



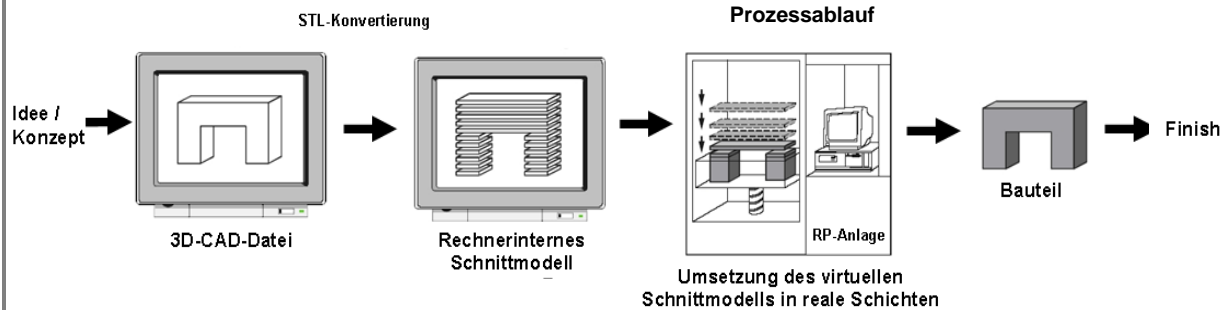
BMW Group – 26.04.2013

# **ADDITIVE TECHNOLOGIES FOCUSING ON INDUSTRIAL APPLICATIONS FOR METAL AND PLASTIC PARTS.**

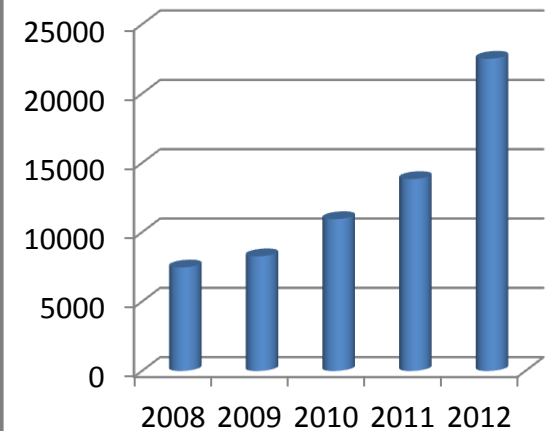
**DR. FRANK WÖLLECKE**

# ADDITIVE TECHNOLOGIES.

## Additive Process:



## Orders:



## Commercially available additive Technologies:

**Selektive  
Laser  
Sintering**



5  
Installations

**Selektive  
Laser  
Melting**



3  
Installations

**Stereo  
Lithography  
Apparatus**



1  
Installations

**3 D  
Printing**



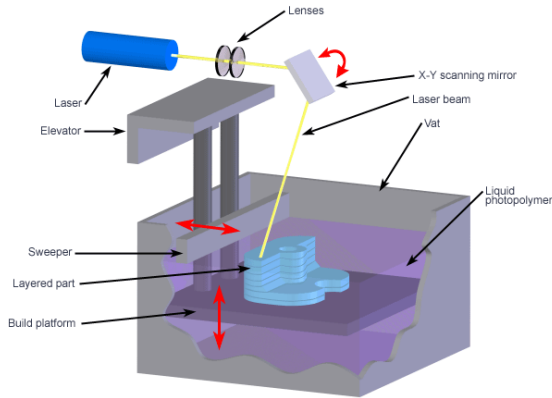
3  
Installations

**Fused  
Deposition  
Modeling**



3 Installations

# AM TECHNOLOGIES. STEREOLITHOGRAPHIE (SLA).



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## Characteristics:

- First rapid prototyping process, 1988 by 3D Systems Inc.
- Support structure is needed

## Strength:

- Design parts
- applicable for trials, e.g. Flow investigations
- high accuracy (+/- 2mm)
- good alternative to 3D-Print
- better post processing than for SLS
- high material diversity

