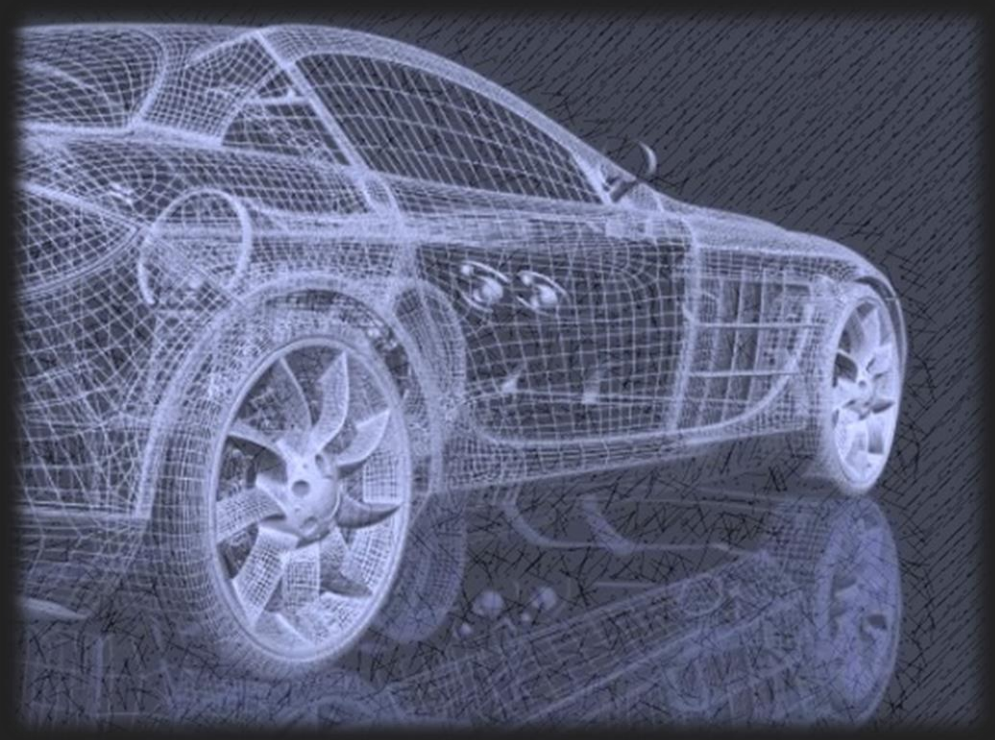

ADDITIVE MANUFACTURING HAS ALREADY CHANGED THE AUTOMOTIVE INDUSTRY – BUT WHERE

SMARTECH – WHO ARE WE?

About SmarTech Markets Publishing

- Specialized Industry Analysis – Additive Manufacturing is Our Foundation
- Purpose built industry market models and forecasting methodologies
- Solving the critical business development, strategic, and evolutionary challenges emerging from the industry today

SMARTECH - WHO DO WE SERVE?

80+ Clients Served

Industry Pioneers

Global Technology Leaders

Critical Suppliers

Users and Developers

How We Serve

Vertical Deep Dive Market Reports

- Automotive, Aerospace, Medical, and many more
- Exploring applications, strategies, supply chain analysis, adoption and penetration, etc.
- Valuation of opportunities by hardware, materials, software, and services

Critical Market Databases

- Global or regional unit sales by technology
- Install base data by technology
- Modeling of deep metrics – utilization, material costing, part volumes, technology die out, etc
- Historical and forecasted data

Customized Research Reports

- Client specific needs and parameters
- Insider interview database and insight collection
- Planning and strategy for specific products or business units

Ongoing Monthly Advisory Services

- Monthly reports and continually updated forecast data
- Covering markets by primary segmentations – metals, polymers, etc

AGENDA

- Additive Manufacturing in the Automotive Sector – A Strategic Analysis
- Design Evolution in Automobiles and Proper Application of AM Technologies
- Trends in the Automotive Industry and Their Impact on Adoption of Advanced Manufacturing Technologies
- Presentation of Relevant Additive Manufacturing Market Data
- Closing Review

