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TEILEFABRIK

September 2011

Agenda

- Vorstellung alphacam
- Die 3 Wege
- Die Teilefabrik
 - Materialien, Baugrößen
 - Warum benötigen wir Prototypen
 - Kunststoffteile aus Additive Fertigung Beispiele

Wer sind wir?



- Gründung am 1. Oktober 1992
- Stammsitz in Schorndorf (bei Stuttgart)
 - Niederlassung in Bergisch Gladbach
 - Tochter in der Schweiz - mecasale
- deutschlandweite Präsenz
- Seit 1979 im CAD/CAM Lösungsgeschäft tätig
- Seit 1989 Erfahrungen mit Rapid Prototyping
- 56 Mitarbeiter
- Mehr als 3500 Kunden
- Umsatz (2009/2010) 16.5 Mio EUR

Der dritte Weg

Kunststoffteile aus Additiver Fertigung



Kunststoffteile aus Thermoplast

Herstellungsmöglichkeiten

Spanende Bearbeitung



ab 1

Spritzgussform



Stückzahl

ab 200

Additive Fertigung



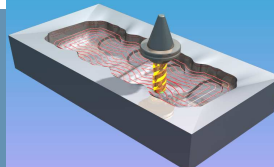
ab 1

Was braucht man dazu

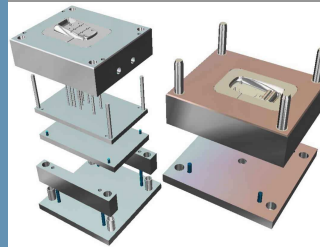
3D CAD
Model



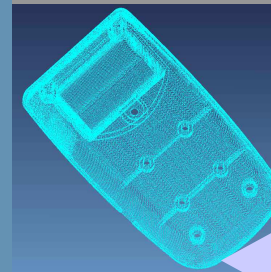
3D CAM
NC Programm



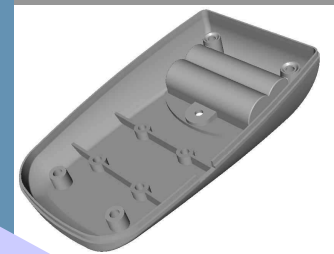
Werkzeug



Punktewolke
3D



3D CAD
Model



FDM Verfahren



Spanende
Bearbeitung



Kunststoff-
Spritzguss

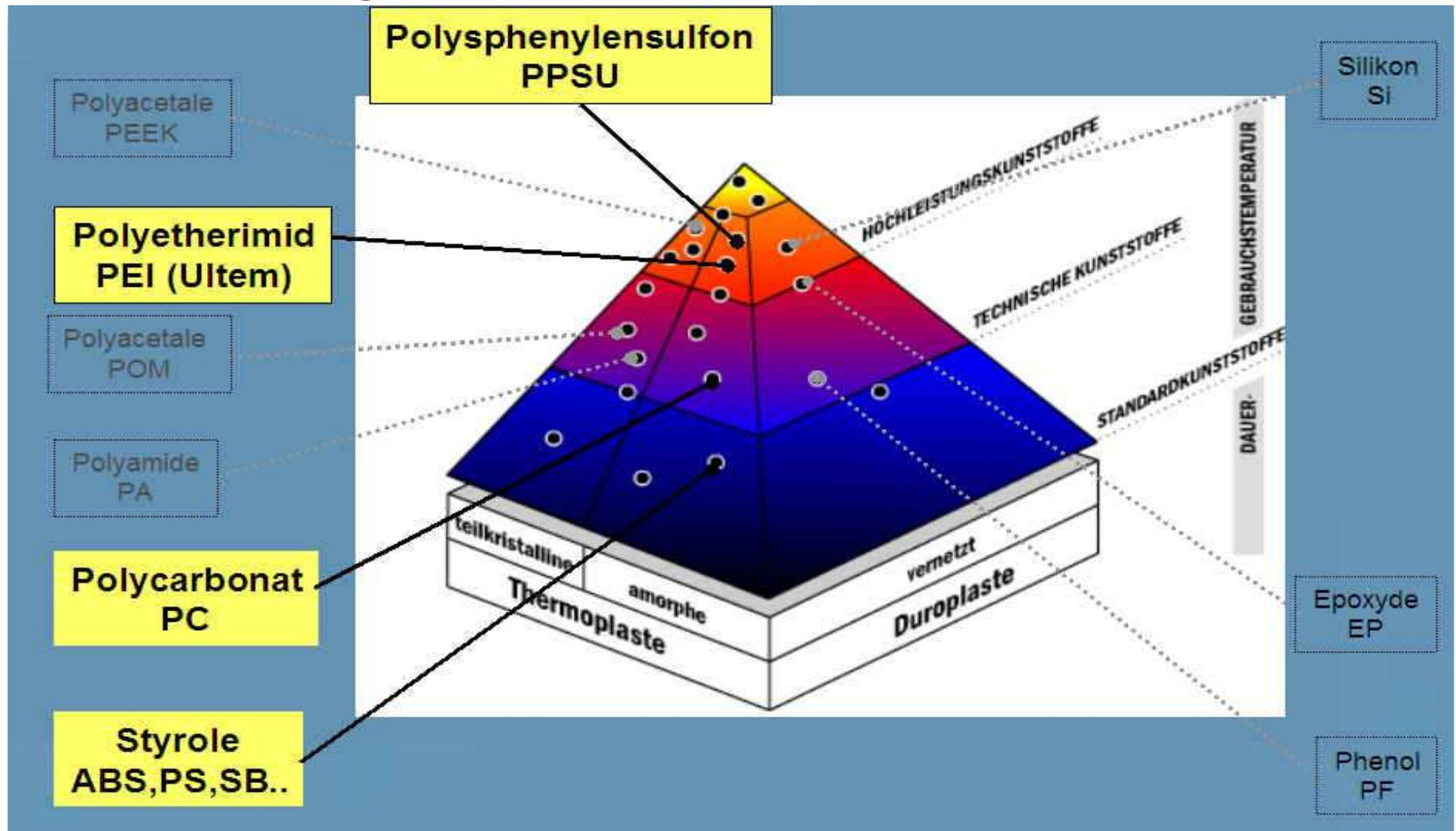




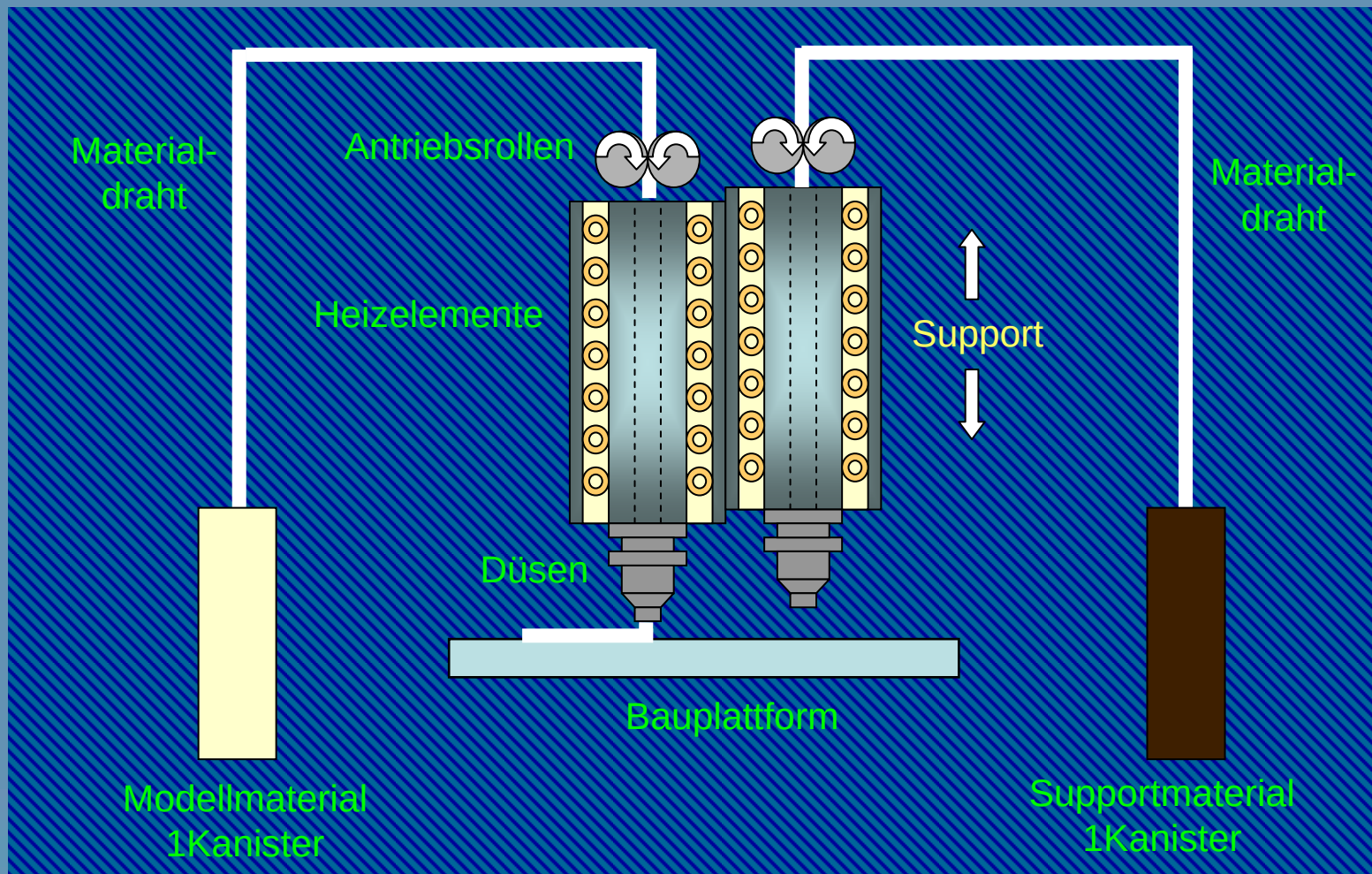


Kunststoffe

Werkstoffpyramide



Funktionsprinzip FDM FORTUS



Baugrößen - Materialien der FORTUS 3D Systeme



	FORTUS 250mc	FORTUS		
maximale Bauteilgröße in mm (X x Y x Z)	254 x 254 x 305	406 x 35		
verwendbare thermoplastische Materialien	ABSPius	ABS-M30 PC-ABS PC		
			Ultem-9085	