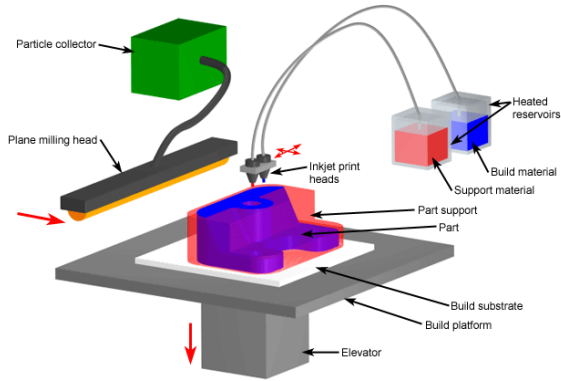
## Materials:

### Liquid Photopolymer

- Somos 18420 (Epoxydharz)
- Water Clear Ultra 10122
- Somos 7120 (Epoxydharz)



# AM TECHNOLOGIES. 3D-PRINTING (3DP, INKJET).



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## Materials:

## UV curable resin

- VeroWhite
- VeroClear
- TangoBlackPlus

# Digital material



Source: Stratasy

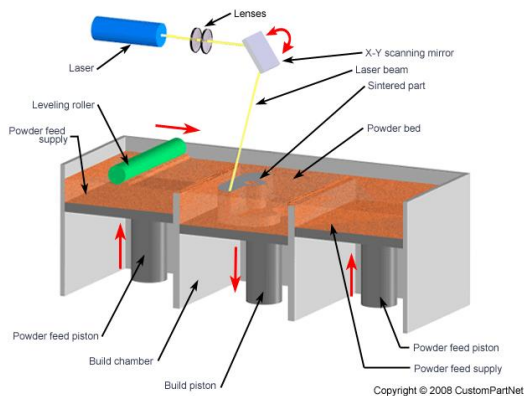
## Characteristics:

- Ink-jet printing head deposits resin
- Support structure is needed

### Strength:

- high accuracy
- high resolution → smooth surface, many details
- thin walls ( $< 0.6 \text{ mm}$ )
- easy removal of support material

# AM TECHNOLOGIES. SELECTIVE LASER SINTERING (SLS).



## Materials:

- PA 12 unfilled or filled
- PA 11
- TPE
- PEEK

## Metalcoating (SLS/SLA)

For improvement of strength  
„Metall optic“

## Characteristics:

- Laser beam sinters the powder layer by layer
- No Support structure is needed

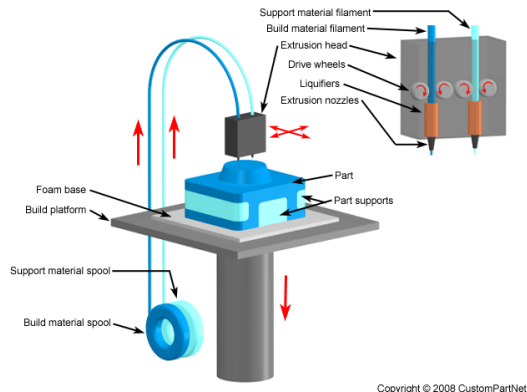
## Strength:

- Thermoplastic material, possible fiber reinforcement
- Tough
- low cost
- high E-Modulus, elongation @ Break
- Post processing by infiltration possible



# AM TECHNOLOGIES.

## FUSED DEPOSITION MODELLING (FDM).



### Characteristics:

- Material supply to a heated extrusion nozzle
- Extrusion of melted material to form layers
- Support structure is needed

### Materials:

- ABS
- ABS / M30
- PC / ABS
- Ultem

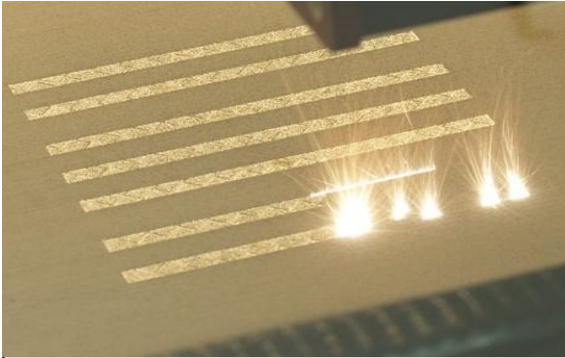


Source: Stratasys

### Strength:

- part size
- low warpage
- relatively low cost
- similar material property  
` as ABS