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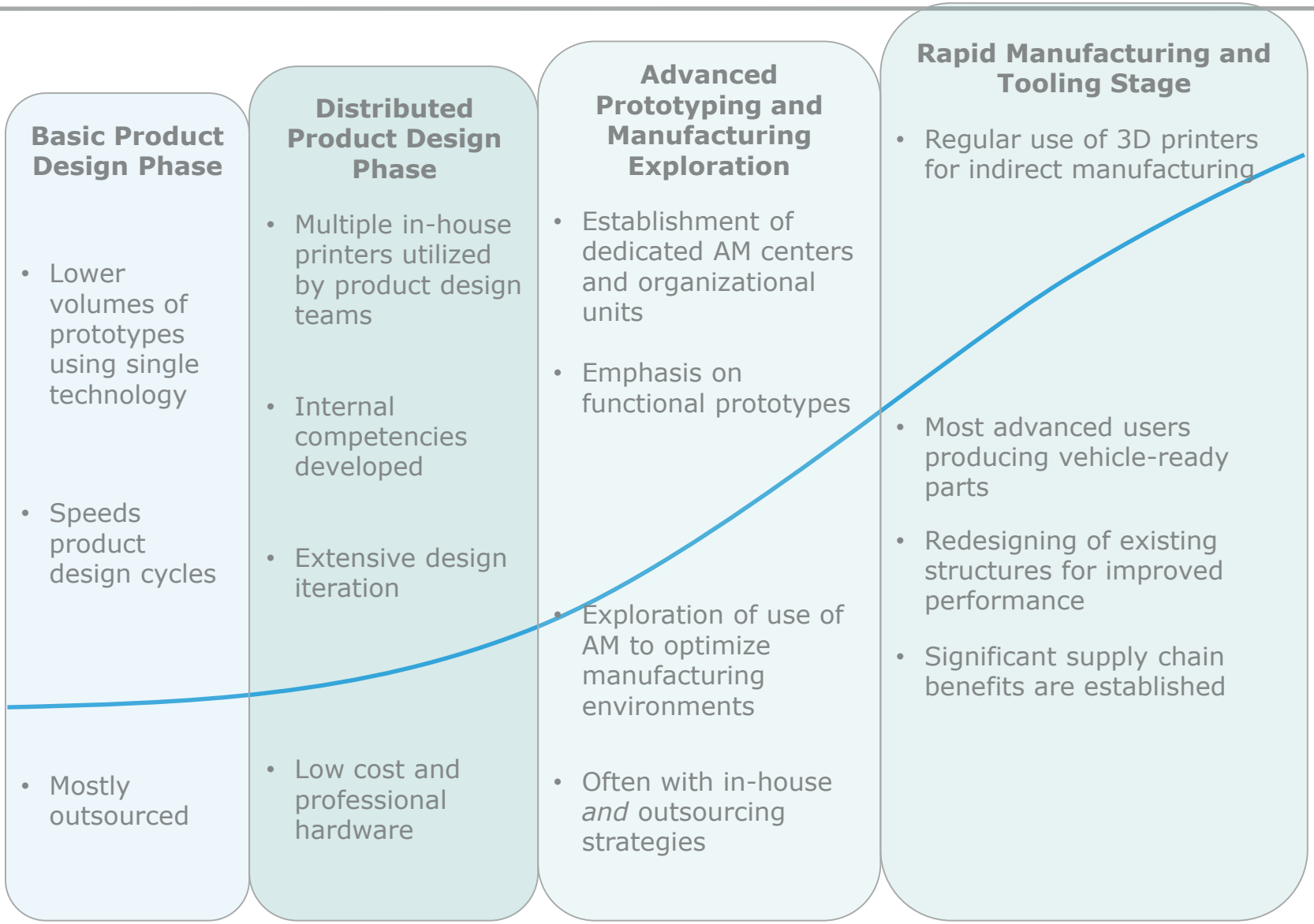
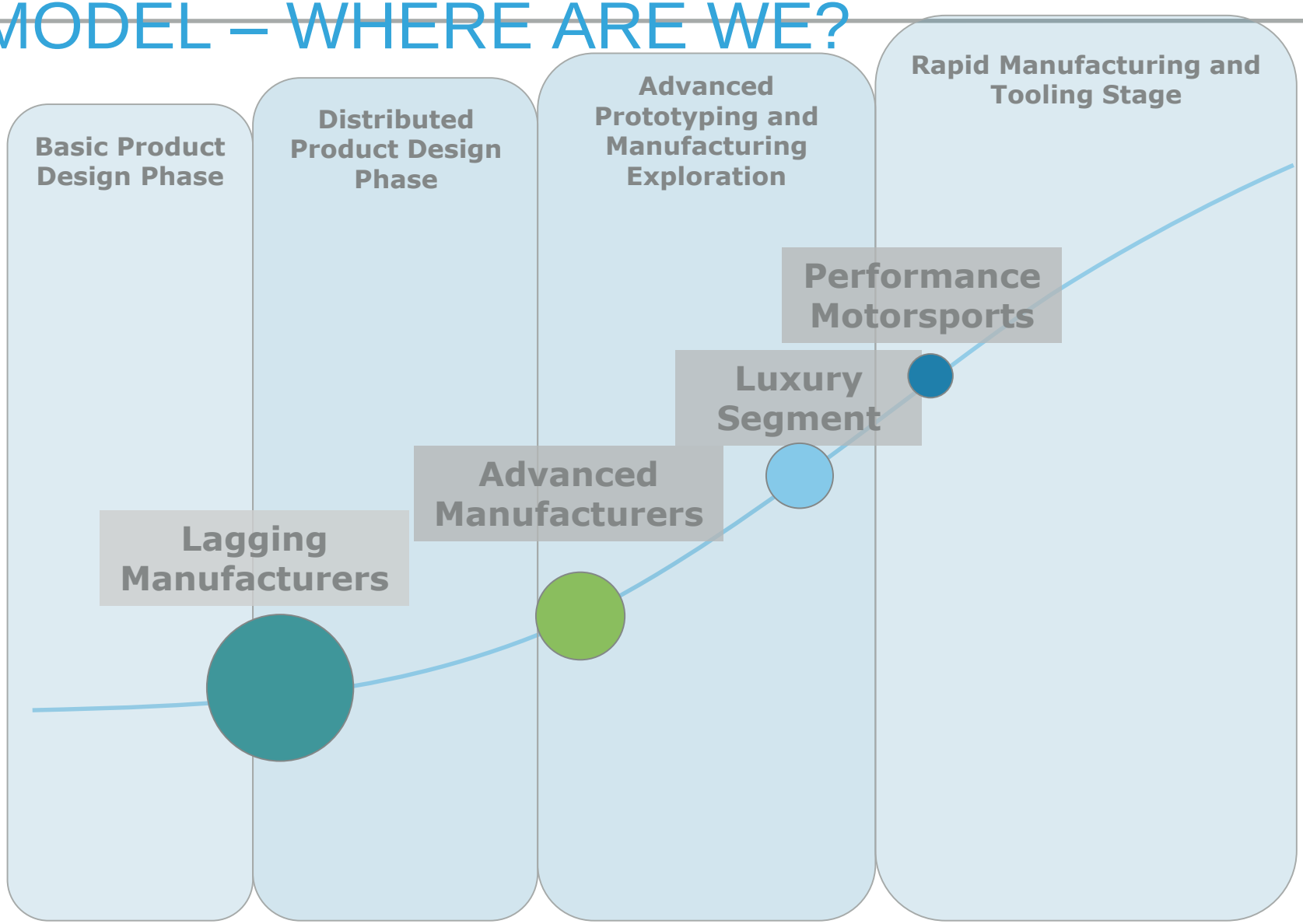
SECTION ONE