erreichbare Genauigkeit in mm	+/- 0.1% d. Einzelmaße (mind. +/-0.1mm)	+/- 0.1% d. Einzelmaße (mind. +/-0.1mm)	+/-0.1% d. Einzelmaße (mind. +/-0.1mm)	+/- 0.1% d. Einzelmaße (mind. +/-0.1mm)

Materialüberblick

Fortus – Commercial Thermoplastics

Robust	Strong, stable, and durable
Clean	Solution for any office or facility
Safe	No harmful chemicals or powders
Green	All material & packaging recyclable
Intelligent	Canister-system communication
Variety	Select material best for application

Wide Variety of Materials

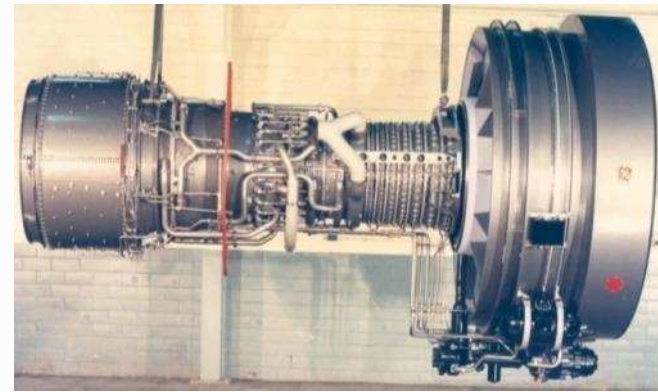
ABS-M30	Versatile material
ABS-M30i	Biocompatible (ISO-10993)
ABSi	Translucent
PC-ABS	High Impact Strength
Polycarbonate	High Tensile Strength
PC-ISO	Biocompatible (ISO-10993)
ULTEM 9085	FAA - FST Certification
PPSF/PPSU	Thermal/Chemical Resistance



