PLF
Precision Livestock Farming

Dr Theo GM Demmers
Precision livestock farming
Definition

“Management of livestock farming by continuous automated real-time monitoring/controlling of production/reproduction, health and welfare of livestock and environmental impact.”

Prof. Daniel Berckmans, KU Leuven, Belgium
Any living organism is unique

An individual is:
• Complex
• Individual
• Time Varying
• Dynamic
Engineers idealistic view

Fully automated systems to continuously and quantitatively measure production, behaviour and health of animals
Engineers idealistic view

Fully automated control of broiler growth

- Flockman system operational in 2002
- Not taken up by industry!
- Only simplified version in use!
European collaboration on PLF

Bright Animal

BioBusiness

All Smart Pigs

EU-PLF
Welfare Quality: methods to quantify Animal Welfare

Audio-visual scoring by experts on farm at specific days
Focus on monitoring of animals

- **Parameters**
  - Temperature
  - Climate
  - Water
  - Feed
  - Animal Weight
  - Animal Health
  - Animal Behaviour

- **Stakeholders**
  - Farmers
  - Veterinarians
  - Engineers
  - Distribution
  - Public
Examples: Climate Control

Temperature control: Closed loop control.
   So old now everyone uses it without much thought!!

Now also includes:
   Humidity Control
   CO$_2$ Control
Water Usage

- Indicator of problem
  - leaks
  - disease
  - temperature

Install water meters (cheap & robust)

It's that simple
Visualisation of usage will give immediate indication of problem!
Feed dosage

Indicator of problem
  disease
  temperature (loss of appetite)
  poor environmental conditions
  performance i.e. growth

Monitor feed amount supplied
  Load cells on weigher/mixer
  load cells on silo
  auger run time
Weight Estimate

Pigs
- Manual Scales
- Weigh platforms
- Camera based systems

Poultry
- Scales
Behaviour

Camera systems

Continuous monitoring of:
- distribution
- activity
Behaviour

Camera systems

Continuous monitoring of:

- distribution
- activity
Animal Health

Pig Cough Monitor (Microphone)

- Recognising individual sound characteristics of pig coughs

(*) In collaboration with UNIMI (Italy)
Animal Health

Pig Cough Monitor

- Recognising individual sound characteristics of pig coughs
- Counting number of coughs
- Localisation of coughs
Animal Health

Pig and Farmer benefits for the future:
Data Visualisation

Most important element of PLF for farmer!!!
Data Visualisation

Most important element for farmer!!!
Detail highly dependent on individual
Future Developments of PLF

Where is the limit
- Sensors price will continue to fall
- Sensor will get progressively smaller
  - Physiological parameters?
  - Direct measurement of disease indicators (app)?
  - Mental state of animals?
Expanding on camera applications

> **Pig drinking behaviour**
  - Monitor visits to nipple drinker
  - Estimate amount of water consumed (l/pen)
  - Estimate individual amount consumed (l/pig)

> **Pig activity**
  - Monitor general movement
  - Estimate overall activity
  - Report deviation from norm
Expanding on camera applications

- Monitoring and reducing aggressive interactions in pigs using image analysis

KU Leuven, TIHO, UMIL, Fancom bv

- 2 Farms:
  - Ruthe, Germany (Experimental farm)
  - Madou, The Netherlands (Commercial farm)
- Rounds: 5
- Round: 3 hours per pen per day / 2 days
- Hours of recording: 60 hours
- Aggressive events: 228
Expanding on camera applications

- Monitoring and reducing aggressive interactions in pigs using image analysis

Labelled variables:
- Duration of aggression (start-finish time)
- Time of feeder activation
- Aggression interrupted/not interrupted

- Type of aggressive interaction
- Aggression initiator and receiver
- Individual reaction to feeder activation
Expanding on camera applications

- Monitoring and reducing aggressive interactions in pigs using image analysis

![Graph showing the relationship between Feature 1 and Feature 2 with data points for Aggression and No Aggression. The graph includes an equation $y = 0.34x + 0.82$.]

<table>
<thead>
<tr>
<th>Class</th>
<th>Predicted Group</th>
<th>Total</th>
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<td></td>
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<td>120</td>
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<td>Aggression</td>
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<td>148</td>
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- Cross-validated

<table>
<thead>
<tr>
<th>Class</th>
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<tr>
<td>Aggression</td>
<td>11.3</td>
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Sensitivity: 88 %
Specificity: 89 %
Accuracy: 89 %
Expanding on camera applications

- Manage dust concentrations through animal activity  
  *(RVC, KU Leuven, Fancom bv.)*
Environmental monitoring

- Monitoring aerial environment
  - EnviroDetect *(PLF Agritech)*
    - Ammonia
    - Dust
    - CO₂
    - Temperature
    - Humidity
    - Ventilation rate
    - Emissions
Incubator technology
Modern Incubation technology

Capacity: 115,000 eggs/batch

“Embryo-Response Incubation”

PLF sensors detect embryo development

Synchro-Hatch detects hatch window
The Hatch Window (HW) Problem

10% to 90% over 24 hours

Number of chicks hatching/hour

Hatching time (hours)

Hatch Window

24 hours
The Hatch Window (HW) Problem

Up to 72 h of feed and water deprivation

Consequences

- Lower chick weight
- Lack of uniformity
- Reduced chick quality
- Impact on animal welfare
- Economical losses for chicken industry
Modern Incubation technology

Future developments

Include natural conditions in incubation
  Light
  Sound

New sensors
  individual egg temperature
  microphones
Conclusions

- Fully automated and continuous monitoring/control technologically possible
- PLF first and foremost a farm management tool, creating added value to the farmer and improving animal health and welfare.
- Focus on monitoring and data visualisation