The Laser-Sinter-Technology – Key technology advantages

Roman Lerchenmüller
May 6th, 2014 – 3D-Printing-Forum Vienna
Agenda

- Company Overview
- The Laser-Sinter-Process and the EOS Product-Portfolio
- Key technology advantages
- Design-Rules
EOS: Technology and Market Leader for Design-Driven, Integrated e-Manufacturing Solutions

- **Family-owned**, founded in 1989,
- Headquartered in Krailling near Munich, Germany
- Integrated solution provider for Additive Manufacturing
- Solution portfolio: Additive Manufacturing (AM) systems, materials (plastics and metals), software and services
- Complete end-to-end solutions: from part design and data generation to part building and post-processing
- EOS enables competitive advantages for a variety of industries, such as medical, aerospace, tooling, industry, lifestyle products and automotive
- EOS is committed to: Innovation – Quality – Sustainability

EOS Management

EOS Headquarters in Krailling, Germany
**EOS: Global Presence**

**EOS worldwide installed base**

**1,330 Systems**
- ⅓ Metal systems
- ⅔ Polymer systems
- 266 customers with more than 1 system

**EOS global footprint**
- Customers in 51 countries
- EOS Sales & Service offices in 11 countries, distribution partners in 22 countries
- More than 500 employees worldwide (74% Germany, 26% International)
- Strong patent portfolio: More than 700 active patents in nearly 100 patent families
- R&D Spendings of approx. 15% of Sales

Source: EOS. Installed base (includes purchased and rented systems) as per 12/2013. Staff figures as per 09/2013.
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EOS Additive Manufacturing: Functional Principle

From a 3D CAD model...

- Application of powder
- Exposure by Laser

- Lowering of platform
- Re-application of powder
- Exposure by laser

... to complete parts

Functional principle for polymer and metal materials. Source: EOS
Our technology activities are seamlessly linked to our strategy resulting in various challenges

EOS: Strategy basis and resulting challenges

Balanced triangle

Process

Part quality

Process robustness

Industrialization

Material

System

In dependency to each other

Effects

Hurdles to overcome

Process Robustness
- Build platform
- Several jobs
- Several machines
- Several suppliers

Industrialization
- Automation
- Quality assurance
- Easy-to-Service
- Productivity

Part Quality
- Mechanical properties
- Dimensional accuracy
- Surface quality
- Density
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Industrial Companies Face Similar Challenges – Additive Manufacturing Offers Unique Solutions

**Challenges of industrial companies**

- Faster **Time-to-Market** combined with **shorter Lifecycle**
- **Productivity increase:** Need for cost reduction
- Flexible production ("factory around the corner")
- **Innovation** → Increase of customer value add
- **Customisation** of products
- Focus on **Sustainability**

**Additive Manufacturing advantages**

- **Productivity advantage**
  - Rapid prototyping and serial applications
- **Cost advantage**
  - Integrated functionality without assembly
- **Freedom of design**
  - Lightweight
  - Complex component
- **Customisation**
  - Customer specific adaptations
  - Cost efficient small series
Laser sintering offers various advantages compared to traditional manufacturing processes

### Key differentiation criteria for laser sintering

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Source: EOS
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Source: EOS
Lightweight is key for aerospace applications

Example lightweight

Engine cover door hinge

Application
- Engine cover door hinge on the A380
- Material: titanium

Advantages
- **65% weight savings** compared to conventional casting design (sums up to more than 10kg per aircraft)
- Significant fuel and thus life time cost reduction
- Material efficient process (no wasted material through machine tool stock removal)

Source: EADS, EOS
An innovative drive shaft design resulted in more than 70% weight reduction

Example lightweight

Innovative drive shaft

Application
- Drive shaft for formula student race cars
- Laser sintered twin walled end fittings
- No failure for entire race season

Product details
- Weight: 350g
- Length: 50 cm
- Material: Carbon fibre & titanium

Advantages
- Massive weight savings by 73% compared to steel drive shaft (1,300g)