Komplexität der Produkte

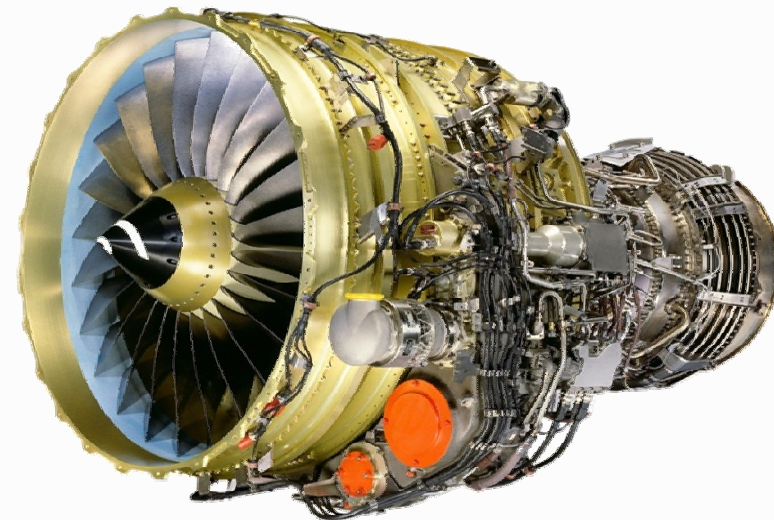
1960's

~3,000 parts



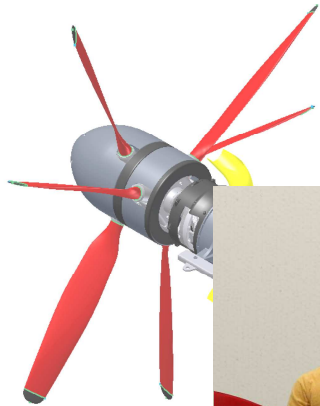
1990's

~20,000 parts



Komplexität der Produkte

- Steigende Komplexität der Baugruppen
- Mehr Elektronik in Verbindung mit der Mechanik

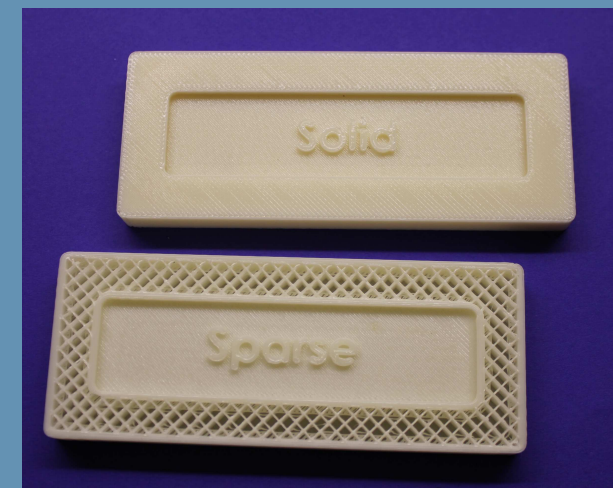


Formteile aus der Teilefabrik

Vorteile

Vorteile durch das FDM Verfahren

- Nur 3D Daten werden benötigt (STL)
- Material PC (Polycarbonat) oder PPSU (Polyphenylsulfon)
 - Wärmebeständig PC > 140°C, PPSU 230°C
 - Stabiles Schlagfestes Material
- Sparse Bauweise
 - Teil nicht Luftdicht (Vakuum durch Form hindurch)
 - Stabilität der Form gegeben



Thermoforming mit Formteilen aus der Teilefabrik

Thermoforming for Prototype and Short-Run Applications

Thermoforming for Prototype and Short-Run Applications

BY BRIAN SABART, STRATASYS, INC.
AND JEFF GANGL, FORMECH INTERNATIONAL LTD.

Thermoforming is a relatively simple manufacturing process that is inexpensive when compared to other plastic molding and forming methods. Although thermoforming is often associated with manufacturing of packaging items such as blister packs and disposable coffee cup lids, the time and cost advantages are realized in a broad spectrum of products in an equally broad range of industries. When using FDM (fused deposition modeling) to construct thermoforming tools, the process becomes simpler, more efficient and increasingly cost-effective.



holes to be drilled. With FDM tooling, the operation was eliminated.

However, the biggest benefit is not in labor savings. It is in process improvement. The typical product development cycle has package design and development as one of the last tasks before product launch. Being last meant that any delays in prior processes reduced the time available for package design. With FDM, the company now produces prototype products and prototype packaging well before final design release. Removed from the critical path, there is more time to design and prototype innovative packaging. The results are less time pressure on the package development team and more creativity in package design.

For consumer products that are picked from a display rack, package design is often the key difference that motivates the consumer to buy a product. FDM for vacuum forming enables the company to stand out on product shelves.

Process Guide

Vacuum forming is a simple, five-step process: tool design, tool building, tool preparation, part forming and part finishing. For many parts, the entire process can be completed in one to two days at a cost of U.S. \$100 to \$1,000 for the first part. Additional parts will have a typical cost of only \$1.00 to \$3.00, including process labor.

The vacuum forming process, as described below, is specific to the capabilities and operations of Formech vacuum forming machines. This information is applicable to the full line of Formech equipment, from the small, manually operated devices to the large-format, semi-automatic machines. However, the process guide also applies to the operation of a wide array of vacuum forming systems.

Short-Run Applications

1. Tool Design

Vacuum forming uses three types of tools: male, female and matched. The selection of tool type is based on design specifications and consideration of the vacuum forming process.

Figure 3

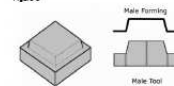


Illustration of a male tool.