STRATEGIC ANALYSIS OF AM IN THE

SmarTech Adoption Model for Automotive AM/3DP



SMARTECH AUTOMOTIVE ADOPTION MODEL – WHERE ARE WE?



AM/3DP HAS ALREADY CHANGED THE AUTOMOBILE MARKET

- The automotive industry is a case study in 3D printing technology penetration trends

- Rapid prototyping using 3D printing in the auto sector is the most well established vertical integration of 3D printing technology

- **Reduction of product development time** currently rules the value proposition for 3D printing in passenger and commercial automobiles

- Many major of the leading automobile makers *rely* on 3D printing

AM TECHNOLOGY DEPLOYMENTS IN THE AUTO SECTOR

Print Technology	Automotive Value	Qualified Applications
Photopolymerization	Best aesthetic value and material flexibility	Interior and aesthetic prototypes for grills, dashboard components, consoles, shifters, tread modeling, aerodynamic modeling
Polymer Powder Bed Fusion	Best mechanical value and good productivity	Longer lasting, higher strength parts for more functional prototyping of various components and structural systems
Binder Jetting	High productivity for rapid iteration and design change, sand cores for casting	Design communication models, tooling for rapid casting of functional metal prototypes
Material Extrusion	Mechanically sound prototypes at a relatively low cost per part, tools for operational flexibility	Environmental control systems, electrical housings, various functional prototypes, assembly tools, layup tools

AM/3DP HAS ALREADY CHANGED THE PERFORMANCE AND LUXURY AUTO MARKET

- The performance and high end luxury markets are exploring utilization of AM in a much different way

  - Low part volumes and high per-part values fit the current technological and economic capabilities of existing solutions

