BMW i3 Teardown and Benchmarking Study:
Reports Summary and Pricing Detail
“Engineering consultant Sandy Munro has a shop in suburban Detroit where he takes apart cars, seeking clues to design and manufacturing tricks he can sell to manufacturers eager for a cram course on their competition.”
– Joseph B. White, Wall Street Journal

“…rest assured, a lot of people in the auto industry want to know its secrets… [Munro delivers] a detailed analysis of the costs and processes involved, right down to the individual nuts and bolts used.”
– Joann Muller, Forbes

When such “disruptive” new cars come to market, competitors are often quite curious about what makes them tick… some that do will also engage the talents of Michigan-based cost-estimating and benchmarking consultancy Munro & Associates to tackle the most bleeding-edge projects. Chinese automakers have been steady customers of late, and Munro claims to have helped Indian upstart Tata trim 1,750 pounds (and considerable cost) out of its home-market Aria crossover.
– Frank Markus, Motor Trend
The most comprehensive teardown and benchmark analysis available of the BMW i3!

While the BMW i3 has, and will continue to be, the subject of a myriad of different analyses and reports, only Munro will provide detailed findings that breakdown and detail every manufacturing cost.

Munro has a long history of producing teardown benchmarking studies for both the public sector and private clients, however the i3 study will mark the first time that these types of reports will be made available for general distribution.

The i3 study will tap into all facets of Munro’s deep knowledge of technologies, materials and manufacturing processes. The company is uniquely positioned to analyze and report findings on the i3’s ground breaking use of carbon fiber as well as other light-weight materials, metal forming and molding. Munro’s extensive experience with powertrain and battery technologies will also be leveraged to provide a comprehensive analysis of the BMW i3.

This study includes:

• Over 40,000 pages of complete cost, assembly, and materials-analysis for all parts specific to a zone or system.
• Detailed vehicle specifications including all weights and dimensions through fully descriptive and pictorial reports.
• Exclusive access to time lapse video and photography of the teardown process highlighting key features and functions.
• A complimentary edition of the vehicle Fit and Finish Quality Audit (FFQ) report Audit.
• Comprehensive analysis of the i3’s carbon fiber manufacturing and assembly process.
• Detailed reporting of the battery design and construction.
• A complimentary single license of Munro’s proprietary Design Profit® software which provides the purchaser the ability to print Cost Maps®, indented Costed Bill Of Materials (CBOM).
• Copies of, or links to, any known BMW public domain articles and videos.
• Special report outs via webinar or at our benchmarking facility and more...

“Experience without theory teaches nothing!”

Munro & Associates BMW i3 report is an extensive lesson in ‘theory of design’! This powerful report is an irreplaceable instructional tool that will not only guide your engineering team by the hand through the incredibly important HOWs and WHYs of automotive design but will also reveal the financial impact a design can have on the company’s bottom line!
Study Overview
In late 2014 Munro & Associates, a global leader in manufacturing costing and benchmarking, began the monumental challenge of producing an industry exclusive, highly detailed, teardown and benchmark study of the revolutionary BMW i3 Electric Vehicle. Using proprietary advanced design, quality and costing software, Design Profit®, Munro will disassemble and meticulously analyze the entire vehicle, system by system, at its world class benchmarking facility in Auburn Hills, Michigan.

Report Overview
Munro & Associates will be releasing a series of reports on the i3 in the first quarter of 2015 as various phases of the vehicle teardown and analysis are completed. The initial report scheduled for release is a Fit, Finish and Quality report. Following in succession will be a series of reports covering ten designated vehicle zones. Zone reports will be made available individually and will also be packaged into larger reports to provide all information pertinent to five key vehicle systems:

1. Body
2. Rolling Chassis
3. Battery and Heat Exchange (HEX)
4. Powertrain
5. Interiors

An Original Equipment Manufacturer (OEM) level Master Report covering all aspects of the vehicle, including all five systems and total vehicle assembly hours, will also be made available shortly after completion of the teardown and benchmark process. Delivery is currently slated for early 2015.
Study Highlights

The BMW i3 is celebrated for being the first mass produced electric vehicle to extensively feature carbon fiber. The cost and methodologies related to the assembly and fabrication process, especially those of the carbon fiber life module, are of high interest. In addition, the BMW i3 utilizes the state-of-the-art battery technologies featuring an innovative modular design. Combined with an optional range extending engine (REx), the system sets new industry standards. Munro’s unique software methodology, Design Profit®, allows us to provide detailed engineering, processing and financial insights into these and other key areas of interest.