Figure 4

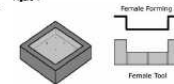


Illustration of a female tool.

Male tools (Figure 3) offer detail and texture on the inside of the part (toward surface) while female tools (Figure 4) offer the opposite. An additional consideration is that male tools are likely to have thicker sections at the periphery of the part and thinner sections in the center. The opposite is true of female tools. Matched tools incorporate both male and female tools for consistent wall thickness with detail and texture on both sides of the part. Match tools are also used to prevent compression of foam cells when forming foam materials. However, matched tools are not used with prototype vacuum forming machines.

PROCESS GUIDE - THERMOFORMING Thermoforming for Prototype and Short-Run Applications

Key factors that affect vacuum formed part quality include heating cycle and the forming cycle. In both steps, if the sheet is either too cool or too hot, the quality of the part will suffer. The heating cycle's time and rate will vary with material and sheet thickness.

When there are guides available for common materials, an-and-sensor may be required. Once the sheet is in a state, the speed at which the tool press into the sheet vacuum is drawn must be fast enough to prevent xoring but slow enough to allow the material to flow into the tool. As with the heating cycle, the forming cycle may require experimentation to get the results.

In the vacuum forming process, the tool is placed in a frame, and the extruded plastic sheet stock is firmly held in a frame located above the tool (Figures 10 and 11). Infrared ceramic heating elements warm the sheet to soften the material to a point at which it will sag, but not drop (Figure 12). At this temperature, it deforms to the contours of the tool.

When the part begins with a pre-stretch (Figure 13), air is fed between the tool and plastic sheet to cause the sheet to follow away from the tool. This stretching improves consistency of the wall thickness across the part.

3

Clamp Frame →
Heating Frame →

Blank/Full Table

of vacuum forming

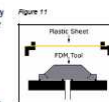


Figure 11

Thermoplastic sheet is clamped in frame.

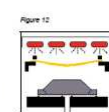


Figure 12

Heating elements warm thermoplastic sheet.

Immediately after the pre-stretch, the tool is raised into the plastic sheet (Figure 14), and a vacuum, approximately -24 to -30 inches of mercury, is pulled through the tool (Figure 15). The plastic sheet draws tight to the tool surface to form the plastic part.

When using plug assist, the plug is forced down through the plastic sheet into the matching cavity in the tool before the vacuum is applied (Figure 16).

To prevent deformation of the part, it is allowed to cool prior to removal. The cooling cycle can be accelerated with air or a fine mist blown onto the part. Once rigid, the part is released with air pressure forced up through the tool (Figure 17).

FDM PROCESS GUIDE - THERMOFORMING Thermoforming for Prototype and Short-Run Applications

As to that of many vacuum formed materials, the heat applied to the sheet is localized, which means that the tool is exposed to the elevated temperatures required to soften the thermoplastic.

In demanding applications, PC or PPSP/PPSU (Figure 6) may be selected. Both offer higher glass transition temperatures than ABS, which extends tool life and accommodates the forming of high temperature thermoplastics. PC ($T_g = 320^{\circ}\text{F}/160^{\circ}\text{C}$) and PPSP/PPSU ($T_g = 45^{\circ}\text{F}/229^{\circ}\text{C}$) offer increased resistance to thermal radiation—often resulting in a glazing of the tool surface in repeated heating and cooling cycles—that extends the life of the tool. When forming high temperature materials, such as polycarbonate or HDPE, PC or PPSP/PPSU should be selected.

Figure 6



Figure 6

Tool made in PPSP/PPSU, formed more than 600 parts with no sign of wear.

With just one exception, the STL file is processed in FDM Insight™ software in the same manner as any other prototype or tool. Increasing road width (the width of the extruded path) yields a tool that is porous on all non-vertical surfaces (Figure 7). This porosity allows the vacuum to be drawn through all areas of the tool.

Figure 7



Figure 7

Close up of the tool in Figure 6 shows the porosity that results from modified build parameters.

Porosity is advantageous when vacuum forming. For other tool creation methods, vacuum holes (small vents in the tool) are added around the periphery of the tool, in areas of detail, and in central areas of the tool where the vacuum pressure may be too low to pull the sheet to the tool. In order to obtain a prototype with good detail, all air must be removed during the forming cycle. If air becomes trapped (in corners for example), the sheet stock will not draw down onto the tool surface. The quantity and placement of the vents directly affects the quality of the formed part. Vent placement also affects the cycle time of the forming process.

