

## Titanium Aluminide Components Challenges and Risks for Industrialization

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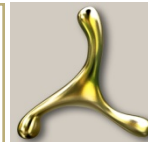


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TITANIUM EUROPE 2013  
Hamburg, March 5-7, 2013

# Content of the presentation

- Motivation
- The markets
- TiAl a substitution technology targeting at
  - being economically beneficial
  - bringing substantial technological advantages (weight, E-modulus)
  - allowing designs for components that can hardly be achieved with Ni base components
- Risks
- Conclusion and outlook



# Motivation

The main aim of recent developments for the next generation of aircraft engines is to improve power efficiency and environmental impact.

Turbocharger developments are all aiming at a reduction of the time to torque

**Solution:** Increase of process temperature & decrease of inertial forces

- ➔ new materials
- ➔ reduction of weight

Weight saving with intermetallic TiAl alloys compared to conventional Ni-based alloys is in excess of 50%.

- ➔ Weight saving for aero engines
- ➔ Time to torque for turbochargers



# Market for TiAl LPT blades in new engines for commercial single-aisle aircraft

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## A320neo

1734 orders and options by December 2012

Possible engines: LEAP-1A and GTF PW1000G PurePower

## Boeing 737 MAX

1000 combined orders and options by December 2012

Possible engine: LEAP-1B

## COMAC C919

1000 orders and options by December 2012

Possible engine: LEAP-1C

## Bombardier CSeries

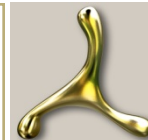
360 orders and options by December 2012

Possible engine: GTF PW1100G PurePower

**More than 4000 aircrafts  $\triangleq$  more than 8000 engines**



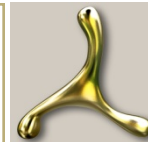
more than  
**1.2 Million**  
TiAl LPT Blades  
to be manufactured  
over the next years



# TiAl – The promised land for aero engine and automotive applications

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- **Yes; but** we are facing a substitution technology
- TiAl is competing against Ni base superalloys, a material everybody feels comfortable with because of the vast experience and database!
- **The new technology must bring substantial technological advantages and must be economically beneficial!**
- TiAl requires new approaches and production methods along the entire process chain!
- There is a certain aversion to the risks associated with new approaches and production methods due to the high investment involved – so, who should move first
  - ➔ The OEM
  - ➔ the alloy supplier
  - ➔ the casting vendor
  - ➔ the forging house
  - ➔ the machining house
  - ➔ the coating shop

