Transferring results of behavioral research to industry to improve animal welfare on the farm, ranch and the slaughter plant

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Abstract

Knowledge learned from research has been effectively transferred to the agricultural industry in some areas and poorly transferred in others. Knowledge that has been used to create a thing such as pharmaceutical or a piece of equipment is more likely to be adopted by industry than a behavioral management technique that reduces stress to improve productivity and welfare. The author has observed during her career that some people will purchase a new cattle handling system which is designed with animal behavioral principles but they will continue to handle cattle roughly. People are more likely to purchase new equipment than use easy to learn low stress techniques for moving cattle. Even when financial benefits are clear, some people find it difficult to believe that a purely behavioral management method will really work. Many studies done during the last twenty years on dairies and pig farms have clearly shown the benefits of good stockmanship on animal productivity. Unfortunately a large segment of the livestock industry has been slow to implement improved stockmanship. I would like to speculate that a possible reason why some people resist learning better stockmanship is because a good stockperson must recognize that an animal is a conscious being that has feelings.

Ethologists, veterinarians and animal scientists need to spend more time transferring the results of their research to industry. Successful transfer of knowledge and technology to industry often requires more work than doing the actual research. For a successful technology transfer to take place the method or equipment must be successfully used by the people who initially adopt it. If the new piece of equipment fails on the first or second place that adopts it, transfer to the whole industry may fail. In this paper the author describes a successful case study of transfer of a restraint system based on behavioral principles from the research lab to half of the large U.S. and Canadian beef slaughter plants. Scientists should choose places that have management who believes in their research work. Researchers need to spend more time making their work relevant to industry by writing articles in popular and industry magazines. Speaking at producer meetings and websites should also be used to transfer research results into practice. The steps for successful transfer of behavior research to the industry are: 1) Communicate your results outside the research community, 2) Be prepared to spend lots of time with the first place that uses your findings, 3) You must supervise other early adopters to prevent mistakes which could cause the method or technology to fail, 4) Do not allow your method or technology to get tied up in patent disputes.

Introduction

There is a large amount of behavioral knowledge that has not been successfully transferred to the industry. In the U.S., many people in the pork industry do not know about the extensive research that has been done on pig behavior. Some upper level managers of large corporate pig farms do not know that behavior is a field of research. There is a need to do a much better job of transferring research results into industry practices. This paper is divided into six sections of 1) Getting people to recognize the importance of behavioral knowledge and behavioral based management methods, 2) The problem of some people in the industry who do not want to discover that a common agricultural practice is either stressful or painful, 3) Successful transfer of equipment designed according to behavioral research to the industry, 4) Failure to transfer a good piece of equipment that is based on behavioral research to the industry, 5) How to maintain and motivate excellent stockmanship and animal handling, 6) Conclusions.

1. Recognizing the importance of behavioral management of animals

Years ago W.D. Hoard the founder of Hoard's Dairyman magazine recognized the importance of good stockmanship (Rankin, 1925). Many research studies show that good stockmanship improves animal productivity. Jack Albright (1978) reported that cows with small flight zones that allowed people to approach them were more productive and gave more milk. Seabrook's (1972) work also shows the importance of good stockmanship in a dairy. Hemsworth et al. (1981) has reported that sows on farms where they were more willing to approach a person had greater productivity and more piglets. In another study, milk production was lowered when a handler who had previously treated cows in a severely aversive manner was present (Rushen et al., 1999). A recent study by Munksgaard et al., (2001) showed that the presence of an additional person who had done mildly aversive things to the cows did not affect milk yield. In this study, the cows were milked by the regular dairy farm staff. In most studies where good stockmanship improved productivity, the behavior of the regular milker or caretaker was the major variable. It is likely, that if the cows associated the milker with aversive acts there would be a more detrimental effect on milk production than association of a bystander with something bad. Hemsworth and Coleman (1998) found that people who have a good attitude towards animals and like animals have more productive animals. Further research by Voisinet et al. (1997) and Fell et al. (1999) found that cattle that became agitated during handling in a squeeze chute had lower weight gains and more sickness.

Even though numerous studies show the advantages of good stockmanship, adoption of good stockmanship principles has been slower than adoption of behaviorally based facility designs. During the last 20 years, the author has written many articles on behaviorally based cattle handling principles (Grandin, 1980, 1987). However, many people still handle beef cattle roughly and have poor stockmanship skills. On some large dairies, the level of stockmanship is still poor. Why are some people so reluctant to adopt simple to learn behavioral principles of quiet animal handling? This has been very frustrating for me.

