
„IPEK – Research and Teaching for Innovation“
o. Prof. Dr.-Ing. Dr. h. c. Albert Albers / OI Norbert Burkardt
Karlsruhe Institute of Technology
One institution. Two missions.

Staff
8,000

Professors
350

Students
23,500

12 km - 20 min

Million Euros Budget
650
The Vision
Triad of excellent research, innovation and teaching

research

innovation

teaching

01.07.2011
KIT - Centers and Focuses
Concentration on Topics, Strategic Research Planning

- KIT Centers
  - Energy
  - Nano & Micro Science and Technology
  - Elementary Particle and Astroparticle Physics
  - Climate and Environment
  - Mobility Systems

- KIT Focuses
  - COMMputation
  - Optics and Photonics
  - Humans and Technology
  - Anthropomatics and Robotics
KIT Centre of Mobility Systems
Facing the Challenge of Individual Mobility

Environment & Society
Infrastructure
Traffic
Driver & Vehicle
Vehicle
Component
Element
Material
IPEK ▪ Institute of Product Engineering Karlsruhe

Facts

- 2 professors
- 7 research groups
  - 3 senior engineers
  - 54 scientists
  - 20 technical staff
- education
  - since 1996 50 Ph.D.
  - 14 lectures
  - over 300 student assistants
  - ~3000 coached students
- equipment
  - automotive test labs
  - high performance computing
  - test vehicles
  - mech. & elec. workshops
IPEK Research Approach

- **systems**
  - drives
    - e.g. vehicle powertrains
  - mechatronical systems
    - e.g. humanoid robot
  - micro systems
    - e.g. micro planetary gear
  - power tools
    - e.g. direct fastening tool

- **methods**
  - validation methods
  - Contact & Channel-Model
  - development methods
    - e.g. knowledge management
  - optimization methods
    - e.g. topology optimization

- **process models**
  - holistic development processes
    - e.g. integrated product engineering model iPeM
  - optimization processes
IPEK Research Approach

Research Fields

Research Designs the Future.

- drive systems
- optimization
- lightweight design
- condition monitoring
- design methods and management
- friction systems
- NVH / driveability
- mechatronic systems
- appliance and power tool design
Armar III in Action

Recognition and 6D pose estimation of colored and textured objects
Product Development in Mechanical Engineering
Characteristic Features – Simulation (CAE Optimisation)

Fiber Reinforced Structures in humanoid Robots (ARMAR IV)

- Benefits:
  - Energy consumption
  - Safety
  - Precision
  - Dynamy Operating Conditions

Body designed as a Hybrid Structure

Multifunctional Leight-Weight Wrist-Joint
Validation
Driveability und Comfortasssessment
Vehicle-in-the-Loop
Real Driver Integration
Example - test bench PLP
powertrain validation generation 2
Vehicle-in-the-Loop
NVH Phenomena

Acoustics of hybrid electric vehicles
(engine hood measured with 3D Scanning Vibrometer)

Vehicle-in-the-Loop
electric mode only
with combustion

Steering Wheel Vibrations (measured with 3D Scanning Vibrometer)

Vehicle-in-the-Loop
without fixing,
without weight as "sensor"
without fixing,
with weight as "sensor"
with fixing,
with weight as "sensor"
High Expectations in Education

- … The government has to treat its universities neither as secondary schools nor as special schools…
  [Wilhelm von Humboldt (1767-1835)]

- … Researching education and educational research form the universities…
  [Albert Albers]

Our demand: Research and development of methods and processes for product engineering including their evaluation using real systems and prototypes and their integration into excellent education and teaching.
IPEK Teaching Approach

KaLeP – Karlsruhe Teaching Model of Product Engineering

KaLeP – Karlsruhe teaching model of product engineering

- teaching
  - lecture
  - tutorial
  - project work

- environment
  - providing a realistic environment

- key skills
  - integration into project work
## KaLeP: Karlsruhe Education Model for Product Engineering

