

Project/Activity Number: NCDC 235
Project/Activity Title: Annual Report
Period Covered: Inception until May 15 2021
Date of This Report: June 28, 2021
Annual Meeting Date(s): May 13 – May 14, 2021

Participants:

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Rosa	Guilherme	grosa@wisc.edu

Meeting Activities:

NCDC 235 had our first formal meeting this spring. Due to the COVID-19 pandemic we choose to meet over zoom the afternoon of May 13 and the morning of May 14, 2021. This formal meeting chose to include all of the members of NC1211.

The goals of our meeting were to 1) introduce members to each other, 2) discuss the development of the NC-1211 proposal and the changes from the early discussions to the final proposal, 3) present the final objectives, and 4) understand members strengths, industry needs, and available funding.

The current breakdown of current 24 members includes 17 members from universities, 2 international partners, 4 companies, and 1 government employee. Our members distribution is focused mainly in the Central US.

We started the meeting with brief individual introductions, and the history of the development of the committee. Then to ensure members were able to truly interact with each other we developed a series of 3 breakout sessions, and 2 informal virtual social hours. Thursday afternoon we had 2 breakout rooms and a social hour. The first breakout room gathered information on gathering information about members: focus species, discipline, current focus, and needed partnerships (expertise). The second breakout room gathered information on industry needs. We set up the breakout rooms by species. During the social hour we had members send pictures of their facilities. As we showed the pictures, we had members to talk about their research and facilities. It was a fun way to learn more about members.

Friday morning, we started our meeting with a donut social. We showed a few more facilities pictures. Members were asked to present any currently available positions for graduate students, post-docs, faculty positions and industry. Then we had our final breakout room. This break out room was focused on potential funding sources.

As all NC1211 members were invited to participate and we had good attendance, the committee votes to make this the first official meeting of the NC-1211 committee.

Official Actions:

Tami Brown-Brandl was elected Chair and Juan Steibel was elected Secretary. Next year's meeting will be held in Madison, WI. Guilherme Rosa will be the organizer of the 2023 meeting.

Analysis of breakout activities.

Breakout #1- Member information

- Species focus: swine, poultry, beef, dairy, horse, goats, fox, and fish.
- Disciplines represented: Data science, animal science (animal behavior/welfare, genetics, nutrition), agricultural and biological systems engineering, poultry science
- Focus areas: animal behavior, animal tracking, social interactions, environmental enrichment, stress, disease detection, animal weight analysis, virtual fencing, image analysis, sound analysis, robotics, smart control, impact of environmental on animal, spatial and temporal analysis machine learning, deep learning, computer vision, technology implementation time series analysis, data fusion, sensor fusion
- Needed expertise: Computer science, Welfare expert, Statistician/Data science, Engineers/Companies, partnership, data science, data integration,

Breakout #2 Current and future needs were:

- Trained personnel for development, for operation and for maintenance of PMA technologies
 - Data-savvy graduates with animal science background
 - Provide More opportunities for those working in PMA to network with each other
 - Computer scientist and animal scientists that can work with each other.
- Validation and benchmarking of existing technologies/sensors for:
 - Environmental variables (CO₂ and other greenhouse gases, NH₃, temperature)
 - Continuous monitoring of animal behavior, physiology, stress and welfare. Including disease detection
 - Manure quality and management
- In depth mining and integration of existing datasets and data streams
 - Discovery of novel sensor functions/applications.
 - Facilitate real-time on-farm consulting.
 - Implement analysis through artificial intelligence.
 - Formulate clear standards on data ownership and use.
 - Deliver easily interpretable data interfaces.
- Improved farm infrastructure to facilitate PMA
 - Better connectivity for data transfer including data storage and transmission.
 - Housing designs that easily accommodate emerging technologies
 - Robust and cost-effective hardware solutions for on-farm use.
- Flexible and reliable animal Identification
- Cost-effective drone technology for animal monitoring that is robust and applicable under farm conditions.