Carbon Fiber Life Module: Carbon Fiber Life Module components, materials and processes are disassembled, analyzed, documented, cost modeled and summarized. Detailed information regarding the cutting, forming and molding of carbon fiber sheets as well as their assembly into single body structural units will be provided. In addition both the materials and costs for adhesive fastening of the body structure to the frame will be provided including the number and size of joints, adhesive types, and the types of machines used for adhesive application.

Battery: The high voltage battery pack, battery management electronics housed within the battery pack, battery cells, and cables, assemblies, and sensing wire harness are all disassembled, analyzed, documented, cost modeled and summarized. Fastener types, properties and fastening techniques are all analyzed, documented, cost modeled and summarized. All internal components of the battery are analyzed and cost modeled including the electrolytes and active materials used in the electrodes. Full detail of the electrode manufacturing process, including mixing of active materials, coating, drying, slitting and compaction is provided. In addition, all related electronic control modules and printed circuit boards are analyzed.

REx System: The REx system is completely disassembled, analyzed, documented, cost modeled, and summarized. The study includes the removal and disassembly of the REx engine, electric generator harnesses and mounting hardware. The engine, fuel and exhaust systems as well as the engine accessory components are fully reviewed for cost of materials, fabrication and the assembly and fastening processes. Complete engineering, processing and cost information on related electronic system control modules and harness components are provided, as is full detail on the materials and installation of any associated noise abatement components.

Electronics: Integrated vehicle electronics are disassembled, analyzed, documented, cost modeled and summarized. TechInsights Teardown.com worked with Munro & Associates to identify, cost and document circuit designs, analyze the structure and board layout, and provide detailed Bill of Materials for over 70 boards found in the i3. Key areas of focus include the infotainment system and instrument cluster, the Advanced Driver Assistance Systems (ADAS), power train systems, and body control systems.
Report Contents

All reports (Master/OEM, System and Zone) will contain comprehensive information including the following:

- Videos of the disassembly process with modules highlighting key features and functions.
- Detailed vehicle specifications including all weights and dimensions through fully descriptive and pictorial reports.
- Complete cost, assembly and materials-analysis for all parts specific to a zone or system.
- A complimentary edition of the vehicle Fit and Finish Quality Audit (FFQ) report Audit.
- A complimentary single license of Munro’s proprietary Design Profit® software which provides the purchaser the ability to print Cost Maps®, indented Costed Bill Of Materials (CBOM) and more.
- Copies of, or links to, any known BMW public domain articles and videos.

Report Delivery

All reports and accompanying deliverables will be made available for easy access through a secure File Transfer Protocol FTP site. A user-friendly format will help ensure that subscribers can easily locate a wide range of materials in addition to the reports, including a host of relevant video and media content. The reports themselves utilize hyperlinks within a table of contents to facilitate the ability to easily navigate throughout the contents and quickly find specific data and information to meet user needs.

Report Detail and Pricing

Vehicle Fit, Finish and Quality Audit

The Fit, Finish and Quality Audit (FFQ) is a thorough yet non-intrusive evaluation of the i3. The purpose is to analytically document what one would see, hear and feel when experiencing the vehicle. Vehicle weight and key dimensions are provided. All gaps, flushness, forces and weights are assessed using standard gauges and scales. This report also includes water ingress testing results.

Price: This report is provided free to subscribers who purchase Master, System or Zone reports. It can also be purchased separately for just $10,000.
Report Detail and Pricing (continued)

▶ Master OEM Report

The Master OEM report is a comprehensive analysis of all aspects of the vehicle and includes the complete findings of the study. This report contains full descriptive and pictorial detail on every facet of the vehicle – from assembly sequence to costing, labor, quality projections and, in general, every phase of the manufacturing of the product.

This report is highly advantageous for Original Equipment Manufacturers or Tier Suppliers looking to effectively expand and compete in new markets.