# AM TECHNOLOGIES. SELECTIVE LASER MELTING (SLM).

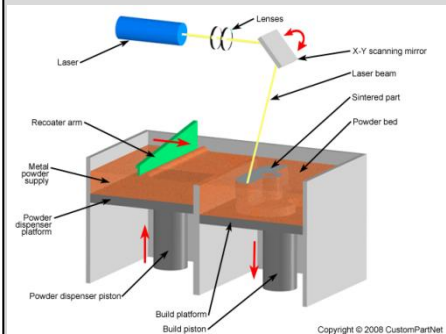


## Characteristics:

- Laser beam sinters the powder layer by layer
- Support structure is needed

## Materials:

- tool steel
- stainless steel
- Aluminium
- „every weldable material“

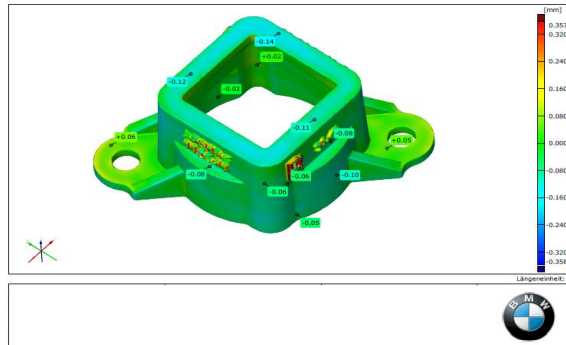


## Strength:

- high cooling rates compared to die casting
- high strength
- requirements of series parts can be fulfilled
- warpage can be minimized by support structures or heat treatment

Source: SLM Solutions

# QUALITY CONTROL.



## **machines :**

GOM Atos II Triplscan  
accuracy measurements

Powdershape  
particle size /form

Z020 (Zwick/Roell)  
tensile tests

to ensure:

- robust process
- reproducibility of part properties

## **Pre-Process:**

- Particle analysis
- particle flowability
- MFI (melt viscosity)

## **In-Process:**

- tensile tests
- Shore hardness

## **Post-Process:**

- accuracy measurements

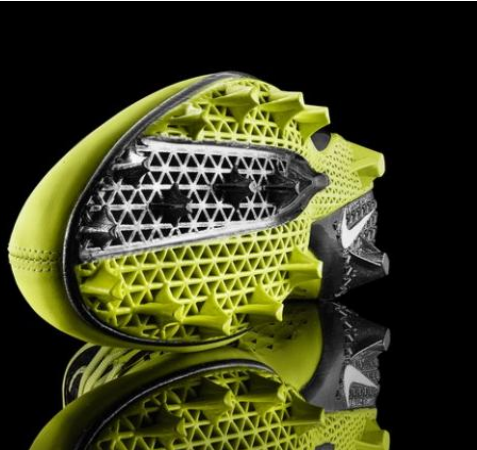
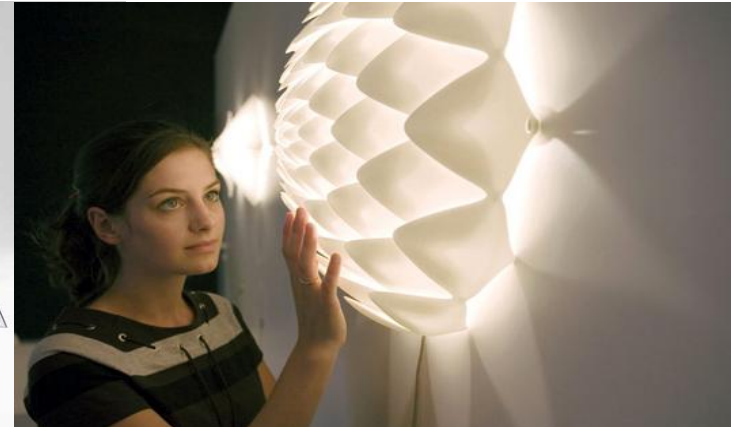