  - Increased performance generally rules the value proposition for racing, motorsports, and high end luxury markets

  - The focus is continuing to look towards production of vehicle-ready parts to increase mechanical performance (racing) or perceived value (luxury)

AM TECHNOLOGY DEPLOYMENTS IN THE PERFORMANCE AUTO SECTOR

Print Technology	Automotive Value	Qualified Applications
Metal Powder Bed Fusion	Solution for direct metal prototypes and short run production	Rotors, brackets and structural components, combustion elements, custom manifolds
Polymer Powder Bed Fusion	Solution for mechanically strong and aesthetic polymer parts	Fuel tanks, custom paneling and aerodynamic components for racing, lightweight polymer structures, custom interior components for luxury
Binder Jetting	Solution for efficient large polymer prototypes and tools	Large format prototypes and tooling for large vehicle structures and engine components
Photopolymerization	Solution for functional concept prototypes	Concept components of highest aesthetic value and lower long term performance requirements

WHERE DO WE GO FROM HERE?

- Current Trajectory:
- Improving the Efficiency of Automobile Manufacturing

Increasing the Install Base
- Down the supplier tier
- Low cost systems for even more access

Next Generation Technologies
- High speed photopolymerization variants
- High speed polymer powder bed fusion variants

Adapting for Manufacturing Efficiency
- Continued expansion in production tooling
- Continued implementation of assembly tools

- Emerging Trajectory:
- Redefining Automobile Manufacturing and Design Through Additive Manufacturing

Transition to Additive Design
- Redesign of multicomponent systems for reduced manufacturing steps/processes

Implementation of New Material
- Riding the composites wave
- Bringing high performance alloys selectively

Fuel Efficiency
- Designing new structural systems for advanced geometries and lightweight structures

SUMMARY – OUR AUTOMOTIVE AM WORLDVIEW

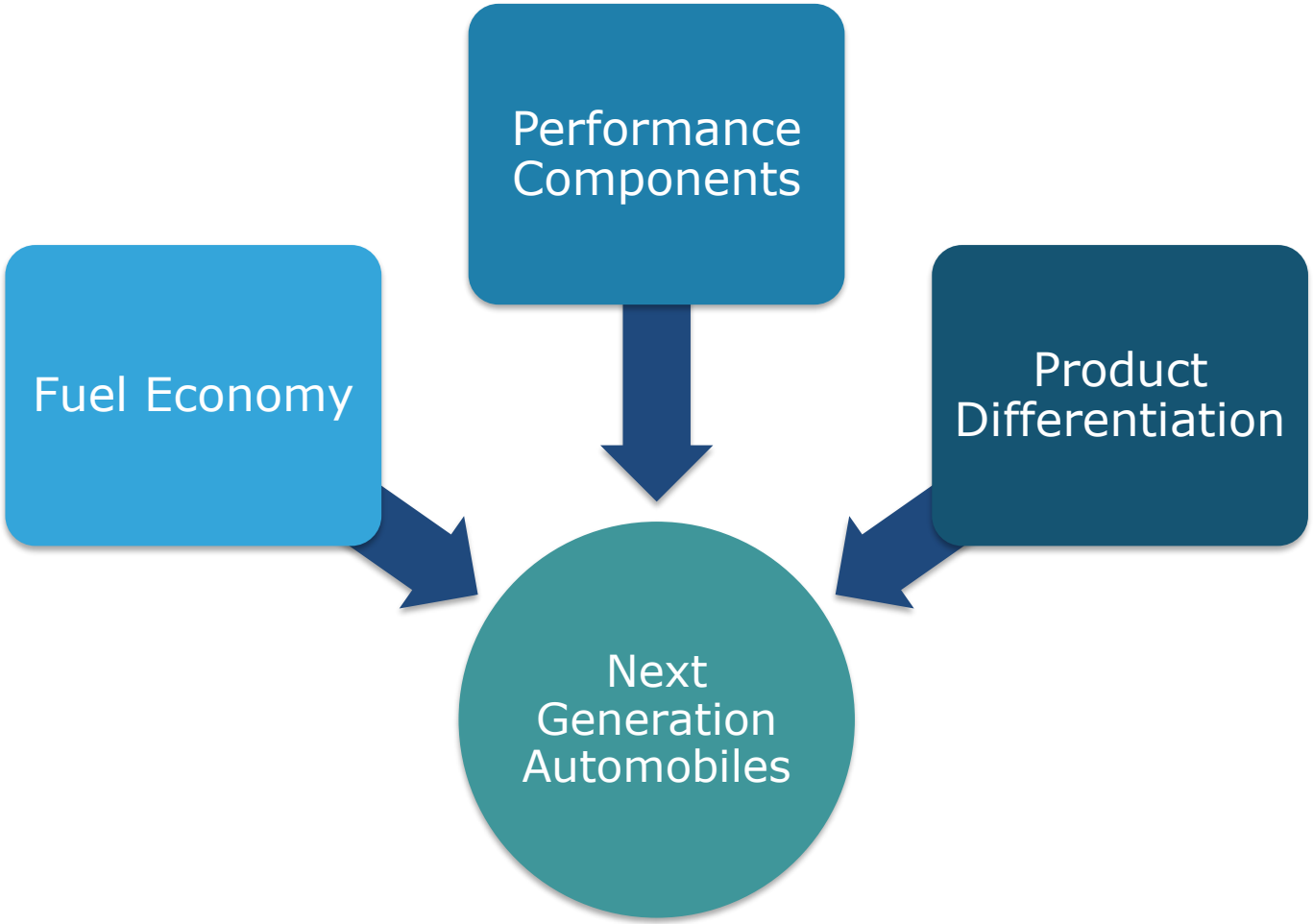
- **Automotive** – high potential segment for additive manufacturing/3D printing driven by the three primary needs of the modern automobile design: **fuel efficiency, product differentiation, and performance.**

