STUNNING CATTLE

2ND EDITION

Temple Grandin
Department of Animal Sciences
Colorado State University
Trouble Shooting
Stunning Problems

1. Excessive electric prod use due to distractions
2. Stunner maintenance
3. Employee training issue
4. Ergonomics or design
5. Cattle can see people
6. Slipping on the floor
Modern Curved Chute in South America
Well designed stun-box with an adjustable side
Well Designed Stun Box
Non-slip Flooring on Restrainer Entrance is Essential
Conveyor Belt Flap Blocks Vision
Sharp Edges Cause Vocalization
Conveyor Must Fit the Animal
Stunning Box Common Problems

- Too wide (provide drawing)
- Cattle slip on floor
- Feet slip under door
- Cattle see movement under the door
- Cattle see feet under the door
Trouble-Shooting Restrainer-Conveyor Problems

- Hold down too low
- Entrance too dark
- Slick floor
- No entrance ramp
- Leg spreader modified
- No false floor
- No belly rails on entrance
- Sees Distractions
- Broken sharp edges
- Hold down too short
- Hold down too high
- One side runs faster
- Animal not centered
Location of the Brain
Correct Stunner Positions
Cartridge Fired Stunner

Must keep cartridges dry
1. Ergonomics
2. Bolt Velocity
3. Air Pressure

Pneumatic Stunner
Cardboard to prevent cattle from seeing through cracks.
Head holding devices may be needed if non-penetrating captive bolt is used.
Non-penetrating captive bolt used with head holder
Indentation in the skull from non-penetrating captive bolt
Non-Penetrating Captive Bolt

- Require more precise positioning than penetrating

- **Effective** stunning and brain damage are opposing goals

- Less effective on cattle with thick hair

- Will not work on large bulls
Electric Stunning of Cattle
Electric stunning with too much resistance is not effective
Requirements for Effective Electric Stunning

- Low resistance
- Maintain firm contact
- Head restraint
- Systems that ground out through the floor often work poorly
Effective electric stunning with continuous wetting

Be careful **not** to create a new circuit over the surface of the animal with water
Types of systems

• New Zealand split stun
  - separate head only and head to body circuit

• Single circuit head to body
  - similar to U.S. pig systems
Head Holder for the Center Track Restrainer
Steer in head holder on the center track restrainer
Insensibility

- No blinking
- No arched back, righting reflex (small side flex is permissible)
- No breathing
- Floppy head
- No nose movements “rabbit nose”
- Limp flaccid tongue (may be trapped in the mouth of a properly stunned animal)
Correctly Stunned Animal

Completely insensible
Sensible bovine with righting reflex

(photo not from U.S.)
Checking for breathing by holding the nose
It is normal to have kicking in a correctly stunned animal. The tail relaxes or spinal reflexes subside.
Head must be Dead!!!

Ignore the Body
The animal should be held in an upright position, for religious slaughter.
Welfare Tips for Religious Slaughter without Stunning

- Calm animals lose sensibility faster
- Fast knife strokes are more effective
- Use upright restraint
- Perform throat cut immediately after restraint
- Vocalization score of 5% or less
- Knife is twice the width of the neck
Behavioral Principles of restraint

- **Non-slip** floor
- **Blocking** vision
- **Equipment moves with smooth motion**
  - (jerky motion scares)
- **Optimal** pressure -
  - not too tight not too lose
- **Reduce** noise
### AMI Scoring System

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunned with one shot</td>
<td>95%</td>
</tr>
<tr>
<td>Insensible</td>
<td>100%</td>
</tr>
<tr>
<td>Electric prod</td>
<td>25%</td>
</tr>
<tr>
<td>Falling down</td>
<td>1%</td>
</tr>
<tr>
<td>Vocalizing</td>
<td>3%</td>
</tr>
<tr>
<td>Vocalizing with head holder</td>
<td>5%</td>
</tr>
</tbody>
</table>
# Balking Scores

<table>
<thead>
<tr>
<th></th>
<th>Low Balking Plant (well-trained handlers)</th>
<th>High Balking Plant (facility problem)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Cattle Backing Up in the Chute</td>
<td>% Vocalizing</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>3%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Vocalization Score increase due to increased electric prod use
### Ratio of Fully Insensible to Partially Sensible Cattle

<table>
<thead>
<tr>
<th>Fed Beef Plants</th>
<th>Cow Plants</th>
<th>Total Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/3000</td>
<td>1/758</td>
<td>4/8225 approx.</td>
</tr>
</tbody>
</table>

*All cattle were restunned prior to skinning*
On a single 100 animal audit by a customer 100% of the animals must be insensible to pass.

