The supply chain implications of producing affordable electric vehicles

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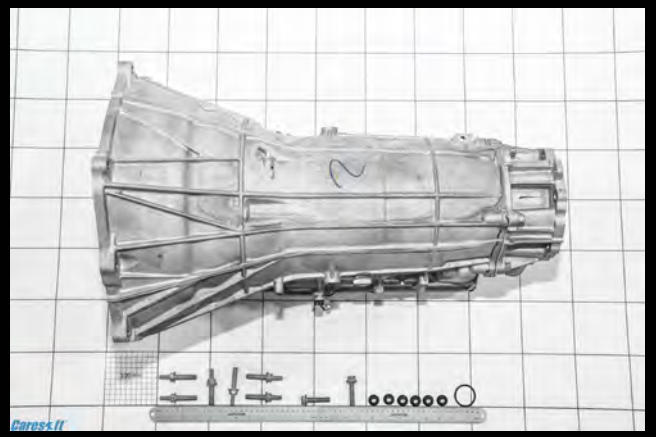
PREMISE

Policy makers seem focused on Engines & Transmissions → Batteries & Motors—The shifts we are seeing could also have profound consequences for the industry

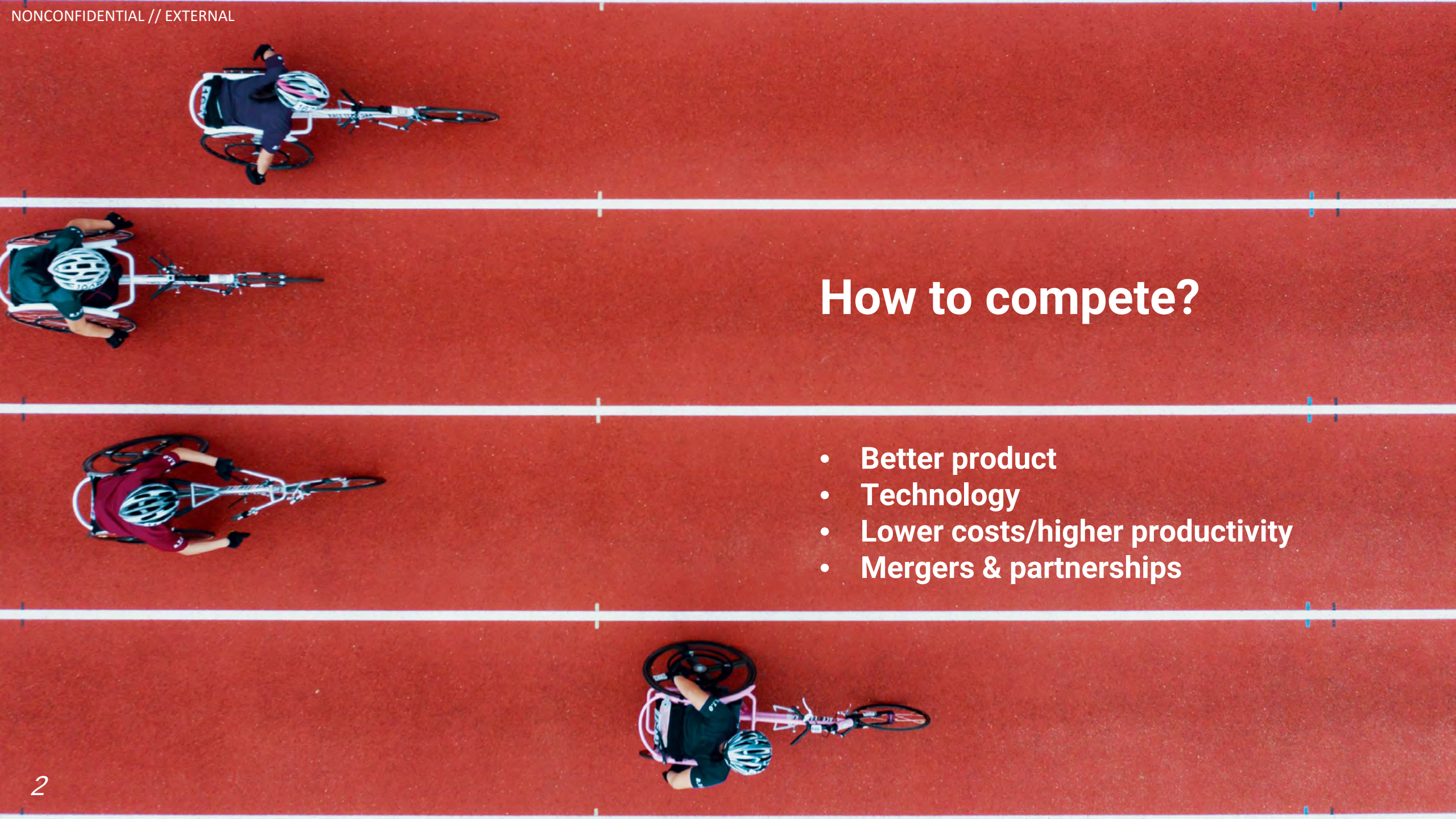


2021 GMC Yukon Denali (T1XX)

"The shifts we are seeing could also have profound consequences for the industry" ?