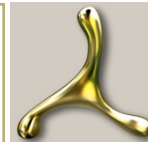


## TiAl – The promised land for aero engine and automotive applications

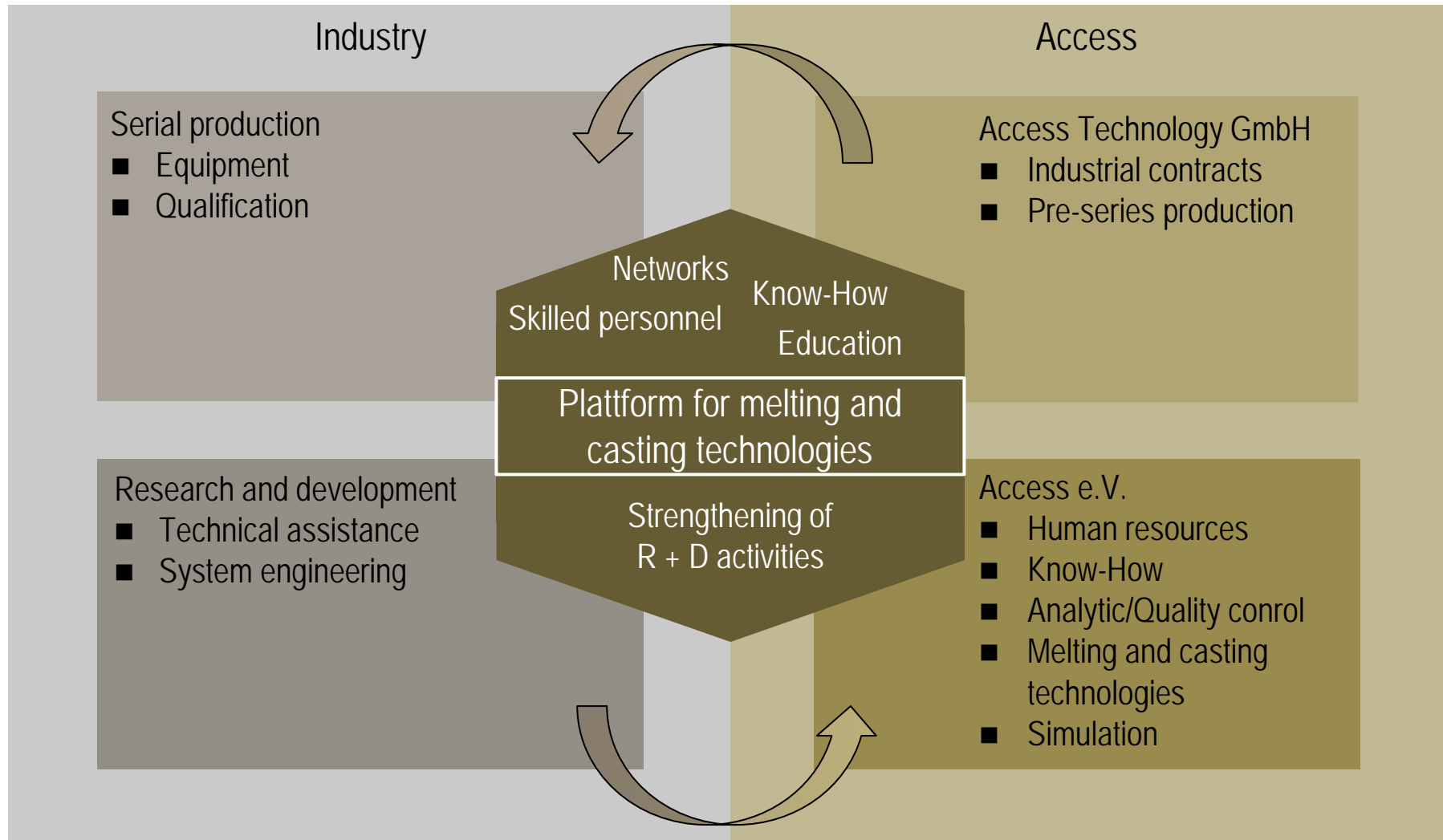
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The decision making process for a new material in combination with a new process is a tough challenge

- ➔ The initial tight specification given by the OEM is difficult to match by the supply chain struggling already to cope with the challenges to manufacture TiAl components.
- ➔ Design tends to be a moving target!
- ➔ Uncertainty with regard to concessions and thus a considerable economical risk for the suppliers.
- ➔ No major investments will be made unless technology readiness level 6 is reached.
- ➔ Market participants tend to stick to the established production methods.
- ➔ The OEM has no sufficient prove to be confident for a final decision regarding the selection of the suppliers.
- ➔ The OEM has to take decisions that are technologically and commercially viable on a long term.