Price: $496,000

▶ Vehicle System and Zone Reports

In order to best accommodate the needs of both larger and smaller manufacturers, Munro is providing both System level reports and Zone level reports. System reports essentially provide a cost effective way for larger manufacturers (Tier 1 and 2) to obtain critical competitive data on multiple systems that tend to be interrelated, while Zone reports provide an opportunity for more specialized manufacturers to obtain data specifically related to the components they produce.

These reports will be extremely valuable in assisting suppliers of all sizes in internally benchmarking their assemblies or parts against potential future materials and processing trends that impact product planning and development.

Price: Varies by System/Zone (See Page 6: Master, System, and Zone Report Options and Pricing)
Munro & Associates, Inc

BMW i3 Report
Sample Report: Zone 4 Battery System

The following sampling of slides are presented to demonstrate the level of detail used in analyzing the BMW i3 battery components. This only is a small sampling of slides (out of roughly 40K+ in the actual report), but serves to convey the general look and expected data.

**Note: Some types of slides conveying specific cost, quality data, and suppliers are not included in the following examples section. Neither are full assembly maps and certain in depth descriptions of highlights and significant technology developments.**

* As the analysis progresses the part count diminishes with each level of detail.
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Discrete Part Count: 102
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Sub Count: 60
Step Count: 426
Total Fastener Count: 0
Discrete Fastener Count: 0
Fluid Fastener Count: 0
Tool Count: 1
Inspect Count: 0
Operation Count: 158
MultiTouch Count: 58
Ergo Danger Count: 0
Poka Yoke Count: 0

Cell Stack Asm

Winding Stack Asm
367.3
165
70

Cover Asm
319.3
215
27

Cover to Winding Weld Asm
40
21
0

End and Side Insulator Asm
47.3
13
3

Current Collector Insulator
12.3
1
1

Current Collector Insulator Asm
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**Winding Stack Asm**

1. 0s
   - Winding Stack Asm
   - Outer Cell Winding Asm
   - Inner Cell Winding Asm

2. 0s
   - Winding Stack Asm

3. 20.4

4. Supplier Automated Asm

5. x2
6. x2
7. x2
8. x2
9. Auto Unload Medium Part
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**Outer Cell Winding Asm**

![Diagram of Outer Cell Winding Asm]

- 1. Battery Cell Winding
- 2. Separator
- 3. Outer Cell Cathode Arm
- 4. Outer Cell Anode Arm
- 5. Cell Winding Tape
- 6. Cell Winding Label
- 7. Battery Cell Winding
- 8. Auto Load Medium Part
- 9. Outer Cell Ground Protector
- 10. Ultrasonic Metal Weld
- 11. Auto Index
- 12. Auto Unload Medium Part

![Diagram of Outer Cell Winding Asm]
Outer Cell Cathode Asm
BMW i3 Teardown and Benchmarking Study

Total Part Count: 5
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Fluid Part Count: 0
Sub Count: 1
Step Count: 9
Total Fastener Count: 0
Discrete Fastener Count: 0
Fluid Fastener Count: 0
Tool Count: 0
Inspect Count: 0
Operation Count: 2
MultiTouch Count: 1
Ergo Danger Count: 0
Poka Yoke Count: 0

Outer Cell Anode Asm

Diagram of anode assembly process with labels for each step.
Key Points of Interest

- **Battery Cooling and Heating**
  - The usage of ozone-friendly R134a in twin parallel circuits compared to a traditional ethylene glycol based system.
    - Eliminates the need for many valves, heaters, chillers and the weight of the coolant is extensive.
    - Ability to use the aluminum evaporator in the battery case as a heat sink for the option 1000w HV heating option.

- **High-Pressure Die castings welded into the aluminum sub-frame**
  - The two large castings in the rear of the sub-frame won the prestigious JEC Europe Innovation Awards for topology optimization.
  - The Casting is AlSi10MnMg yet the part is still welded even with the high Silicon content.
  - This allows for thin wall sections attributing to an overall lighter weight casting.

- **Safety Interlock System**
  - Every large HV connector utilizes a circuit breaker that must be removed in order to slide the lock for connector removal.
  - The male portion of the connector also has protective covers that pop up when the mating connector is removed.

- **Rear Casting Integration**
  - All ten rear suspension bushings are pressed into the left and right portions of the aluminum sub-frame.
  - The left and right driveline mounts are pressed in the Y direction and no fasteners are used to secure to the sub-frame.