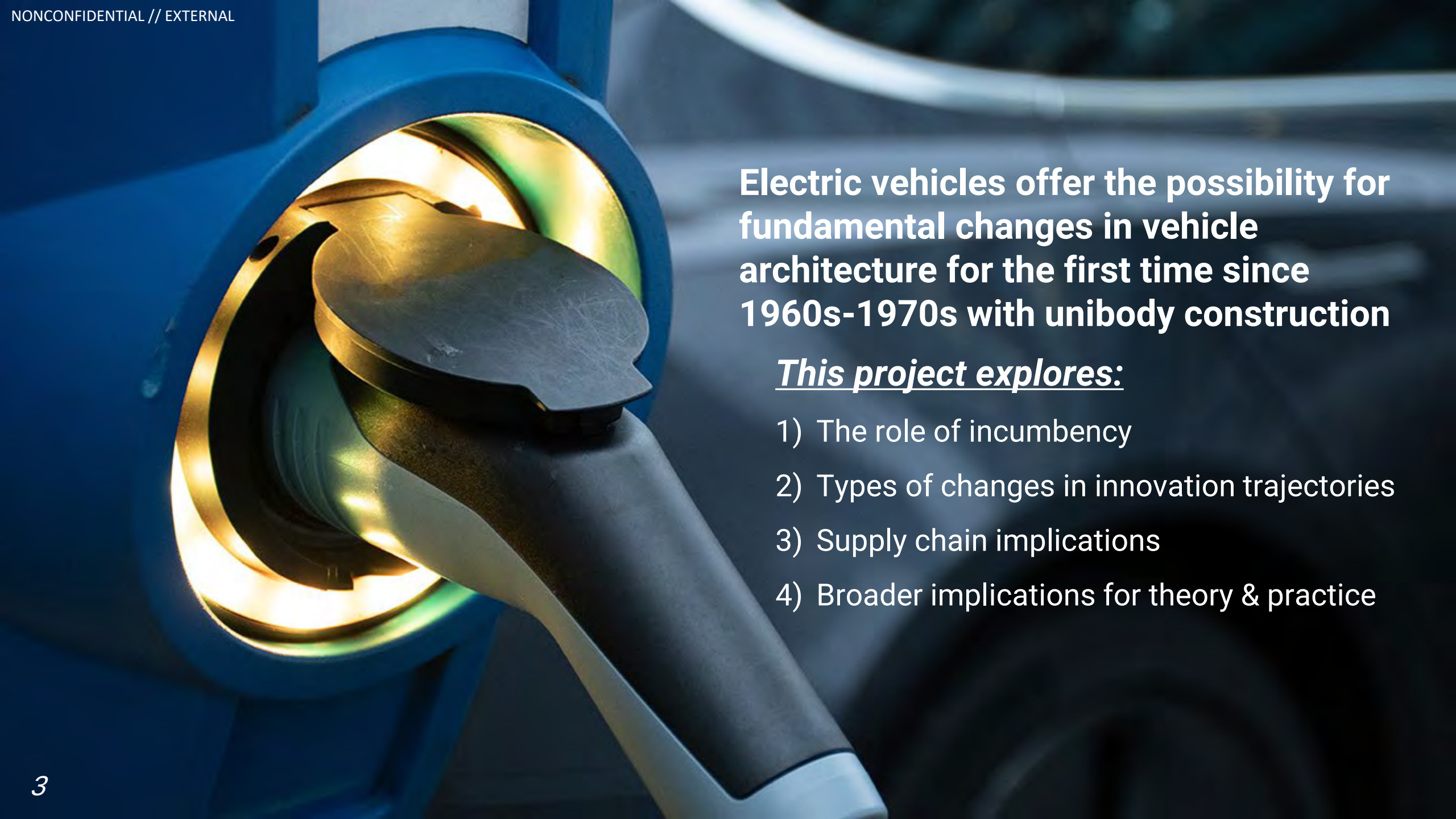
2022 Hummer EV Pickup (BT1)

Image Source: Caresoft Iceberg Teardown Dataset



How to compete?

- Better product
- Technology
- Lower costs/higher productivity
- Mergers & partnerships



Electric vehicles offer the possibility for fundamental changes in vehicle architecture for the first time since 1960s-1970s with unibody construction

<u>This project explores:</u>

1) The role of incumbency
2) Types of changes in innovation trajectories
3) Supply chain implications
4) Broader implications for theory & practice

