AACHEN CENTER
FOR ADDITIVE
MANUFACTURING

Your Partner for Additive Manufacturing in Aachen

Community | R&D | Services | Education

RWTH Aachen University Campus

A unique research environment – and unique in its shape

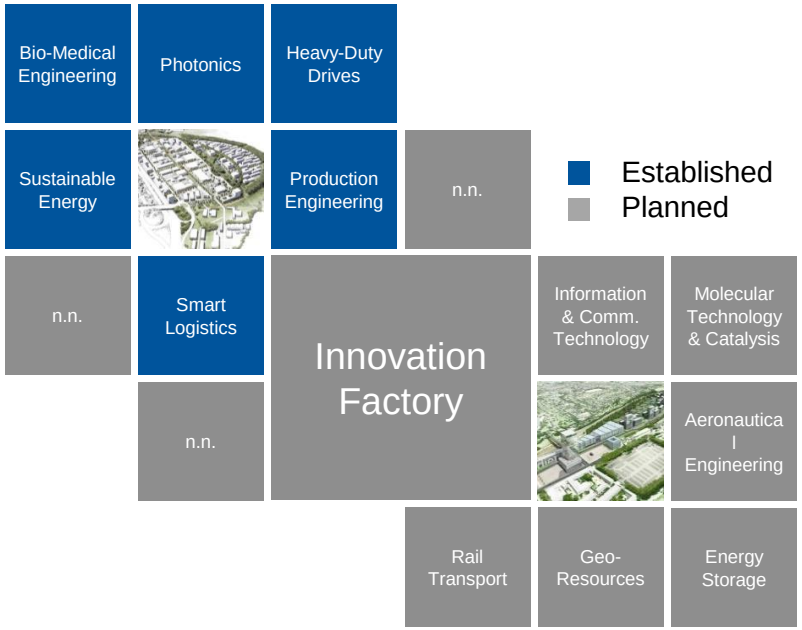
Campus Melaten 2012

- From first idea to final product
- Winning formula:
  „Kannste mal eben?“

- Broad engineering portfolio tailored to industrial needs
- Trust is the key! Infrastructure and expertise is not enough
- Systemized learnings

Campus Melaten 2016

Engineering Valley - The RWTH Aachen University Campus
Key Facts



- Shared lab & office space for
  - industrial R&D partners
  - research chairs
- 16 clusters overall
- 300+ industry partnerships already established
- Hotels, shopping, leisure, day-care, …

- Know-how of RWTH Aachen
- Among best technical universities worldwide
- 43,000 students
- 500+ professors
- Vast amount of industry cooperations

RWTH AACHEN UNIVERSITY

Engineering Valley - The RWTH Aachen University Campus
Focus Areas

Production Engineering
- WBA Tooling Academy
- Aachen Center for Integrative Lightweight Production
- Complexity Management Academy
- Ramp-up Factory

Photonics
- Digital Photonic Production
- ACAM Aachen Center for Additive Manufacturing

Biomedical Engineering
- Intel. Implants & Support Systems
- Biohybrid Syst. & Tissue Engineering
- Europ. Training Center for Innov. Med.

Geo-Resources
- Rare Earths

Smart Logistics
- Center Smart Services
- Center Enterprise Resource Planning
- European 4.0 Transformation Center
- Electromobility Lab

Sustainable Energy
- Flexible Electric Networks
- E.ON Energy Research Center

Heavy-Duty Drives
- Center for Wind Power Drives
- Center for Mobile Machinery

Future City
- Smart Infrastructure
- Urban Production
- Smart Urban Systems

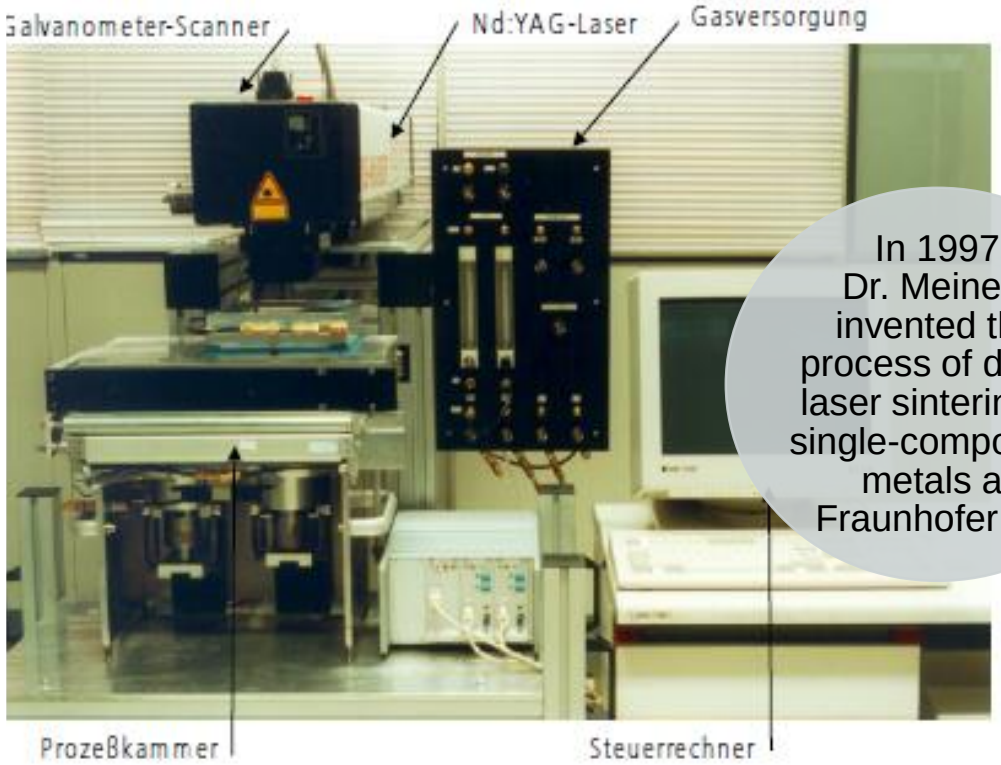
Railway Transportation
- Condition-based Maintenance
- Future Train
- Sustainable Energy Supply
- Future Train Station

Aeronautical Engineering
- Silent Air Taxi
- Intern. C. for Turbomach. Manufacturing

Innovation Factory
- Invention Center
- Controllable Digitalization
- Internet of Production

Initial clusters
Planned clusters

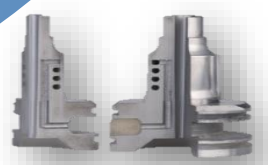
Back in the Days…



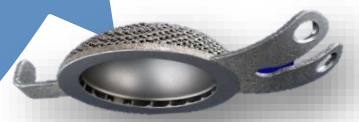
In 1997 Dr. Meiners invented the process of direct laser sintering of single-component metals at Fraunhofer ILT

