

## MACHINE DESIGN

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Dr. David S. Pratt: It is a distinct pleasure to introduce now, Dr. Sverker Hoglund. Dr. Hoglund grew up on a farm in northern Sweden, completed his education as a physician, and went on to obtain specialty training—first in hematology and then in internal medicine and occupational health. He is currently an Associate Professor at the Institute in Stockholm, and he has worked actively in occupational health since 1974. In 1980, he became the Medical Director of the Swedish Farmworker Safety and Preventive Health Association—a very important model I think many of us could learn a great deal from. He is currently also the First Vice President of the International Association for Agricultural Medicine and Rural Health and also the Secretary of the Scientific Committee on Occupational Health—a part of the International Commission. Please welcome Dr. Sverker Hoglund from Stockholm:

Agriculture is a risky operation. Statistics from many parts of the world show that accidents and work-related diseases are frequent among farmers and agricultural workers.

Often, however, statistics are insufficient because farming, in many countries, is based on small enterprises run by the farmer, his family, and few employees. The ambition to report accidents and other health injuries is probably limited.

In Sweden severe accidents causing fatalities are, fortunately, rather few in agriculture. However, compared with the total worklife in Sweden, it is obvious that farming is over-represented among fatalities due to work accidents.

It has been shown that about 20 percent of the fatal accidents in Swedish worklife occur within agriculture and forestry. Only about 3 percent of the total workforce are occupied within this field. Recent studies in our organization have shown that the real incidence of work accidents is about twice what is reported from official statistics. Moreover, work-related diseases have

been shown to be common among farmers and agricultural workers.

Forestry work by self-employed farmers is the most risky operation in the total worklife in Sweden. Work injuries, as well as work-related diseases, are to a high extent related to agricultural work using different kinds of machinery. Machine design, therefore, is an important factor to consider.

### THE PROBLEM

Machine design may be related to hazards of two kinds. One is accidents causing acute injuries. The other is chronic injuries or illnesses because of long-term, unfavorable effects on the body during work operations. Symptoms from the locomotor organs are most common because of bad ergonomics, vibrations, etc. Hearing loss due to damaging noise is also very frequent.

### Accidents

In Sweden, approximately 150,000 persons are occupied within agriculture and forest-

ry. However, only about 50,000 are occupied full-time at this.

According to official statistics, about 6,000 work accidents occur yearly. This information is based on the reports of injuries for workers' compensation. The compensation is less well developed for the self-employed farmer. Therefore, the ambition to report accidents is less strong.

During 1988, the Swedish Farmers' Safety and Preventive Health Association studied 20,000 farmers concerning work injuries that had occurred during 1987. The study was performed as a postal inquiry and a telephone interview with those who had reported an injury in the inquiry.

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From the results of this random sample, an estimation of the total frequency of work accidents within agriculture and forestry among self-employed farmers and forestry owners could be made. It showed that the real frequency during 1987 was at least double that of the official statistics.

The most common cause of agricultural accidents (just above 25 percent) was handling animals. Falling, on the same level or to a lower level, was almost as common a reason for accidents. Machine-related accidents were about 12 percent in agriculture, and in forestry about 20 percent.

Of those accidents related to tractor driving, about 50 percent happened when climbing up and down the tractor and about 35 percent when connecting equipment to and disconnecting it from the tractor. In these respects, the design of the machinery plays an important role.

The turnover of tractors is still an important reason for severe accidents, as is unshielded power takeoff (PTO). Tractor work may also cause injuries driving on uneven surfaces. Headbumps and hits from the inside of the tractor cabin are a risk, as are hydraulic devices with oil under pressure. Sometimes exhaust gasses may cause problems.

One important machine that is commonly used in agriculture and forestry is the chainsaw. It may cause accidents by kick-backs of the sword.

### Chronic Injuries and Diseases

More than 50 percent of the diagnoses at physicians' consultations with farmers concern locomotor organs. Neck and shoulder symptoms, back problems, and hip and knee diseases are common.

A special interest has been focused on hip arthrosis. Recent studies in our country have shown a significant increase of this disease in farmers compared to the general population. The disease occurs about 8 to 10 times more often in farmers. Still, only limited studies have been performed relating different factors in farmwork to the disease.

So far results indicate that there is a positive correlation between tractor work and the disease. One reason might be the design of tractors where, even in modern machines, the driver has to sit in a bent

and twisted position to survey the equipment behind the tractor.

It has been suggested that the twisted position in the tractor chair may cause a rotation in the hip joint. It can also cause unfavorable pressure on the cartilage, which may cause damage.

Other well-known machine-related chronic injuries are, for instance, white fingers caused by vibration in chainsaws and steering wheels on tractors. In farmers and forestry workers, hearing loss is frequent because of noise exposure from tractors and other vehicles, threshing mills, and chainsaws.

## **INTERVENTION**

There is still a lack of knowledge concerning hazardous effects of different environmental factors in agriculture and forestry and further research is needed about causal relationships. However, today sufficient knowledge exists to start to improve the work environment in order to reduce the health hazards. The outline for an intervention program could consist of three main parts.

1. There may be legal actions taken in order to prevent extreme hazards.
2. There should be strong enforcement on constructors, manufacturers, and dealers of agricultural machines in order to improve the working environment.
3. Information and education must be intensified and directed to dealers of machinery, extension service officers (agents), farmers, farm workers, and forestry workers.