PERSPECTIVE

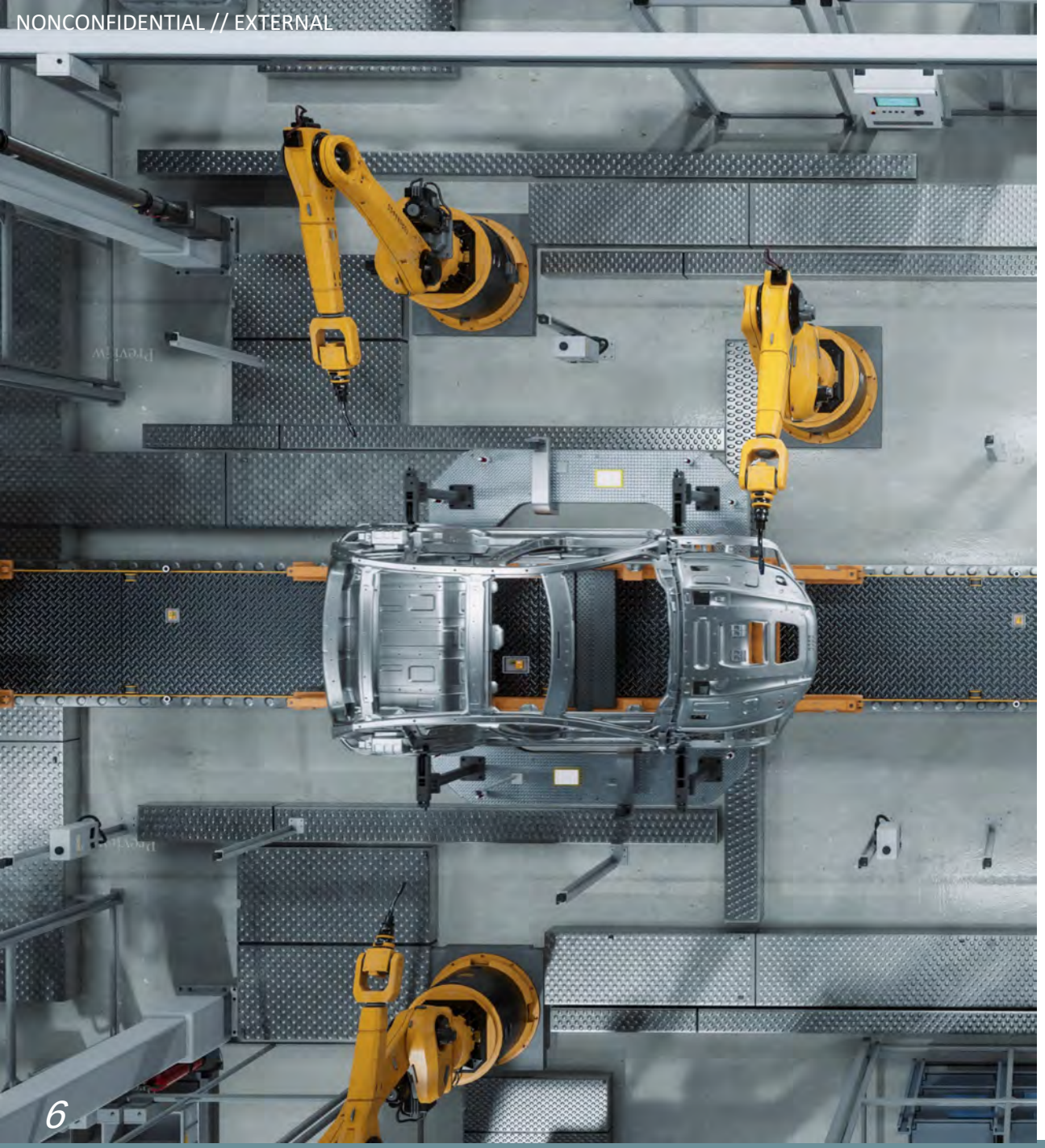
Today: simplification opportunities for start-up and legacy producers

- Differential advantages of Incumbents and Startups →
- Differential responses to policy uncertainty →
- Differential implications for parts count reduction, parts redesign
- Implications for supply chain:
  - Upstream parts suppliers (even non-propulsion)
  - Downstream repair and insurance
- These implications won't be confined to EVs
- Some lessons from history
  - Role of vertical integration and parts modularity

PERSPECTIVE

Differential advantages of incumbents & start-ups

- Incumbents:
  - Can draw on legacy products (and face pressure to do so)
    - Allows for common parts across models, platforms with different propulsion systems
  - Customers want all features they had before
  - Investors want consistent and short-term returns
- Start-ups
  - Have ability to start with clean sheet
  - Lack legacy plant, equipment (+ and -)
  - Customers more open to novelty
  - May have lower costs of capital, less risk-averse investors

