, sometimes even saying no to things you know you'll eventually pursue, is essential. Beyond that, we've successfully run several different chemistries in the lab, solid-state, high-nickel, LFP, but haven't yet taken all of them to the pilot line. That is simply because we need to stay focused on what the market and our customers need most right now.



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And on the flip side, what do traditional cell manufacturers tend to underestimate about your approach?

Lie Shi: Most of them look at our electrostatic deposition process, run their own calculations, and conclude we'll never reach the uniformity levels of the wet process. That's exactly what we intend to keep proving wrong. Over the last eighteen months, we've found our speed challenge to be a linear one rather than an exponential one: add more rows or nozzles, and speed increases accordingly. Uniformity is the harder question, and it's where people underestimate the innovation happening that isn't visible from the outside.

Mr. Shi, where do you see AM Batteries in three years, in terms of manufacturing process and automation maturity?

Lie Shi: We want to be the dominant player in the dry battery space, with at least 25 percent market share in the Western world, China is its own story. Concretely, that means licensing agreements with major players, electrode sales at the gigawatt scale, and our first commercial equipment capable of producing more than five gigawatt-hours of electrode capacity a year. None of that happens without the automation and control foundation we've been building together with partners like the Lebbing company.

Mr. Shi, Mr. Garris, thank you both again for such a detailed and technical conversation, and many fascinating insights into your pilot lines – thank you for having us.