## **Legal Considerations**

In most countries there is some legislation concerning work environment and protection from health hazards. The extent to which legislation should be used is always under debate. The ambition is to have as little legal enforcement as possible.

In Sweden in 1959 the law was put forward concerning safety frames (roll-over protection structures) in new tractors. It was also decided that employed agricultural workers were not allowed to work in tractors lacking such frames. Self-employed farmers and family members for many years were excluded from this law and could use old tractors without frames in farm work. A new tractor, of course, had this device.

In 1983 the law was extended to include family farmers. It was later decided that even old tractors had to have frames if they were to be used in agricultural work.

The effect on fatalities due to tractor turnover since the year of legislation was striking. It is obvious that this action from the authorities, unpopular as it might have been, has had quite a significant effect in preventing severe accidents. Side effects of this safety frame law have resulted in proper cabins on the tractors protecting the worker from noise, dust, wet, cold, etc. This is also quite a step forward concerning work environment.

Another example of effective legislation concerns chainsaws. When they came into frequent use, it was soon obvious that they could cause severe damage to the user by so-called kickbacks. In 1971 in Sweden, it was enforced by law that a special protective device should be applied to all saws.

It operates so that when the sword is flung backwards, the device causes the chain to stop. The drop in severe injuries from chainsaw operations is also significant from the time the law was introduced.

### Improvement of Machine Design

Legal actions can only be taken into consideration concerning specific work environment factors causing severe injuries of high frequency. However, many hazards remain where improved design of the machinery could reduce the risk. It is important that occupational health professionals have the possibility to transmit knowledge about health effects of different factors to the designers of machinery, the producers, and dealers. In industry more work has been done in this area, mainly due to efforts from workers, and representatives in trade unions, etc.

In agriculture and forestry, labor unions are weaker and the workforce is dominated by self-employed farmers. The individual farmer has very little possibility to get his opinion known to the machine designers.

One major task for occupational health organizations in agriculture is, therefore, to improve communication between manufacturers and users. When designing new equipment, they must understand the importance of also considering work environment factors.

In Sweden, we have been able to produce a specification of the demands for good and healthy work environments in tractors. It has resulted in a checklist. The work has been performed in close collaboration with the National Institute for Occupational Health, the organization of the machine manufacturers (LELA), and our organiza-

tion. The checklist now also exists in an English version.

It is our hope that it should be accepted and used on a broad international basis. We have planned to invite representatives of tractor manufacturing companies to a seminar concerning this topic a year from now.

There is, of course, standardization work going on internationally considering work environment factors. However, this checklist goes much further and aims to create a work environment that is healthier in all aspects.

We have recently used the checklist performing a test of new tractors from the ergonomic and work environment point of view. The result has been published in the weekly farm magazine called *Land*. It has been very much appreciated by the farmers.

The manufacturers who got many stars for their tractors are, of course, happy. Those with fewer stars have been rather angry with us. We think, however, that it is our job to take this kind of action.

Our experience is that, after the first disappointment and angry reactions, the dealers with less than good results usually come back and ask for our opinion on how they could make their equipment better. This is exactly what we have wanted with our action.

Today it often occurs that a manufacturer of some equipment asks for our opinion when he is planning a new product. When this happens, we think that our work has been, to some extent, fruitful.

To prevent injuries, there is still much to wish for in tractor design. The power-take-off shield is often of bad design and broken in many older tractors, which causes a significant risk.

In collaboration with the Institute of Agricultural Engineering, we have been engaged in the construction of a new device. This seems to be a significant step forward.

The coupling of equipment behind the tractor often causes injuries. The rapid coupling systems, which exist on the market are not ideal and little used by the farmers. Properly used, they cause a significant reduction of work loads and health hazards.

A big part of the injuries related to tractor work occur when the driver is climbing up and down the steps. They are often of a miserable design and get slippery by dirt. Simple devices can improve this.

The chronic diseases concerned with tractor driving are neck, shoulder, back, and hip problems related to the driver's twisted and bent position while controlling the equipment behind the tractor during long working hours. Knee problems are common in tractor driving and are related to too-heavy clutches. As much as 600-700 newtons have been found in new tractors.

In the new ergonomic check list, 150 newtons has been appointed as acceptable. Valmet, the only Nordic tractor constructor, presented a new model a couple of years ago where many of these problems have been considered.

The driver's seat, steering wheel, and maneuvering devices could be turned 180 degrees so that the driver might sit in a backward position when much work had to

be done with equipment behind the tractor. There was no clutch because of hydrostatic driving of the machinery.

Two important improvements from the work environment point of view were achieved by this construction. The need to sit in a twisted position was markedly reduced, and the clutch operation was no longer needed. We need more of this new and brave thinking in the machine design for the future. Because of other technical reasons, the model still is experimental.

It still happens that kickbacks cause injuries concerning chainsaws. A Swedish doctor has constructed a new protection device, which should be more effective. It is now tested. The Swedish firm, Husquarna, is going to provide some models with this new and safer device.

### Increased Awareness

In spite of legal considerations and improved machine designs, there will still be hazards concerned with machine operations. It is, therefore, important, along with other actions, that knowledge about health hazards and how they can be prevented is increased. This is needed among the users of agricultural machinery and also among advisers within different branches of extension services to farmers, and among dealers of agricultural machinery.

It is a difficult task. Farmers are usually very busy and get much information of different kinds. They have very little time to consider different offerings. Written information often is neglected. The motivation to consider information about health hazards is usually low among people who are quite healthy and do not consider accidents a reality.