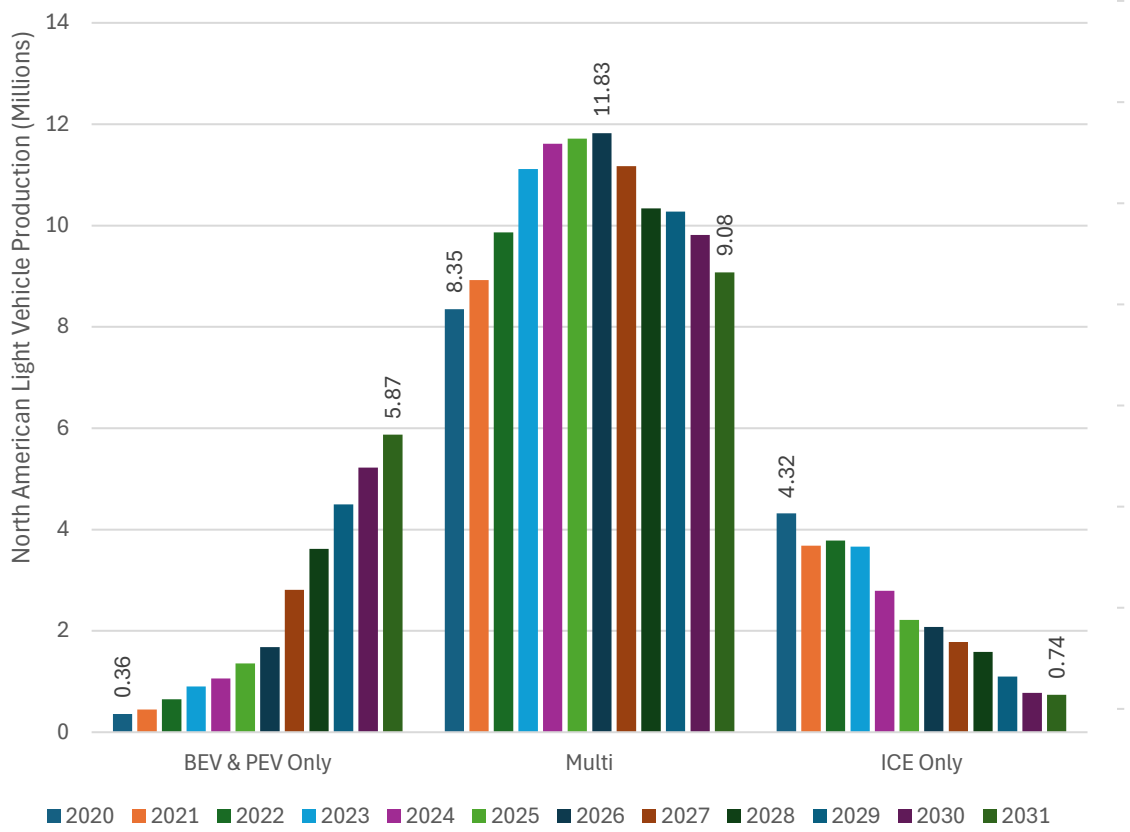


Differential Responses to Policy Uncertainty

ROLE OF INCUMBENCY

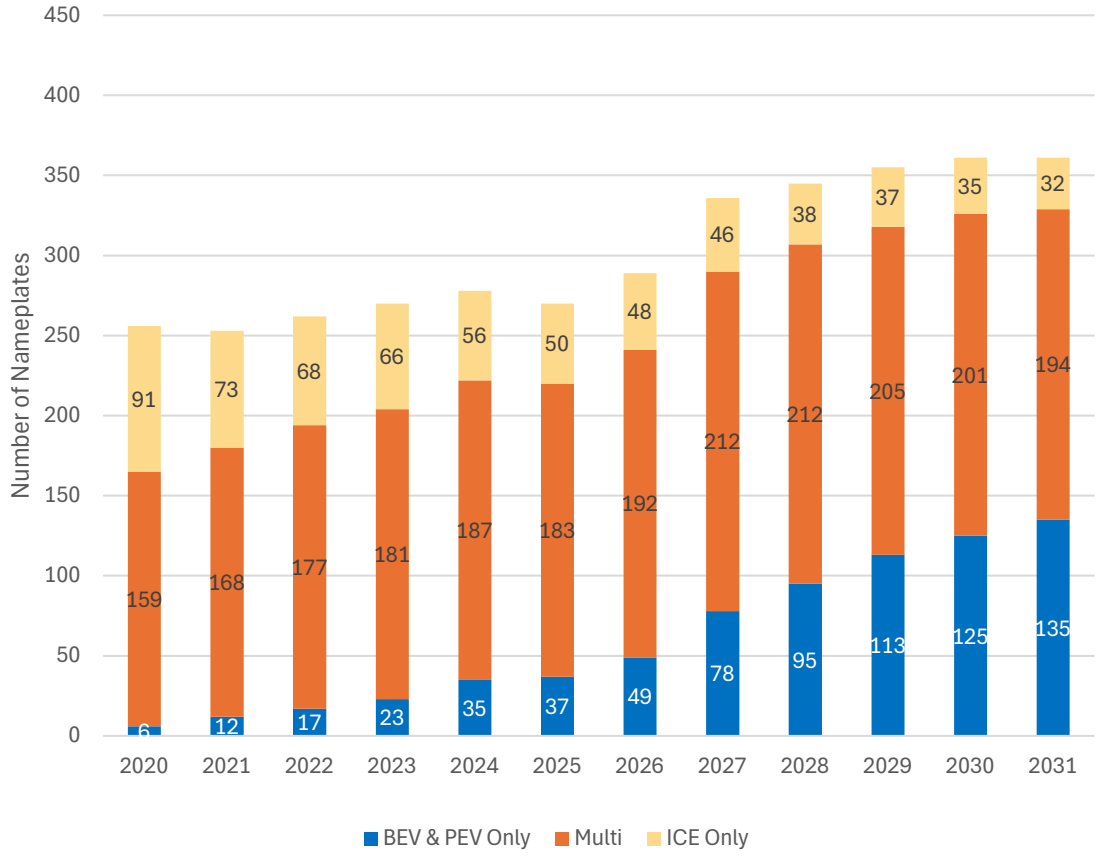
"Multi propulsion" platforms offer North American producers speed-to-market & flexibility, but come with additional costs