# APPLICATIONS

## DIFFERENT INDUSTRIAL BRANCHES

FREEDOM OF  
CREATION

CREATIVITY



NIKE

INDIVIDUALISATION

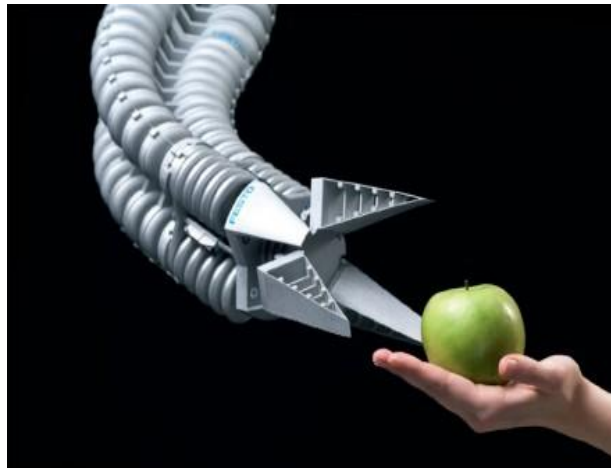
MATERIALISE

# APPLICATIONS

## DIFFERENT INDUSTRIAL BRANCHES

IRIS VAN HERPEN  
MODE

JEWELRY  
MATERIALISE



ECONOMIST  
TREND

FUNCTIONALITY  
FESTO

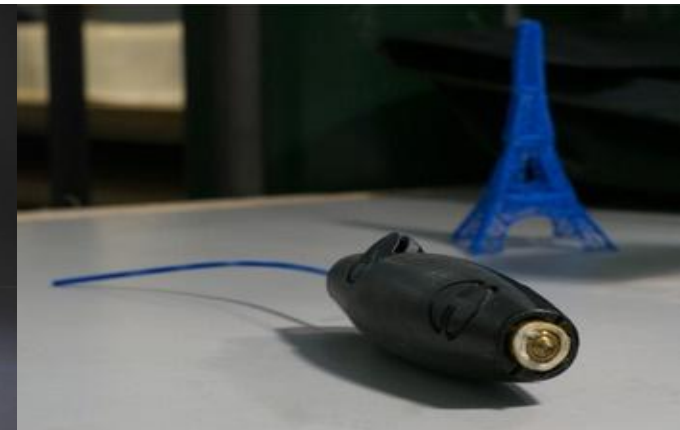
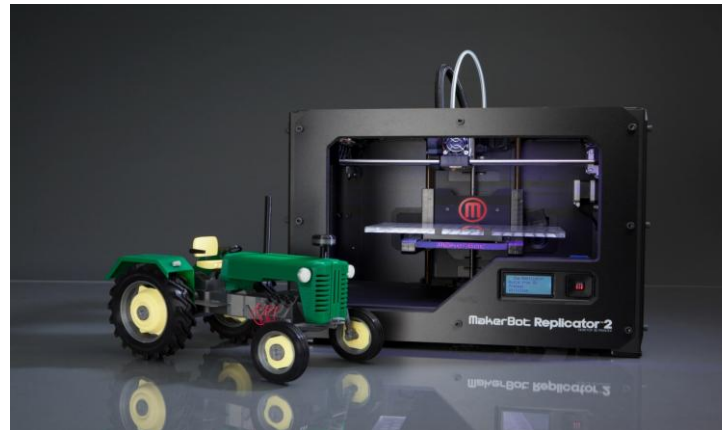
# APPLICATIONS