For regulatory purposes when hundreds of animals are observed, I recommend keeping a running average on the percentage of animals that were insensible at hoisting that show signs of partial return to sensibility after hoisting.
Completely Eliminating these animals is impossible

And I recommend setting the limits on Critical Control Points based on data collected on thousands of animals.
There is a Zero Tolerance for Hoisting an Animal that is Showing Obvious Signs of Sensibility

There is **Zero Tolerance** for Skinning, Scalding, Dehairing or Removal of Any Body Part on an Animal that Shows any Sign of Partial Return to **Sensibility**
### Improvements in Penetrating Captive Bolt Stunning Due to Restaurant Audits

<table>
<thead>
<tr>
<th></th>
<th>Average – percentage of cattle stunned with one captive bolt shot</th>
<th>Percent that passed audit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline USDA Survey, (N = 10)</td>
<td>89%</td>
<td>30%</td>
</tr>
<tr>
<td>Fourth year of Restaurant audits, (N = 53)</td>
<td>97%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Grandin, Colorado State University
# Improvements in Vocalization Scores due to Audits

<table>
<thead>
<tr>
<th></th>
<th>Average – percentage of cattle vocalizing during handling and stunning</th>
<th>Worst plants</th>
<th>Percent that passed audit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline USDA Survey, N = 10</td>
<td>8%</td>
<td>32%</td>
<td>43%</td>
</tr>
<tr>
<td>Fourth year of Restaurant audits</td>
<td>2%</td>
<td>6%</td>
<td>91%</td>
</tr>
</tbody>
</table>

Grandin, Colorado State University
USDA Survey – Before Restaurant Audits Started Reasons for Failure to Stun 95% or More of the Cattle with One Shot from a Captive Bolt

<table>
<thead>
<tr>
<th>Number of Plants</th>
<th>Stunner Maintenance</th>
<th>Aim Ergonomics</th>
<th>Aim Cattle Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Grandin, USDA 1997
Comparison of fed cattle to bulls and other cattle with heavier skulls on the percentage of animals returning sensibility after penetrating captive bolt

<table>
<thead>
<tr>
<th></th>
<th>Fed beef</th>
<th>Bulls and cull cows</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>1826</td>
<td>692</td>
</tr>
<tr>
<td><strong>3 (0.16%)</strong></td>
<td>8 (1.2%)</td>
<td></td>
</tr>
</tbody>
</table>

All animals were restunned prior to dressing procedures

Grandin, 2002
Out of 11 cattle which showed signs of returning to sensibility there were:

- 6 mature bulls
- 1 mature Brahman cross cow
- 1 older Mexican Brahman steer

3 young fed beef – lighter skulls

Grandin, 2002
Major Causes of Stunner Malfunction

- Damp cartridges
- Bent firing pin or cocking mechanism
- General lack of maintenance and cleaning
- Sticking contact trigger
- Dirty air supply
- Air pressure too high or too low
BOLT VELOCITY

To be effective high bolt velocity is required

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<table>
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<tbody>
<tr>
<td>STEERS</td>
<td>55 METERS PER SECOND</td>
</tr>
<tr>
<td>BULLS</td>
<td>72 METERS PER SECOND</td>
</tr>
</tbody>
</table>

Daly et al., 1987
Non-Penetrating Captive Bolt

- Is effective if placed accurately
- More accurate aim required than penetrating
- Head holder required
- Must not be shot on an angle
- Most effective on young fed beef
- Problem with mature and cattle with bulls heavy skulls
- May not work on animals with curly long hair
Head holding devices may be needed if non-penetrating captive bolt is used.
Effective Non-Penetrating Captive Bolt and Electric Stunning Both Require a Head Holder

**Maximum speed** that a single head holder will work on a center track conveyor restrainer is about **275 large cattle per hour**
Head Holder for the Center Track Restrainer
Indentation in the skull from non-penetrating captive bolt

A captive bolt stunner must damage the brain and cause concussion to be effective

Gregory, 1998
Effect of Non-Penetrating Captive Bolt on 75 Fed Steers and Heifers

- 70/75 rendered instantly insensible
- Created a 1 cm deep depression
- Intact skin in 63 cattle no visible brain material on any animal
- Head holder used
- Main causes of failure were shooting on an angle, extra heavy skulls and thick curly hair

Grandin, 2005
Penetrating Captive Bolt with Air Injection Causes Large Visible Brain and Spinal Cord Fragments to be Found in other Parts of the Body