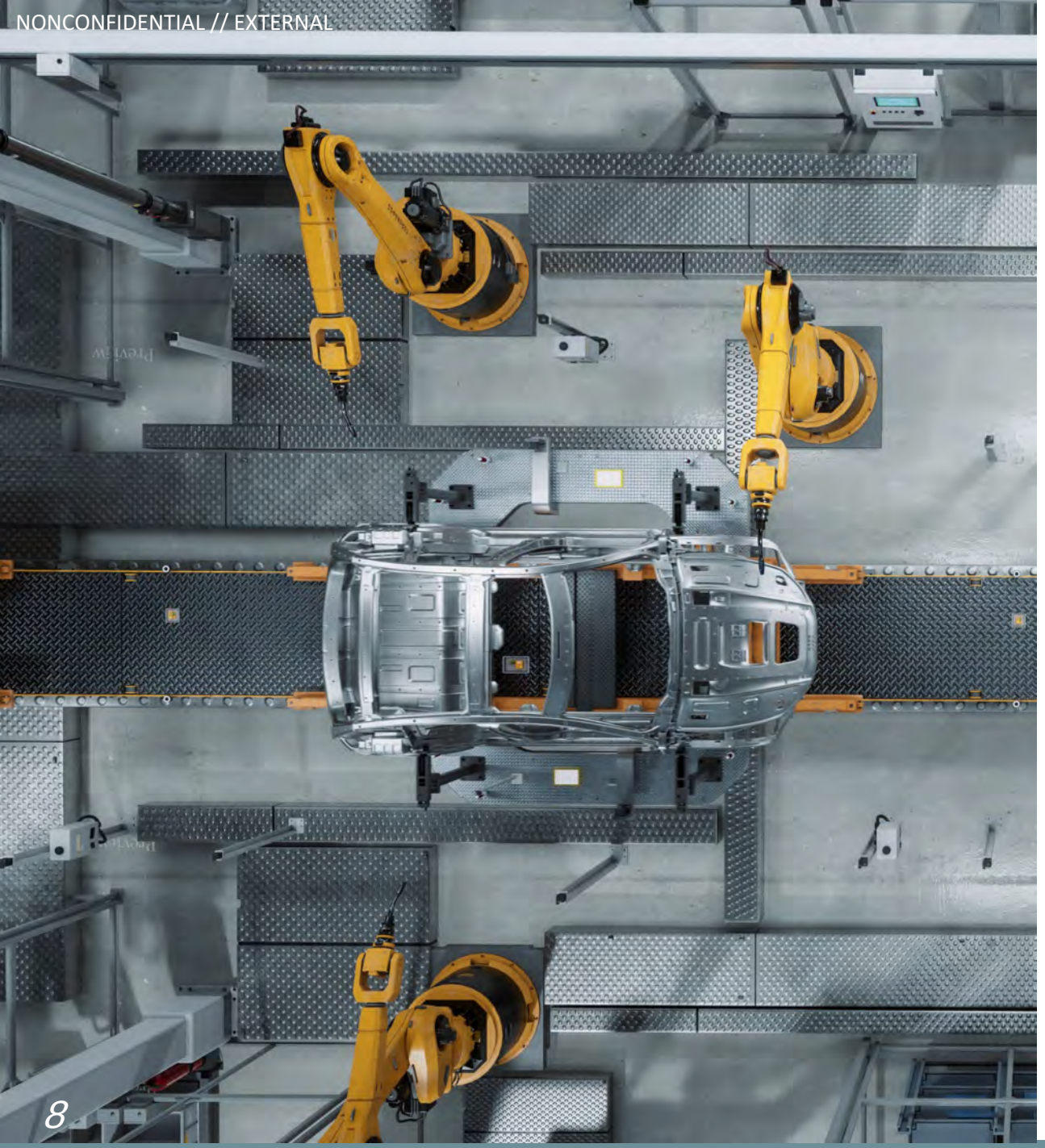
North American Production Volume per Platform Classification, 2020-2023, 2024F-2031F Updated 12 16 24



Source: S&P Global Mobility, Light Vehicle Powertrain & E-Propulsion forecast, May 2024

North American Number of Nameplates per Platform Classification, 2020-2023, 2024F-2031F Updated 12 16 24





Differential Implications for Parts Count Reductions & Parts Redesign

CHANGES IN INNOVATION TRAJECTORIES

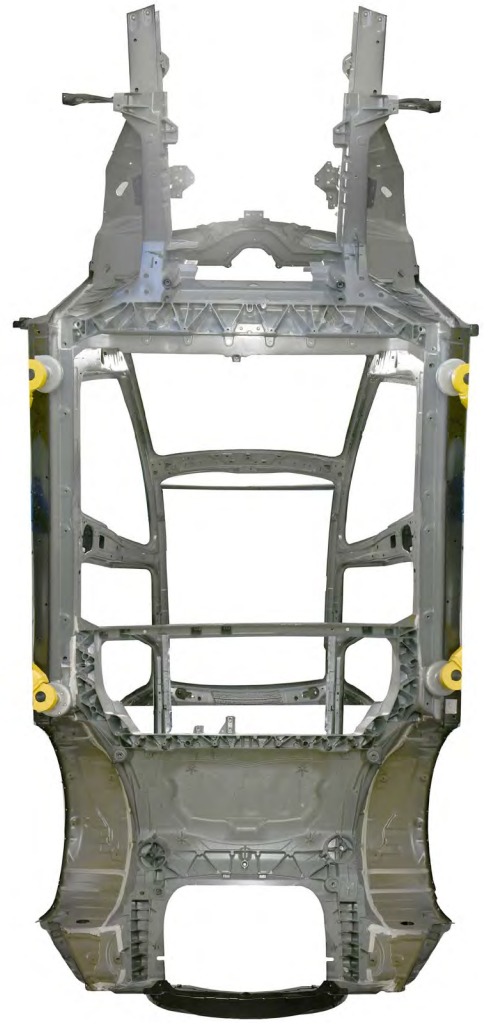
Clean-sheet Rethinking: The Ghost of Henry Ford

"Whenever anyone suggests to me that I might increase weight or add a part, I look into decreasing weight and eliminating a part."

From My Life and Work by Henry Ford and Samuel Crowther, 1922.

- No need for parts required for vehicles with an engine (firewall, fuel tank, engine mounts, most NVH, air intake, exhaust)
- Example:
  Battery as the floor (10% less mass, 370 fewer parts, +14% range—Caresoft)