Breakout Room #3: Funding Opportunities

- Federal Sources
 - USDA-NIFA-AFRI
 - Various foundational programs
 - IDEAS
 - DSFAS
 - CARE
 - Sustainable Agricultural Systems
 - Foundation for Food and Agriculture Research
 - NSF
 - Advanced Animal Systems
 - Cyber Physical Systems
 - Early Career Award
 - Convergence accelerator on digital agriculture
 - Canada provincial and federal agencies
- Commodity groups
 - US Poultry and Egg
 - Egg industry center
 - National Chicken Council
 - National Turkey Federation
 - National Pork Board
 - North Carolina Agricultural Foundation
 - American Holstein association
 - Michigan Alliance for Animal Agriculture
- Corporate sources
 - Sensor companies
 - Smithfield (in-kind, data sharing)
 - Maximus (in-kind, data sharing)
 - Boehringer Ingelheim (in-kind)
 - Microsoft AI

Station Reports:
North Dakota State University

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Collaborative Manuscripts/Conference papers

Byrd

1. Wagner, S. A, V. F. Fajt, C. P. Lo, and **C. J. Byrd** (2021) Pharmacokinetics of oral firocoxib in un-weaned calves. *Journal of Veterinary Pharmacology and Therapeutics*. In Press.
2. Luna, D., C. González, **C. J. Byrd**, R. Palomo, E. Huenul, and J. Figueroa (2021). Do Domestic Pigs Acquire a Positive Perception of Humans through Observational Social Learning? *Animals*, 11, 127. doi:10.3390/ani11010127
3. J. S. Johnson, Maskal, J. M., A. W. Duttlinger, K. R. Kpodo, B. R. McConn, **C. J. Byrd**, B. T. Richert, J. N. Marchant-Forde, D. C. Lay, S. D. Perry, M. C. Lucy, and T. J. Safranski (2020) In utero heat stress alters the postnatal innate immune response of pigs. *Journal of Animal Science*. 98: skaa356. doi:10.1093/jas/skaa356.
4. Maskal, J. M., A. W. Duttlinger, K. R. Kpodo, B. R. McConn, **C. J. Byrd**, B. T. Richert, J. N. Marchant-Forde, D. C. Lay, S. D. Perry, M. C. Lucy, T. J. Safranski, and J. S. Johnson (2020) Evaluation and mitigation of the effects of in utero heat stress on piglet growth performance, post-absorptive metabolism, and stress response following weaning and transport. *J. Anim. Sci.* doi:10.1093/jas/skaa265.

Sun

1. Sunil, G. C., Borhan M. D., Yu, Z., Demetris, R., Mostofa, A., Eric, P. B. & Sun, X*. (2021). Using Deep Learning Neural Network in Artificial Intelligence Technology to Classify Beef Cuts. *Front. Sens.* Accepted. doi: 10.3389/fsens.2021.654357
2. Liu, J. H., Newman, D. J., Young, J. M., & Sun, X*. (2020). Prediction of Whole Pork Loin and Individual Chops' Intramuscular Fat Using Computer Vision System Technology. *Meat and Muscle Biology*, 4(1).

3. Chen, X., Ogdahl, W., Borhan, M. S., & Sun, X*. (2020). Evaluation of Beef Cattle Temperament Using Video Technology. *Transactions of the ASABE*, 63(6), 1905-1911.
4. Knutson, E. E., Menezes, A. C. B., Sun, X., Fontoura, A. B. P., Liu, J. H., Bauer, M. L., ... & Ward, A. K. (2020). Effect of feeding a low-vitamin A diet on carcass and production characteristics of steers with a high or low propensity for marbling. *Animal*, 14(11), 2308-2314.
- 5.

Collaborative Grants

North Dakota State University/Texas Tech University/University of Missouri-Columbia
Anderson, N.C., Byrd, C.J., Wagner, S.A.,
USDA-NIFA Higher Education Challenge: Using virtual reality to increase student understanding and interest in farm animal welfare.

North Dakota State University/Texas Tech University
Byrd, C.J., Wagner, S.A., Young, J.M.
USDA-NIFA-AFRI: A novel housing system to decrease injury and distress during transport in swine.

Prairie View A&M University

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Collaborative Manuscripts/Conference papers: None related

Collaborative Grants: None related

NC 1211 Station Report -MSU

Institution: Michigan State University (MSU)

Station Members: Juan P Steibel, Janice Siegford

Date: June 28th 2021

Animal Science

Biological Systems Engineering

University of Nebraska–Lincoln

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Collaborative Manuscripts/Conference papers with NC1211 Member stations

1. Dong, Liu, D. He, Chen Chen, Juan Steibel, Janice Siegford, and Tomas Norton. "Recognition of Aggressive Behaviour in Group-housed Pigs Based on ALR-GMM." *Nongye Jixie Xuebao/Transactions of the Chinese Society of Agricultural Machinery* 52, no. 1 (2021): 201-208.
2. Chen, Chen, Weixing Zhu, Juan Steibel, Janice Siegford, Junjie Han, and Tomas Norton. "Recognition of feeding behaviour of pigs and determination of feeding time of each pig by a video-based deep learning method." *Computers and Electronics in Agriculture* 176 (2020): 105642.
3. Chen, Chen, Weixing Zhu, Juan Steibel, Janice Siegford, Junjie Han, and Tomas Norton. "Classification of drinking and drinker-playing in pigs by a video-based deep learning method." *Biosystems Engineering* 196 (2020): 1-14.