I have observed that people will adopt new handling equipment based on behavioral principles much more quickly than behavioral principles which they have to learn. In my business I sell twice as many \$55 books on how to build corrals and races based on behavioral principles than \$59 videotapes which can be used to train stockpersons. Many people want the "thing" rather than learning better management practices. They think buying the technology is all they need to do.

Even when a behavioral method has been documented to make money, people have been slow to adopt it. In one slaughter plant I documented a \$500 to \$1000 savings per day by training people to handle cattle quietly. When I left they quickly reverted back to their old rough ways. Why is all this research on good

stockmanship ignored by a large portion of the industry?

I would like to speculate that a possible reason why some people resist learning good stockmanship is because to be a good stockman one must recognize that the animal is a conscious being that has feelings. It is not a machine or just an economic entity.

2. There are certain things people do not want to discover

There are many people in the livestock industry who do not want to find out that a commonly used agricultural practice is either stressful or painful to an animal. For example, research has clearly shown that castrating piglets without an anesthetic is stressful and painful (McGlone, et al., 1993, McGlone and Hellman, 1988 and White et al., 1995).

Discussions with different researchers has indicated that funding for research in areas where the results may force the change of a common agricultural practice may be difficult to get. I have also observed that there is a certain percentage of physiologists and veterinarians who do not recognize the importance of behavior. The animal may be violently struggling and vocalizing but the physiologist will say "It is not distressed because its physiological measures are low." Would the physiologist say the same thing if a person was screaming in pain when a dentist drill hit a nerve? To address this issue more research is needed on brain neutronsmitter systems so that behavior can be correlated with activity in specific brain systems which are known to be associated with distress in humans.

While discussing distress in animals, it is important to separate the variables of pain and fear. Both of these variables either singly or combined would create distress. Another component of the broad term distress would be physical stress such as fatigue or heat stress during a long truck ride. All of these variables would interact together to cause distress. For example, a tame animal that is accustomed to handling would have less fear stress during loading and unloading from a truck than an animal that is not accustomed to being handled (Grandin, 1997a).

3. Examples of Successful Transfer of Behavioral and Welfare Based Technology to the Industry

Research results on animal handling, transport and stunning methods have been successfully transferred to the livestock industry. Hoenderken's (1982) and Gregory and Wotton (1984) work on the electrical parameters for stunning pigs and sheep are used worldwide. Work done by the author on the design of cattle and pig handling systems for ranches, feedlots and slaughter plants are also used worldwide (Grandin 1980, 1982, 1992, 1997b, 1998a, 2000). Transportation guidelines for stocking density in trucks are also widely used (Warriss, 1998; Knowles, 1998; Tarrant and Grandin, 2000). One of the reasons I was able to successfully transfer cattle handling facility designs to the industry is that I wrote over a hundred articles in the livestock industry press on behaviorally based cattle handling. I also posted the designs on my website www.grandin.com and gave talks at cattle producer meetings. I gave away the designs and made a living by charging for custom designs and consulting. People are often too reluctant to give information away. I discovered that when I gave out lots of information I got more consulting jobs than I could handle. However, it may be advantageous to keep quiet about new ideas when they are in the early development stage.

3.1 Case History of a Successful Behaviorally Based Technology Transfer

The center track or double rail conveyor restrainer for handling cattle in slaughter plants is now being successfully used in 25 plants in the U.S., Canada and Australia. Half the cattle in the U.S. and Canada are handled in this system when they go to slaughter. The case history of this system is a good example of a technology that started in the research laboratory and was adopted by many of the world's largest beef plants.

The original project was funded during the early 70's by the Council for Livestock Protection. The council was a consortium of U.S. animal welfare groups which included the Humane Society of the U.S. and American Society of Prevention of Cruelty to Animals. In the early seventies, they gave a grant of \$60,000 to researchers at the University of Connecticut to develop an alternative method to replace cruel shackling and hoisting of conscious calves and sheep by one rear leg prior to Kosher slaughter.

The Connecticut researchers started the project with a complete search of all patents and literature to determine the "state of the art" prior to inventing new designs. A complete review of the literature is important to prevent "reinventing the wheel." The researchers invented the idea of having the calf or lamb straddle a moving conveyor and they showed that this method of restraint was low stress (Giger et al., 1977 and Westervelt et al., 1976). The Council patented the system so no one else could patent it and block transmission of the invention to the industry.