Tesla Model Y Performance AWD 2020



Tesla Model Y Long Range AWD 2022

Image Source: Caresoft Iceberg Teardown Dataset

CHANGES IN INNOVATION TRAJECTORIES

Clean-sheet Rethinking: Parts Count Reduction

Front Fascia

C Segment EV Competitor

- Front Fascia Weight: **15.57 kg**
- Fastener Weight: **0.13 kg**

Front View

Front Fascia Construction

Part Qty: 28
Fastener Qty: 61, Type Qty: 8
Inline Connector Qty: **2**

Installation Fasteners

Tesla Y

- Front Fascia Weight: **11.43 kg**
- Fastener Weight: **0.08 kg**

Front View

Front Fascia Construction

Part Qty: 7
Fastener Qty: 32, Type Qty: 7
Inline Connector Qty: 1

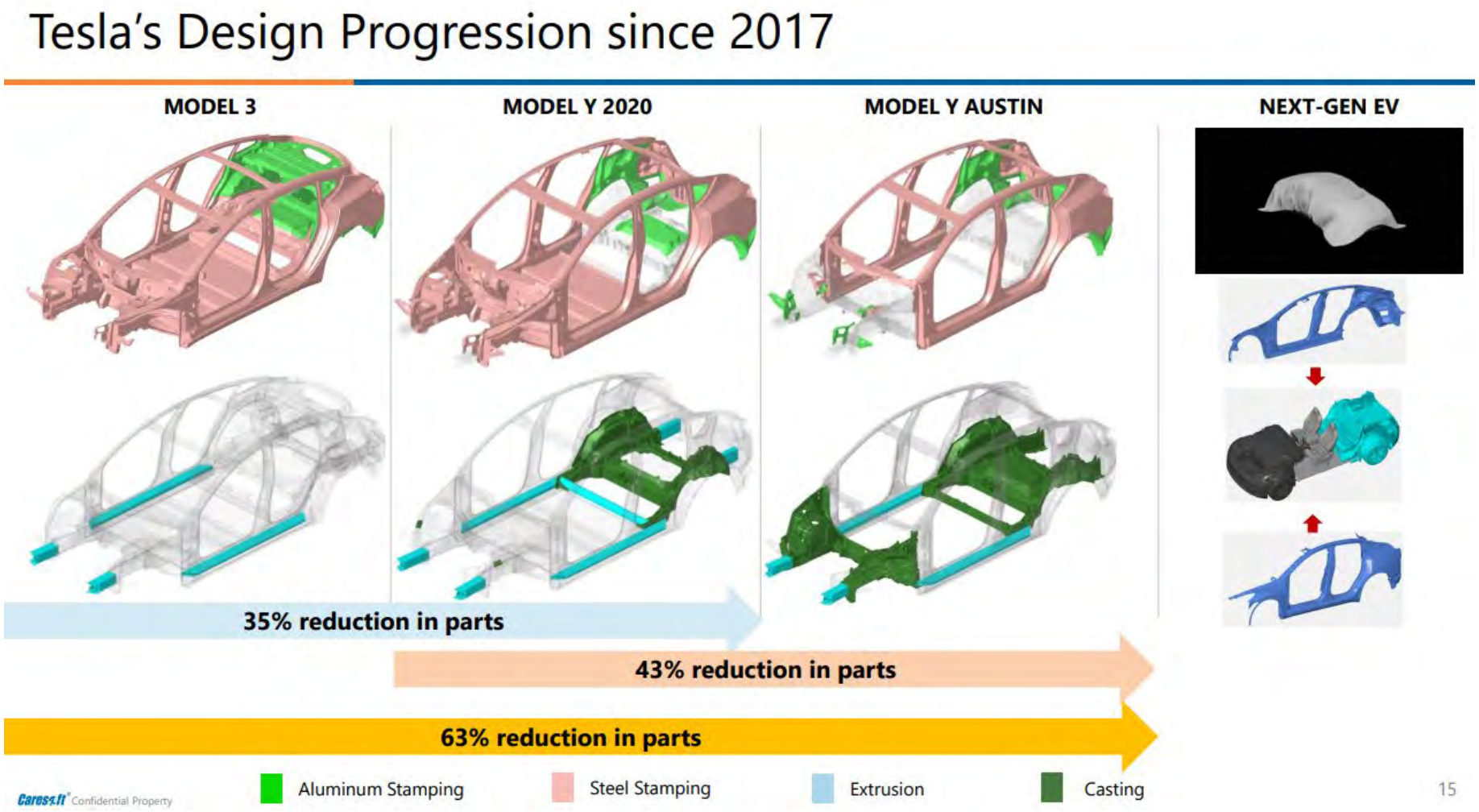
Installation Fasteners

- Tesla Subassembly **27%** Lighter (lighter by 4 kg)
- **75%** less parts in Tesla Fascia Sub assembly construction
- 50% less fasteners used Tesla Fascia Sub assembly
- 50% Less Fasteners for End Item Install
- Tesla 1 Inline Connectors vs. competition -4, & Tesla 9 Application connectors vs. competition 11