Collaborative Grants with NC1211 Member stations

1. Michigan State University, University of Nebraska-Lincoln, University of Wisconsin, Catholic University of Leuven
Steibel, J., Brown-Brandl, T., Rosa, Siegford, Psota, Dorea, Morris, Benjamin, and Norton. FACT-CIN: A Coordinated Innovation Network for Advancing Computer Vision in Precision Livestock Farming. NIFA-AFRI.
2. Michigan State University, Scotland Rural University College, Ohio State University, Iowa State University
Siegford J, Turner S, Akaichi F, Benjamin M, Rozeboom D, Steibel J, Vigors B, Johnson A, Parris-Garcia M, Thompson D, Zangaro C. Understanding Precision Livestock Farming Adoption in the U.S. Swine Industry: Examining Needs, Perceptions, and Willingness to Pay of Users and Consumers. NIFA-AFRI.

CHONGXIAO (SEAN) CHEN

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2018 **Ph.D.** in Poultry Science – Department of Poultry Science, University of Georgia, Athens, GA, US

2014 **DVM** College of Veterinary Medicine, China Agriculture Univeristy, Beijing, China

PROFESSIONAL EXPERIENCE

2019/8 –Present Research Assistant Professor (non-tenure), Prestage Department of Poultry Science, North Carolina State University, Raleigh, NC, US

2019/12-Present Research Project Coordinator/Manager, Animal Health & Nutrition Consortium, North Carolina University, Raleigh, NC, USA

2019/1 – 2020/8 Postdoctoral Researcher Department of Poultry Science, The University of Georgia, Athens, GA

CURRENT RESEARCH AREA

1. Protozoal disease in turkeys
2. The relationship between animal behavior and diseases
3. Nutrition factors in poultry diseases

RESEARCH PAPERS (2020-2021, selected)

1. M. Yamada, **C. Chen**, T. Sugiyama, W.K. Kim. Effect of Age on bone structure parameters in laying hens. 2021, *Animals*
2. MK. Sharma, D. White, **C. Chen**, W.K. Kim, P. Adhikari. Effects of the housing environment and laying hen strain on tibia and femur bone properties of different laying phases of Hy-Line hens. *Poultry Science*. 2021
3. **C. Chen**, D. White, B Marshall, W.K. Kim. Role of 25-hydroxyvitamin D3 and 1, 25-dihydroxyvitamin D3 in chicken embryo osteogenesis, adipogenesis, myogenesis, and vitamin D3 metabolism. *Frontiers in Physiology*, 2021
4. **C. Chen**, R. Adihikari, D. White, W.K. Kim. Role of 1, 25-dihydroxyvitamin D3 on osteogenic differentiation and mineralization of chicken mesenchymal stem cells. *Frontiers in Physiology*, 2021
5. H. Ma, B. Xu, W. Li, F. Wei, W. K. Kim, **C. Chen**, Q. Sun, C. Fu, G. Wang, S. Li, Effects of stocking density and alpha-lipoic acid on the behavior, serum indicators and bone quality of broilers. *Poultry Science*, 2020
6. R. Adhikari, **C. Chen**, W. K. Kim. Effect of 20 (S)-Hydroxycholesterol on Multilineage Differentiation of Mesenchymal Stem Cells Isolated from Compact Bones in Chicken. *Genes*, 2020
7. **C. Chen**, W. K. Kim. The application of micro-CT in egg-laying hen bone analysis: introducing an automated bone separation algorithm. *Poultry Science*, 2020
8. **C. Chen**, B. Turner, T. Applegate, G. Litta, and W. K. Kim. Role of long-term supplementation of 25-hydroxyvitamin D3 on laying hen bone 3-dimensional structural development. *Poultry Science*, 2020
9. **C. Chen**, B. Turner, Role of long-term supplementation of 25-hydroxyvitamin D3 on egg production and egg quality of laying hen. *Poultry Science*, 2020