- Analysis shows penetration of 3DP relative to potential is still significantly low, even in use of rapid prototyping

SECTION TWO

DESIGN EVOLUTION IN AUTOMOBILES AND APPLYING AM

NEXT GENERATION AUTOMOTIVE MANUFACTURING AND DESIGN REQUIREMENTS



HOW DOES AM/3DP APPLY TO NEXT GEN DESIGN PRINCIPLES?

- **Fuel Efficiency**
  - The most potentially direct application for AM to address next generation design principles
  - Also perhaps the most difficult to achieve today
  - Lightweighting through AM is a relatively proven concept through applications in aerospace utilizing complex designs, reduction of subassemblies, and high strength to weight materials
  - Challenge is applying today's direct part production technologies to the light passenger vehicle market where fuel efficiency has the biggest impact

HOW DOES AM/3DP APPLY TO NEXT GEN DESIGN PRINCIPLES?

- **Performance Components**
  - A relative no brainer at the high end of the automotive spectrum, utilizing performance alloys and metal AM technology like powder bed fusion opens the door for increased performance in automobile parts
  - The challenge is scaling what is capable and proven today to the wider market
  - Costs quickly become prohibitive, along with challenges in repeatability for higher volumes of metal components
  - Again, however, examples in aerospace engine components suggest that AM can indeed provide solutions for better performing metal components

HOW DOES AM/3DP APPLY TO NEXT GEN DESIGN PRINCIPLES?

- **Product Differentiation**
  - A much more subtle and artistic potential for AM through realization of improved designs, but also customization
  - Many AM technologies could theoretically play in this area, and this could probably be considered the low hanging fruit
  - Could improve on what we have seen in the aircraft industry with production of non-critical parts slowly implemented into more and more automobile models

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SECTION THREE

TRENDS IN THE AUTOMOTIVE INDUSTRY SHAPING

AUTO MARKET PRODUCTION NEARING RECORD LEVELS

- Stronger economic factors, low oil prices driving record sales in U.S.
  - Expectations are for three consecutive 17 million + years
- Thus, production expectations are higher than pre-recession levels
- Profitability in the U.S. market is high, which is a big positive for investment in new equipment and R&D throughout the supply chain

