

Reimagining production: Tesla's unboxed approach

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During Tesla's Investor Day earlier this year, the carmaker explained its intention to increase the production of its next-generation electric vehicles and stationary battery storage in order to speed up the world's transition to electric vehicles (EVs).

The driving force behind this is its Unboxed Process, a combination of refined manufacturing techniques and strategic process overhauls that will contribute to a substantial production cost reduction and facilitate the profitable build of the sub-\$30k EV that Tesla has long targeted. The idea is that, by deconstructing the assembly approach, individual car components are meticulously fine-tuned before seamlessly converging in a preliminary phase, culminating in a final assembly. The unboxed approach is likely to debut at Tesla's upcoming Santa Catarina plant in Mexico.

What sets Tesla's unboxed production system apart as innovative is not how vehicles are manufactured, but rather how their design is tailored to the manufacturing process. While the conventional approach involves designing sub-assemblies for assembly on the production line, the unboxed system involves designing sub-assemblies to be pre-assembled or pre-cast into larger sub-assemblies.

However, we do not have to look far to find critics. While some raise doubts about whether a system dependent on tried-and-tested methods can lead to substantially reduced production expenses, others question the carmaker's ability to apply this approach to various vehicle models within a single production facility. They also point to its track record of not meeting production deadlines and encountering difficulties when attempting to implement untested technology. This suggests that the timeline for successful implementation might be more protracted than anticipated.

Tesla's main objective is cost reduction. There is every chance that the unboxed approach could reduce labor expenses — to some degree, although may not actually meet expectations — by reducing the assembly tasks required on the production line. It should also trim manufacturing costs by enabling more efficient fabrication of these sub-assemblies in more accessible locations.

Although the new process has the potential to upend the traditional moving assembly line, time will tell if it is truly revolutionary. If anyone can pull it off, then Tesla can.

For a view of how this process could unfold, we talked to subject matter experts within S&P Global Mobility's Supply Chain and Technology practice.

Calum MacRae

Director, Supply Chain & Technology, S&P Global Mobility

Tesla's presentation on 'unboxed production' is similar in concept to project Blue Macaw that GM tried in Brazil in the 1990s. In the case of Blue Macaw, much of the responsibility for the sub-assemblies was shifted to the suppliers, most famously to Dana's rolling chassis (parallels here with EV skateboard platforms), but also involving complete front ends, interiors and so on. This gave rise to the Tier 0.5 supplier. Where Blue Macaw and subsequent Tier 0.5 efforts fell short was in the OEMs realizing they'd lost a lot of transparency on cost (it's easier to hide a bit of extra profit in a complete front-end module than it is if you're itemizing systems component by component). Doing the sub-assembly approach within the confines of Tesla itself gets rid of this drawback.

One other concept that there are some parallels to is the smart factory at Hambach (now repurposed as the INEOS Grenadier production site). Here, the plant was much smaller than previous linear factories (laid out like a plus sign) and the body parts and panels were painted separately in the way that Tesla foresees. Again, the Hambach factory allowed for a much smaller footprint per manufacturing capacity, but much of the sub-systems assembly work was farmed out to several Tier 1 suppliers. This kept Hambach's directly employed labor costs low, but they just appeared elsewhere in the accounts. You could see this by just comparing the size of the final assembly facility with the adjacent supplier facilities.

“While Tesla's approach looks promising on paper, I'd also caution that it might accentuate the inherent drawbacks of mass production/Taylorism. Workers becoming disaffected and de-skilled by the monotonous repetition of mundane tasks could be a more acute problem if work is reduced to just responsibility for the front end of a car. But be careful what you wish for here — Volvo's attempt at its Kalmar plant to alleviate some of the dourness of assembly line work was a productivity disaster.

One other note of caution is that introducing a new product to a new facility is widely frowned upon by other premium manufacturers. They'll try out existing products at new plants first (or vice versa) as BMW and Mercedes both did with their US plants or BMW did with its Leipzig plant. To have a new product, new plant and new production process simultaneously would be heresy for the established manufacturers, but then a lot of what Tesla does can be filed in the folder marked heresy!

Tesla might have hit upon something with its unboxed concept — a kind of revisit to old ideas around sub-assembly but made accomplishable by modern technology and keeping responsibility in-house. For example, the sub-systems and parts it'll have to orchestrate for final assembly are undoubtedly made more straightforward in this day and age by the Internet of Things and low-latency data connectivity, so a lot of the old overhead costs that would have been required by the introduction of additional final assembly complexity are removed (same as with the fewer choices Tesla offers and its software-defined vehicle/over-the-air update approach).”