One way to improve the possibility to get information through is by an occupational health service. In Sweden since 1978, occupational health service for farmers and farm workers has been organized and now covers the whole country.

It has about 60,000 affiliated members. Our customers are offered services consisting of regular health checkups, information meetings, farm visits, short courses concerning specific health problems, first aid, back and neck schools, etc.

They also have access to health care in case of medical problems related to work. It has turned out that the awareness of health hazards has increased considerably during the last years.

The farmers inquire about work-environment factors when they are buying new machinery more than previously. They are also inclined to use the personal protective equipment more frequently. Nurses performing health checks on farmers, physiotherapists, and safety engineers visiting farms pointing out ergonomic details to the farmer on his tractor have golden opportunities to provide information to motivated farmers.

It is also possible to concentrate on one specific problem and to broaden the information by educating advisers to the farmers. An ongoing project is to produce

information materials concerning the new ergonomic checklist and to give the extension service officers and safety engineers education on how to use it in their work with the farmers. Teachers at agricultural schools and dealers of agricultural machinery are also invited to these courses.

## **CONCLUSION**

Today's knowledge about health hazards in relation to machine operations is fragmentary but, in many cases, enough to start prevention programs. Thus, the hazards may be reduced and health and well-being improved among farmers, farm workers, and forestry workers.

Legal actions may considerably reduce specific risks associated with machine design. By influencing constructors and manufacturers, improved work conditions can be achieved.

By effective information and education awareness of hazards, preventive measures can be augmented. A branch-specific occupational health service for agriculture and forestry is a valuable tool in this respect.□

## VECTOR CONTROL

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Dr. David S. Pratt: We are going to move along to this morning's program with Dr. Robert Pinger. Dr. Pinger got his undergraduate training at San Jose State in California, and received a master's and a Ph.D. from Iowa State University, right here in the great state of Iowa. He has worked extensively with vector control and entomological research both at the National Research Council at Walter Reed Army Institute of Research in '74 and '75, and then also had some tropical experience in Brazil as an associate research scientist at the National Research Institute of the Amazon. Since 1977, a little less tropical, he has been at Ball State University in Muncie, Indiana, and his current research interests include mosquito- and tick-borne diseases. Dr. Pinger's going to talk about vectors and agricultural safety and health. Dr. Pinger:

Farmers, ranchers, and others employed in agriculture are, by the very nature of their work, at significant risk for acquiring certain vector-borne diseases. Some of you may ask, "What is a vector-borne disease?" or, for that matter, "What is a vector?"

A vector is an invertebrate animal, usually an arthropod, that transmits disease from a reservoir of infection to a susceptible host.

What is an arthropod? An arthropod is a joint-footed animal with a hardened exoskeleton such as an insect or a tick. Examples of arthropod vectors are mosquitoes, flies, fleas, lice, and ticks.

Vector-borne diseases are caused by microscopic agents such as viruses, bacteria, protozoans, or worms transmitted by these vectors, usually when they bite. Examples of vector-borne diseases that occur here in the United States include at least four arthropod-borne encephalitides, malaria, dengue fever, Rocky Mountain spotted fever, and Lyme disease.

Before I discuss these diseases, I should like to state that those in agriculture are

also exposed to a variety of arthropod-related health problems. The insects or arthropods are themselves the agents of disease or injury.

In these cases, the arthropods affect health directly, rather than indirectly (as vectors). Direct effects include entomophobia (an unrealistic fear of insects), annoyance and blood loss, envenomization caused by biting and stinging, dermatosis, myiasis, and allergies.

### ENVENOMIZATION

My students are sometimes confused about the difference between biting and stinging.

### Biting

Biting refers to interactions in which the arthropod uses its mouth parts. Biting insects include, but are not limited to, mosquitoes, horse flies, fleas, lice, and bugs.

Biting arachnids include ticks, such as the American dog tick, the lone star tick, the deer tick, and chiggers. Venomous arach-

nids include the brown recluse and the black widow spider.

### **Stinging**

Stinging refers to interactions in which the arthropod uses its tail (usually a modified ovipositor) to inject venom. Stinging arthropods include bees, such as the recently arrived Africanized honey bee; wasps, including the newly introduced German yellow jacket; and in the South, fire ants and scorpions. Male entomologists, who are easily in the majority, generally enjoy pointing out at a time like this that virtually all of this biting and stinging is done by female arthropods.

Although all too familiar, and at times very annoying, these occurrences are of relatively minor public health importance compared with the disease transmission capabilities of arthropod vectors. Today I will describe some of these vector-borne diseases, discuss vector control strategies and outline personal precautions that can reduce the likelihood of vector-borne disease transmission in the agricultural setting.

## **VECTORS**

We can divide vectors into two major types: mechanical vectors and biological vectors.

### **Mechanical Vectors**

As mechanical vectors, insects can be thought of as contaminators. They carry disease-producing agents from an unwholesome environment, such as septic tank overflow, to a clean environment such as the top of your beverage can or sandwich.

In some rural settings, house flies may become so numerous that they represent a significant health problem. The variety of disease-producing agents that have been recovered from house flies is staggering. The list includes those agents that cause amebic dysentery, typhoid fever, cholera, shigellosis, trachoma, poliomyelitis, and infectious hepatitis.<sup>1</sup>

Another mechanical vector is the cockroach, from which about 40 strains of pathogenic micro-organisms have been isolated. These microorganisms include four strains of poliomyelitis virus, cholera, diphtheria, pneumonia, tuberculosis bacteria, and numerous intestinal protozoans. Mechanical transmission can also occur when a blood-feeding insect, such as a horse fly or stable fly, is interrupted while feeding upon an infected host, then completes its feeding on a susceptible host.