THE EFFECT OF OIL PRICES

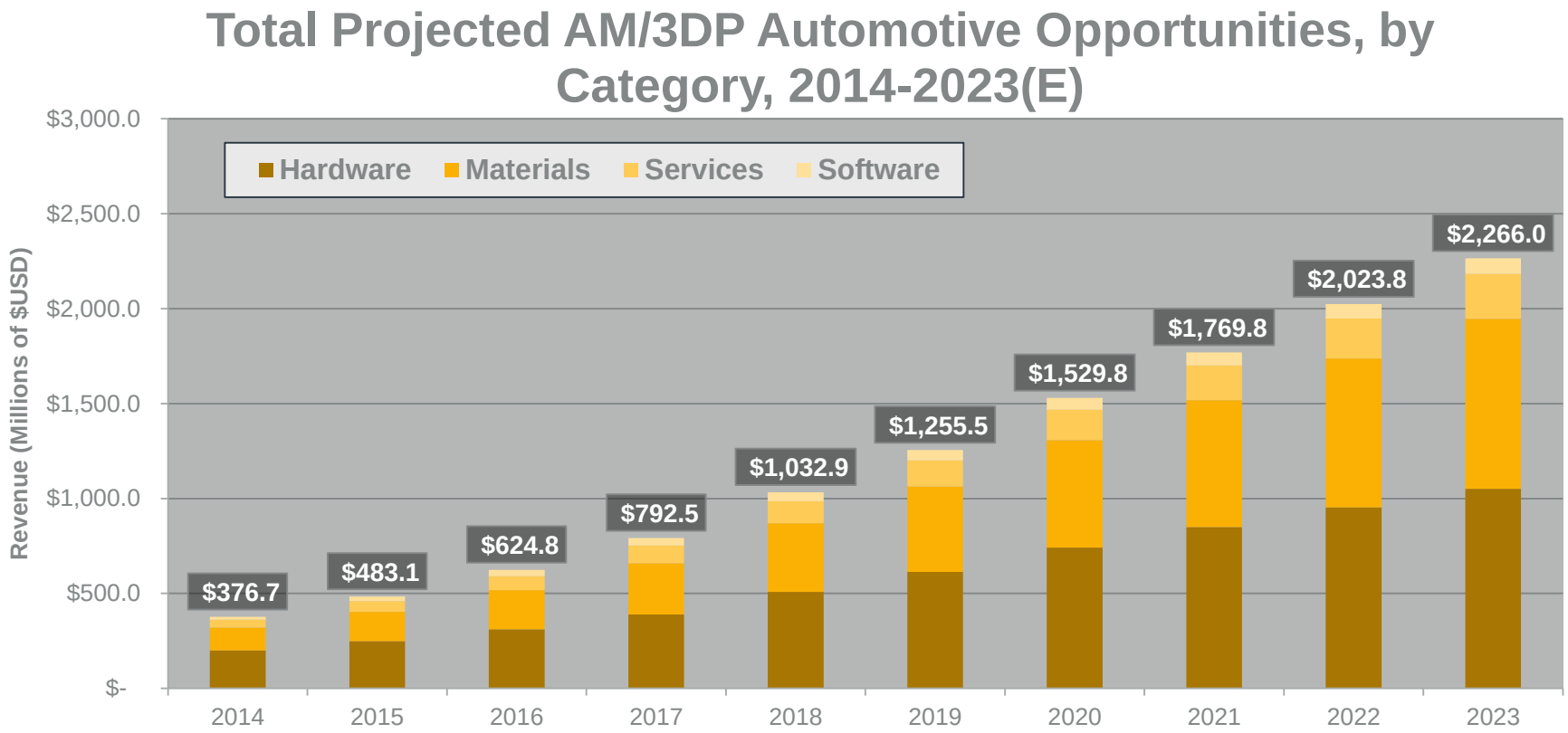
- Oil prices remain at significant lows compared to the last decade, driving consumer tastes to trucks, SUVs, and CUVs
- This is putting some manufacturers at odds with looming CAFE standards
- Should oil prices remain low for the foreseeable future (as expected) issues of lightweighting vehicles become even higher priority in the North American market

PLASTICS AND COMPOSITES LOOKING MORE ATTRACTIVE THAN EVER

- As a result of the previous slides, manufacturing continues shifting towards plastics and lightweight alloys
- Whether or not this presents a significant challenge to the metal AM technology sector looking to capitalize is unclear
- Composite and FRP AM technologies are seeing a huge increase in development activity, we credit automotive as a significant reason

AM AUTOMOTIVE OPPORTUNITIES AND MARKET DATA

- Current outlook still very much driven by “current trajectory,”…. But winds of change beginning to be detected