„The cradle of metal AM“

1997:
Basic Patent at Fraunhofer ILT



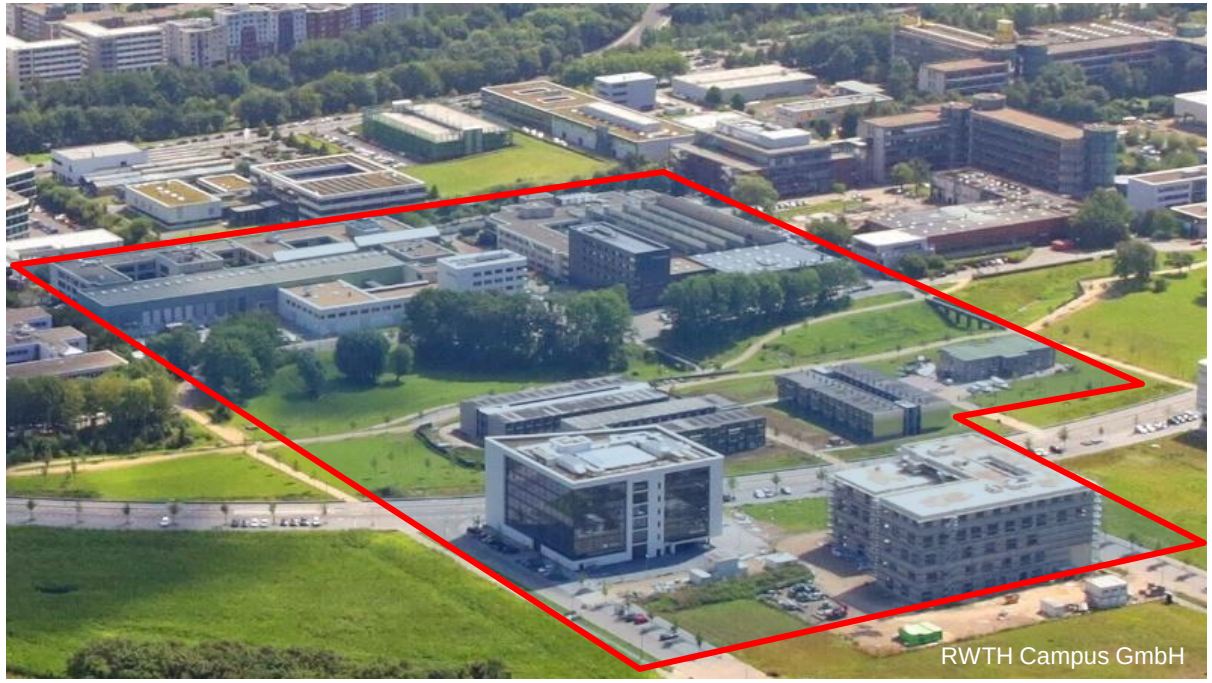
2001:
First Tool Insert



2008:
First Implant

„The world‘s most vivid and multifaceted AM ecosystem“

Additive Manufacturing at the RWTH Aachen Campus
Nowadays – Cluster Photonics



AACHEN CENTER FOR ADDITIVE MANUFACTURING

Fraunhofer ILT

Fraunhofer IPT

dap Digital Additive Production | RWTH AACHEN UNIVERSITY

WZL An-Institut der FH Aachen

More than **100 researchers** dedicated to AM

200+ years of person years in R&D experience

3,000 m² AM lab space

Design, post-machining and testing facilities

25 systems for metal AM, 15 for polymers

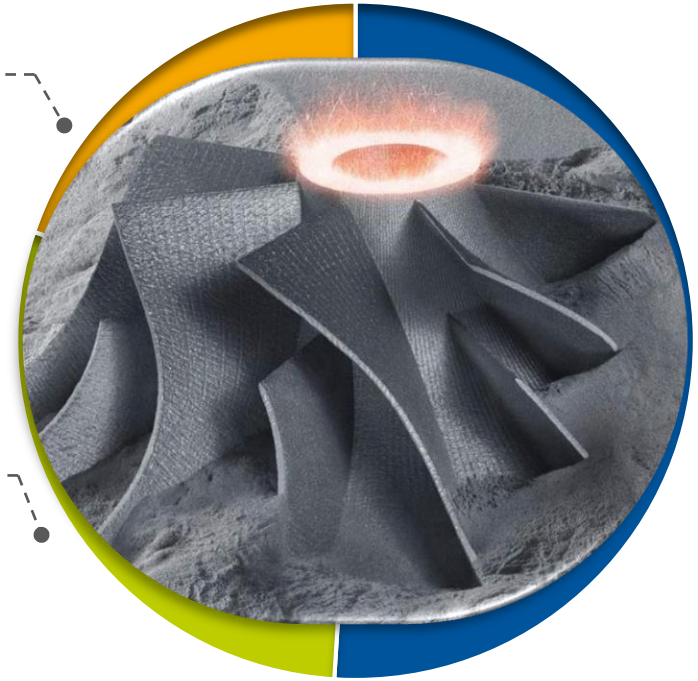
L-PBF, DED, SLS, SLA, EBM, FDM

16 Mio. € yearly overall AM budget

40% industry share

Economical perspective

The potential of Additive Manufacturing



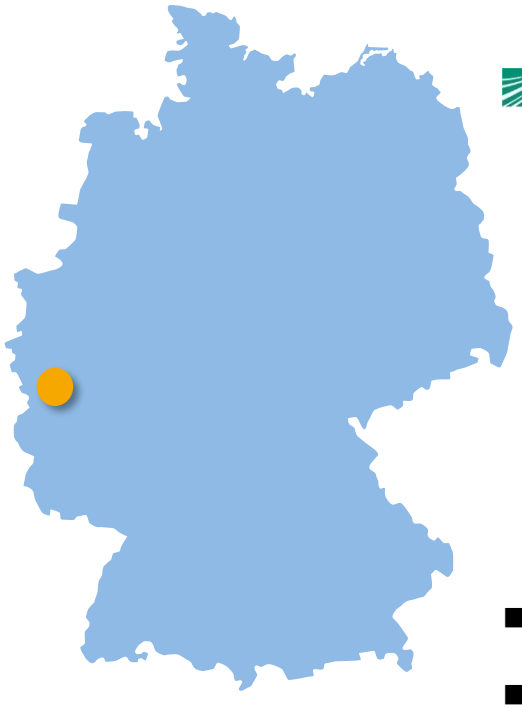
UP

10,8 Bi. €

The global market volume of products and services in the field of Additive Manufacturing will increase to € 10.8 billion by 2020.[1]

Source: [1]Wohlers Report 2013; Image: trumpf.com

Navigating AM Complexity



University, research institutes and spin-off companies in Aachen

Research Partners at the

AACHEN CENTER FOR ADDITIVE MANUFACTURING

- **One stop shop** for Additive Manufacturing
- We pool resources and facilitate the access to the Additive Manufacturing expertise of the **leading research institutions**
- We provide opportunities for **joint R&D**, a sophisticated **training and education** program and an **online platform**
- We enable industry partners to **strengthen their AM footprint**, to be upfront in **technologies** and build **business connections.**

Highlights in research, development and cooperation

1995: First hybrid machine tool

Development and patent of „Controlled Metal Buildup CMB“ at Fraunhofer IPT

2015: Foundation of ACAM

With 10 research partners and a growing number (now 30) of industrial members AM is being industrialised

1997: Basic patent for SLM

Development and patent of laser based powder bed fusion of metals at Fraunhofer ILT

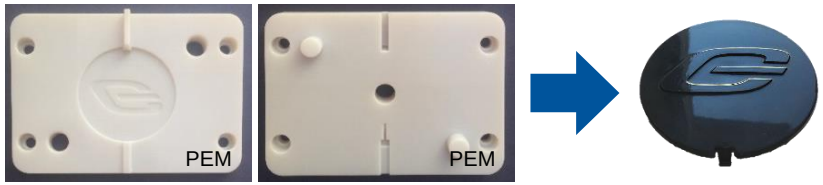
2016: LMD ten times faster

Development and patent of High Speed Laser Metal Deposition at Fraunhofer ILT

Additive Manufacturing at the RWTH Aachen Campus

ACAM promotes AM as a core element of agile and adaptive production for e.Go Mobile

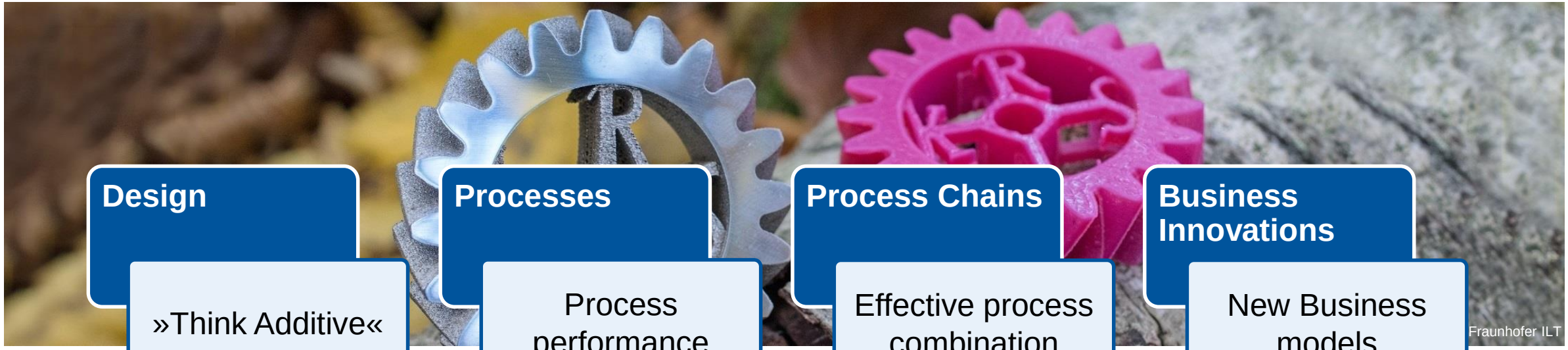
The ACAM has provided the business with its product design and manufacturing processes expertise.



PEM Chair of Production Engineering of E-Mobility Components | RWTH AACHEN UNIVERSITY

The ACAM is a central component of the RWTH Aachen Campus and development partner of the e.GO Mobile AG.

Technology Focus of the ACAM

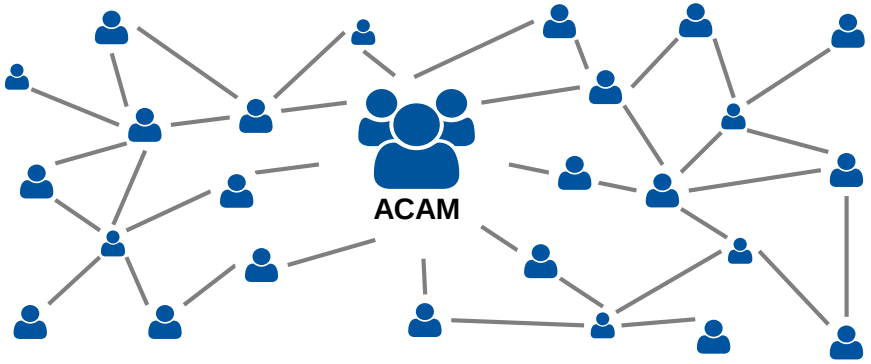


Design	Processes	Process Chains	Business Innovations
»Think Additive«	Process performance	Effective process combination	New Business models
New algorithms & CAD functions	Process development	Efficient adaption of process chains	Benchmarks and studies
Design rules	Quality management	Planning algorithms	Strategic decision support