## DIFFERENT INDUSTRIAL BRANCHES

MAKERBOT  
REPLICATOR

DIY @ HOME

3DOODLER



MATERIALISE

DIY @  
FACTORY

# Freeform in function of Aesthetics Design Cars made by AM

Pininfarina Sintesi

Citroën Hypnos Citroën GT

Renault Ondelios

PGO Hemera

Mazda Kiyora

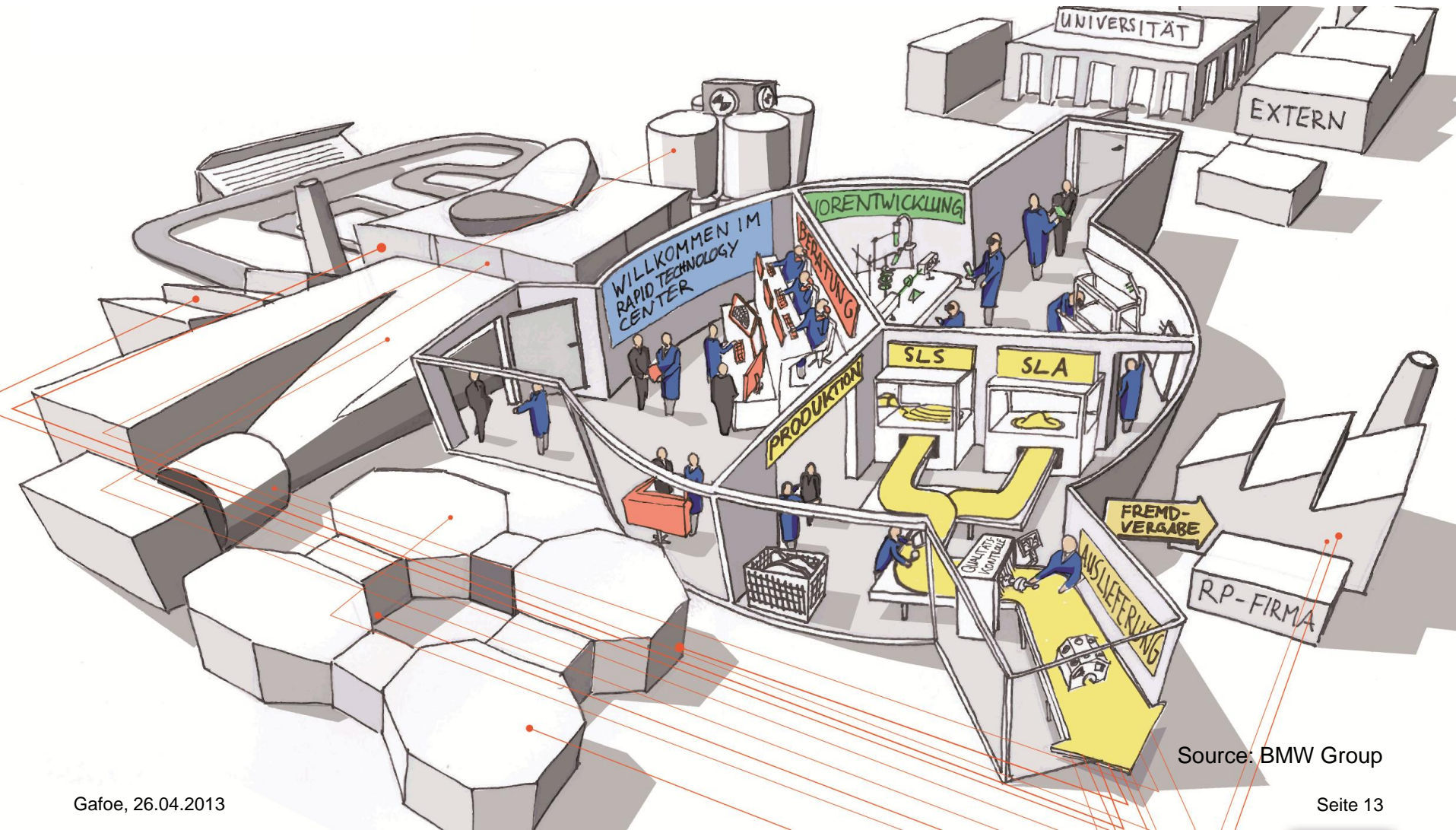
Citroën Revolte Jaguar CX-75



Renault Ondelios



# RAPID TECHNOLOGIES CENTER AT BMW.



Source: BMW Group



# APPLICATIONS

## GEOMETRICAL SAFEGUARDING WITHIN THE DEVELOPMENT PROCESS.



Vehicle front using SLS



Crankshaft using SLA



Various motor parts using SLS