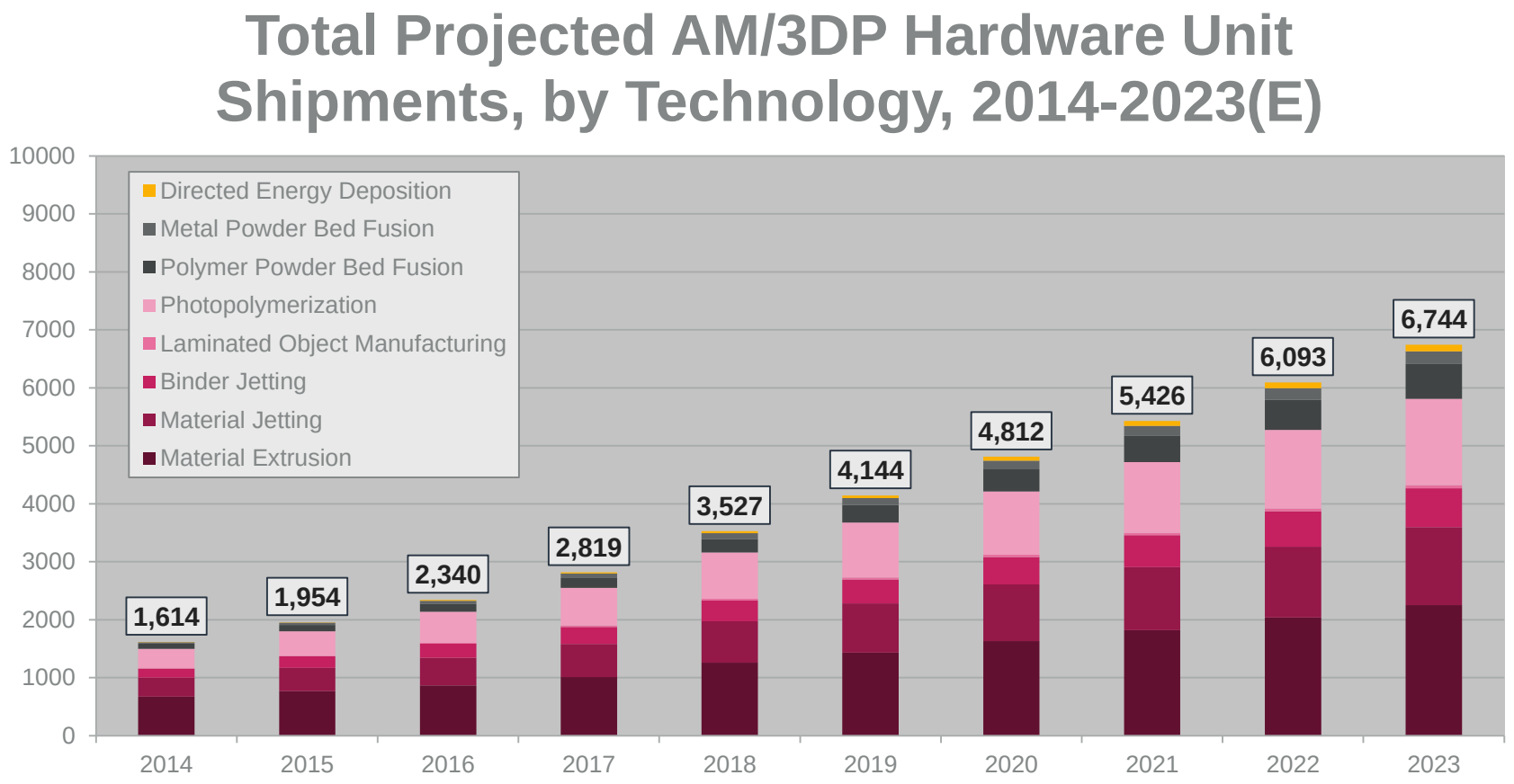
Source: *Additive Manufacturing Opportunities in the Automotive Industry* – **SmarTech Publishing**

CHANGING EXPECTATIONS FOR AM OPPORTUNITY FORECASTS

- A shift in trajectory favoring development of production ready technologies and applications would result in:
  - Moderate increase in projected AM hardware revenue
  - Potentially significant increase in projected AM material revenue
  - Uncertainty in the outlook for AM services (likely a mix)

AM HARDWARE METRICS IN AUTOMOTIVE

- Changes expected in the makeup of technology breakouts based on recent hardware development trends



Source: *Additive Manufacturing Opportunities in the Automotive Industry* – **SmarTech Publishing**

HARDWARE FORECAST SHIFTS

- Changes to expectations of hardware sales for AM/3DP equipment are likely to include:
  - Overall professional unit decrease
  - Potential increase in lamination and extrusion technology
  - Expected increase in photopolymerization
  - Uncertainty in polymer powder bed fusion

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SECTION FOUR

TAKEAWAYS

AUTOMOTIVE AS ONE OF THE HIGHEST VALUE TARGETS FOR AM

- AM/3DP manufacturers are continuing to take a serious approach to vertical integration, but automotive has lagged as a strategic focus

- On the flip side, AM/3DP is continuing to become a strategic focus in leading auto manufacturers

"Our aim is to use 3D metal parts for regular car production"