- **High Voltage HVAC Heating**
  - The HVAC unit is supplied with 4500 watts of heating capacity in 6 different phases.
  - The HV Heater utilizes a dedicated loop of Ethylene Glycol and a small pump to circulate through the HVAC heat exchanger.
  - Three separate HV resistors supply a different heating capacity each and can be activated in six combinations.

- **Battery Serviceability**
  - The battery can be removed easily in the Z direction by removing only 26 fasteners.
  - One HV Connection, two AC lines, and two LV connects must also be removed.
  - The R134a refrigerant eliminates the potential hazards associated with removing a battery with traditional, ozone-depleting R-12 coolants or similar.
Key Points of Interest

- **Carbon Fiber Reinforced Plastic features**
  - The molding process for the CFRP parts of the Body-in-White (BIW) ingeniously allows for voids in the mold to create features for alignment and attachment.
  - The interior Noise, Vibration and Harshness (NVH) shields attach to epoxy features with edge biting clips.
  - Many interior panels are aligned and secured to similar feature as locators and guides.

- **Aluminum door hinge supports with floating nuts**
  - Both front and rear door hinges are secured to aluminum structures securely trapped inside the CFRP inner and outer body side.
  - The floating nuts allow for the correct fitment of the doors.

- **Head unit wire routing**
  - The head unit for the BMW i3 is stored under the rear seat to allow for a streamlined look on the IP.
  - For signal quality, a dedicated line is routed to the head unit from the IP display with zero breaks in the line.
  - This dedicated line does raise a serviceability concern, but signal quality was the primary objective.

- **High Glass content Nylon seat back**
  - The seat back for the driver and passenger seats are composed of Nylon and have a slim, sleek, profile.
  - The Nylon seat back allows for a thin packaging and increased interior space.

- **Kenaf plant fibers are used in IP and Door panels**
  - The multi-purposed and increasingly popular Kenaf Plant fiber is used for the Class A surfaces on the IP and Door panels.
  - Kenaf fiber offers a natural woven fiber look and is an environmentally friendly alternative to petroleum based plastics.
Key Points of Interest

The CFRP Life Module
(included in Zone 1)

• The *Life Module* of BMW’s LifeDrive vehicle architecture for the i3 is its carbon fiber reinforced plastic (CFRP) passenger cell and incorporated safety features.

• Multi-layered, resin injected carbon fiber sheets and multiple metal and polymer components are joined using a structural adhesive, forming the skeleton of the “body-in-black”. Several parts with structural or safety functionality are enclosed within the inner and outer panels of the body side shell.

• Raw carbon fiber waste is recycled and integrated in the vehicle roof. Mechanical and bonded fasteners and brackets provide mounting locations for interior and exterior parts and trim.

• Detailed costing of all major components is performed with Munro’s proprietary software, [Design Profit®](#). Pricing for commodity items (i.e. seals, rivets, snap rings) are assigned from our Knowledge Library.
  
  • *Estimates are based on actual parts.*
  • *Photos are taken on 100mm grid paper for scale.*
BMW i3 Teardown and Benchmarking Study

Key Points of Interest

The Frame
(included in Zone 3)

• The BMW i3 frame is solidly constructed from aluminum components and supports the carbon fiber life module.

• The frame consists of two front strut tower castings, two rear frame castings, and extruded front, rear and side rails. The frame also provides the mounting points for the suspension and power train components.

• The aluminum components of the frame are welded together and support the suspension components with threaded fasteners. The life module is fastened to the frame primarily with adhesive sealant and minimal number of threaded fasteners.

• Detailed costing of all major components is performed with Munro’s proprietary software, Design Profit®. Pricing for commodity items (i.e. seals, rivets, snap rings) are assigned from our Knowledge Library.
  
  • Estimates are based on actual parts.
  • Photos: Background on 100mm grid paper.
The Battery Pack
(included in Zone 4)

- The battery pack is a self contained unit attached to the underside of the vehicle with 27 bolts. The enclosure of the battery pack is also used as a stiffening element for the Aluminum frame, to which the body and drivetrain are connected. The i3 battery pack is a self contained unit which can be removed from the vehicle for maintenance or replacement.