Although mechanical transmission by flies and cockroaches can be of public health concern in some agricultural settings, biological transmission of diseases by arthropods is much more important. In biological transmission, the disease microorganism undergoes developmental changes and/or multiplication in the vector.

There is also an incubation period during which the arthropod is infected but not infectious. It is unable to transmit the disease. After incubation, the arthropod becomes infectious, and remains so for life.

### **Biological Vectors**

Examples of biological vectors include mosquitoes, ticks, fleas, lice, and certain other biting flies. Mosquitoes, the most notorious of all insect vectors, are capable of transmitting at least 3 species of filarial worms, 4 species of malaria, and a large

number of disease-producing viruses. Of the roughly 500 different arthropod-borne viruses catalogued, 249 have been isolated from mosquitoes.<sup>2</sup>

Ticks also transmit a variety of disease agents including those that cause babesiosis, Lyme disease, Rocky Mountain spotted fever, Colorado tick fever, and Powassan fever. Disease agents transmitted by other insects include murine typhus and plague, transmitted by fleas; epidemic typhus and trench fever, transmitted by lice; and a multitude of viruses, bacteria, protozoans and worms transmitted by biting flies and gnats.

On a worldwide basis, vector-borne diseases continue to affect the health of agricultural workers on every continent. In Africa the tsetse fly and sleeping sickness not only cause 7,000 human deaths per year, but also limit cattle production over 10 million km<sup>2</sup>. Therefore, they contribute to the severe protein malnutrition on that continent.

Malaria and mosquito-borne encephalitis affect rice farming in Sri Lanka and elsewhere in Asia.<sup>3</sup> Yellow fever afflicts those clearing forests for farming in parts of Central and South America.

In the United States, most of the vector-borne diseases that have an impact on agriculture and agricultural health are zoonoses, diseases of animals transmissible to humans. Among the best known zoonoses are those caused by four mosquito-borne viruses: the St. Louis encephalitis (SLE), the California encephalitis (CE) viruses, the western (WEE) and eastern equine encephalomyelitis (EEE) viruses. Each of these diseases has its own geographical distribution and pattern of transmission.

While periodic outbreaks of these mosquito-borne viral encephalitides occurred, no doubt, long before the arrival of Europeans<sup>4</sup>, accurate records of outbreaks date only to the 1930's. Between 1930-1945, mosquito-borne encephalitis killed an estimated 300,000 horses and mules in the U.S.<sup>5</sup> Human illnesses were often associated with these epizootics.

For example, in 1941 North Dakota alone reported 1,080 human cases with 96 deaths.<sup>6</sup> During the period 1956-1969, reported human cases of arthropod-borne encephalitis numbered more than 3,000.

In 1975, both SLE and WEE were epidemic and epizootic throughout much of the United States. There were more than 2000 human cases,<sup>7</sup> many of them in farm workers. The WEE epizootic spread into Manitoba, where the importance of outdoor exposure is illustrated by the distribution of 14 human cases.

All but three of these cases were men. Interestingly, all three women who contracted the disease were widows who presumably then did more outside chores than their married counterparts.

Why do we not hear about these diseases anymore? Are they still around?

Let me call your attention to last year's St. Louis encephalitis outbreak in Florida. Although case investigations are still being completed, the first case occurred in Fellsmere, Florida, an agricultural area. At least some of the cases were in farm workers.

The economic impact of this outbreak is still being felt. Disneyworld receipts were off 10-25 percent for October through December. The annual costs of mosquito

control ran \$2-4 million above the normal cost, and there was a \$270 million shortfall in Florida's tax revenue for 1990.<sup>8</sup>

It is true that the current epidemics and epizootics seem less pronounced than those of 50-60 years ago. There are several reasons for this. First, there are fewer horses now than there were in the 1930's and 1940's.

Second, vaccination of many of the remaining horses against WEE and EEE has no doubt contributed to the elimination of large epizootics in horses. This does not explain the decline in human cases, however, particularly when there is no evidence of a decrease in the level of virus activity in nature.

Gahlinger, Reeves, and Milby postulate that changes in people's behavioral patterns have been responsible for the decline in human cases in California. Their study demonstrated that the advent of air conditioning and television substantially reduced exposure to infectious mosquitoes. People were found to prefer remaining indoors during the peak feeding times of the primary vector, *Culex tarsalis*.<sup>9</sup>

Others suggest that the low number of confirmed cases is a product of our disease-reporting system. This phenomenon has been referred to as the "vector-borne disease iceberg."

In this model, we see that most of the cases of mosquito-borne encephalitis are never reported because of misdiagnoses, poor follow-up, and no confirmatory serum sample. Grimstad and coworkers determined that the ratio of reported cases to actual cases in Indiana is about 1:250 for St. Louis encephalitis. The ratio of report-

ed cases was 1:1,000 for the LaCrosse strain of California encephalitis.<sup>10</sup>

Some cases are reported incorrectly as aseptic meningitis or "unspecified viral encephalitis." Cases often end up in this category when no convalescent or follow-up blood sample is submitted. The seasonal distribution suggests, though, that they are, in fact, arthropod-borne illnesses.

