Challenges and Emerging Needs for the Next Generation of Swine Production Facilities

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We have made great strides in:

- Nutrition
- Reproduction
- Health
- Meat Quality
- Management
- Etc.
.. but then we (sometimes) don’t pay close attention to the environment

It’s like....

- Measuring with a micrometer
- Marking with chalk
- And then..... cutting it with an axe
Systems Design

- We need to focus on the system design.
Challenges & Needs

- Human Safety
- Animal Well-Being
- Biosecurity
- Environmental
- Public Issues
- Transportation
- Facility Infrastructure
Human Safety: What’s the Concern?

- Acute Exposure
- Death
- Explosions

Farmer injured in barn fire

Two people are dead following a hog barn fire east of Jasper, MN
Methane Dangers

- Foaming manure tends to trap methane.

- Main causes of danger:
  - Barns sitting empty with no ventilation
  - Breaking the foam during power washing
  - Welding within the barn

Explosive between 5% and 15% in air
H₂S - Danger to Haulers

- Reported elevated exposure of manure haulers
- Many pits are building up solids because of less aggressive agitation
Hauler Employee Monitoring

Readings during 193 alarms (6 employees)

- < 20 ppm
- 20-50 ppm
- 50-100 ppm
- 100 (limit)
CO - Brooders

To clean the jet orifice apply compressed air to both ends of the jet. **Warning! Never insert any object into the orifice to dislodge foreign material.**

**Two Causes**
- Dirt filter which prevents air flow
- Orifice that has been cleaned with a wire, letting extra fuel to pass

**Typical Levels in WF**
- Typically at least ~ 50 ppm
- May be 300 – 500 ppm
Human Safety Priorities

- Improve safety while improving environment
  - Move storage out of the building… good goal but comes at a price
  - $\text{H}_2\text{S}$ during manure pumping may still be an issue
  - Innovative heating systems less likely to produce carbon monoxide
Animal Well-Being: Issues

- Loose sow housing – individual feeding/treatment with freedom of movement
- Farrowing crates – protection of piglets while allowing increased movement
- Heat stress in various phases
Biosecurity Issues – Filtration

- Filtration systems involve complex static pressure management and controls and require expertise. Hire more trained individuals.

- Filtering/treatment designs
  - Is counting on a pallet of caulk each year the best system we can design???
  - Making positive pressure work (after being opposed to it)
  - Evaluation of filter life & pressure characteristics
  - “Leak points”
Biosecurity Issues

- Biosecurity during transport
- Treatment of building exhaust air
- Carcass disposal in a bio-secure method
- Foreign animal disease vectors – detection, mitigation, monitoring, action plans
- Real-time health monitoring (cough monitor)
- We need more bio-sensor development
Public Issues

- Great influence on practices!
- How it “looks” matters
Public Issues

- Food Safety (HAACCP)
- Individual animal traceability
  - From farrowing through grocery
- Odor (siting)
- Water rights
- Manure application (odor/variable rate, etc.)
- Agro-tourism facility design
Transportation Issues

- At no time is livestock & poultry more visible to the public and more of a disease vector through “ambient” exposure.
Transportation Issues

- Trailer design
  - Reduce cold/heat stress
  - Improve animal movement
  - Improve worker safety
  - Improve clean-ability
  - Reduce public visibility (market)
  - Filtration during transit (weaned pigs, gilts)

- Secure load/unload facilities
- Traceability of pigs
Facility Design Issues

- Building shell/layout
- Shell integrity (it’s not a “barn”)
- New materials (easily cleaned/strong/replaceable)
- Accommodating increased animal sizes
- Building security/monitoring/alerts
- LEED certification??
Facility Design Issues

- Environmental control
  - Heat stress reduction/effective cooling
  - Heat distribution/microclimate
  - More intuitive controllers
  - Sensors to evaluate animal comfort (and early signs of disease)
  - Ways to handle extreme amounts of data in a meaningful way
Facility Design Issues

- **Feed/Water/Manure**
  - Feed flow/Prescriptive delivery
  - Water distribution
  - Air-tight manure storage/separation??

- **Other**
  - Animal health monitoring
  - Individual animal tracking
  - Employee entry
Concrete slat issues

- Rebar provides the strength in the tension part of concrete (the bottom).
- Failure occurs when rebar corrodes.

Courtesy of Altenburg Construction
Concrete slat issues

Cracking where rails meet the header.

Courtesy of Altenburg Construction
Concrete slat issues

Cracking along the rails. Poorly placed rebar.

Courtesy of Altenburg Construction
Concrete slat issues

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Concrete slat issues
Precision Livestock Farming
Facility Design - Sensors

- Thermal Environment Sensor Array
Facility Performance Testing

- Commissioning
- Functional Performance Testing
  - Fan Performance
  - Inlet Distribution
  - Controller Capability
  - Heater Distribution
  - Animal Zone Comfort
  - Thermal Stress Assessment
How do we address the future?

- Define the need and think of system impact!
- Instrumentation & sensors!!!
- Value the environment and engineering design behind it!
- Few programs are producing ag engineers with livestock expertise!
Questions??

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