- The pack contains eight (8) battery modules containing 12 individual cells. Each module is designed to be a self contained unit, with a control board mounted on each module. The modules can be replaced by disconnecting one (1) power connection, one (1) communication connector and four (4) nuts.

- The battery pack components were evaluated in detail down to the internal cell components for the batteries, the control PC board components, connectors, pack cooling/heating system. The cost associated with the assembly test and formation of the cells are included in the cost evaluation.

The Battery Pack continued…
Key Points of Interest

The Battery Pack (continued)
(included in Zone 4)

• As the image below indicates, foresight and customer consideration were key ingredients used by BMW in the battery pack’s unique, 8 module, design. In the event of a battery cell failure, an individual 45 volt module can easily be replaced eliminating the costly need to replace the entire battery pack.

• Detailed costing of all major components is performed with Munro’s proprietary software, Design Profit®. Pricing for commodity items (i.e. fuses, contactors, substrates, chemicals, fasteners) are assigned from our Knowledge Library.

   • Estimates are based on actual parts.
   • Photos: Background on 100mm grid paper.
Zone 5 in the BMW i3 Report details the Electronics and contains the following: System Electronics, Infotainment, Body Control Module, and Fuse Box. Each of the various functionalities of the Electronics will be highlighted in the main report. Each detailed analysis report will be located in the associated Zone appendix.

**Product Description**

The Control Board is a component of the Battery Module designed into the BMW i3 hybrid electric vehicle. The primary function of the Control Board is to monitor battery status and send fault messages to a central processor located in another part of the vehicle. Its key devices include a Freescale MC9S12P64 16-bit microcontroller and Linear Technology's LTC6801G battery fault monitor and LTC6802G-2 battery stack monitor. Support consists of Texas Instruments' LM2904AVQ dual op-amp and CD74HC4538M dual monostable multivibrator along with an LM2903YDT dual comparator from STMicroelectronics. An Infineon TLE7273-2EV50 provides general voltage regulation, while Analog Devices supplies the ADR366 precision voltage reference.

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**Key Points of Interest**

- **6 - Linear Technology**
  - #LTC6802G-2
  - Battery Stack Monitor

- **7 - Infineon**
  - TLE6250GV33
  - CAN Transceiver

- **8 - Silicon Labs**
  - SI8422
  - Dual Digital Isolator (2-Die Pkg.)

- **9 - Texas Instruments**
  - CD74HC4538M
  - Dual Monostable Multivibrator

- **10 - Infineon**
  - TLE7273-2EV50
  - LDO Regulator

- **11 - Linear Technology**
  - LTC6801G
  - Battery Fault Monitor
Key Points of Interest

Electronics
(included in Zone 5)

Excerpt from Electronic Circuit Board Report

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The Driveline
(included in Zone 7)

The motor, gear box, and half-shafts.

• The electric motor for the i3 is a three phase permanent magnet induction motor.

• The gear box for the i3 is a single speed fixed ratio gear box. Assembly and manufacturing details for the gear box will be thoroughly covered in the BMW i3 report.

• The BMW i3 half shaft assemblies are of the Schaeffler LUK FAG Axial spline design type with some unique features which help unit balance and durability.

• Detailed costing of all major components is performed with Munro's proprietary software, Design Profit®. Pricing for commodity items are assigned from our Knowledge Library.
Key Points of Interest

Engine and Mounts

(included in Zone 8)

• The gas-powered Range Extender (REx) Engine for the BMW i3 is a 2 cylinder motorcycle engine used in the BMW C650 GT.

• The engine consists of an aluminum multi-piece machined head, block, girdle, engine covers, camshaft retention cover, valve cover, bed pan and oil pan. These are all die cast designed. The crank shaft, balance shafts, and cam shafts consist of a machined forged steel design. The engine utilizes the rotary motion of the balance shafts to keep oil from reaching the positive crankshaft ventilation in a unique and innovative design.

• The engine mounts are designed specifically for this BMW i3 application. Assembly and manufacturing details for the components will be covered through out the report.

• Detailed costing of all major components is performed with Munro’s proprietary software, Design Profit®. Pricing for commodity items (i.e. seals, rivets, snap rings) are assigned from our Knowledge Library.