The Connecticut researchers developed a laboratory prototype but many more components had to be invented to make a commercially usable system. In 1985 the Council for Livestock Protection gave another \$100,000 grant to build a system in a commercial veal slaughter plant. I was hired to do this job. I invented a new entrance design to facilitate calf entry onto the conveyor and adjustable sides for different sized animals (Grandin, 1988). To make my design available I published the drawings and placed them in the public domain. This prevented people outside the U.S. from patenting it. The system was then installed in two other veal plants.

I knew that the system would work really well for large cattle, but plant mangers were reluctant to try the new design until I obtained a second grant from another animal welfare group. This made it possible to give a restrainer to a plant that was willing to pay for building remodeling costs. Since the large cattle are wilder and more difficult to handle than tame milk formula fed veal calves, I had to make more modifications to the system to keep the large cattle calm. I added a solid roof (hold down) over the head of the cattle to block their vision and prevent them from seeing an escape route until they were fully restrained (Grandin, 1991). This roof did not press down and physically hold the animal down (Figure 1). It simply blocked the animal's vision of an escape route until the animal's back feet were off the entrance ramp and he was completely settled down on the conveyor restrainer and supported by his brisket and belly. A solid false floor was also added to prevent the animals from seeing the "visual cliff" effect as they entered the restrainer (Figure 2). The conveyor was mounted 2 m off the floor and animals would often refuse to enter if they could see the steep drop off (Grandin, 2001). The false floor provided the optical illusion of a solid floor to walk on. As the animal entered, it was high centered on the moving conveyor and its feet were 20 cm above the false floor. These extra pieces of metal that controlled what the cattle could see were essential. Cattle remained calm and entered the restrainer easily when the vision blocking panels were installed. Prior to installation of the false floor and solid roof the cattle often became extremely agitated. Details of design are important.



Figure 1. A steer sits quietly on the center track conveyor which is shaped to fit its brisket. The solid roof over the steer's head must be long enough to block his vision until his back feet are off the entrance ramp. The maximum width of the conveyor is 30 cm.



Figure 2. Diagram of the center track (double rail) conveyor restrainer system. A false floor below the animal's feet prevents incoming cattle from seeing a 2 m high drop off under the conveyor. A non-slip entrance ramp is essential. Cattle back out if they slip.

Transferring this technology out of the first successful beef plant to the rest of the industry was very time consuming. I went to the next seven plants that installed the equipment to make sure it was installed correctly. Improper installation and bad modifications made by steel welding companies caused big problems. I had to be there at startup to correct these problems. Equipment installers often failed to install the false floor or shortened the overhead roof that blocked the cattle's vision. They did not understand a purely behavioral reason for having extra metal that would need to be cleaned. At the second plant the welders shortened the solid roof and the cattle often struggled. I demonstrated the need for a longer roof by laying a 70 cm wide piece of cardboard across the system to lengthen the roof. A piece of cardboard instantly made 450 kg cattle become calm. This demonstration of the power of behavior convinced the welders to replace the cardboard with additional metal sheets. Three different equipment construction companies did not build the false floor and I had to go to the plants and put it back on, because the cattle balked and refused to enter the restrainer and ride on the moving conveyor. The false floor was clearly

marked on all the drawings provided to the equipment companies. Transfer to the restrainer technology to the industry could have failed if I had not been there to correct mistakes made by the early adopters.

One month before my Wood-Gush lecture I visited the most recent restrainer installation. They had built the false floor and the overhead roof correctly, but they had omitted two belly rails that keep the cattle centered as they enter the restrainer. This is a third behavioral component. To induce the large cattle to straddle the leg spreader bars at the entrance race must be made narrower at the animal's belly height; and be wider at the floor to provide the animal with adequate space for walking (Figure 3). When the belly rail is missing, the cattle had a tendency to walk on one side of the leg spreader bar instead of straddling it.



Figure 3. Belly rail that keeps the animal centered as it enters the center track conveyor.

Working on the center track conveyor restrainer system convinced me of the power of behavior for handling large cattle which were not accustomed to close contact with people. Some of the range cows were wild animals. The behavioral principles that make the animals remain behaviorally calm are:

- 1. Block vision of an escape route until the animal is completely restrained.
- 2. Do not allow incoming animals to see the visual cliff effect.
- 3. Equipment must move with steady motion and have no jerky motion.
- 4. Slipping frightens animals and the system must have a nonslip entrance ramp.
- 5. Optimal pressure. The adjustable sides had to hold the animal snugly enough so it felt held but not so tightly as to cause pain or discomfort.