Process Tip:

To eliminate finishing of the FDM tool, use the raw part from the machine and draw a thin sheet of PVC onto the FDM form. Drill vents through the PVC sheet and drill vacuum assist holes in the FDM tool in areas that may trap air. Place the PVC form on the FDM tool and vacuum form the desired sheet stock.

Thermoforming Guide für das FDM Verfahren

- Aufbau der Form
- Werkstoffwahl
- Hinweise *best practices*

Thermoforming

Beispiel – Bauteil

Form aus der Teilefabrik

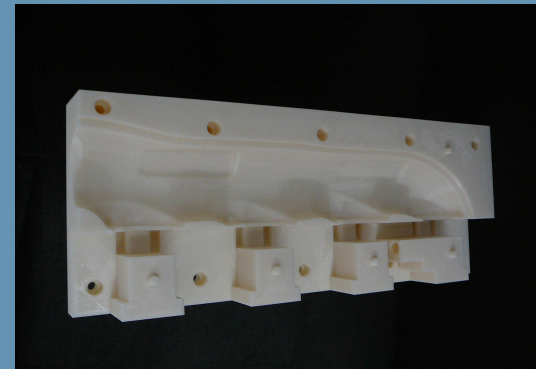


Tiefziehteil



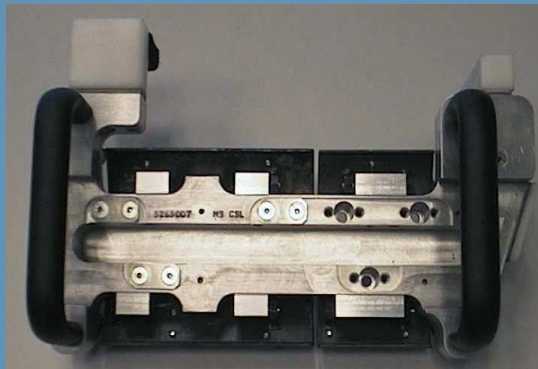
Vorrichtungsbau

- Muster als Kommunikationsmedium für die Werkzeugbesprechung vor Ort
- Machbarkeitsstudien für die Werkzeuge
- Einsatz als Lehren für die eigene Kleinserien – Produktion
- Werkstückträger zum Messen / Transport



.... bei BMW im Vorrichtungsbau als Fertigungsmittel

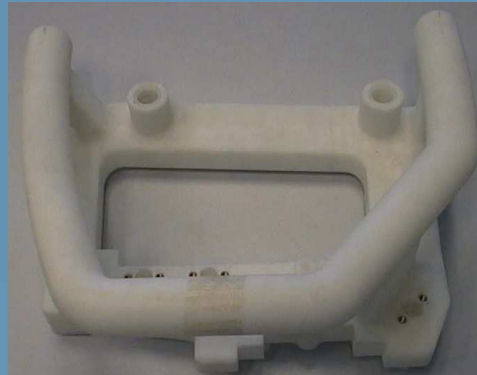
vorher →



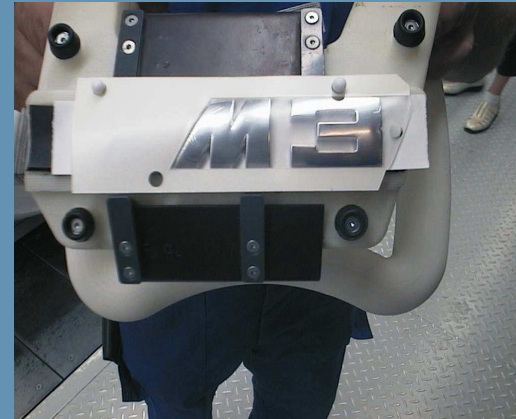
Modellschriftzug



Fertigungsmittel FDM



.... bei BMW im Vorrichtungsbau als Fertigungsmittel



Fertigung

- Einsatz als Lehren für die eigene Kleinserien – Produktion
- Bauteile mit geringer Stückzahl aus Kunststoff (z.B. Displayrahmen, Griffe, Schlauchführungen etc.)
- Halterung von Hilfsmittel
- Werkzeuge