Schmidt et al., 1999

Air Injection is now banned
Penetrating Captive Bolt with No Air Injection

causes much lower levels of central nervous system tissue contamination

2/108 cattle- faint positive on immuno-assay

Horlocher et al., 2002

2/726 cattle positive on immuno-assay

Lucker et al., 2002
Comparison of penetrating and non-penetrating captive bolt for CNS contamination measured by presence of marker protein or brain fragments in jugular vein blood

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Penetrating</td>
<td>4% of cattle</td>
</tr>
<tr>
<td>Non-penetrating</td>
<td>2% of cattle</td>
</tr>
</tbody>
</table>

Coore et al., 2005
<table>
<thead>
<tr>
<th>Study in 12 Large Beef Plants:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test for CNS contamination after penetrating captive bolt stunning with immuno assay GFAP test</td>
</tr>
<tr>
<td>1/360 positive for CNS marker protein after penetrating captive bolt</td>
</tr>
<tr>
<td>0/30 positive Kosher slaughter</td>
</tr>
</tbody>
</table>

Rovira et al., 2005
Colorado State University
In 10 out of 12 plants all the cattle were shot with one shot.

In the plant with the positive test, the plant layout made it impossible to visually confirm a single shot at the point on the bleed rail where the sample was collected.
Why the Differences Between Studies?

How Many Cattle were Shot Twice?

How Much Skull Damage?

How Does Skull and Brain Damage Relate to Contamination?
Coore et al. (2005) used a method that may have confounded their results.

The captive bolt was applied to anesthetized cattle.
Brain tissue contamination caused by stunning is low compared to spinal cord contamination caused by carcass splitting.
Splitting saw transfers of spinal tissue between carcasses

Helps et al., 2004

Smearing of spinal cord tissue due to splitting

Prendergast et al., 2003
Minimum Current for Effective Electric Stunning of Cattle

1.5 amps at 50 hz

Wotton et al., 2000

The electricity must induce a grand mal epileptic seizure
New Zealand System

Split stun- separate head only and head to body circuit

South American System

Single circuit head to body similar to U.S. pig systems
Requirements for Effective Electric Stunning

- Low resistance
- Maintain firm contact
- Head restraint
- Systems that ground out through the floor often work poorly
Electrical Immobilization that is used to suppress kicking may mask signs of return to sensibility

Electrical immobilization which does not induce insensibility is highly aversive if it is applied to sensible animals

Pascoe 1986; Grandin et al., 1986; Rushen 1986; Lambooy, 1985
A Big Problem with Electric Stunning of Young Fed Beef is Blood Splash and Blood Spotting

- Older mature cows have fewer problems
- Worse in young fast growing animals
Immediate bleeding reduces blood splash

New Zealand system - roll animal out of the stun box and bleed within 10 seconds (Jarvis)

German system – Electric stun then bleed while still held in the head holder
Fast bleed with a 1 or 2 second interval (Banss)
Blood removal

Box in shackling position
Electrical Characteristics To Reduce Blood Splash

• Higher frequencies reduce blood splash

• Up to 800 Hz across the head is used commercially in pigs

• Up to 1500 Hz will induce insensibility in research pigs       Anil and Mckinstreg, 1992

• Electrode position – different muscles have different electrical characteristics       Clyde Daly, 2005

• Changing frequency during the stun

• Changing wave form during the stun
The Future is Now

Video Auditing of stunning and the 5 core criteria of the AMI guidelines

Live online auditing of Plumrose Foods processing line – shown to trade show visitors at the Food Expo by Arrowsight
The Future is Now

- Robotic vision systems that see and behave like a human operator are available now

- Intelligent robotic arms are already in operation on the slaughter floor (Banss Meat Technology)
3D-laser scanning for exact measurement of carcass
Escáner láser 3D para la medición exacta de las canales

BANSS PC evaluation software for the transmission of measurement data to the robot control system
Software de evaluación BANSS de PC para la transmisión de los datos de medición al sistema de control del robot
My Predictions of the Future

To reduce blood splash an

• **Intelligent robotic arm** safely performs bleeding while the animal is still in the electric stunner.

• **Super accurate stunner placement.**

• Development of a non-penetrating captive bolt stunner with **ultra high bolt velocity** and wider mushroom head that would cause less skull damage than existing non-penetrators.

  Less skull damage, probably has less brain contamination.

  Only a robot could safely handle the recoil from this stunner.
What Could Hold Robots Back?

- Moisture
- Blood corrosion
- Will require careful maintenance of waterproofing
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