3.2 Example of A Whole Systems Approach to Designing a System

Research results on welfare friendly housing for pigs have been adopted in the European Union but have not been widely adopted in other parts of the world. The main reason that handling transport and slaughter research has been more widely accepted is because implementing improved equipment often has a financial benefit such as reducing bruises or it reduces labor requirements. Unfortunately welfare friendly housing often costs more money. In the U.S. people are becoming more and more concerned about individual stalls for gestating sows.

I have been thinking about how to economically convert hundreds of existing totally slatted sow stall buildings to group housing. To keep the cost down, and to be able to use the existing waste disposal systems, the group housing system would have to be unbedded. This would not be the ideal system, but this approach would keep the costs low enough so that large scale conversion of existing gestation stall buildings may be feasible. Whether or not this approach would work may be dependent on factors such as pig genetics or feeder design. One has to look at a whole system that has many variables such as pig genetics, financial costs and weather. Many parts of the U.S. are either too wet or too cold to house sows on pasture systems similar to the systems used in England.

A recent excellent review of the literature on pig housing failed to address genetic differences in how pigs may respond to different housing systems (Barnett et al., 2001). The genotype of the pigs placed in a group housing system may be a determining factor that determines whether or not an unbedded system succeeds or fails. Some pig genotypes are more aggressive and fight more than others (Busse and Shea-Moore, 1999). Aggressive lines of sows are likely to have more injuries in certain types of group housing. I have observed that sows housed in groups on a concrete slotted floor with electronic individual feeding will have some injuries due to fighting. My observations of sows housed in different pens in the same facility indicated that sows from a lean hybrid line had more injuries and abnormal behavior such as ear sucking than a fatter genetic line of sows.

If my goal is to successfully replace individual sow stalls with an indoor unbedded group housing system, it is more likely to be successful if less aggressive sows are housed in the system. The choice of pig genetics may determine whether or not I could successfully replace individual show stalls with an unbedded group system. Critics of group housing systems are quick to point out injuries from fighting. I responded to the critics by pointing out that the group housing system had no shoulder lesions caused by laying in an individual stall. The overall level of injuries to sows is probably similar in the two systems.

3.3 How to Successfully Transfer Knowledge

Scientists need to spend more time communicating with the public and the livestock community about the importance of their work. To do this often requires writing many similar articles for the livestock magazines. The research must also be published in the scientific literature to provide a permanent, accessible record of the knowledge. This prevents knowledge from being lost.

Scientists also need to learn how to write without jargon. Scientific writing needs to be precise and sometimes a simple word is just as precise. One of the things that I have learned during a career where I have successfully transferred behavioral knowledge, is that transfer of the knowledge is more difficult and time consuming than doing the research that generates the knowledge. It is extremely important that the first places that adopt the technology are successful. If the early adoptees of a technology fail, the word

will get out and convincing more people to adopt the technology will be more difficult. To insure that the early adopters are successful requires a great deal of time working with the early adopters to insure that the method or equipment is used correctly.

4. Failure to Transfer Research Results to Industry

Researchers and producers have designed several excellent farrowing stalls for sows which allow the sow to turn around. These stalls are cost competitive and they could be easily adopted by the industry. Unfortunately these excellent designs are not widely used in the U.S.

Another excellent behaviorally based design that was not adopted by the largest U.S. pork companies was a feeder design based on pig eating behavior ergonomics that prevented the pig from wasting feed. A super slow motion camera was used to film the pig's eating movements. Many commonly used feeder designs have feed wastage of up to 20%. Unfortunately, the measurements and specifications for the ergonomically designed feeder were never published in a journal where they could be easily located. One would have to locate Ian Taylor's Ph.D. thesis at the University of Illinois or contact Ian Taylor directly. Another factor that reduced successful large scale transfer was that the design was originally done on sow feeders. If the design had been promoted for finishing market pigs there would have been bigger potential group of people to adopt it.

Why are these excellent and cost effective behaviorally based designs not being widely used? First of all, the farrowing stall designs did not receive enough promotion. And secondly, some of the early adopters tried to modify the design and this resulted in problems. On one farm in the U.S. changes in some of the dimensions caused a turn around farrowing stall to perform more poorly than a conventional farrowing crate. Details of design are important and modifications made by people who did not know what they were doing can block the transfer of promising technologies. Modification of dimensions and installation mistakes can cause systems installed by early adopters to fail.