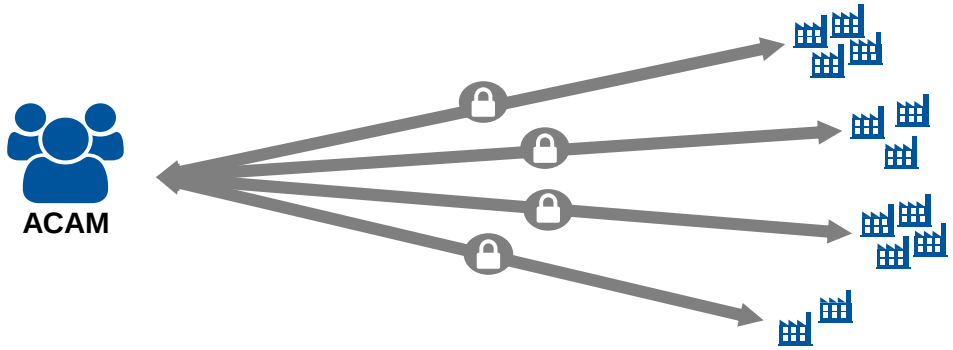
Range of Services

Four pillars ensuring successful AM implementation for our partners

Community

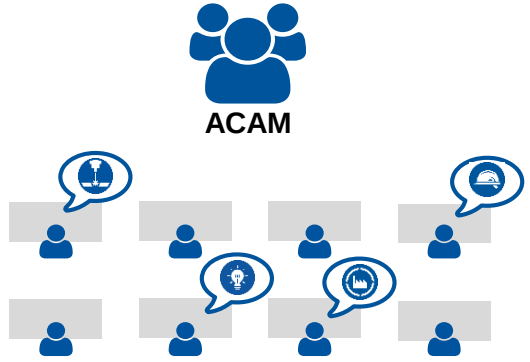


Consortial R & D



Contractual R & D

Training and Education



Range of Services

Four pillars ensuring successful AM implementation for our partners

Community

- Physical and virtual networking and exchange in the ACAM Community
- Annual ACAM report and AM Technology Monitoring and Review
- Marketing and Website Package

Consortial R&D

- Strategic ACAM R&D roadmap and research topics
- Annual ACAM R&D projects on agreed topics (shared IP)
- Joint acquisition and realization of public funded research projects (shared IP)

Services and Contractual R&D

- Bilateral research and development projects
- Prototype manufacturing along the process chain
- Strategy, market and technology oriented consulting projects

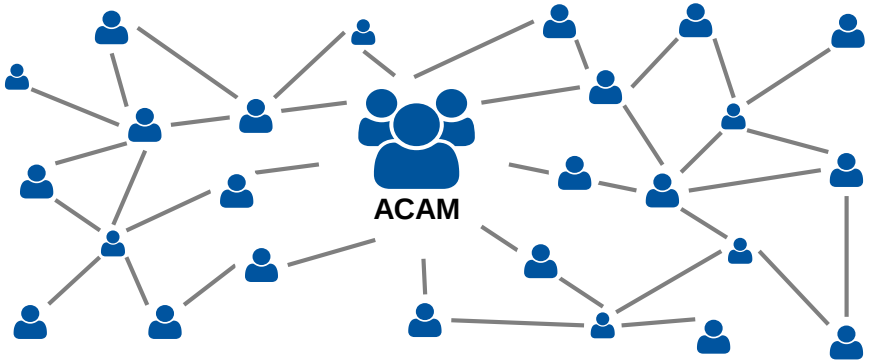
Training and Education

- Seminars for employees and decision makers
- Modules for professional further education
- In-house seminars

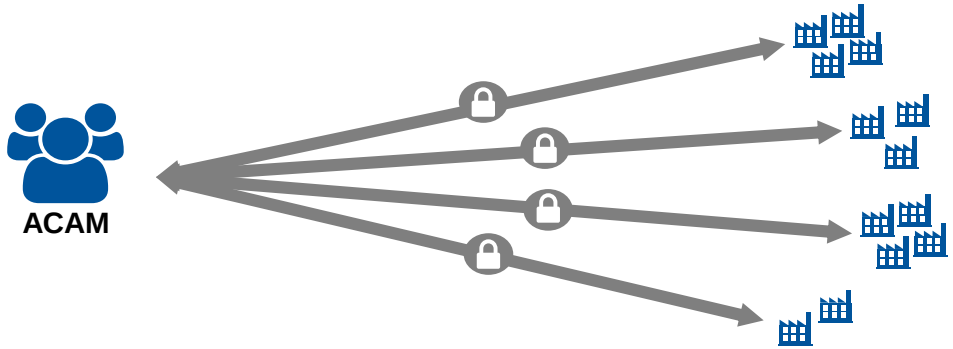
Range of Services

Four pillars ensuring successful AM implementation for our partners

Community

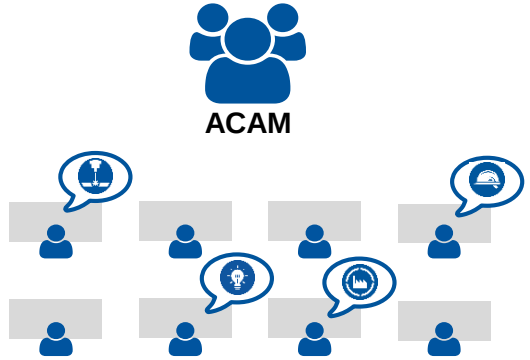


Consortial R & D



Contractual R & D

Training and Education



Community

Our Member Network

BUSINESS Members

GMH GRUPPE | [INDUS] HOLDING AG | oerlikon | SCHAEFFLER | TOYOTA | ZOLLERN

BASIC Members

aalberts | AMEXCI | BeAM DIRECTED ENERGY DEPOSITION | CONCEPTLASER a GE Additive company | Danfoss | DENSO Crafting the Core | ebi bilstein

GEA engineering for a better world | GKN SINTER METALS | hirtenberger Engineered Surfaces | Hydro | THE LINDE GROUP | LMT TOOLS BELIN FETTE KIENINGER ONSRUD | Materials Magic Hitachi Metals

MESSER | OKUMA OPEN POSSIBILITIES | OTTO FUCHS | PRIMETALS TECHNOLOGIES | PROTIQ A Phoenix Contact Company | toolcraft | voestalpine ONE STEP AHEAD.

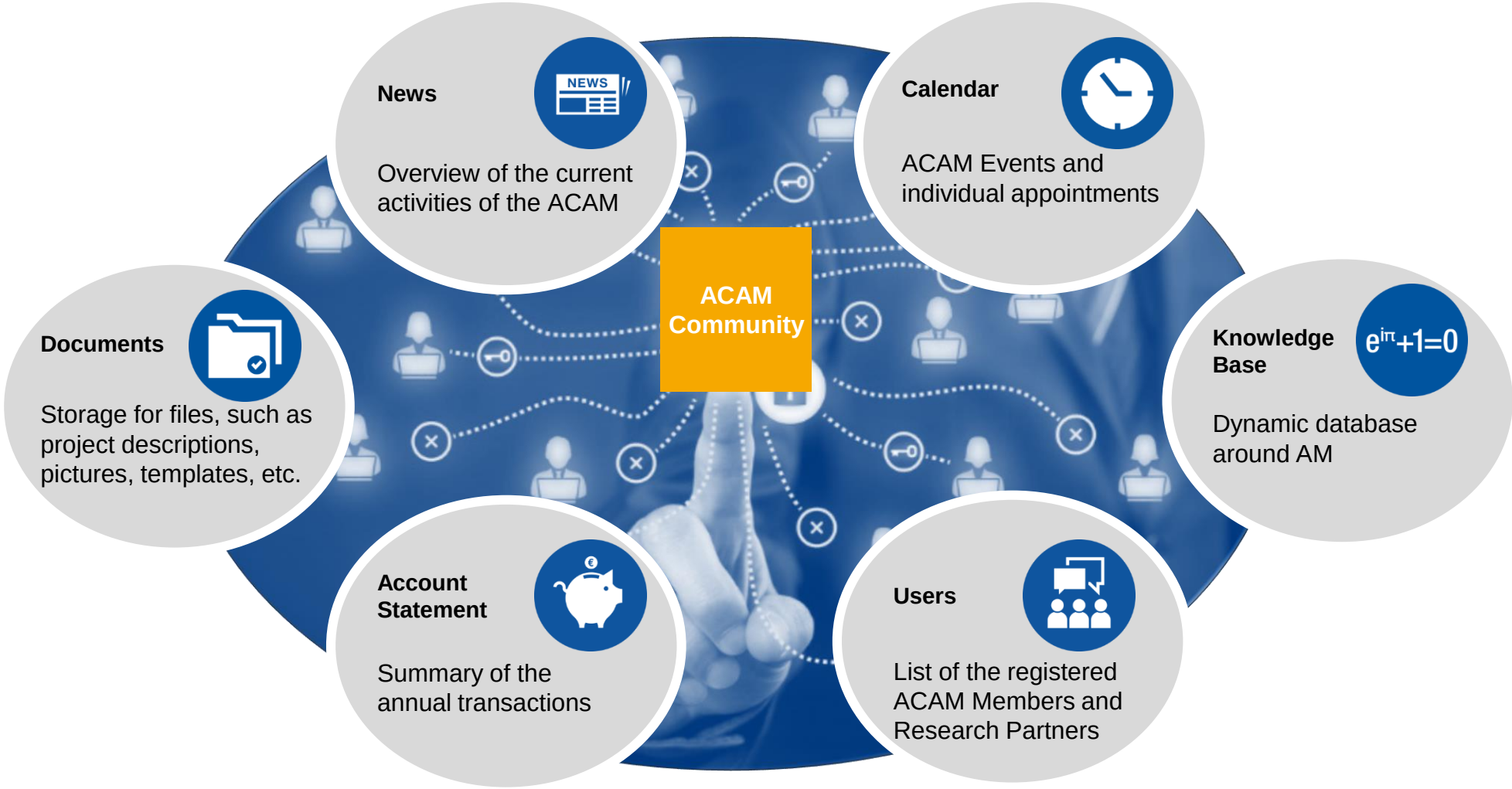
VOLKSWAGEN AKTIENGESELLSCHAFT

COOPERATION Members

ACUNITY | Efficient Elements | formnext | IUN LASERTECHNIK GMBH | LINK3D Additive MES Software | LUNOVU Integrated Laser Solutions | stratasys

