Stand und Tendenzen der Mähdrusch-Entwicklung
Status and trends of the threshing development

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Fundamentals of Agricultural Engineering
Market and Product Offer
Threshing, Separating and Cleaning
Cutterbars and Straw Management
Drives and Chassis
Electronics, Control and Information Technology
Machine Use and Operating Costs

Status and trends of the threshing development
Development of important combine markets. Data from VDMA and AEM

Combine market shares Germany. Data from VDMA

Market and Market Shares
Product Offer and Versions

- most of the manufacturers offer all threshing and separation systems
- continuous increase of engine power
- continuous broadening of the product range
- strong increasing number of versions

Development of engine power of the product offer in the German combine market.

Engine power of the combine market offer in German 2013.
Threshing, Separating and Cleaning

- Process Management
  - Identify
  - Adjuste
  - Controle

- Process Stabilization
  - Adapte the settings
  - Settings with more stable performance

- Examples
  - Concave setting
  - Circular cleaning unit
  - Future measurement methods
Possible solutions:
- mechanically: one lever
- mechatronically: six actuators

Many possible settings

Advanced optimization needed

Requirement:
- easy adjustment

Threshing:
Process Management and Stabilization
Cleaning unit with circular oscillation

- Mechanical parameter
  - linear vibrations
  - circular excitation
  - elliptical excitation

- Pneumatical parameter
  - air velocity
  - flow direction

goals: low loss level
high throughputs
stable loss characteristic

Cleaning: Process Management and Stabilization
Look Inside: High Speed Camera & Color Segmentation
Technical principle of ETC based on different dielectric properties:

Example for reconstruction of spatial structure:

Zhaoa, T. et al.

Look Inside: ETC Electrical Capacitance Tomography
Look Inside: Terahertz-Strahler, Fa. Synview
Cutterbars and Straw Management
Lightweight Design

Schneidwerk/ cutterbar
- Standard
- variabel/ lang
- klappbar
- Draper

spez. Gewicht/ spec. weight

Arbeitsbreite/ working width

kg/m

350

300

250

200

150

3 6 9 12 15 m
Einflussgrößen:
- Erntebedingungen
- Klimadaten
- Bestandsmerkmale
- Geländebeschaffenheit
- Stoffeigenschaften

Führungsgrößen:
- Flächenleistung
- Verluste, Position/Strecke
- Kraftstoffverbrauch
- Gutart, Feuchte
- Reinheit, Bruchkorn, Qualität

Fahrerinformation:
- Techn. Überwachung
- Verluste
- Flächenleistung
- Durchsatz
- Kraftstoffverbrauch

Betriebswirtschaft. Daten:
- Erntemengen
- Flächen
- Betriebsstunden
- Kraftstoffverbrauch
- Erträge

Datenerfassung, Datenausgabe

Prozess-Rechner mit Regler

Stellsignale

Stand der Technik

Einzellösungen, Vorserien

Electronics, Control and Information Technology
Art. 8.5: „Every driver shall at all times be able to control his vehicle or to guide his animals.”

Art. 13.1: „Every driver of a vehicle shall in all circumstances have his vehicle under control so as to be able to exercise due and proper care and to be at all times in a position to perform all manoeuvres required of him.”

→ No reason for less safety under off-road conditions
### Degrees of Vehicle Management

- **Driver only**: steering and speed
- **Assistent system**: steering or speed
- **Semi-automatic system**: permanent monitoring by driver, take over at any time
- **Highly automatic system**: no need to monitor permanently, driver must take over when prompted by controller
- **Fully automatic system**: returns automatically to risk-minimal state

### Examples for Cars

<table>
<thead>
<tr>
<th>System</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACC</td>
<td>Stop &amp; Go</td>
</tr>
<tr>
<td></td>
<td>Lane Keeping</td>
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<tr>
<td>ACC +</td>
<td>Stop &amp; Go +</td>
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<tr>
<td></td>
<td>Lane Keeping</td>
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<tr>
<td>Highway Chauffeur</td>
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<td>Highway Pilot</td>
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</table>
- (Nearly) autonomous test drive from Mannheim to Pforzheim
- "Only" cameras and radar as additional sensors
- Driver assistance needed several times: computer overload, wrong parking cars, garbage truck

→ Bunch of sensors, perhaps usable in ag. machines

High Tech Package for
Step 4: Highly Automatic System
Will be covered by presentations …
## Market and Product Offer:
High diversity and complexity achieved with all models

## Threshing, Separation and Cleaning:
- Process knowledge
- Process management
- Process stabilization

## Electronics, Control and Information Technology:
- From assisted harvesting to (highly) automatic harvesting
- Cross-linking of process controls

## Simulation:
- Promising methods
- Complex verification and validation

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