  • Estimates are based on actual parts.
  • Photos: Background on 100mm grid paper.
Key Points of Interest

The Brakes
(included in Zone 3)

Electric motors on the rear calipers actuate the rear brakes accordingly.

The parking brake is activated and deactivated by the driver from a dual action switch on the center console.
Certain key elements in the full reports are not provided in this example section which are:

- Detailed cost, quality, assembly, and materials-analysis for all parts specific to a zone or system.
- Detailed vehicle specifications including all weights and dimensions.
- Libraries of time lapse video and photography of the teardown process.
- Fit and Finish Quality Audit (FFQ) report Audits.
- Detailed Cost Maps® with indented Costed Bill Of Materials (CBOM).
- Detailed Supplier data.
- Links to BMW public domain articles and videos.

These items will be provided in the paid report.
# Pricing: Master Report, System Reports, and Zone Reports

## MASTER Report
Includes All **Systems & Zones**

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## ZONE Reports

### Zone 1 **BODY**
- Life Module
- Front Clip
- Glass
- Closures
- Latches & Hardware
- Seals
- Adhesives
- Chemicals

**$95,000**

### Zone 2 **EXTERIOR**
- Rear Quarter Panels
- Fascias
- Cladding
- Badging
- Fenders
- Door Exterior
- Windshield Wipers
- Headlamp/Tail lamp/Fog lamps
- CHMSL

**$50,000**

### Zone 3 **ROLLING CHASSIS**
- Frame
- Crush Zones
- Suspension
- Brakes
- Electronic Parking Brake
- Brake Lines
- Electronic Power Steering
- Wheels
- Tires
- Sealant Kit/Pump

**$75,000**

### Zone 4 **BATTERY SYSTEM**
- Battery Pack
- DC/DC Converter
- Power Module
- 12V battery
- Battery Harness
- Charger

**$110,000**

### Zone 5 **ELECTRONICS**
- System Electronics
- Infotainment
- Body Control Module
- Fuse Box

**$75,000**

### Zone 6 **COOLING PACK & HVAC**
- Cooling (Battery/Engine)
- Radiator
- HVAC
- Evap. Condenser
- Compressor

**$45,000**

### Zone 7 **DRIVELINE**
- Driveline
- Motor
- Gear Box
- Half shafts

**$50,000**

### Zone 8 **REx SYSTEM**
- REx System
- Engine / Mounts
- Generator
- Fuel and tank
- Exhaust / Shields
- Engine Dress & Harness
- Electronic Control Unit

**$85,000**

### Zone 9 **IP & INTERIOR TRIM**
- IP & Harness
- Cross Car Beam
- Floor Console / Shifter
- Door Trim
- Headliner
- Carpet/Mats
- Trunk Trim
- Pedal Box
- Steering Wheel

**$80,000**

### Zone 10 **SEATS**
- Seats
- Restraints
- Air bag
- Safety

**$60,000**

**MASTER Report**: $496,000
Frequently Asked Questions

“How deep was Munro & Associates analysis on the unique carbon fiber reinforced polymer (CFRP) material used on the BMW i3 body. In other words, how much aluminum in proportion to carbon fiber reinforced polymer (CFRP) was used? How were the proportions calculated – by the entire vehicle or sub-systems? Are the material compositions laid out in detail and specified?

General information is interesting but not beneficial to us. We must have specifics.”

Our ‘deep dive’ examination into the i3 materials has surpassed any previous analysis performed by Munro & Associates in our 28 year history. In fact, every single part has been painstakingly investigated and detailed in the BMW i3 report including analysis on the ‘super’ adhesives used and even the chemical composition of the batteries.

But we didn’t stop there…our team partnered with Teardown.com to tear into the i3’s advanced electronics down to the circuit component level offering you detailed imagery on what makes the BMW i3 tick.

To date, we have upwards of 166,000 manufacturing steps documented including a staggering 50,000 parts (29,000 mechanical and 21,000 electronic/electric). The i3 Report is in excess of 40,000 digital pages and that does NOT include the Cost Maps® and Process Sheets.

“Does the i3 report detail how BMW managed the connection between different materials and their suppliers? Did Munro analyze the supplier systems as well as the related costs? (For example, we know BMW worked with SGL for carbon fiber but how about battery components, electrical components and all the other raw materials?)”