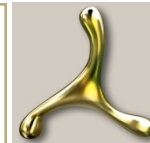
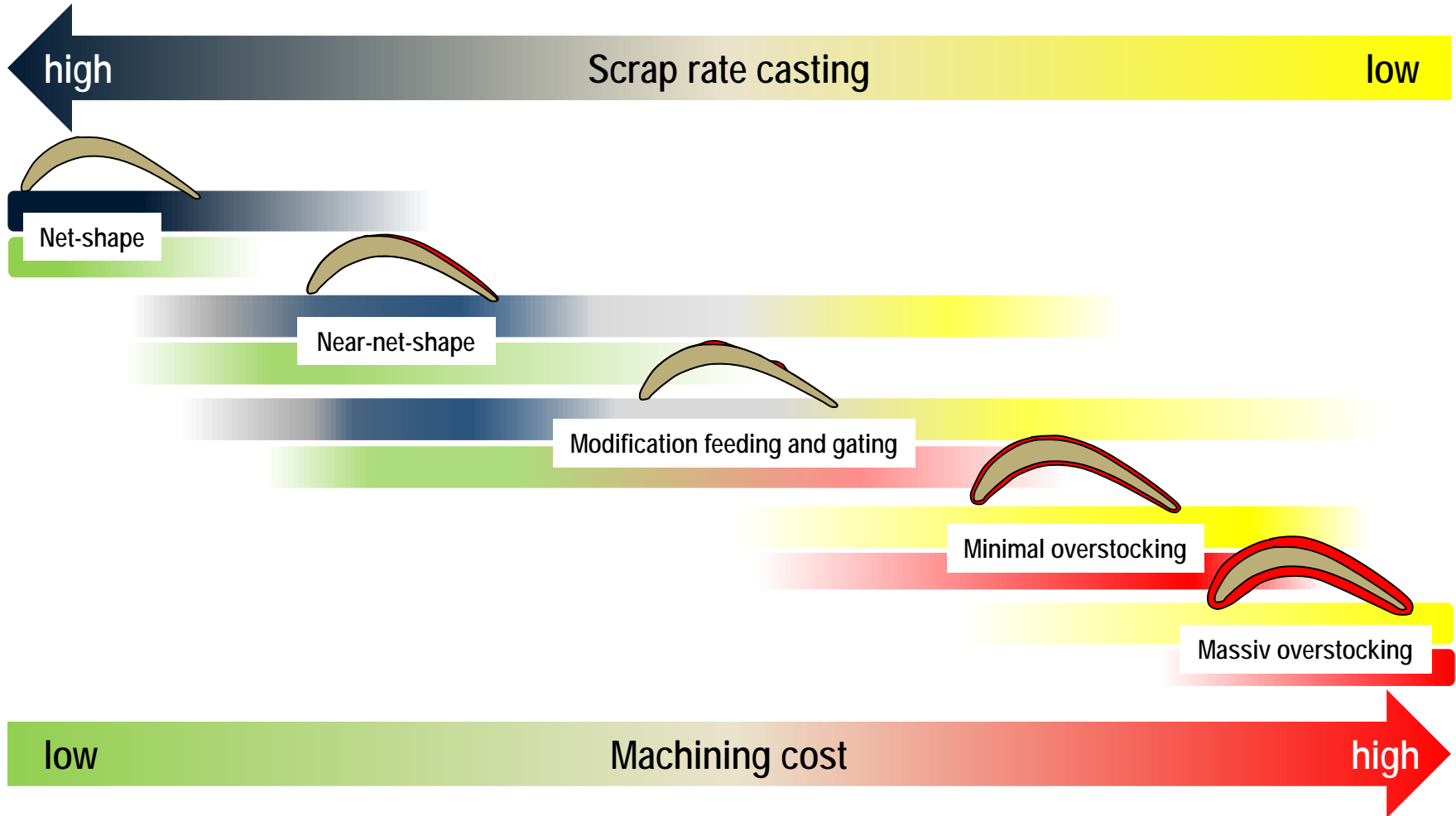


# The approach of Access – BEST trade off between casting and machining



# The approach of Access – BEST trade off between casting and machining

Integrated casting and machining strategy for a commercially viable large series production of TiAl LPT blades



# The approach of Access – BEST trade off between casting and machining

Investment casting route



Leistritz

OEM

GfE

Manufacturing of ingots (VAR)



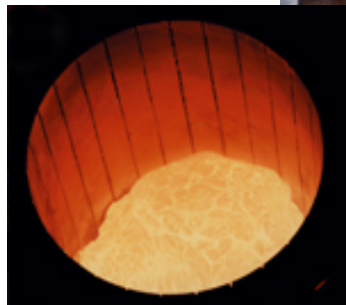
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"Near-Net-Shape"- casting  
max. 0.3 mm overstock, certain areas "net shape"



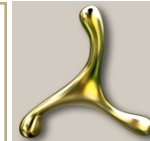
Leistritz

Machining (grinding only)