Montage

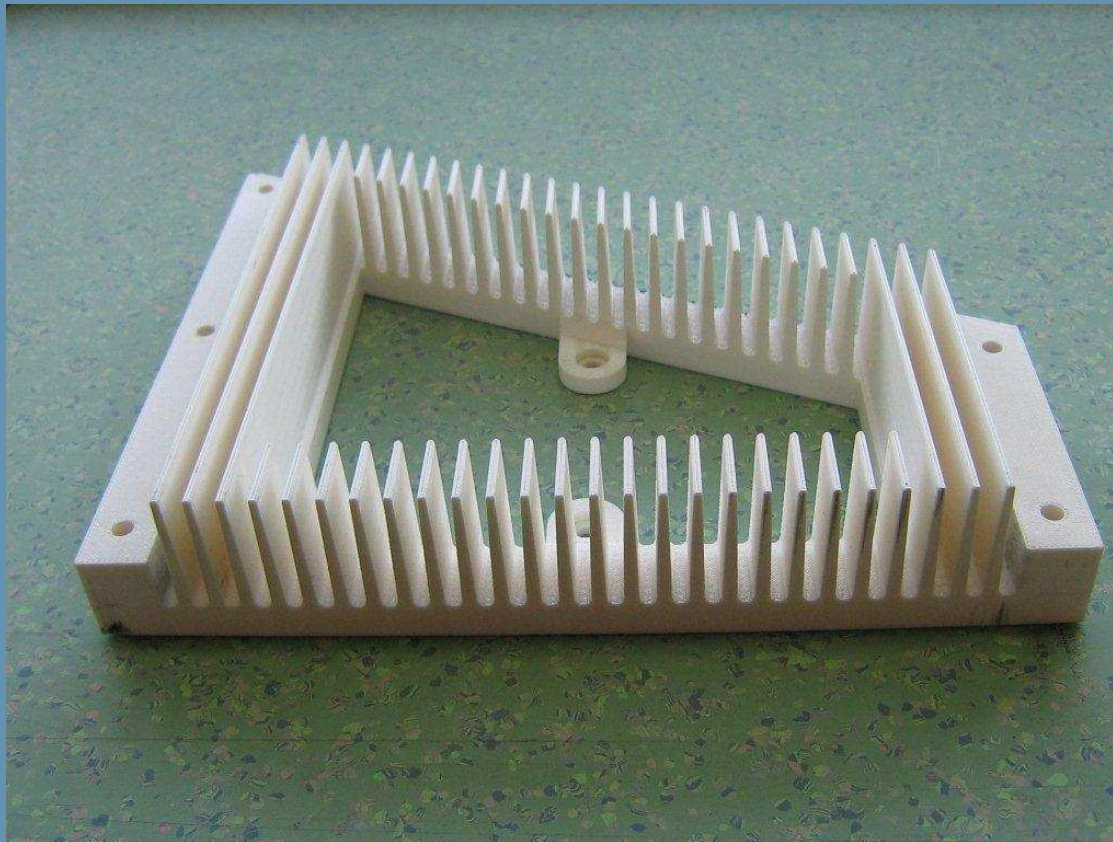
- Haltevorrichtung
- Montagehilfe
- Hilfswerkzeuge
- Biegevorrichtungen