A failure in reporting is less likely to occur when there is a severe or fatal case. It is important to note that, in addition to the pain and suffering associated with a severe case, there can be significant medical costs. This is particularly true if the patient is a child who requires many years of institutional care.

Leaving the encephalitides, I want to mention two other mosquito-borne diseases that affect those in U.S. agriculture: malaria and dengue fever. Malaria, transmitted by *Anopheles* mosquitoes, is once again becoming a concern in California where there have been 60 introduced cases in the last 5 years, virtually all in farm workers in San Diego County.<sup>11</sup>

Florida suffered its first introduced case in 43 years in 1990. An introduced case differs from an imported case in that it is one in which transmission occurs within the state.<sup>8</sup>

Another somewhat vector-borne disease that we have thought of in the past as an exotic disease, but which now poses a very real threat to many in agriculture is dengue fever. Health officials are concerned that the dengue fever virus, imported from the Caribbean into California or Florida with the migrant workforce, could also be transmitted within the United States.

This becomes increasingly more likely with the spread of the Asian tiger mosquito, *Aedes albopictus*, which is now considered to enjoy a statewide distribution in Florida.<sup>8</sup> This specie, which arrived in the United States from Asia in imported truck tires in 1984 or 1985, is a more aggressive biter and a more efficient vector of the dengue fever virus than the yellow fever mosquito, *Aedes aegypti*.<sup>12,13</sup>

Since the early 1980's, tick-borne diseases have received much more publicity than mosquito-borne diseases. Who has not heard of Lyme disease?

For those who have not, Lyme disease is a systemic, bacterial, tick-borne disease with protean manifestations including dermatological, arthritic, neurologic, and cardiac abnormalities. It is caused by the spirochete, *Borrelia burgdorferi*, which is transmitted by ticks in the *Ixodes ricinus* group. It is often the nymphal stage of these ticks that transmits the disease. The most noticeable early sign is a red rash emanating from the site of the bite.

The disease has spread rapidly in the United States since its discovery in 1975. It has now been reported from 47 states including, most recently, New Mexico.<sup>14</sup>

Actually during the period 1983-1987, tick-borne diseases made up more than three-quarters of all reported cases of vector-borne disease in the United States.<sup>15</sup> Rocky Mountain spotted fever actually declined during the 1980's from a high of 0.52 cases per 100,000 in 1980, to 0.25 cases per 100,000 people in 1989.<sup>16,17</sup>

Meanwhile, Lyme disease showed a dramatic increase over the same period from 0.10 cases per 100,000 in 1980, to more than 3.5 per 100,000 in 1989. The 1990

case data are still incomplete for some states. It appears, however, that the number of reported cases of Lyme disease may be leveling off or even declining slightly. This may be due to a change in the case definition, which now requires laboratory confirmation of clinical cases without a rash.

## VECTOR CONTROL

The title given to this presentation was *Vector Control*. Obviously, in the time remaining, I cannot tell you how to control all of the species of mosquitoes, ticks, flies, and other vectors that are of importance to the occupational health of American farmers.

I can review some widely accepted guidelines, however. There are three approaches to vector control: physical control, chemical control, and biological control.

### Physical Control

Physical control is the modification of the environment to reduce or eliminate vector populations. This type of vector control is the most desirable because it is the most permanent. Populations of mechanical vectors such as house flies and stable flies can be reduced or eliminated by maintaining proper sanitary conditions.

For example, the regular removal of livestock and pet manure, soiled bedding, straw, garbage, and all other decaying plant and animal matter will reduce breeding sites for house and stable flies. Similarly, cockroach problems can be reduced or eliminated by the proper construction of human dwellings, regular cleaning, proper food storage, and food waste disposal.

The distribution of the mosquito-borne diseases correlates closely with the distributions of their primary mosquito vectors. Since all mosquitoes are dependent upon standing (or very slow moving) water during the early stages of their development, proper water management in agriculture can substantially reduce the risk of infection with these diseases.

In the west, physical control means efficient water management with respect to irrigation and other methods of watering crops. In the east and midwest, those in agricultural settings should strive to eliminate all standing water near the home.

This means ditching, draining, or filling low areas near homes whether under cultivation or not. It means maintaining steep, weed-free banks in man-made ponds and lakes. It means removing all man-made and natural water holding containers from near the home.

Integrated Pest (Vector) Management (IPM) is the use of the safest and most appropriate combination of methods (physical, chemical, and biological) to control vector populations.

These containers afford breeding sites for the vectors of LaCrosse encephalitis. Examples of containers that should be eliminated are rain barrels; used car, truck or tractor tires; paint buckets; and plastic containers of all kinds. Tree holes that are found should be filled in with sand or cement.

Physical control methods for ticks include the removal of all unnecessary shrubs and vegetation from near living quarters, the

extension of the mowed portion of the yard, and the regular and close mowing of grass for at least a 50 foot perimeter around the house. The greatest enemy of ticks is desiccation. By removing vegetation you reduce the survival time of ticks.

### Chemical Control

Chemical control is the use of chemical agents (pesticides) to reduce or eliminate vector populations. Chemical control is best viewed as an adjunct to physical control.

When properly applied, it can be of great assistance in lowering the risk for disease transmission on a temporary basis. There are many excellent chemicals on the market for mosquito and tick control.

However, we are all familiar with the problems associated with extensive reliance on chemical control. These include the development of resistance, the destruction of non-target organisms, and cost.

