Integrated Design of Material, Manufacturing and Product Performance

Ideo_M^2P^2
Statement

Computational methods for Concurrent design of material, manufacturing process and product is a key factor for competitiveness and sustainability in 21st century.

Dave McDowell
Strategic relevance

• The competiveness of Swedish companies consists mainly in **competence**. The knowledge to design and produce products, services etc that are ‘needed’.

• We have been and still are in many areas world leading. However, above is not a unique Swedish strategy and the competition is fierce.

• There are still opportunities for the classical mechanical industry to go one step further.
Ideo_M$^2$P$^2$

Key ingredients:

- Models based engineering design.
- Creating a larger design space enabling disruptive engineering solutions.
- Transforming engineering design by merging materials, process and product design. Eliminating its dichotomy into materials science, production and mechanics as well as restructuring engineering education.
- Business role between material user and producer will change.
State of Art and Ideo_M²P²

Related strands in US

- ICME
- Hierarchical Multiscale Resolution Theory
- MGI 2xfaster&cheaper [www.mgi.gov](http://www.mgi.gov)
- MSA Material State Awareness
- Statistical calibration
- AIM Accelerated Insertion of Materials
Ideo_IM$^2$P$^2$

Simultaneous and hierarchical design of
Performance
Product
Manufacturing process
Material properties
Geometric distribution of properties$^1$
Material microgeometry$^2$
Microstructure
Design of initial chemical composition

$^1$reinforcements, surface layers or barriers
$^2$powders size distribution, granular materials
Paradigm Shifts in Engineering Methods

- Merger of Material, Production and Design
- Science and Model Based Engineering
- Use of manufacturing for creating material properties rather than attempting to minimize its negative effects

Leading to improved (incremental and disruptive) materials, manufacturing processes products w.r.t.
- Performance including multifunctionality and
- Sustainability.
Key modelling ingredients:

- Thermodynamics
- Engineering Materials (mechanical, thermal, corrosive, electrical…)
- Small scale(s) modeling and homogenization
- Virtual material testing
- Macroscopic material models
  - Process models
  - Product models

Integrated into FE-code according to the project initiative #20