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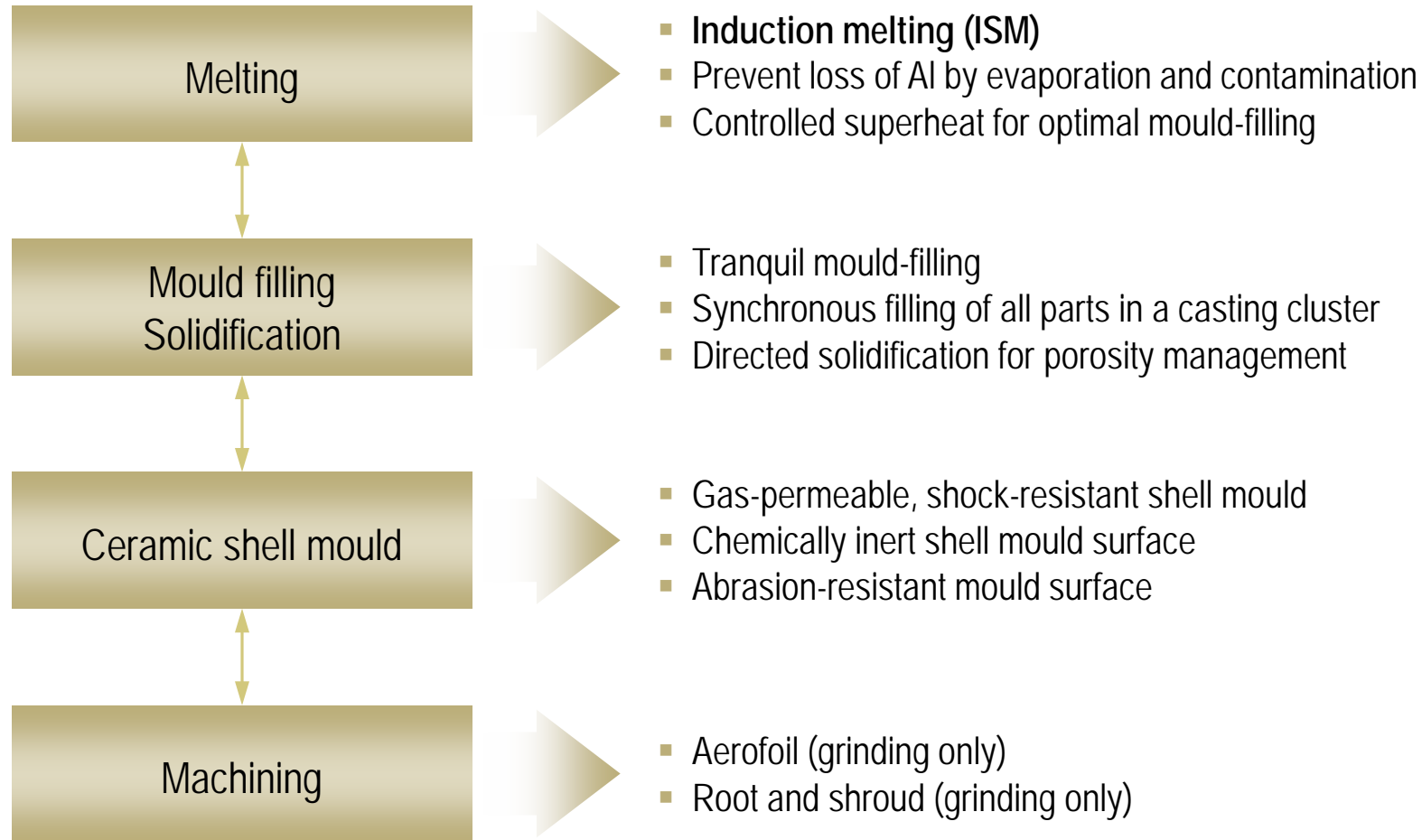
powered by technology



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# The approach of Access – BEST trade off between casting and machining

Requirements arising from special properties of TiAl



## Conclusion and Outlook

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- TiAl is a typical substitution technology.
- TiAl requires new approaches and production methods along the entire process chain.
- Only the OEM's have the power to bring the entire technology to a commercially viable serial process.
- The supply chain relies on support from the OEM to minimize the considerable risks when establishing the new production methods along the process chain.



# Acknowledgement

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