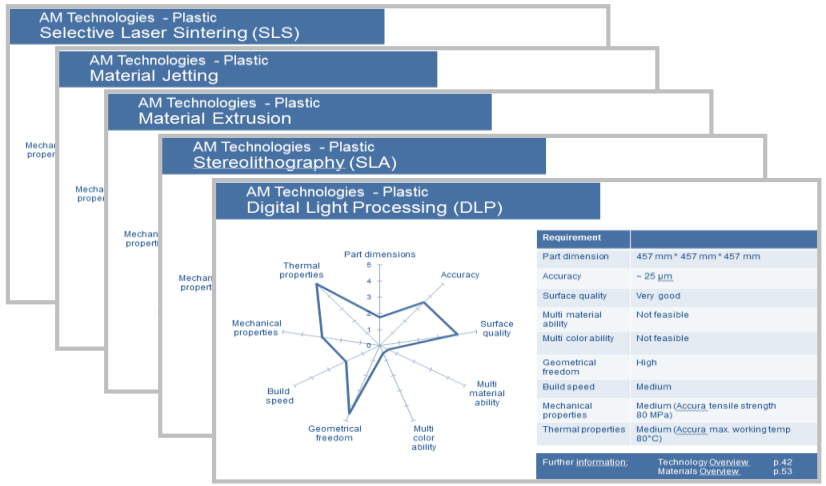
Community

Virtual Networking in the ACAM Community



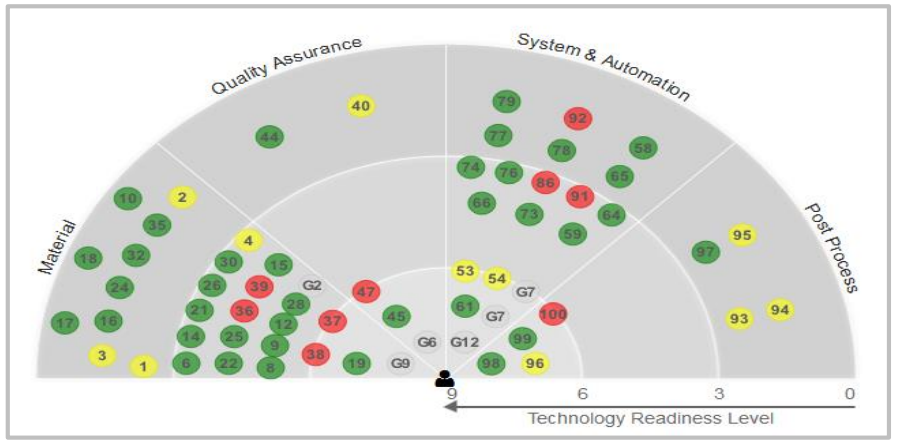
AM Technology Monitoring and Review

Technology information



- Technology maturity
- Technology developments
- Technology performance

Market information

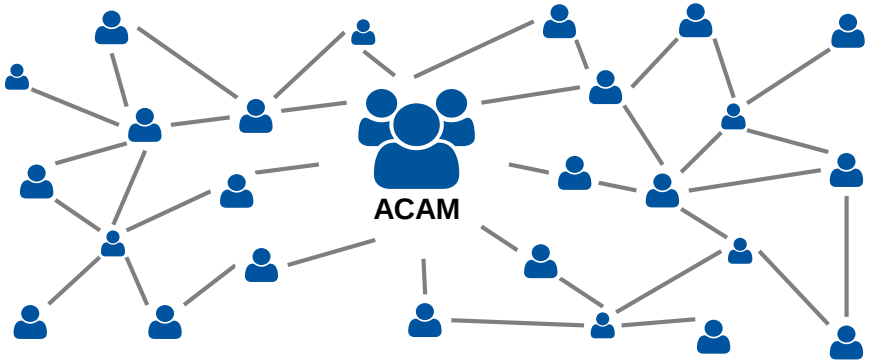


- Market players and share
- Suppliers and research institutes
- Price and cost development

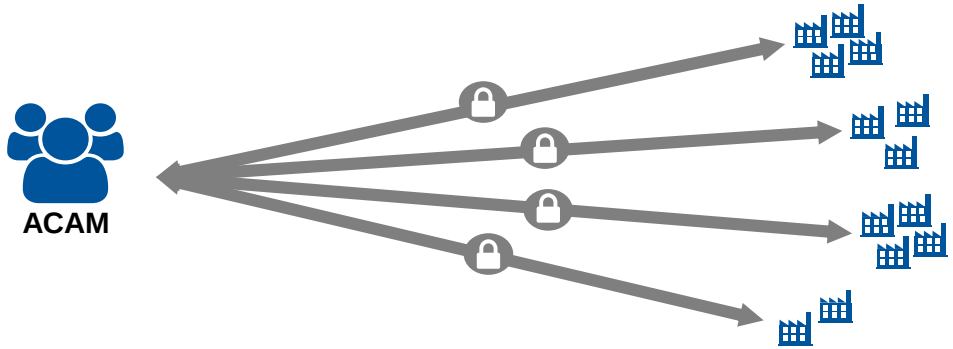
Range of Services

Four pillars ensuring successful AM implementation for our partners

Community

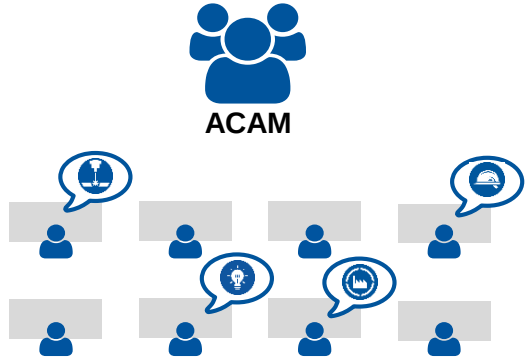


Consortial R & D



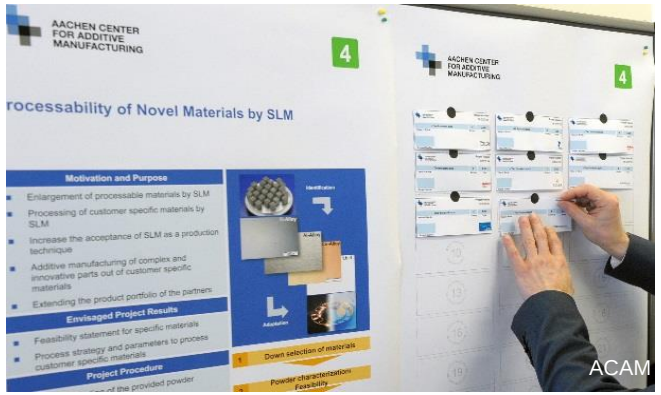
Contractual R & D

Training and Education



Consortial R&D

Based on our members´ needs



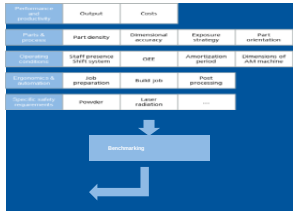
ACAM Consortial Projects

- Annual joint R&D projects with ACAM industry and research partners
- Topics range from polymers to metals, from design and processes all the way to innovative business models and new possibilities in AM.

Together with our research partners, the ACAM facilitates the access to the Additive Manufacturing expertise and conducts R&D projects on wide range interdisciplinary topics for the industry members.

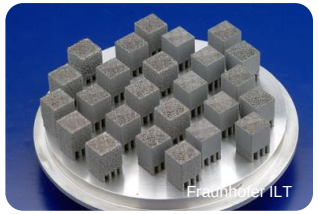
Consortial Projects 2016

Benchmarking of SLM Production Systems



Florian Eibl – Fraunhofer ILT
Tobias Pichler – Fraunhofer ILT

Processability of Novel Materials by SLM

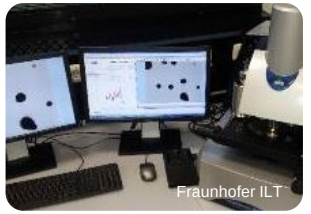


Wilhelm Meiners – Fraunhofer ILT
Sebastian Bremen – Fraunhofer ILT

Requirements for Industrial AM Process Chains

Mortiz Wollbrink – Fraunhofer IPT

Qualification of Metal Powders for SLM

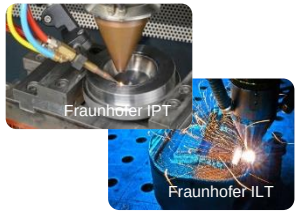


Sebastian Bremen – Fraunhofer ILT
Simon Vervoort – Fraunhofer ILT

Powder handling & Workplace Safety

Prasanna Rajaratnam – FH Aachen

Potential Industrial Applications for Powder Based and Wire Based LMD



Nils Klingbeil – Fraunhofer IPT
Dr. Chongliang Zhong – Fraunhofer ILT

Powder Production – Market and Technology

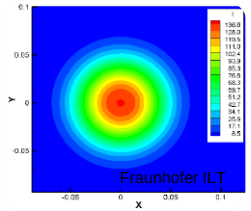
Frederik Klöckner – KEX AG

Consortial Projects 2017

Prototyping and Part Production Using Qualified Series Thermoplastics

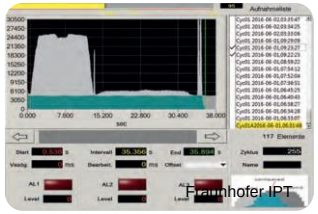
Nicolai Lammer – IKV

Development of a Procedure for Evaluation and Testing of AM Systems



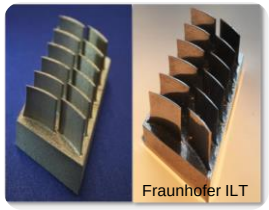
Sebastian Bremen – Fraunhofer ILT
Joahnnes Schrage – Fraunhofer ILT