Source: Caresoft Presentation, January 2024

CHANGES IN INNOVATION TRAJECTORIES

Fundamental Rethinking: Reduce by changing parts entirely

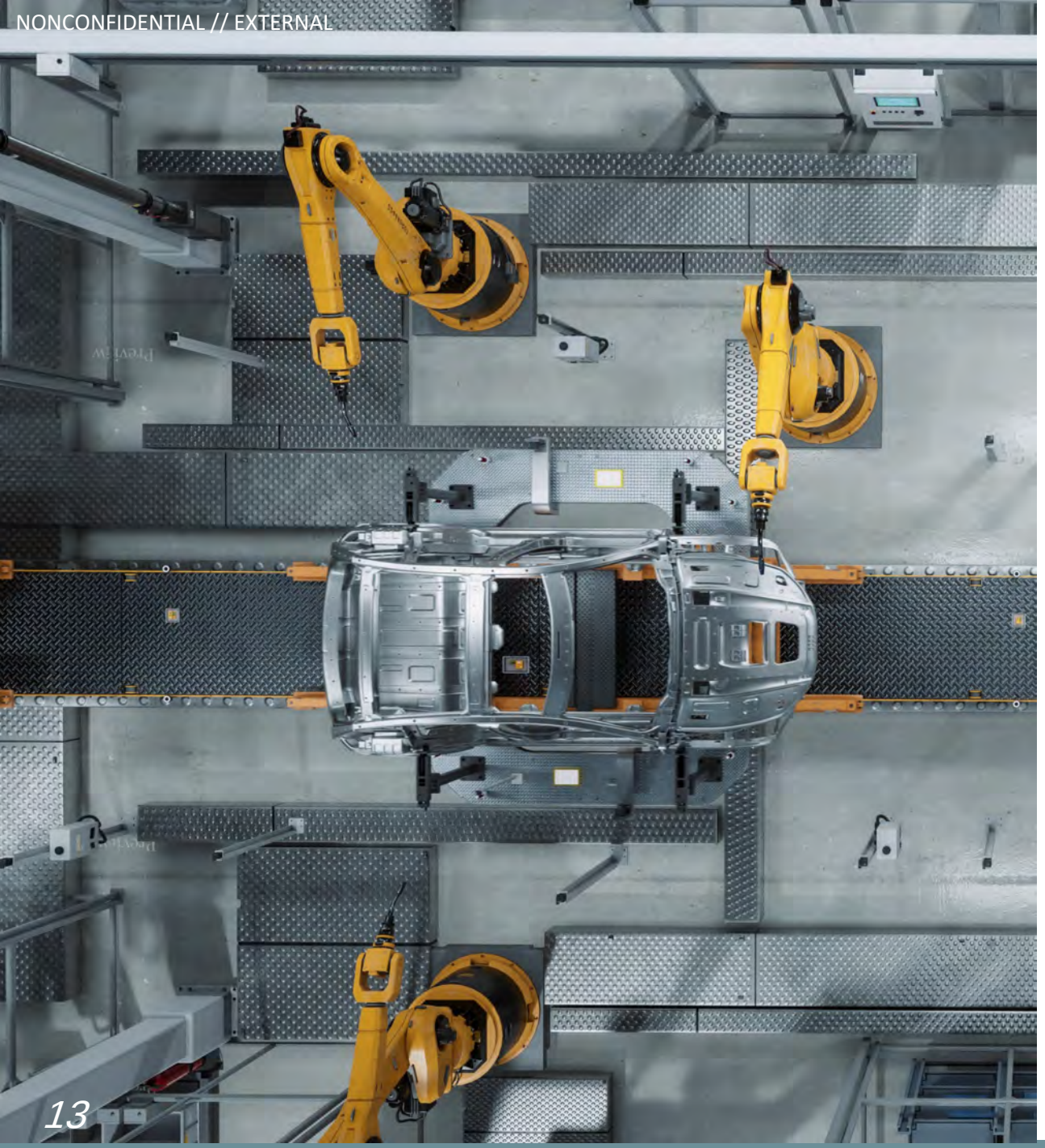


Source: Caresoft Presentation, January 2024

CHANGES IN INNOVATION TRAJECTORIES

Fundamental Rethinking: Giga/megacasting pros & cons

- Pros:
  - Saves weight
  - Reduces number of parts
  - Reduces assembly complexity
- Cons:
  - Up-front investment cost
  - Huge machines
  - Not yet at assembly takt time
  - Potentially higher repair & insurance costs
- Discussion:
  - Why was Tesla first to implement giga/megacasting on mass scale?
  - Will others follow—and will their implementation differ?



Implications for Supply Chain:

- Upstream parts suppliers (Even non-propulsion)
- Downstream repair & insurance

Reuters

Autos & Transportation | Partnerships & M&A | Sustainable & EV Supply Chain | EV Strategy

Exclusive: GM snatches key Tesla gigacasting supplier

By Norihiko Shirouzu

November 15, 2023 7:52 AM EST · Updated 7 months ago

[1/3] Hummer EV are seen on the production line as U.S. President Joe Biden tours the General Motors 'Factory ZERO' electric vehicle assembly plant, in Detroit, Michigan, U.S. November 17, 2021. REUTERS/Jonathan Ernst/File Photo

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Automotive News Europe

A CRAIN FAMILY BRAND

October 11, 2023 06:33 AM

Ford, Hyundai test Tesla supplier's Giga Press

Tesla has pioneered the use of massive casting machines to make large single pieces of vehicle underbodies.

Reuters

TWEET SHARE SHARE EMAIL

LUCA CIFERRI

A Ford-branded Giga Press from Idra is pictured.

Bloomberg

Tesla's Latest Disruption in Carmaking Draws Followers in Japan

- Top auto companies, suppliers exploring merits of gigacasting
- Toyota says bigger isn't better, looking into modular presses

Toyota's gigacast rear component. *Photographer: Kiyoshi Ota/Bloomberg*

By Nicholas Takahashi and Tsuyoshi Inajima

October 26, 2023 at 4:30 PM EDT

Automotive News Europe

A CRAIN FAMILY BRAND

Lexus, Toyota to adopt Tesla production method for next EVs

The production method pioneered by Tesla is also being adopted by automakers such as Volvo, Ford and Hyundai.

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Lexus will use gigacasting for EVs, starting with the LF-ZC, seen here as a concept at the Japan Mobility Show.