<table>
<thead>
<tr>
<th>Course Focus</th>
<th>Systems</th>
<th>Methods</th>
<th>Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Title</td>
<td>Machine Design</td>
<td>Methods of Product Development</td>
<td>Integrated Product Development</td>
</tr>
<tr>
<td>Settings</td>
<td>Lecture, Tutorial, Project</td>
<td>Lecture, Tutorial</td>
<td>Lecture, Tutorial, Project</td>
</tr>
<tr>
<td>Competence Acquisition</td>
<td>High</td>
<td>Medium</td>
<td>Very High</td>
</tr>
<tr>
<td>Course Content</td>
<td>Team Work, Self Organization, Communication, Idea Transfer</td>
<td>Design Methods, Creativity Techniques</td>
<td>Team Development, Team Leading, Project Management, Presentation</td>
</tr>
<tr>
<td>Number of Students</td>
<td>800</td>
<td>400</td>
<td>42</td>
</tr>
<tr>
<td>Curriculum</td>
<td>Bachelor</td>
<td>Bachelor</td>
<td>Master</td>
</tr>
</tbody>
</table>
IPEK Teaching Approach

Excerpt of IPEK Lectures

- mechanical design I-IV
- product development
- integrated product development
- powertrain systems A+B
- lightweight design
- friction systems
- mechatronic systems
IP Lectures – Structure Project Work

Company

Projectmanager

Technologie

Innovation

Projectmanagement

N.N.  N.N.  N.N.

Team 1  Team 2  Team 3  Team 4  Team 5
IP Powertrain 2015 Project
Teamdevelopment
Integrated Product Development
Project Example

Task Project „GreenKeeper“ IP 03/04

Development of an innovative product for the company STIHL, which extends the product portfolio in the target market „Lawn & Garden“ in a promising way.
Integrated Product Development
Project Example

Konkreter Projektverlauf

Task

---

Kick-Off
Profiel
Concept
Embodyment

TTM-Project

-------- 4 Months --------

Series development at STIHL

Carrier Support System HT

Market Launch

------ 18 Months ------

01.07.2011
IPEK - International Education

- University of Purdue, USA
- DEFIS – Paris / Metz, France
- EDC University of Cambridge, UK
- SJT und Tongji University Shanghai, China
- FDIBA – TU Sofia, Bulgaria
- University of Budapest, Hungary
- University of Nis, Serbia
- Partners of Tempus IV 2012 (Nis, Belgrad, Sarajevo, Skopje, Sofia, Novi Sad, Kragujevac et al....)
### IPEK Innovation Approach

The Spectrum of Cooperation

<table>
<thead>
<tr>
<th>Profile and Idea</th>
<th>Design</th>
<th>Technology or product</th>
<th>examples of cooperations</th>
</tr>
</thead>
</table>
| **Inno5**
Innovation in a week | ![Profile](image1) | ![Design](image2) | ![Technology or product](image3) |
| **IP-project**
Projects within the master-course Integrated Product Development | ![Profile](image1) | ![Design](image2) | ![Technology or product](image3) |
| **Innovation- and technology-project**
Bundeling of combined competencies | ![Profile](image1) | ![Design](image2) | ![Technology or product](image3) |

- **Inno5**: HILTI Federn Brand
- **IP-project**: Stihl – carry system, LuK – powerdrive
- **Innovation- and technology-project**: Single project to strategic partnership
Innovation
Innovation am Beispiel des Automobils

ca. 1900

heute

www.porsche.de
Die deutsche Wirtschaft ist stark abhängig von den internationalen Märkten.

- Jeder vierte Arbeitsplatz in Deutschland ist vom Export abhängig.
- Zwei Fünftel des BIP werden im Ausland verdient.
Deutscher Außenhandel
Deutschland als Exportland

Exportstärkste Länder 2011 (in Mrd. US-Dollar)

- China: 1898,6 Mrd. US-Dollar
- USA: 1480,6 Mrd. US-Dollar
- Deutschland: 1473,9 Mrd. US-Dollar
- Japan: 822,7 Mrd. US-Dollar
- Niederlande: 660,4 Mrd. US-Dollar
- Frankreich: 597,1 Mrd. US-Dollar
- Südkorea: 555,0 Mrd. US-Dollar
- Italien: 523,0 Mrd. US-Dollar
- Russland: 522,0 Mrd. US-Dollar
- Belgien: 476,3 Mrd. US-Dollar
- Großbritannien: 473,3 Mrd. US-Dollar

Quelle: WTO
Idea for a product
Dual Mass Flywheel

Quelle: LuK
Product of an idea

Quelle: LuK
Product life cycle

marketvolume/sales

profit

turning point

sales (s (t))

max.

profit *

* accumulated

time

profit treshold

development introduction growth saturation
Life cycles

Product generation life cycles

Branch life cycles

Product life cycles

sales