Source: University of Warwick, EOS
New design structures in heat exchangers increase compactness and effectiveness

Example complex components

Conceptual heat exchanger

Application
- Design study for heat exchanger
- Repeated sub-elements can be formed into almost any shape
- Self-supporting, integrated cooling fins on outside surfaces
- Turbulators inside the cooling tubes disrupt the flow of the cooled fluid
- Material: Aluminum

Advantages
- Compact and scalable design
- Maximum heat transfer

Source: Within, 3T, EOS
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Source: EOS
Festo designed a gripper that is produced in ‘one shot’ and ready to operate.

Example integrated functionality

**Bionic handling assistant**

**Application**
- Bionic gripper, self adapting to objects
- Movements realized by pneumatically operated membranes

**Advantages**
- Safe and gentle handling
- Weight 'reduced to the max'
- Highly flexible due to self adapting gripper fingers
- Cost efficient – entire gripper produced in 'one shot', no post assembly

Source: Festo, Fraunhofer IPA, EOS
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Source: EOS
In the medical market, customization delivers high value for patient matched implants

Example customization

Medical implants

Application

- Patient matched implants
- Example hip implants, cranial implants and spine implants

Advantages

- Optimized patient match (e.g. size and strength of an acetabular cup)
- Improved functionality (e.g. enhanced design to stimulate bone growth)
- Reduced cost

Source: Within, 3T, EOS
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Source: EOS
Rapid prototyping decreases time to market

Example: time to market

**Industrial hook**

**Manufacturing process**

**Production of small series**

**Application**
- Simple hook to attach components in industrial machines
- Laser sintered part in PA 2200

**Advantages**
- Tool less production, thus -60% cost reduction per part
- Production time reduced from 8 to 1 week

Source: Festo, EOS
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However, to retrieve the maximum value, the design needs to leverage all possibilities

Example integrated functionality

Diode clamp

Application
- Diode clamp for illumination purposes in machinery environment
- Hollow and material efficient design, integrated hinges, labeling and series number

Advantages
- About 80% reduction of assembly time (from 10 to 2 minutes)
- More than 30% cost advantage
- Lead times reduced by 75%

Source: Kuhn-Stoff, EOS
A conventional handling device was redesigned leveraging the possibilities of laser sintering

**Conventional design**
- Hole gripper to pick up pieces out of an injection molding machine
- Four grippers mounted on a base plate
- Gripping mechanism operated by distributed compressed air
- Base plate being attached to a three axis robot

**Laser sintered design**

Source: Wittmann, Kuhn-Stoff, EOS
For the gripper, weight has been reduced by 80% whilst keeping handling properties.

Example Kuhn-Stoff: new gripper design

**Lightweight gripper**

**Application**
- Hole gripper for part handling
- **Weight** of gripper: **19g**
- **Handles** up to **12kg parts**
- Integrated pneumatic membrane to apply gripping force

**Advantages**
- About **80% weight reduction** compared to conventional gripper
- Printed in one shot - no final assembly
- Geometry fully flexible and scalable
- Tested to **>5 mio. cycles**

Source: Kuhn-Stoff, EOS
The application perfectly answers today’s Handling & Robotics challenges

Example Wittmann / Kuhn-Stoff: Advantages compared to conventional solution

**Flexibility**
- Base plate generates lightweight stiffness and at the same time allows integrated air channels
- Three components vs. 21, leading to less list positions and logistics effort

**Cost per part**
- **CAPEX reduction**
  - -50% gripper cost reduction
  - -86% less weight leading to smaller robot size
- **OPEX reduction**
  - Lightweight and smaller build height (-60mm) resulting in shorter cycle times of injection molding machine

**Time-to-market**
- Laser sintered gripper to be produced “overnight”
- **Reduction** of manufacturing time by 17 days
- Fast reaction possible for spare parts or product design changes

Source: Wittmann, Kuhn-Stoff, EOS
Thank you for your attention!

www.eos.info