Rear motorcycle wheel using SLA

# APPLICATIONS.

## FUNCTIONAL SAFEGUARDING WITHIN THE DEVELOPMENT PROCESS.



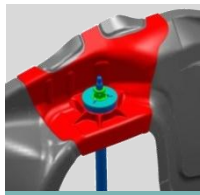
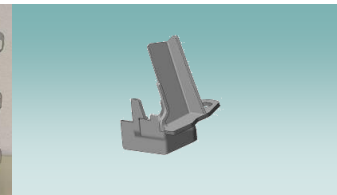
Enginecover (SLS)



Drive train kinematics (SLM)



C-pillar intersection  
(precision casting)



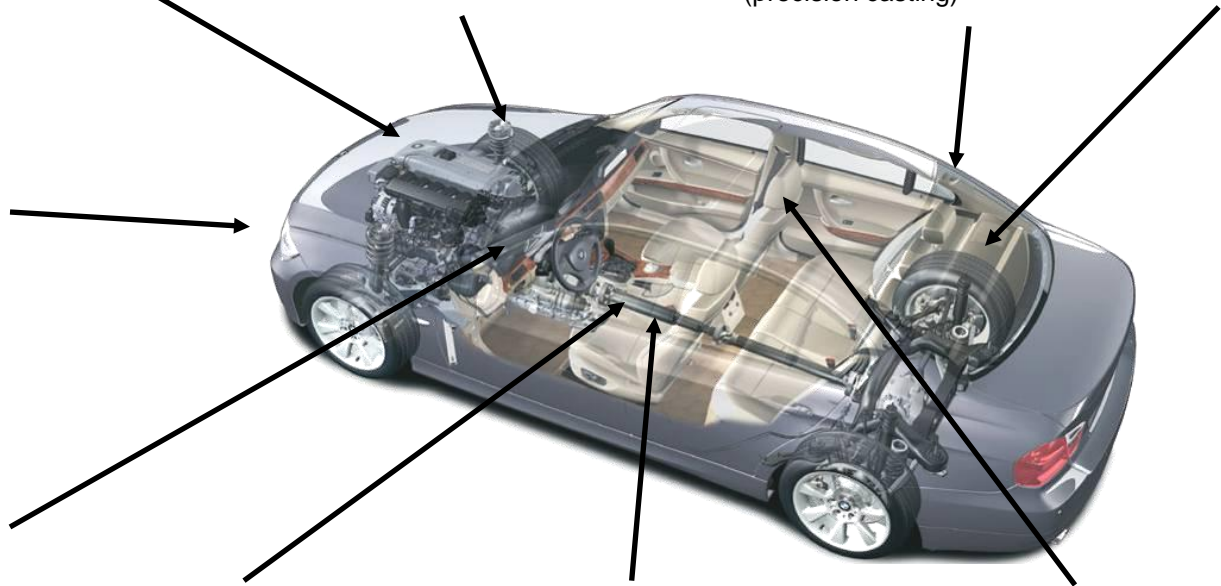
Shock-connect  
(SLM)



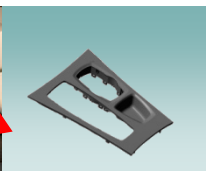
Headlight casing  
(Vacuumforming)



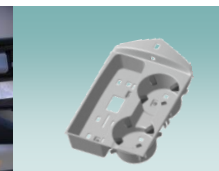
Cover for A- and B-pillars  
(Vacuumforming/SLS)



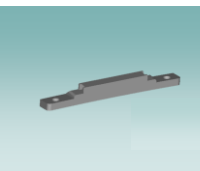
Covers for center console  
(SLS)