10. S. Su, Y. Wang, C. Chen, M. Suh, M. Azain, W. K. Kim. Fatty acid composition and regulatory gene expression in late-term embryos of ACRB and COBB broilers. *Frontiers in Veterinary Science*. 2020
11. C. D. Aranibar, C. Chen, A. J. Davis, W. I. Daley, C. Dunkley, W. K. Kim, C. Usher A. B. Webster, J. L. Wilson. Impact of an alternate feeding program on broiler breeder pullet behavior, performance, and plasma corticosterone, *Poultry Science*. 2020

NC 1211 Station Report

Institute: PIC

Station members: Dr. Eric Psota, Dr. Robert Burns

Report date: May 3, 2021

Dr. Eric Psota is currently the Digital Innovations Manager at PIC. He specializes in computer vision, image processing, and machine learning and works with others at PIC to apply these skills toward improved phenotyping of pigs. Prior to working with PIC, he was a Research Assistant Professor in the Department of Electrical & Computer Engineering at the University of Nebraska-Lincoln from 2011-2021. While at UNL, he worked with researchers in Animal Science, Biological Systems Engineering, and many other agriculture-related disciplines to advance the field of precision livestock farming.

While at UNL, Dr. Psota worked with Dr. Ty Schmidt and Dr. Benny Mote to develop a long-term tracking system for group-housed pigs. The system captures and processes consumer-grade security camera footage using a combination of deep learning and Bayesian inference to reliably track the locations, orientations, and basic activities at an individual level with > 90% precision and recall. The system has been tested on thousands of pigs and continues to be a tool used by researchers at UNL for data capture.

Along with the tracking method, Dr. Psota has also been involved in projects to monitor the breathing rate of heat-stress-challenged sheep, re-identify animals without visual markers, estimate feed consumption using depth cameras, and develop a deep-learned fiducial marker system that would allow automated ID of livestock without requiring RFID or manual tag reading.

Dr. Psota has ongoing research relationships with people on this committee. This includes Tami Brown-Brandl, Madonna Benjamin, Rob Fitzgerald, Tomas Norton, Guilherme Rosa, Janice Siegford, Juan Steibel, and Yijie Xiong. Along with Dr.'s Brown-Brandl, Benjamin, Norton, Rosa, Siegford, and Steibel, he is involved in a funded NIFA-FACT-CIN grant that aims to address many of the existing needs in the precision livestock farming fields. By creating computer vision datasets and facilitating grand challenges posed to broad research community, this group hopes to consolidate otherwise parallel efforts in this field and accelerate advances across the globe.

Robert Fitzgerald is a part of the Genetic Improvement team within PIC. His current focus is on applying sensor technology to advance PIC's phenotyping measurement platform. He is also responsible for the execution of PIC's commercial progeny testing program named GNX.

Robert started his work in sensor technology during his doctoral research at Iowa State University, whereby he partnered with ISU's Ag Biosystems Engineering department to design, build and test a force plate that evaluates individual leg weight distribution in sows. Since then, he has collaborated on research projects with members on this committee to predict body weight in pigs and develop algorithms to detect pig behaviors while tracking pigs throughout large pens.

NC 1211 Station Report - Tennessee

Institute: The University of Tennessee (UT)

Station members: Dr. Robert Burns, Dr. Yang Zhao

Report date: May 3, 2021

Member introduction

Burns is a Distinguished Professor of Biosystems Engineering and Soil Science at The University of Tennessee, Knoxville. Dr. Burns holds a BS in Agricultural Engineering, MS in Environmental Engineering, and PhD in Civil Engineering from The University of Tennessee and is a registered professional engineer. He has 26 years of experience as a faculty member at the University of Tennessee and Iowa State University working with manure storage and treatment systems, nutrient management, the quantification of air emissions from livestock and poultry production systems and precision livestock farming.

Zhao is an Assistant Professor of Animal Science at UT. Zhao got his PhD degree at Wageningen University in the Netherlands. He worked as postdoc and assistant scientist at Iowa State University for five years. He was an Assistant Professor of Agricultural and Biological Engineering at Mississippi State University before joining UT in 2020. Zhao has 15 years experiences in poultry (laying hens and broilers).

Research

Burns and Zhao work together in UT Precision Livestock Farming Program (<https://plf.tennessee.edu/>, website to be launched on May 6, 2021) that involves 17 UT faculty members, 5 staff members, and 10 graduate and undergraduate students across three departments. The program aims to advance livestock and poultry production through the use of real-time monitoring of images, sounds and other biological, physiological and environmental parameters to assess and improve individual animal health and well-being within herd or flock production systems.