### Biological Control

Biological Control is the use of biological agents, such as microorganisms, other arthropods, or vertebrates, to reduce or eliminate vector populations. In some respects, biological control is a promise that has never been fulfilled. Nonetheless, the use of mosquito fish, *Gambusia*, and the spore-forming bacteria, *Bacillus thuringiensis* var. *israelensis*, have been moderately successful in mosquito control.

### Integrated Pest Management

Integrated Pest (Vector) Management (IPM) is the use of the safest and most appropriate combination of methods (physical, chemical, and biological) to control

vector populations. In medical entomology, IPM means the reduction of a vector population to a level below that which poses a significant health risk.

## PERSONAL PROTECTION

Personal protection offers another avenue for lowering your risk of acquiring a vector-borne illness. Personal protection is the practice of health-directed behavior that reduces the risk of acquiring a vector-borne disease infection. Examples include the following:

1. Avoiding areas where and when vectors are present.
2. If you must enter these areas, wearing the proper clothing (long pants and long sleeved shirt, socks, and shoes).

3. Use repellents properly and appropriately.
4. Removing ticks promptly using the correct method. Prompt removal greatly reduces risk of disease transmission. Grasp the tick as closely to the skin as possible and pull slowly and directly out.
5. Notifying a physician if illness occurs. Be sure to mention a tick if you are suspicious.

A knowledge of vector-borne diseases, a sound understanding of approaches to vector control, and a familiarity with procedures for personal protection can reduce the risk of contracting a vector-borne disease.□

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## Intervention - Worker Protection from Environmental Hazards

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## A CONSULTING ENGINEER'S PERSPECTIVE

By Ray H. Crammond, P.E.  
Consulting Engineer, Crammond Engineering Company

Dr. David S. Pratt: The first perspective we will have is from a consulting engineer. Ray Crammond is a consulting engineer born here in Iowa and a graduate of Iowa State University. He has an extensive career and background both with county government and also as a private engineering consultant, at least since 1978. He has extensive knowledge dealing with farm-related and rural resident issues. We are very happy to have *A Consulting Engineer's Perspective*.  
Mr. Ray Crammond:

First of all I would like to say I appreciate the opportunity to be here to speak to you today, and this is an issue I have a lot of interest in. I am glad that the session carried over to this afternoon, because I was tied up this morning in a deposition. It did not have to do with personal injury, just manure run-off between two neighbors.

A lot of times misunderstandings come up when you try to talk about a subject. As an example, I was reminded of an agricultural engineer who had phoned a veterinarian, and he said, "Say, Doc, I have got a sick cat. He just lays around and licks his paws. He has no appetite. What should I do?" The guy replied, "Give him a pint of castor oil." Somewhat dubious, the agricultural engineer forced the cat to take the pint of castor oil and a couple of days later he met the vet in town, and the fellow said, "Well, how's your sick calf." He says, "Sick calf? That was not a sick calf; it was a cat." He said, "Well, you did not give him the castor oil, did you." "Sure did," said the agricultural engineer, "last time I saw him he was going over the hill with five other cats. Two were digging, two were covering up, and one was scouting for new territory."

I have been asked why I got involved in consulting work. The best way to put it is I figured it was easier than farming. I grew up on a farm in Southeast Iowa, and I am still involved in the farm, but I always figured there had to be a better way of doing things. So that is how I got into the agricultural engineering.

We talked some about stress the past day or two. In the 1950's, wheat was \$3 a bushel and psychiatry was \$3 an hour.

In the 1960's wheat was only \$3 a bushel, psychiatry was a little bit better operation; it was \$20 an hour.

In the 70's, wheat was still \$3 a bushel. Psychiatry was a little bit fancier digs, and it was \$60 an hour.

In the 1980's the farmer was into the psychiatrist at \$100 an hour, and the wheat was still \$3 a bushel. That is the way things have gone, and that is one of the reasons for the stress that the farm community is facing.

On the other hand, some people have the idea that an engineer has a life where he can just sit back and say, "Yes, I went through your plans a few minutes ago, and that's all there is to it."

## ENGINEERING

This was a quote from Herbert Hoover who was an engineer as well as a number of other jobs that he had. He talks about it being a great profession:

*...the fascination of watching the pigment of the imagination merge, through the aid of science, to a plan on paper, that moves to realization in stone, or metal, or energy; and it brings jobs and homes to man; and then it elevates the standards of living and adds to the comforts of life. That is the engineer's high privilege.*

The great liability, of the engineer, compared to men of other professions, is that his works are out in the open where all can see them. His acts, step-by-step are in hard substance. He cannot bury his mistakes as a-you can kind of fill in the blank with other professions.

He cannot argue them into thin air or blame someone else. He cannot cover his failures with trees and vines, and he cannot screen his shortcomings by blaming his opponents and hope the people will forget. In other words, if he screws up, he is responsible.

On the other hand, his is not life among the weak; destruction is not his purpose; quarrels are not his daily bread. That is one of the reasons why a lot of engineers do not like to get involved in liability cases or product suits.

To the engineer falls the job of clothing the bare bones of science with life, comfort, and hope. No doubt, as the years go by, people forget which engineer did it, even if they ever knew, or some politician puts his name on it, or they credit it to

someone else who used other people's money.

But the engineer himself looks back at the unending stream of goodness that flows from his successes with a satisfaction that very few professions may know. The verdict of his fellow professionals is all the accolade he wants.