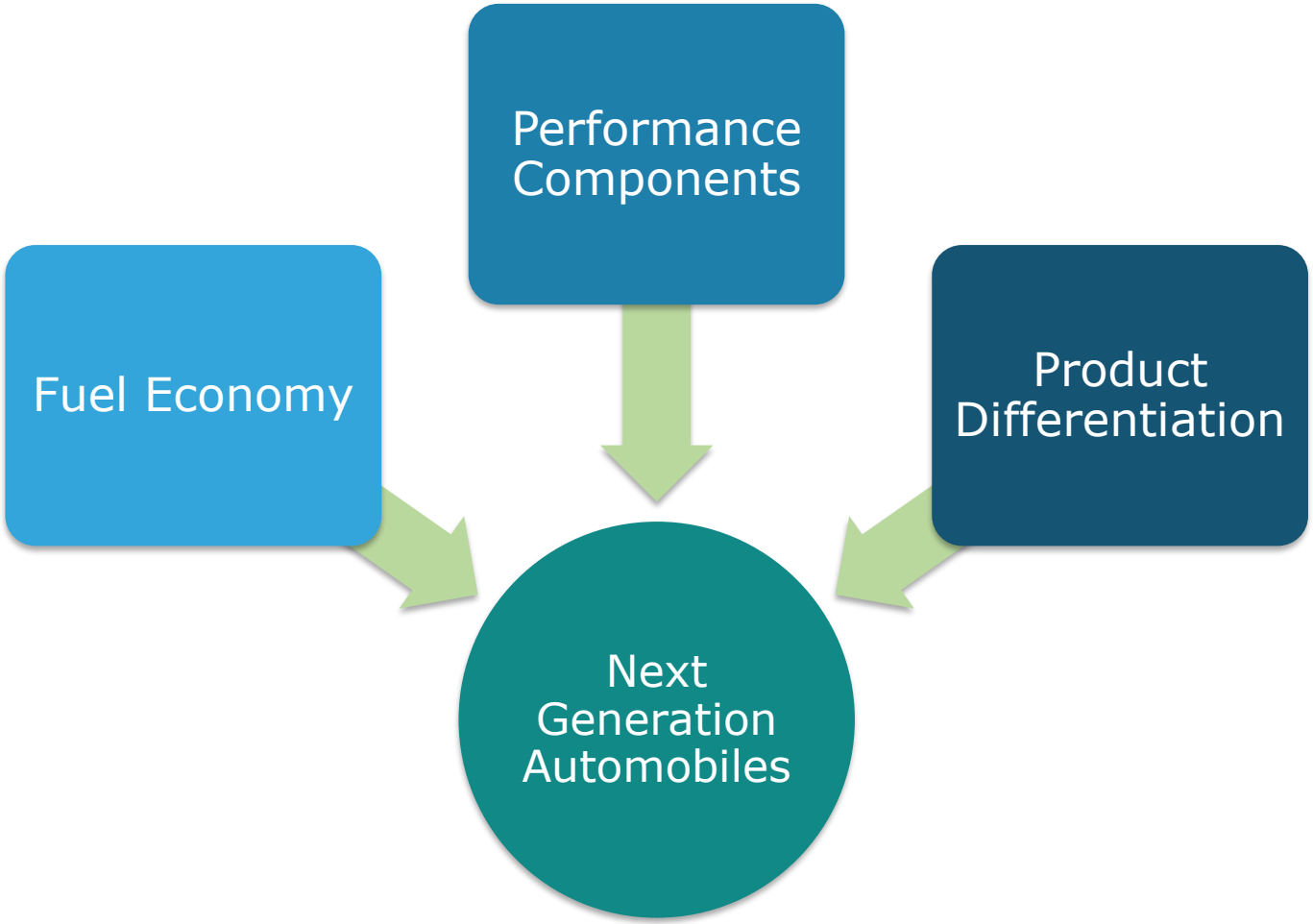
– Audi, Nov. 2015

AUTOMOTIVE AS ONE OF THE HIGHEST VALUE TARGETS FOR AM

- Composites and their increasing role in automobile manufacturing is already becoming a clear focus for AM/3DP solutions companies – one of the largest development pushes for the short term

- Low cost printers will likely have a moderate disruption of the already established 3DP value proposition in automotive

REVIEW – FUTURE ROADMAP FOR APPLICATION OF AM/3DP IN AUTO SECTOR



THANK YOU

- Ask Me Questions: scott@smartechpublishing.com
- www.smartechpublishing.com - 434-872-9008
- Visit us in the exhibit hall booth 1006
- Join us for the panel discussion later this afternoon