Quality Monitoring and Quality Measurement of AM Parts



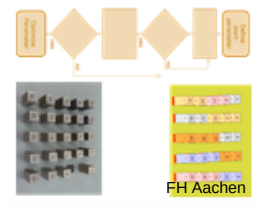
Moritz Wollbrink – Fraunhofer IPT
Jan Riepe – Fraunhofer IPT

Finishing of AM Parts Focus on Areas which are Hard to Access



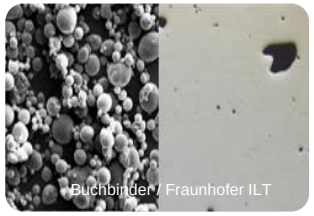
Anders Such – Fraunhofer ILT
Moritz Wollbrink – Fraunhofer IPT

Guideline for Development of Parameters in Metal AM



Prasanna Rajaratnam – FH Aachen

Influence of the Humidity on the AM Process (PBF)



Simon Vervoort – Fraunhofer ILT

Hot Isostatic Pressing (HIP) of Additive Manufactured Parts

Sebastian Bremen – Fraunhofer ILT

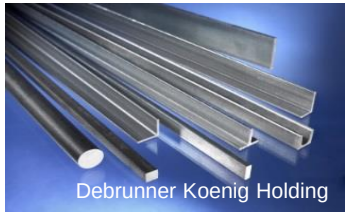
ACAM R&D Projects

Consortial Projects 2018

Microstructure of Additive Manufactured Metal Parts

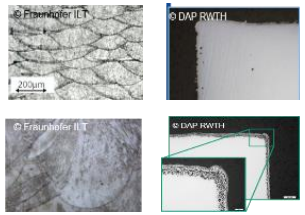
Jürgen Jakumeit – Access e.V.

SLM-Process Development for Corrosion Resistant Steels with High Hardness



Jasmin Saewe – Fraunhofer ILT

Metallographic Preparation and Typical Defects of AM-parts



Robin Day – DAP RWTH-Aachen

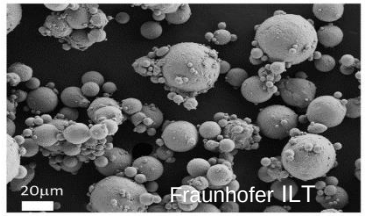
Removal of Support Structures on SLM Parts

Tobias Schmithüsen – Fraunhofer ILT

AM Quality Assurance

Mirjam Knothe – DAP RWTH-Aachen

Low Cost Powder Material for SLM



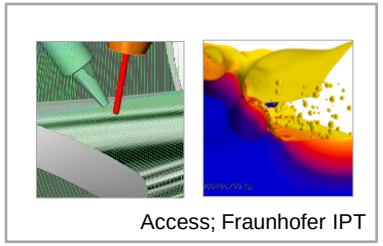
Christian Weiß – Fraunhofer ILT

Study of applying Cost-Efficient 3D Printing

Sebastian Kawollek – PEM RWTH

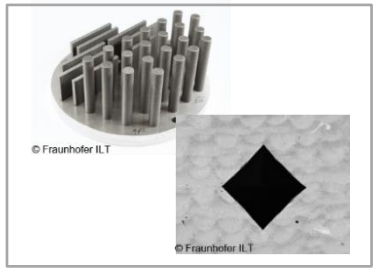
Consortial Projects 2019

Software tools for AM



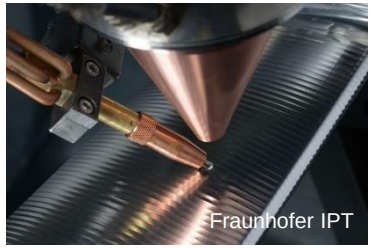
Dr. Jürgen Jakumeit – Access e.V.
Moritz Wollbrink – Fraunhofer IPT