I think that holds true in a lot of cases for the people in the engineering profession. The problem is that in some cases, depending on a person's temperament, training, background, or whatever, the engineering procedure can start you out with a simple premise that the sum of two quantities in the form of one plus one equals two; but then as you study and get deeper into your subject matter you know that one equals log of e and that one equals  $\sin^2 x$  plus  $\cos^2 x$  and so forth.

You get down there and rewrite all those equations. At this point it should be obvious that equation three is much clearer and more easily understood than equation one. Other methods could be used to clarify equation one, but these are easily discovered once the reader grasps the underlying principals.

I think too many times what happens when you talk about whether it is the design of a product or a tax code, whatever it might be, you know that one plus one equals two, but to get back to it, after going through what is on the bottom line there, you wonder where you are at.

This is one of the definitions I like about engineering; It is the art of directing the great sources of power and nature for the use and convenience of man.

Another thing regarding engineers is the study of both human needs and natural phenomenon. These two fields of study give essential unity to the profession for all engineers, whatever their specialty, must know both human ways and natural forces.

### Human Needs

One of the biggest problems I have seen in the 20 years since I have gotten out of college, in the work that I do, is that the engineer—if I am looking at a particular problem on a site or whatever—has looked at only the natural forces. They ignored the human forces - whether by their nature, the course of study, or whatever, they tend to drop one-half of the input there. That is where a lot of problems occur.

So, I think the biggest problem is people who ignore the human input.

I had one engineer say, on a grain bin case that, "Well, if there was a warning saying that it should only be piled to a certain level, by gosh that is what it should be. The grain should be put in at that level."

Knowing how farmers operate and how equipment operates, if you have a building that is about 200 feet wide and over 600 feet long and you are running grain in there at 17,000 bushels an hour, you probably will not hit that line right on the nose. You had better figure that what can be put in there up to the eaves is going to be put in there up to the eaves. If you do not design to that, you are only fooling yourself.

So, I think the biggest problem is people who ignore the human input. It is where they run into trouble.

### Natural Phenomenon

It would be a lot easier these days to be, another type of engineer than an agricultural engineer because on top of everything else that we have got to contend with, just when we think we have got all of our data down, we have to deal with some new factor. Whether it is growth hormone that suddenly changes the dimension of the stalls or the strength of the animals, or whatever it might be.

You can also run into unexpected natural phenomenon, after having, in the past 15 months or so, drilled 200 or 300 holes in Iowa for waste storage basins for livestock facilities. I have run into situations like that.

### SYSTEMS DESIGN

Now a couple of quick definitions from my perspective. I get involved in product design, but more in systems design. If you are talking about a contractor, well then you are generally talking about a gambler who never gets to shuffle, cut, or deal. A bid opening is a poker game in which the losing hand wins. There is the bid that is a wild guess carried out to two decimal points. The low bidder is the contractor who is wondering what he left out. The engineer's estimate is the cost of construction in heaven. Meanwhile, the project manager is the conductor of an orchestra in which every musician is in a different union.

Critical path methods, which some of you may have used, is the management technique for losing your shirt under perfect

control. An auditor is a person that goes in for the wounded after the war is lost and bayonets the half maimed. A lawyer is the person who goes in after the auditors and strips the bodies.

### **"Free" Advice**

I guess one of the things I have run into is the value of free advice might be worth less than what you paid for it. Too many times I have seen situations where somebody relied either on their good buddy or friend, or whomever; maybe even on technical personnel, and come to find out that they got into deep trouble when they relied on a situation where they thought they were getting a good deal.

Another case involved ventilation systems. Well, the fellow himself was not so much personally injured as he lost \$50,000 worth of hogs. You know, any fool can design a ventilation system, a lot of people will say, and so many do.

I have run into cases where you can lead a client to enlightenment. We have been talking about training and so forth. That is all fine and good, but there are some cases where they just simply will not pay attention to you, or go on about their business and ignore you completely.

### **Disclaimers**

Disclaimers should not be used to protect poor design. How many times I have been involved in grain bin cases—whether bin drownings or bin collapses—somebody has a decal or a warning saying, regarding roof vents for instance, that they should be kept cleaned out. The only way to get to them is to tie yourself off on a rope and swing out there like Tarzan to get to it, and

there are no ladders, nor access to it. Does that make any sense?

Does it make the home office feel better that you have got a disclaimer on there so you are protected. To me it is just ridiculous, and you are not fooling anybody, especially the courts. You might find yourself in a lawsuit.

### **Training**

The other thing is it is easier to teach rules and to train rules than to train judgment. That is an area where we have to focus on in training judgment, and we end up trying to legislate common sense.

### **Poor Engineering**

Poor engineering entails failure and misfortune, inconvenience, suffering, death.

In one case three people died in a manure pit when they went down to fix a pump malfunction. In this situation could we have pulled the pump out without having to go down into a pit so a father and his two sons would still be alive?

I remember on a project one time when I was talking to a banker in 1974. He said, "What do we need an engineer for? The building company does all that?"

It turned out later — a few weeks later — I got a call. He wanted me to work on this particular project. Since that time, I have had numerous referrals on similar projects. But in this case they had a \$300,000 building coming in a few weeks, and they had made no provisions or planning on where they were going to put this thing. So, they finally came around to realizing that maybe the building company does not do all of that.

Another comment that I hear out in the field, "I got a special deal on this. How do you like it." A lot of times not very well because it usually leads to either failure or injury; but, the guy got a good deal on it so, to him, it was okay.