Cupholder  
(SLS)



Roofrack holder  
(SLM)



# SELECTIVE LASER MELTING (SLM). PARTS 2011 - APPLICATIONS.



Quelle: Mxp11

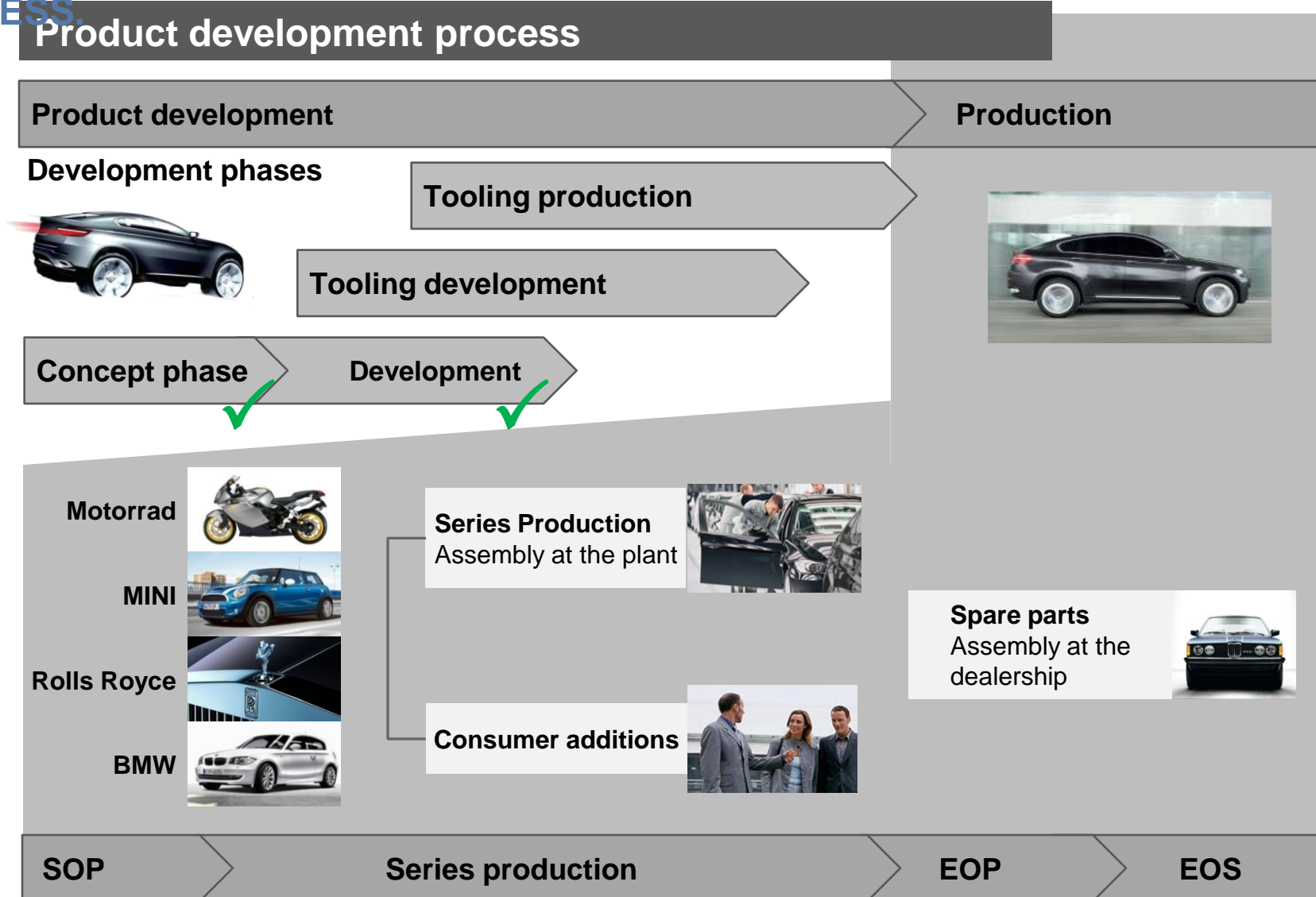
**Substitution of conventional technologies for prototypes by SLM:**