LPBF-Processing of Engineering Steels – Challenges and Potentials



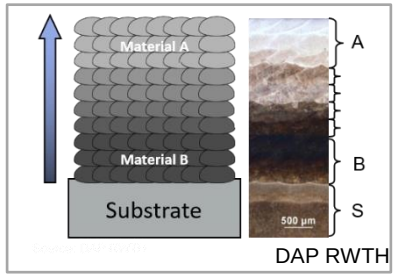
Jasmin Saewe – Fraunhofer ILT

Hybrid Parts – Expedient Combination of Technologies



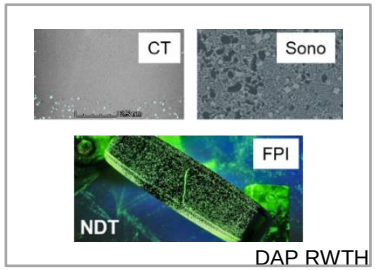
Moritz Wollbrink – Fraunhofer IPT

Case Study – Multi-material Printing



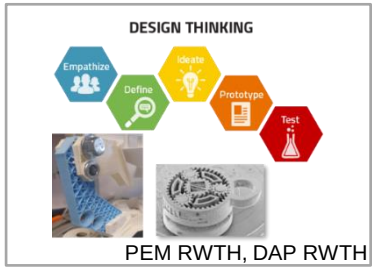
Simon Ewald – DAP

Non-destructive Testing of AM Parts



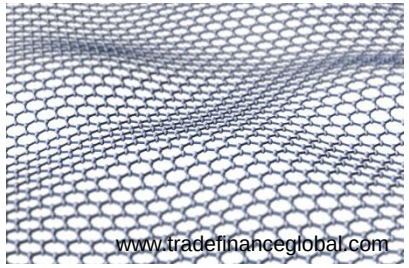
Robin Day – DAP RWTH-Aachen

Think 3D – How to change Designer´s Minds



Martin Kimm – DAP RWTH-Aachen
Gerret Lukas – PEM RWTH-Aachen

Novel AM Materials

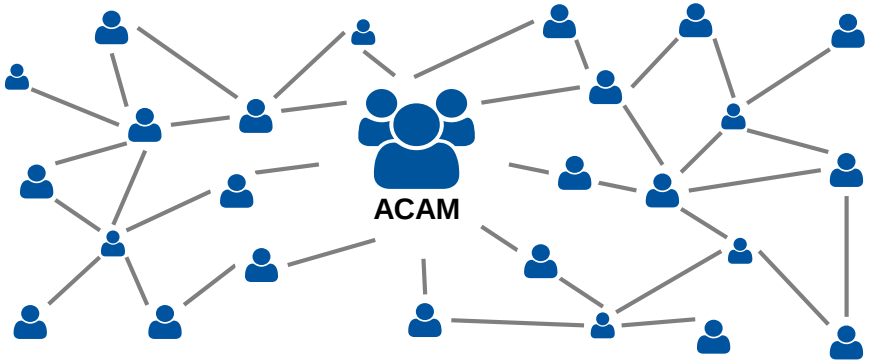


Jonas Alt – KEX AG

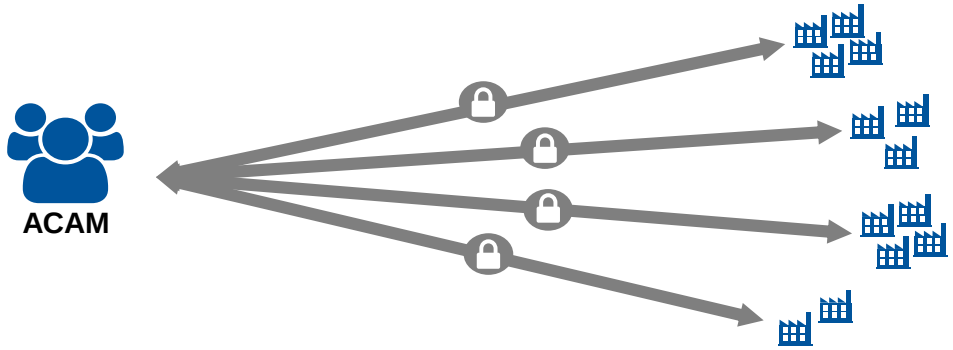
Range of Services

Four pillars ensuring successful AM implementation for our partners

Community

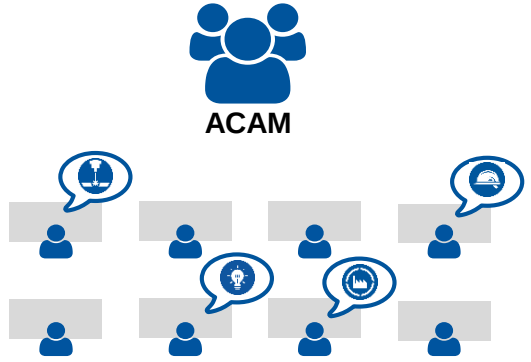


Consortial R & D



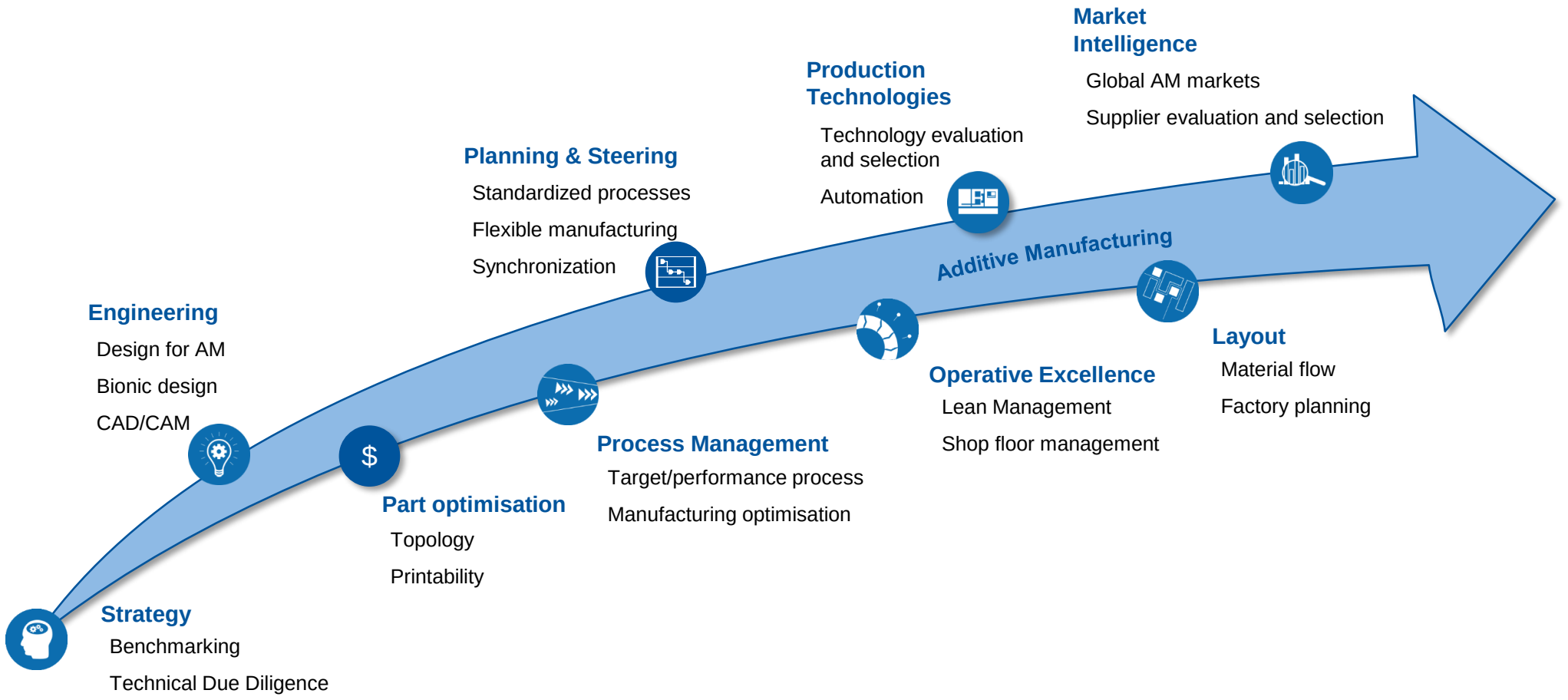
Contractual R & D

Training and Education



Contractual R&D

Consulting Services offered by the ACAM

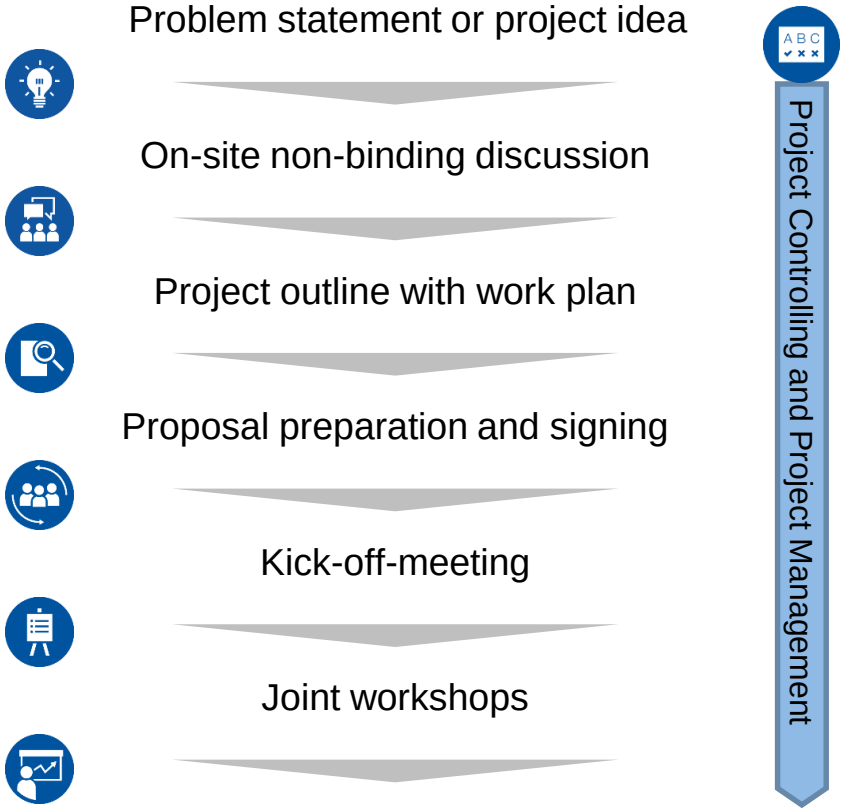


The insight and technological expertise regarding AM is unique

Contractual R&D

Professional project approach

Approach



Success Factors

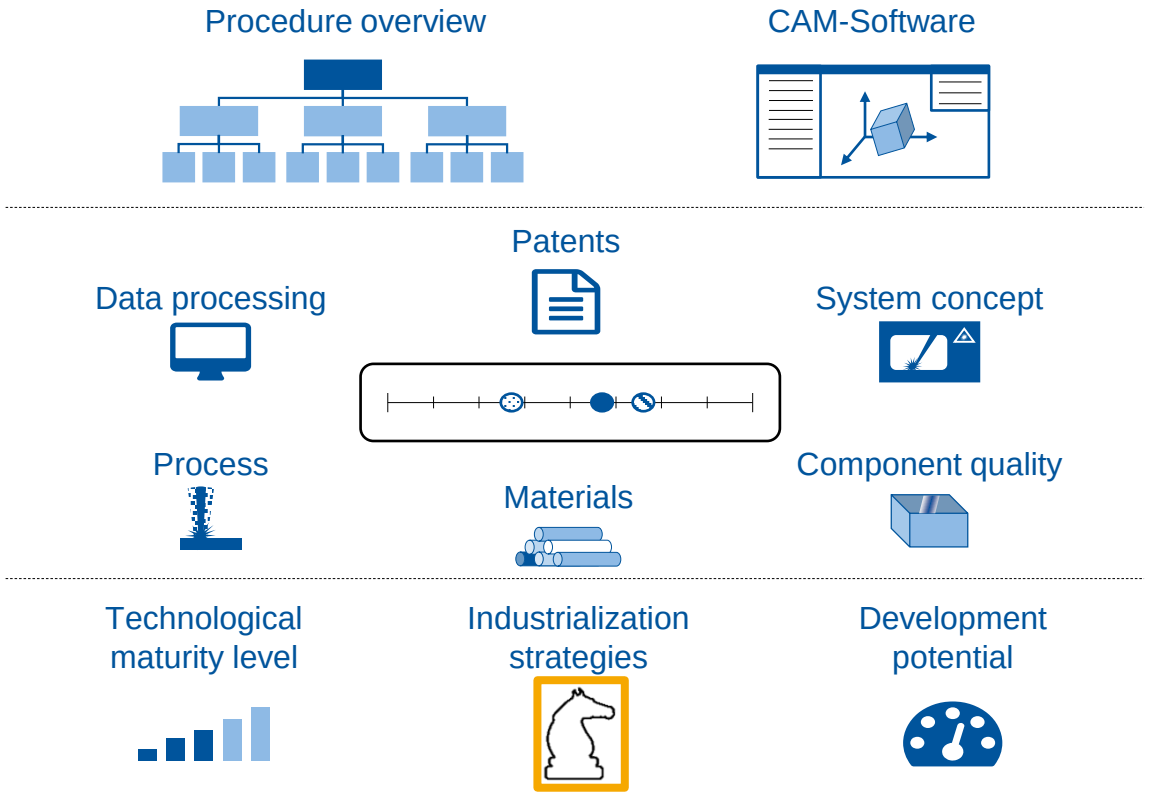
- **Workshop** oriented elaboration of the results
- Intensive **involvement** of all relevant employees of the tool making industry
- Contribution of **external impulses** and integration of issue-specific **best practices**
- Detailed **documentation** of project results and clear definition of **further procedures**

Profit from the experiences of the ACAM network of more than 100 consulting projects per year!