Every aspect of manufacturing has been investigated and documented in the BMW i3 Report. Through our extensive research we have compiled data on major global suppliers and Tier 1, 2, and 3 manufacturer including cost calculations based on the supplier and manufacturer’s Country of Origin.

A brief example…
We discovered BMW has a supplier even in the country of Morocco. To ensure the integrity and accuracy of our report we developed a cost model specifically for that northwest region of the country. Furthermore, our distinct Cost Models are accurate with three levels of labor cost, utilities cost, factory floor cost, taxes and SGNA. The only cost factor we chose not to include is ‘profit’ because that is a variable determined by random objectives.

“The manufacturing process for the body panels is RTM (Resin Transfer Molding). Did Munro figure out the parameters for their lay-out design as far as crash worthiness?”

Good question. Part of what makes CFRP a reliable material is its resistance to delamination once cured. Although full deconstruction of the panels was not performed, some sections were separated during removal. What was revealed led the Munro team to believe that BMW used modeling software to determine the specific angles needed in each panel to achieve crash worthiness. Munro also took the necessary steps to determine the ablation processes and pre-treats needed for adhering the CFRP panels along with the machine tool and materials suppliers.

“We are hoping that the i3 report is technology oriented so that we can use it for accurate benchmarking. Does the report include analysis on materials, processes, cost, supplier system and all systematic performance tests?”

The BMW i3 Report includes detailed engineering analysis on materials, processes, cost, and supplier systems. With regards to systematic performance tests we have listed numerous credible reports completed by US government agencies, reputable publications and even insurance companies. The web links for these reports are listed in the Appendix and Bibliography section of the i3 Report.

“What kind of ‘whole car tests’ did Munro do on i3?”

Munro & Associates deferred this assignment to the agencies responsible for determining and enforcing vehicle safety standards. Whole Car Tests (WCT), including vehicle crash test, are routinely performed by the European Union (Directive 2007/46/EC), the US Department of National Highway And Traffic Administration (NHATA) and the Insurance Institute for Highway Safety (IIHS). These are irrefutable testing agencies with resources superior to vehicle manufacturers and 3rd party testing agencies. The web links to this data are listed in the Appendix and Bibliography section of the i3 Report.
“Was there testing on the battery assembly performance? How was the protocol (Controller Area Network (CAN) Communication Protocol) handled?”

Munro & Associates partnered with the world leader in electrical componentry teardowns – Teardown.com - to methodically analyze the battery, circuitry, and electronic modules down to the component level. Extensive battery testing results by the aforementioned European Union and USA Government regulatory agencies (Directive 2007/46/EC, NHATA) and independent insurance agencies (like IIHS) are well documented and readily available. In addition, safety issues associated with crash and occupant removal in a severe accident are also documented with links in the Appendix and Bibliography.

“Has Munro done any mapping on the functionality of the IP buttons? We now use buttons for Basic toggle operation; can we use combined touch screen for operation?”

Multi-functional IP features are detailed online and in vehicle documentation. The interior electronics on the i3 resembles a Samsung cell phone more so than a conventional car instrument panel.

“Unfortunately, our company lacks the necessary experience to confidently benchmark a vehicle with this high caliber of technology. How can the i3 Report help us?”

Bottom line…the Munro BMW i3 Report is the perfect solution for any company tired of playing ‘catch up’ with their competitors. The BMW i3 Report will instantly catapult your company to the forefront of your industry as you digest, understand and implement the most advanced, innovative, and inspiring technology in the automotive world today!

By offering this valuable information to the public, our goal, our mission, our hope is to be a front seat witness to the rebirth of ‘full capacity’ manufacturing, a wonderful byproduct of fearless, visionary, customer-driven, designs and raw, ingenious, engineering.

Important: Are you Benchmarking your competition? Benchmarking is an incredibly powerful tool which today’s top companies are using to consistently gage (and extract knowledge from) their competition! Call Munro & Associates today and learn how we can assist you in establishing your very own Benchmarking System. But don’t wait to call, our schedule is filling up fast as we have been inundated with Benchmarking request. Call now - 1-248-362-5110
We are overwhelmed but excited!

Below is a small sampling of the prestigious publications, websites, and blogs buzzing with anticipation of the Munro & Associates BMW i3 Report.