NIKKEI Asia

AUTOMOBILES

Toyota gigacasting prototype cuts production from hours to minutes

Die-casting tech aims to streamline assembly in preparation for EV shift

Toyota's next-generation electric vehicles will be produced in three modular sections. (Photo courtesy of Toyota)

TAKAYUKI YAO and KAZUHIRO NOGUCHI, Nikkei staff writers

September 19, 2023 05:33 JST

Reuters

Exclusive: Tesla retreats from next-generation 'gigacasting' manufacturing process

By Norihiko Shirouzu and Giulio Piovaccari

May 1, 2024 10:38 PM EDT · Updated 2 months ago

[1/4] A general view of the Tesla gigafactory in Austin, Texas, U.S., February 28, 2023. REUTERS/Go Nakamura/File Photo

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SUPPLY CHAIN IMPLICATIONS OF CHANGES

Changes in vertical integration, number of operators, automation

- Potentially greater vertical integration as automakers prioritize investments in cost saving strategies & buying fewer parts
- Number of operators/employment levels may not see short-run impacts (more hybrids in transition will require more employees, fewer parts, but part complexity increasing, other policy determinants like trade & industrial policy incentives)
- Increases in automation come with new plant investment & products designed for specialized processes—launches still a few years out

Image Source: Toyota Motor Manufacturing, Huntsville, AL

SUPPLY CHAIN IMPLICATIONS OF CHANGES

Multipropulsion strategies lead to uncertain volumes & challenged forecasts for suppliers upstream

- The ability to rapidly shift to customer demands could leave suppliers in the lurch
- Planning volumes are uncertain
- Difficult to justify ROI on new product investments

Image Source: Canoo SEC.gov filing

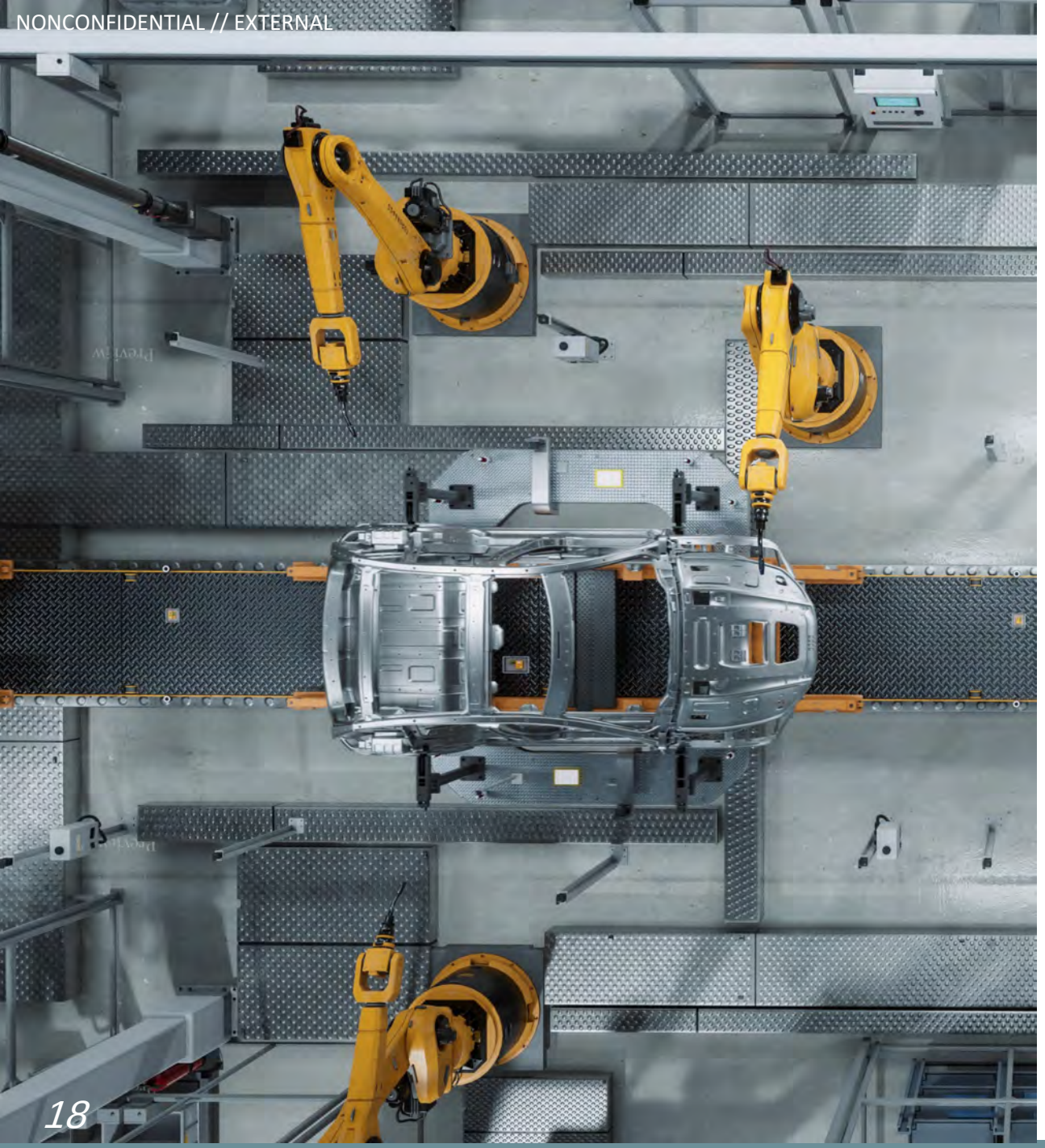
CHANGES IN INNOVATION TRAJECTORIES

Clean-sheet Rethinking:
Reject the design rule that customer should never see a fastener

Chevrolet Bolt Premier 2017

BYD Seagull Flying Edition 2023

Image Source: Caresoft Iceberg Teardown Dataset



These Implications won’t be confined to EVs:

- Some lessons from history
- Role of vertical integration & parts modularity

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