Technical Due Diligence

Technology maturity assessment of a machine manufacturer for metal AM components

- Market analysis of competing Additive Manufacturing processes and of available CAM software systems for metals
- Evaluation of the system and technology developed by the company in the areas of :
  - Data processing
  - Process
  - Materials
  - Component quality
  - System concept
- Evaluation of the patent situation
- Derivation of the technological maturity of developed technology and identification of industrialization strategies



- Detailed market analysis of competitors and competing technologies
- Evaluation of the technological maturity and of the development potential of the system technology

Feasibility study

Alfred Nobel Science Park AB – Laser Cladding

Epiroc

Project Goal

- Nonporous cladding of tophammer housing
- Copper alloy as cladding material
- Good dilution and adhesion between substrate and cladded material
- Material density above 99,5%

Project Procedure

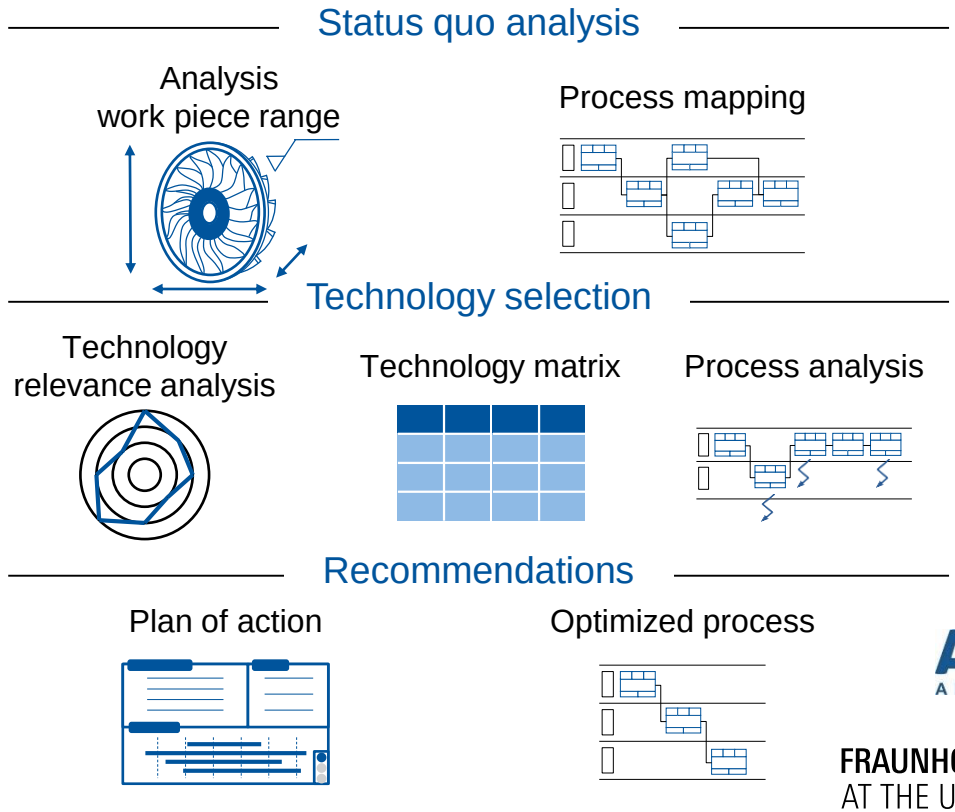
- Hybrid process using a preform in combination with LMD process
- Cladding of housing with inner processing optics

- Reduction of wear during operation of tophammer
- Increase of life time of tophammer housing

Funded project 3D2SKY

Process chain development for finishing of AM work pieces

- Detailed status quo analysis of the production possibilities regarding Additive Manufacturing
- Recording of the actual manufacturing process in order to identify the optimization potential of the manufacturing process
- Development of a company-specific technology matrix for the identification of suitable technologies for specific work piece properties
- Evaluation of the relevant technology aspects with a focus on post-processing of additive manufactured components
- Development and implementation of an optimal company-specific process chain and necessary measures



AERONAMIC
AIRCRAFT SUBSYSTEMS

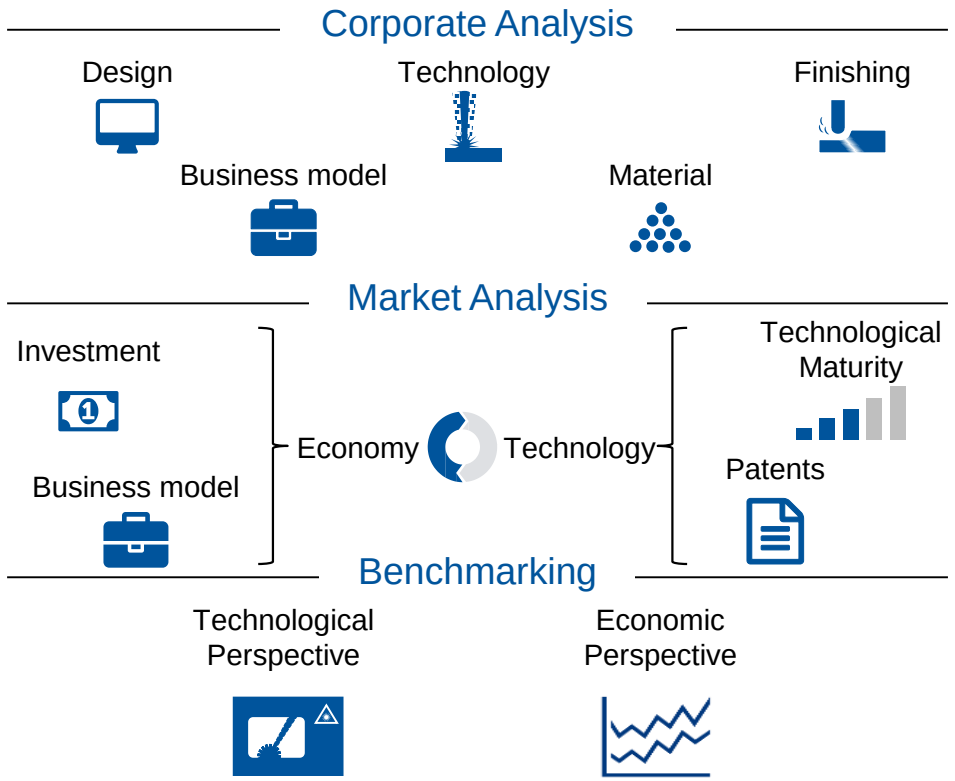
FRAUNHOFER PROJECT CENTER
AT THE UNIVERSITY OF TWENTE

- Analysis of technological possibilities and limits in the field of post-processing of additive components
- Identification of the optimized process chain for post-processing of additively manufactured components

Highlight consulting project

Benchmarking of a 1st-Tier-Supplier from the aerospace industry

- Analysis of the current applications in Additive Manufacturing Technologies and planned future actions
- Qualitative description of the position regarding the applications of AM technologies
- Competitive landscape analysis of application and implementation of AM technologies within the aerospace industry
- Description of current competitive situation regarding economical and technology perspectives



Fraunhofer ILT

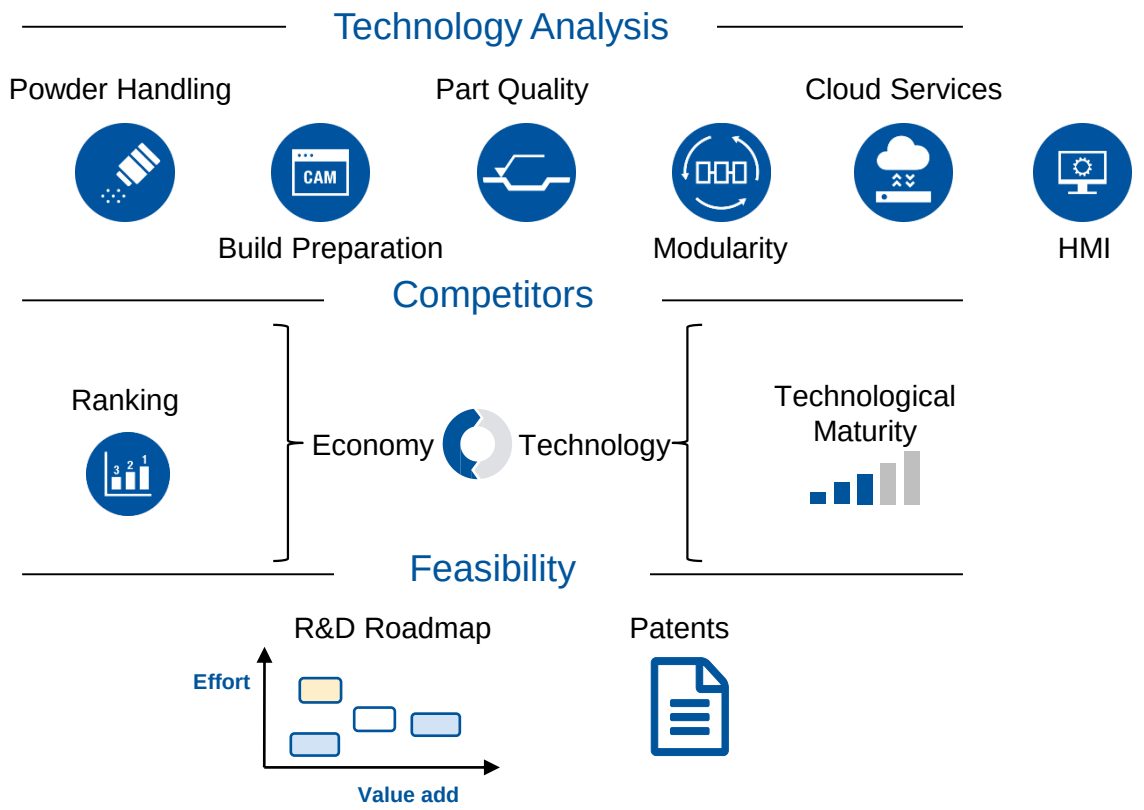
Fraunhofer IPT

- Evaluation of the current situation regarding strength and potentials in Additive Manufacturing
- Detailed analysis of the competitive situation within the aerospace industry
- Definition of field of actions to strengthen the competitive position in the future

Highlight consulting project

Technical due diligence for machine OEM’s investment round

- Analysis of competitive situation and current positioning with regard to manufacturing concept
- Software and hardware benchmark
- Challenging of USPs
- Customer interviews
- Feasibility analysis of technology roadmap
- Global judgement regarding IP and patents



- Evaluation of the current competitive situation and classification regarding hardware and software
- Derivation of recommendations and next steps for potential investor

Highlight consulting project

Market overview – Polymer applications in the aerospace and automotive industry

- Evaluation of current and future polymer material portfolio
- Interviews with relevant industry stakeholders
- Identification of customer and market needs
- Mapping of customer requirements and industry partner's portfolio
- Identification of USPs and derivation of suitable market entrance strategy