*For A Full List of Videos And Articles Click [Here](#).*

- **The Future Of Cars Looks Very Different**
- **Unlocking The Secrets of BMW’s Remarkable Car of the Future**
  Forbes, Jan.
- **Munro Discusses Groundbreaking Technology Finds from BMW i3 Teardown at Plastics in Automotive Conference**
  Bloomberg, Jan. 14
- **Reverse Engineering The BMW i3**
  BMW Blog, Jan. 5
- **Is BMW’s i3 Profitable**
  Motor Trend, Jan. 30
- **BMW i3: The ‘Most Significant Vehicle Since the Model T’**
  Design News, Feb. 10
- **Munro & Associates CEO Offers ‘A Peek into the Future’ of Manufacturing at MFG Meeting**
  Reuters, Mar. 6
- **The BMW i3: Deconstructed**
  Automotive Design and Production, Mar. 2
- **BMW i3 “one of the best engineered vehicles on the planet”**
  Automotive Purchasing, Jan. 15
- **The Most Advanced Vehicle On The Planet Taken Apart And Reverse Engineered**
  Charged – Electric Vehicles Magazine, Jan. 8
- **Is Carbon Fiber Gimmick, Or Paradigm Shift?**
  Repair Driven News, Mar. 26
- **Teardown Reverse Engineering The BMW i3 Technology**
  Ecomento, Jan. 7
- **Us Company Can Reverse Engineer The BMW i3 To Tell You Its Secrets**
  In Auto News, Jan. 5
- **BMW i3 Electric Car Teardown: Profitable At 20,000 Units**
  Green Car Reports, Jan. 5
- **BMW i3 Called Most Revolutionary Car’ Since Ford Model T**
  Autoblog, Jan.
- **2015 BMW i3 Profitable After Just 20,000 Cars**
  Transport Evolved, Jan. 5
- **宝马i3和特斯拉s代表汽车业的未来？**
  US/China Press, Dec. 22
Lux Research says research and development trends in materials and processing indicate that carbon fiber composites will be poised to gain widespread adoption for automotive light-weighting by 2025.

Posted on: 2/23/2015

Source: Composites World

Lux Research (Boston, MA, US) reported on Feb. 18 that it has published a new report, “Scaling Up Carbon Fiber: Roadmap to Automotive Adoption,” that says carbon fiber-reinforced plastics (CFRPs) will be poised to gain widespread adoption for automotive light-weighting by 2025.

Already advances underway in fiber, resin and composite part production will lead to a $6 billion market for automotive CFRPs in 2020, more than double Lux's earlier projection. This figure, says the report, is expected to increase substantially if CFRPs in automotive can become affordable enough for use in mainstream vehicles.

“Current trends strongly indicate significant mainstream automotive adoption of CFRPs in the mid-2020s, and companies throughout the value chain must position themselves to take advantage of the coming shifts,” says Anthony Vicari, Lux Research associate and lead author of the report. “However, long-term megatrends towards urbanization, connectivity and automation suggest that there could be a limited time window beyond that for penetrating the automotive space.”

“CFRP developers will have to continue the pace of innovation to overcome the high cost that has so far limited the material to less price-sensitive markets like aerospace and sporting goods,” he adds.

Lux Research analysts reviewed the technology development in CFRPs, and evaluated its economics to consider its impact on the automotive sector. Among their findings:

Growing partnerships hasten development. The number of direct partnerships between carmakers or Tier 1 automotive suppliers and carbon fiber players has nearly doubled to 11 since 2012. Toray, with partnerships with Plasan Carbon Composites and Magna, has formed the most new relationships and is a major hub.

Patent uptick suggests mid-2020 adoption. Using a predictive tool, Lux Research identified a lag of about 18 years between uptick of patent activity and attainment of mainstream commercial adoption milestones. With another major upturn in CFRP patent activity occurring in 2007, large-scale mainstream automotive use is likely by the mid-2020s.

Other manufacturing costs need to be cut. Carbon fiber itself, at $28/kg for standard modulus fiber, represents just 22% of the cost of a final CFRP part. Additional advances are needed to reduce capital, labor, energy, resin and processing costs, which together make up the remaining 78%.

The report is part of the Lux Research Advanced Materials Intelligence service.