Example ongoing projects of Burns and Zhao includes:

- Development of an automated broiler gait score and flock activity assessment system (funded by Foundation of Food and Agriculture Research)
- Improve health and well-being in broiler chickens through environmental management (funded by USDA-ARS)
- Objective evaluation of broiler welfare and behavior as affected by growth rate and stocking density (funded by US Poultry & Egg Association)
- Robots for reducing and collecting floor eggs in cage-free hen housing systems (funded by Egg Industry Center)
- Development of an automated system to measure beef cattle water intake and feed consumption.

Collaborations

Burns and Zhao currently do not have collaborations with members in this committee, but wish to establish collaborations in future.

Burns and Zhao are currently collaborating with follow extramural researchers:

- Dr. Joseph Purswell, Research Leader and Supervisory Agricultural Engineer, USDA-ARS Poultry Research Unit
- Dr. Tom Tabler, Extension Professor, Poultry Science, Mississippi State University

- Dr. Lingying Zhao, Professor, Food, Agricultural and Biological Engineering, Ohio State University
- Dr. Lilong Chai, Assistant Professor, Poultry Science, University of Georgia
- Dr. Suzanne Millman, Professor, Vet Diagnostic & Production Animal Medicine, Iowa State University
- Dr. Richard Gates, Acting Department Chair, Professor Director of Egg Industry Center, Iowa State University
- Dr. Hong Li, Associate Professor of Animal Science, University of Delaware
- Dr. Robert Spajic, Professional Associate and Production Manager, University of J.J. Strossmayer Osijek, Croatia

NC 1211 Station Report

Institute: University of Minnesota

Station members: Marcia Endres, Yuzhi Li

Report date: May 14, 2021

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Yuzhi Li

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Collaborative Projects:

University of Minnesota and University of Wisconsin-Madison: Swanson, R., M. Peiter, T. Bresolin, J. Dorea, and M. Endres. Using feeding behavior from autofeeder software to predict disease in pre-weaned dairy calves. Work in progress.

Collaborative Grants (submitted to USDA):

University of Minnesota and University of Nebraska – Lincoln: Li, Y., L. Johnston, T. Schmidt, and B. Mote. Utilization of computer vision as a means to understanding etiology of tail biting outbreaks in growing-finishing pigs.

NC 1211 Station Report

Institute: University of Nebraska-Lincoln

Station members: Tami Brown-Brandl, Yijie Xiong

Report date: May 7, 2021

Tami Brown-Brandl

Biological Systems Engineering

University of Nebraska–Lincoln

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Yijie Xiong

Animal Science

Biological Systems Engineering

University of Nebraska–Lincoln

Office: (402) 472-3246

Collaborative Manuscripts/Conference papers

1. Leonard, S. L. H. Xin, B. C. Ramirez, J. P. Stinn, S. Dutta, K. Liu, T. M. Brown-Brandl. 2020 Static and Dynamic Space Usage of Late Gestation Sows. Transactions of ASABE. 64(1), 151-159.
2. Leonard, S.M., H. Xin, T. Brown-Brandl, B.C. Ramirez, and S. Dutta. 2020. Effects of piglet creep floor area on sow behavior and litter productivity in farrowing stalls. ASABE Paper No. Paper # 2000135.
3. Condotta, I.C.F.S., T.M. Brown-Brandl, G. A. Rohrer, K.O. Silva-Miranda. 2020. Development of method for lameness detection based on depth image analysis. ASABE Paper No. 2001082. St. Joseph MI.: ASABE.
4. Pacheco, V. M., I.C.F.S. Condotta, L. S. Martello, E Psota, T. M. Brown-Brandl. 2020. An indoor performance comparison of time-of-flight depth cameras. ASABE Paper No. 2001021. St. Joseph, MI.: ASABE.

Collaborative Grants

University of Nebraska-Lincoln/University of Illinois

Shi, Condotta, Brown-Brandl

FACT-AI: Cyberinformatic Tools for Exploring and Validating Sow Posture and Piglet Activity

University of Michigan, University of Nebraska-Lincoln, University of Wisconsin, Catholic University of Leuven

Steibel, J., Brown-Brandl, T., Rosa, Siegford, Psota, Dorea, Morris, Benjamin, and Norton FACT-CIN: A Coordinated Innovation Network for Advancing Computer Vision in Precision Livestock Farming

Iowa State University, University of Nebraska-Lincoln, University of Kentucky

Ramirez, Hoff, Harmon, Brown-Brandl, T., Hayes, Rohrer

CARE: Modern pigs urgently need facilities with modern ventilation: Updating swine ventilation standards/guidelines