Industry / Technology Focus

Aerospace | Automotive | SLS | FDM | MJ

Market and Customer Perspective

Requirements | Customer Readiness | Market Development | Pricing

- Generation of performance overview regarding productivity and possible part sizes of all relevant polymer printing processes for automotive and aerospace
- Derivation of recommendations and next steps for potential investor

Polymer AM System for Education

Stratasys

Industrial 3D Printing technology

- Stratasys Fortus 450 MC for multiple FDM materials
- Use for training and education activities in Aachen
- First part of ACAM Demo facility for 3D printing

Joint training activities

- Workshops and seminars including the AM knowledge of ACAM and technical experience of Stratasys

Target group

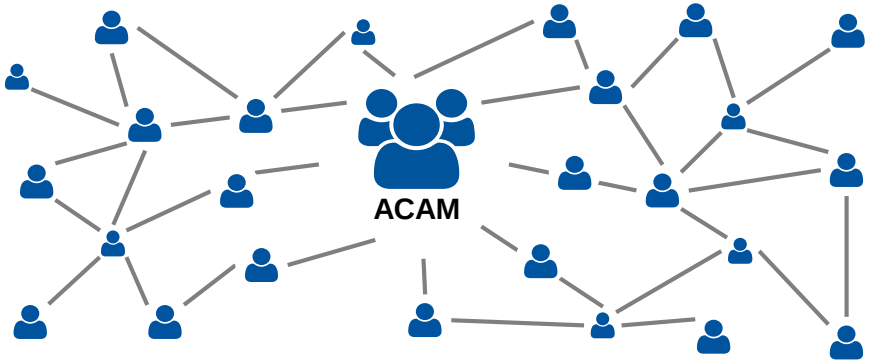
- Further education for professionals from different industry sectors
- Academic education at the RWTH University
- Apprenticeship for young professionals
- All seminars being realized in close cooperation with our research partner network

supported by stratasys

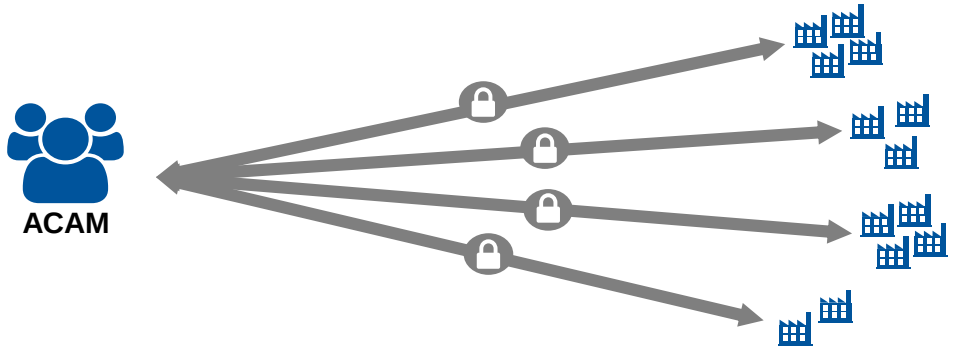
Range of Services

Four pillars ensuring successful AM implementation for our partners

Community

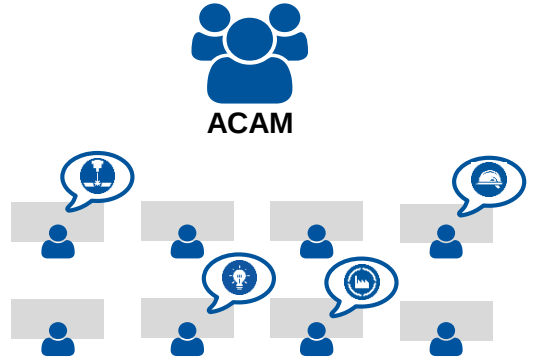


Consortial R & D



Contractual R & D

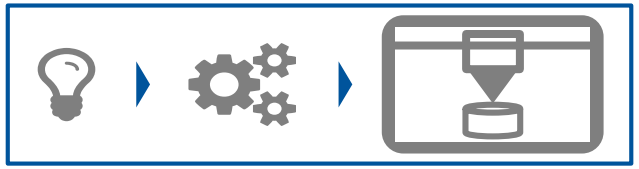
Training and Education



ACAM Professional Education Program 2019

Certificate Course Additive Implementer

Key topics for AM implementation



- 5-day course including social events in Aachen.

One-Day Seminars

Meet with our AM R&D experts

- Seminars with an one-day duration in Aachen.

Modular In-house Seminars

Create a customized seminar based on your specific needs

1,5 h	3,5 h	1,5 h
Basic Module	Advanced Module	Experience Module
Introduction to AM	**Detailed AM insights**	**Real-world scenarios and hands-on training**

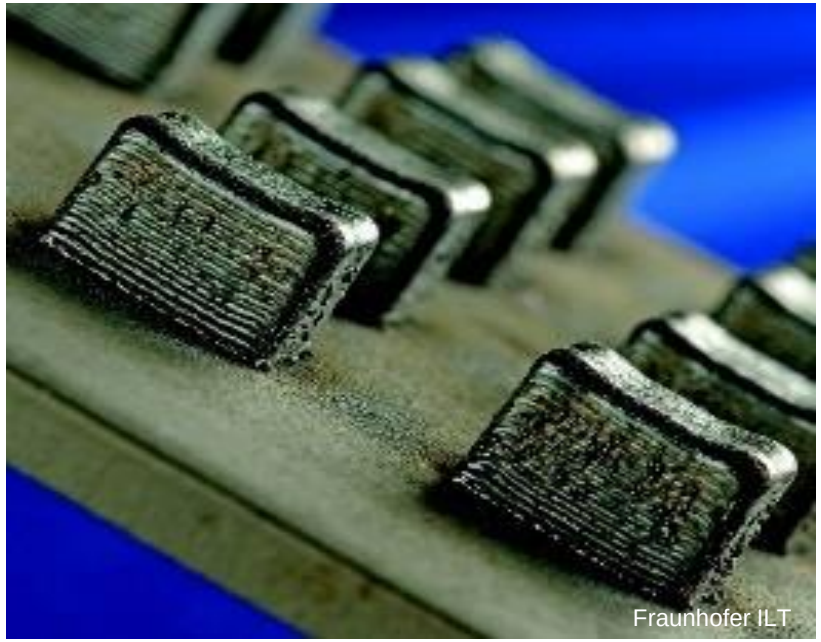
One-Day Seminars 2019

2 Seminars with an one-day duration in Aachen.

- Learning content of specific field of activity.

October 9, 2019

Additive Manufacturing for Tool Making and for Small Serie Production



November 6, 2019

Powder Bed Based Laser Melting Starter Training

ACAM Professional Education Program

Certificate Course AM Implementer

Content

- Overview of all relevant AM technologies and respective know-how necessary for implementation

Target group

- Engineers and managers from the areas of design, production and business development.

Speakers

- Renowned AM experts from ACAM R&D partners

Dates for 2019

Day 01 **October 21, 2019**

AM Technologies and Hardware

Day 02 **October 22, 2019**

Design for AM

Day 03 **October 23, 2019**

AM Applications

Day 04 **October 24, 2019**

AM Process Chains

Day 05 **October 25, 2019**

Market Development, Costing, Health & Safety

Training and Education

ACAM In-House – Customized Seminars

1,5 h

Basic Module

Introduction to AM

Basic

Metal AM (PBF)	Metal AM (DED)	Polymer AM (SLA, SLS)	Polymer AM (FDM, Jetting)	AM Software	Health & Safety	Design for AM

3,5 h

Advanced Module

Detailed AM insights

Advanced

Metal Materials for AM	Market, Costs and Innovation	Post-processing for AM	PBF Process, Parameters & Hardware	Part Identification	Automation & Factory Planning	DED Process, Parameters & Hardware
Plastic Materials for AM	Design for AM	Metrology and Quality Assurance				

1,5 h

Experience Module

Real-world scenarios and hands-on training

Experience

Lab Tour PBF	Lab Tour DED	Lab Tour FDM	Lab Tour Jetting	Lab Tour Post Processing	Exercise Design	Exercise DED Software
Use Case Aviation	Use Case Automotive	Use Case Turbo-machinery	Use Case Medical	Use Case Tooling	Exercise PBF Software	

- Tailored scope and composition of seminar content
- Available in Aachen or at customer's premise
- Experienced, renowned speakers for each seminar

Discover3Dprinting

The ACAM offers together with Formnext a special seminar for beginners during the fair

formnext
discover3Dprinting

Save the Date!
November 19 – 22, 2019

Further Discover3Dprinting dates in 2019

- May 6, 2019 — pcim EUROPE
- November 26 – 28, 2019 — sps smart production solutions

Community

The ACAM Membership Opportunities

ACAM Membership		COOPERATION Adaptable fee	BASIC 12 k€ / a	BUSINESS 40 k€ / a
Voucher	Total value of included ACAM vouchers	€	6 k€	18 k€
Community	Physical and virtual networking and exchange in the ACAM Community	✓	✓	✓
	Annual ACAM report			
	AM Technology Monitoring and Review	€	€	
	Marketing and Website Package	€	-	
Consortial R & D	Decision on ACAM R&D roadmap and research topics	-	-	✓
	Annual ACAM R&D projects on agreed topics	€	Voucher	Voucher
	Joint acquisition and realization of consortial research projects	✓	✓	✓
Services / Contractual R & D	Bilateral R&D projects	€	€	Voucher €
	Prototype manufacturing along the process chain			
	Strategy, market and technology oriented consulting projects			
Training and Education	Seminars for employees and decision makers	€	€	%
	Modules for professional further education			
	In-house seminars			✓

Join ACAM and be part of the community!

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Access to AM know-how, consultancy, training and education.