Edwin Pope

Principal Research Analyst, Supply Chain & Technology Group, S&P Global Mobility

At a systems level, it does look like the unboxed concept is pointing towards lower cost, though I would look at floor space, maintenance, and initial facility capex as the major drivers. Casting equipment for this size is not cheap, but neither are dozens of robots, all the wires connecting the robots, and all the engineering time spent to optimize, troubleshoot, and repair that equipment. This is, of course ignoring all the pain that comes from red x, six sigma, 5s, etc — processes that aim to determine why the build is stacking improperly and then get the changes “good enough.” Reprogramming the robots, changing fixtures, changing welds, or even changing stamping dies all can be a part of the process to fix the BIW assembly problems. There's a massive amount of details for holes, flanges and other features in a body that are usually fixed “on the go” or after the first few vehicles are built. Some of this comes from the multitude of parts, complexity of communications or simply not knowing what needs to be added or removed. Silly things like a small hole to retain a wire or brake line impact these sheet metal parts and incur some job security for BIW manufacturing engineers. In practice, these guys in a manufacturing environment become a reactionary force for changes made to other parts. Casting scans using CT, x-ray and blue light will still require additional expense, but could be less expensive than scanning welded assemblies from an engineering perspective. Scans of multiple

components welded to one another will show as an individual component in most software, requiring manual intervention in most cases to understand that two welds overheated and distorted the entire assembly. For a casting, you look for porosity and maybe distortion. But, distortion in a casting “should” be relatively consistent with process controls in place. Fewer steps mean fewer opportunities for small, unforeseen issues to cascade through an assembly.

Parallel processing at the assembly plant, even with the above being improperly executed, should still yield something for the vehicle. Whether setting up QA cells offline for rework issues that do not halt the production line, changing the layout of assembly plants, or even the shape of assembly plants, I think there are ways to find small efficiencies across the board. Subassemblies will inherently allow many things to occur in parallel, but without as much direct causality. The part I’m most keen to see is how the assembly plant layouts are changed. More operators in an area means more parts being delivered to that area. How do those parts get to that point in the plant more efficiently than today? How does the entire layout change from trucked-in components to bolted assemblies when examining a comparison to larger existing plants? There’s a boatload of effort that goes into managing the movement and placement of assembly-ready components. Maybe the change to assembly that becomes more network or node based than line based will give this facility an edge. There are many cases where getting parts to the line at the right time is challenging for a linear assembly system.

Beyond all this stuff about orchestrated dancing, the difficulty in loading in a 25-30-kg seat on a massive boom arm disappears if we believe Tesla’s current animations. Same thing with a 30kg dash assembly. If TACT time for installing this one assembly is a constraint to overall line speed, as it is for many cases, changing the approach could yield some of their proposed benefits.

Outside of the operational changes the unboxed process brings, there are technical risks too that center around the casting of giga-parts. They can be prone to non-uniform heating and cooling, and there is a high possibility that cavities, cracks and distortion will occur inside the part. Additionally, with large aluminum cast parts, it is difficult to guarantee dimensions due to cooling shrinkage after casting and if there are defects, the cost implications are greater due to the bigger size of the parts. Also, the larger the body part, the greater the cost impact due to defects.

These technical issues are the reason GM is exploring corner castings with its Cadillac Celestiq. Splitting up gigacastings into corner castings and maybe extrusions is much less prone to problems. It’s also simple enough that high-accuracy sand castings can be used. The amount of increased effort with increased size is not a linear relationship, so any ability to shrink the size of casting makes components much cheaper in manufacturing.

However, while there are technical hurdles that need to be overcome, Tesla’s gigacasting and unboxed is of enough promise that Toyota, other Japanese and German companies are evaluating similar strategies for future their BEV platforms. Successful or unsuccessful re-invention of assembly lines is likely to become a gatekeeper for the use of larger form factor castings in future platforms. Cost allocation across the assembly plant and overall line throughput are the two key metrics that will determine the overall success of the direction Tesla is currently taking.

While critics have rightly pointed out that human capital and worker turnover may worsen with this manufacturing strategy, the current workforce reputation and business studies of Tesla might indicate this is quite aligned with its culture and long-term strategy. Turnover and selection for highly motivated employees is, according to some, par for the course in the organization.

Time and expansion will be the judges of this effort as other groups evaluate and test the merits of unboxed. Germans OEMs are reputed for high levels of automation. Japanese OEMs are reputed for high levels of efficiency and variability using minimal capital. It would be another remarkable feather in its cap if Tesla has once again managed to pull off a paradigm shift in the industry — in which it has only been a participant for the past 20 years. It could potentially upend the industry’s mass production system that’s been in place since 1913 and refined by the Toyota Production System since the 1950s.”

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