● master forming    ● metal forming    ● joining    ○ cutting



# APPLICATIONS.

## FUNCTIONAL SAFEGUARDING WITHIN THE DEVELOPMENT PROCESS.



# SLM. ACTUAL APPLICATIONS – ENGINE COMPONENTS.



M3 GT2



Z4 GT3



DTM (ab April '12) Source: Mxp11

**Customer:** BMW Motorsport

**Part conventionally:** plastic part of all Series-M3 and M5, two-part clipped

**Manufactured in SLM:** ~ 330 parts, manually finished

**Material:** AlSi12

**Volume:** 43,6 cm<sup>3</sup> (≈ 118 g)

**Vehicle:** M3 GT2, Z4 GT3, DTM



# ADDITIVE TECHNOLOGIES. FUTURE APPLICATIONS.



Security vehicles



Special editions/  
country specific



Niche models  
(e.g. Rolls Royce)



Spare parts



accessories



Special equipment



BMW Classic



Assembly aids

**Additive  
manufacturing**

# CHALLENGES.

- Robust production processes
- Established total quality management process chains
- Sufficient reproducibility / reliability
- Customer satisfactory surfaces
- Proof of material lifetime sufficiency
- Extension of batch size economics
- Part properties covering the requirements

# HEADLINES.

<http://www.3ders.org/index.html>

**www.3ders.org**  
3D printer and 3D printing news

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 **White House announced new manufacturing hub in Ohio to promote 3D printing**

<< Charge Bikes & EADS 3D printing titanium bicycle parts 3D printing identified in Gartner's 2012 Hype Cycle for emerging technology >>

Aug.16, 2012

White House officials announced today a \$30 million investment to create a National Additive Manufacturing Innovation Institute in Youngstown, Ohio aiming at boosting 3D printing technology.



President Barack Obama's administration will announce details today at M7 Technologies in Youngstown of a partnership between dozens of several private industries, universities and economic development organizations in three-state area: Ohio, Pennsylvania and West Virginia.

The partnership was selected through a competitive process, led by the Department of Defense, and the private industry consortium will add another \$40 million to the pilot program.

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 **Urbee eco-car comes to Euromold**

10/27/2011

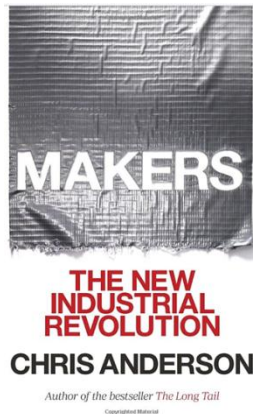
3D printed eco-car will make its European debut; Stratasys will also host aerospace stand at exhibition

- Where / what: Euromold 2011, Frankfurt, Germany
- D132, Hall 11: Stratasys to showcase Urbee eco-car by Kor Ecologic
- C111, Hall 11: Aerospace stand to show FDM parts in context
- When: 29th November ~ 2nd December 2011



Stratasys Inc. (NASDAQ: SSYS) today announced that it will be exhibiting the much publicised Urbee eco-car at this year's Euromold event in Frankfurt. Urbee is the first prototype car ever to have its entire body 3D printed. Stratasys will also host an aerospace stand at the exhibition, which will feature rapid prototyped and end-use parts in situ to illustrate how the commercial aircraft and the defence industries rely on FDM technology.

Urbee, which stands for Urban electric with ethanol backup, is a two passenger vehicle that was designed with sustainability in mind. It requires just an eighth of the energy used by conventional cars and is capable of reaching up to 200mpg (approx 85 km/l) on the highway and 100mpg (approx 43 km/l) in the city. The body of the prototype which will be on display was created using Stratasys Dimension 3D printers and Fortus production systems. Urbee's creators, Kor Ecologic will be on the stand (D132, Hall 11) to answer questions.



# RAPID TECHNOLOGIES CENTER.



Many thanks for your attention.