Biegevorrichtungen und Bohrvorrichtung



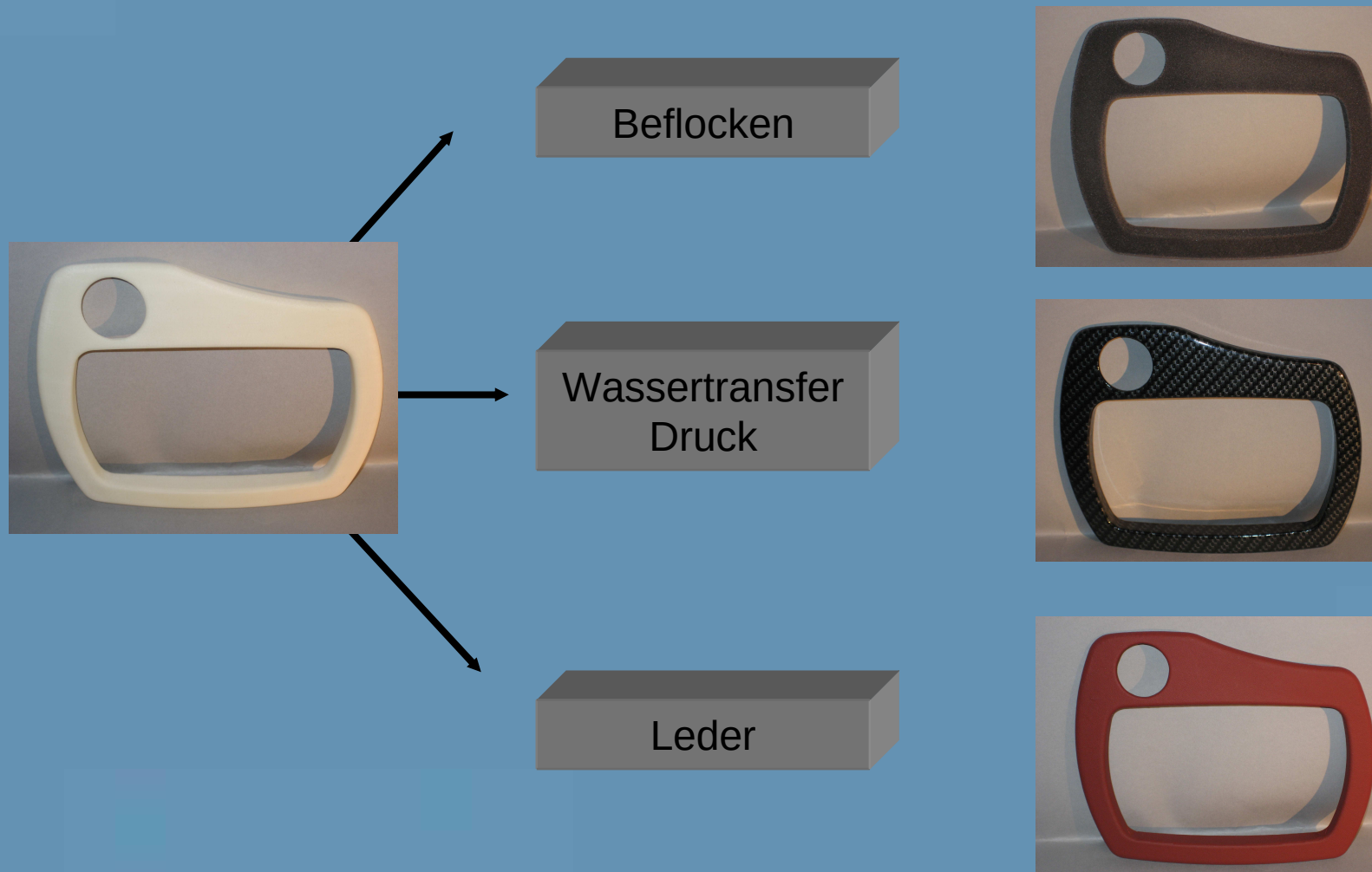
Filterschneide Vorrichtung

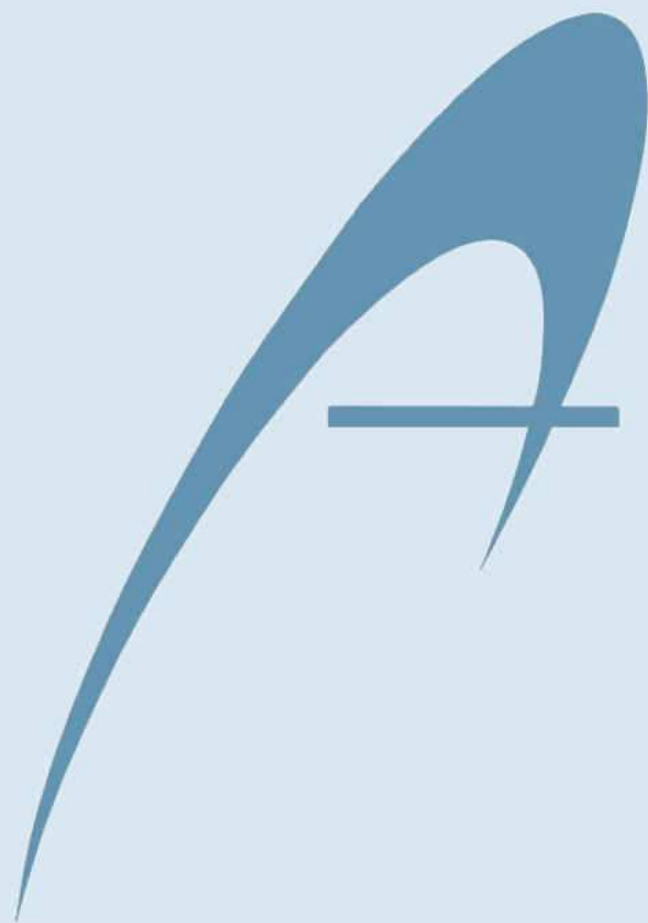


Vorrichtung um Filter-Faltenbälge damit zu fixieren

Wichtig, damit diese beim Schneiden oder/und Kleben in Form gehalten werden

Oberflächen für Prototypen





alphacam

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Beratung Installation Schulung Anpassung Support Implementation