Even today I have to constantly check up on clients to make sure they build my cattle systems correctly. In June 2001 I checked up on a feedlot that was building a new curved race system. A draftsman had made a drawing mistake that would have ruined the system. Successful transfer of technology requires constant checking up on what people are doing in the field.

Some technologies do not get adopted due to patent fights where one company buys up the patent rights to block adoption of a technology. Another business entity that has impeded adoption of some improved designs is building contractors. Building contractors design things for ease of construction. For example, ventilation in many animal buildings in the U.S. has taken some steps backwards. They are designed for ease of construction and to sell fans instead of proper ventilation. For example, a naturally ventilated building with a pitched roof and a wide ridge vent will stay cooler in the summer than a building with a flatter roof and a small ridge vent. Contractors prefer to build the flatter roof and a small ridge vent because it is easier to build and is more profitable for them. To compensate for the poorer air movement they have to install fans. Contractors will often design things to benefit contractors instead of benefiting the animals. I could provide countless other examples.

5. How to maintain excellent stockmanship and animal

As stated previously, people are often more willing to purchase new technology than to make a sustained

commitment to better behavioral management of animals. I have trained many people to handle cattle and pigs in a careful, quiet manner. For a few weeks the handling practices would be good but in many cases the people reverted back to rough practices such as excessive electric prod (goad) use. I call this bad becoming normal. To combat this problem, I developed a simple scoring system for animal handling at the slaughter plant (Grandin 2001, 1998bc).

This system enables management to numerically quantify variables such as the percentage of animals shocked with an electric prod (goad) the number of animals that fall down, the percentage of cattle that vocalize during handling and the percentage of animals stunned correctly. People manage the things that they measure. Measurement also provides a benchmark which enables people to see if their performance has improved or become worse. Other methods for objectively scoring cattle handling are a police radar speed camera or constructing a squeeze chute with sensors to monitor how hard an animal struggles (Burrow and Dillon, 1997, Schwartzkopf-Genwein, 1998). Burrow and Dillon (1997) found that cattle that run fast out of a squeeze chute where they were restrained for vaccination had lower weight gains. Animals that have been shocked repeatedly will run faster out of a squeeze chute and are more likely to struggle.

Animal welfare legislation and requirements specified by large customers such as supermarkets and restaurants serve as powerful motivators to use behavioral methods. In Europe, legislation has prompted the use of research results on welfare friendly animal housing. In the U.S., welfare requirements of the McDonald's Corporation and Wendy's International has greatly improved handling and stunning of cattle and pigs at slaughter plants (Grandin, 2000b). These restaurant companies are using the scoring system I developed for monitoring animal welfare in slaughter plants. Implementing the scoring system required many days of work. I visited over 30 beef and pork slaughter plants to teach restaurant auditors how to use the scoring system. Audits by McDonald's and Wendy's have greatly improved animal handling and stunning in U.S. slaughter plants.

Plant management had to use behavior principles so they could reduce or eliminate electric prods. They now had to comply with the welfare guidelines of their customers. Some of the behavioral principles are in Grandin (1980, 1982, 1992, 1996, 1998c 2000b and 2001). Making several simple changes in handling procedures, lighting or plant ventilation made it possible to reduce or eliminate electric prod usage (Grandin, 1996-2000b). Some of the changes that improved animal movement and made it possible to reduce electric prod use were, lighting a dark restrainer conveyor entrance, moving lamps to eliminate reflections on a wet floor, eliminating air drafts that blew in the faces of approaching animals and filling the crowd pen that leads to the single file race half full (Grandin 2001 and 1996).

Another good motivator for good stockmanship are financial incentives for improvements in animal productivity or for a reduction in bruises or broken bones during handling. In the poultry industry, paying catchers an incentive for reducing wing breakage reduced broken wings over one hundred percent. A farrowing manager will work extra hard if he/she receives extra money for weaning more piglets. Milkers could be paid incentives for increased milk production.

6. Conclusions

Scientists need to take more initiative to get their research results used by the industry. The steps for successful transfer of behavioral research results to the industry are:

1. Communicate your research results by speaking to producer groups, writing in producer

magazines and making websites.

- 2. Find a place that will try your research findings and be prepared to spend lots of time there. This place must have cooperative management. The manager of the place must believe in what you are attempting to accomplish.
- 3. You must supervise installation and correct mistakes made by other early adopters of your methods or technology.
- 4. Do not allow your research findings to get tied up in a patent dispute. This is especially important for behavioral research. Make your money with consulting fees to help people to use your research.

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