A farmer has a choice as to whether he wants to buy this option or accessory item. I think back to the time I sat through a seven-hour deposition involving a bin drowning. We started at nine in the morning and ended up at four. We did not even break for lunch.

The poor court reporter's fingers were about ready to drop off, I think. Somebody brought in some candy bars at about 1:30 p.m. The question was given to me, "Could this farmer buy these roof vents as an accessory item?"

In this particular case I said, "In your own manual it says that if the roof is installed in a certain way with roof clips in the down position where there's no gap, that there must be one roof vent for every so many cubic feet per minute of fan capacity." In this case, I think it figured out five or six roof vents.

This 42-foot diameter bin had no roof vents on it whatsoever. The fellow was in there trying to poke down the corn with a rod, trying to get it broken up so it would feed into the unloading auger. They found him in the middle of the bin about six feet off the bottom.

It had just been minutes before that his nine-year-old son was in there. If his wife had not insisted that the son get out of the bin, while she went to fix dinner that evening, he would have been in there, too.

I pointed out to the attorney who asked me that question, "In their own manual it says that if the roof is installed in this position, there must be a roof vent for so many CFM of fan capacity. How can you, in good conscience, tell me that this is an accessory item?" He never asked me another question.

That is where I think we get into the systems approach. In this particular case, the farmer never got the manual, or he might have discovered there was a problem that he could have acted on differently. We found in discovery that the manual was on back order, and he never received it.

Why did you build at this site? "Well, the salesman said it would work." That has created a number of problems, in some cases the health of people; in some cases their pocket book. One case where people spent over \$300,000 were ready to move some livestock into a building. They were sued, and they had to change things.

"A bin is a bin," spoken by a farmer, a social studies teacher, or someone who bought a bin company because he wanted to get into a business of his own. He put up over 40-thousand bushel bins, and the roof was blown out and disrupted the farmer's income.

He was not around the bin at that time, but he lost the bin, he lost the farm, he lost his wife through the protracted, final settlement. Meanwhile, this guy had been warned by the bin company just a few months before. He was given decals to put on his customer's bins, which warned that there was a problem. He just ignored it. He never went out and contacted anybody.

The other thing relating to that is when we took the deposition of one of the engineers

for the bin company. He had been with the company for over 30 years. He had been in every phase of it, and you would think he would know what was going on. He was asked, "On this warning we are talking about, 'Do not run the fans during icy conditions,' define what that meant?" He said "I don't know."

So, here is a company that charges an engineer with writing up a warning label. He has had 30 years experience with the company.

He writes a warning label that he cannot even interpret, but they can stick it on their manuals or out on the bin and say, "Okay, it is up to you, farmer, to guess what this means." They think they are in the clear. It is things like that, which really burn me up.

## CONSULTATION

Sometimes you run into, "That Product B is no good." You ask them where they get their information. "Oh, the salesman for Product A said so."

I think one of the problems in agriculture is there are very few independent consultants or consulting engineers who have been able to look at a situation and make recommendations regarding some of these factors.

Another thing that was brought up is that we are dealing with, especially traditional agriculture, a farmer who feels that he is a jack of all trades. That being the case, they try to do most of their own repairs a lot of times, sometimes not with the best results.

As an example of designing out problems, about 10 or 12 years ago a fellow came to

me. He wanted a tank designed for manure storage. I changed his original concept. There are half-inch diameter steel cables that are enclosed within panels that go all the way around the tank. There is a special jacking panel where they come out.

One of the problems you can run into on these tanks is the build-up of ice. In this particular case it was a couple or three feet of ice. All of a sudden a big sheet of ice collapsed. That is a lot of force. There have been metal tanks that I know of that have just split in those situations.

In this case, there was a tremendous noise. The guy went running off and two fellows who were near the tank went running off. A guy coming back from the field could not figure out what was going on. They thought the thing was collapsing. Instead of collapsing it held together. That is what factors of safety are for in design.

The panels had holes that are cast right in the panels. What happened was the top cable snapped; when you have 20 tons of force, a cable snaps. I thought back to the time when a friend of mine from high school was in the Navy over in Viet Nam on an aircraft carrier, and when one of those cables snapped, it cut him in half. I thought, well if you are designing a tank like that, if you have cables on the outside and a cable broke, what would happen.

In this case it was completely contained. Nothing happened. In fact, they went on and used it for a year or so, and then the guy came back and threaded in a new cable. So, that is just one example of how problems can be designed out.

I guess from this standpoint, we have heard about the gas from livestock causing problems. We have to decide whether we

are going to encourage and train people or are we going to hit them with regulations and say that, you know the Ten Commandments or whether it is going to be the Golden Rule. How would you do it so you would not cause problems for somebody else?

## **TECHNOLOGY**

The other thing that is affecting this whole situation of injuries and accidents is misapplication of technology. After my sophomore year in 1968, I worked during the summer for a company in Burlington, Iowa.

I remember being impressed at that time as I was putting together drawings from several different departments of a new crawler. One of the other engineers was walking by the drafting table, when he stopped and looked. He never said a thing to me. I was just a student trainee that year. Then he looked at that again. He went and got some other fellows.

They looked at it again, and they had a conference. I did not know what was going on. It turns out that when I had drawn in where the track would go around near the operator's platform, there had been a situation one time, where somebody had been injured or a problem had come up with clearance between the track and the platform for the operator. They caught it, and the design was changed to rule out that problem.

You always have to deal with the question that came up yesterday that if somebody does suggest a change, who is going to pay for it, and whether or not we try to squeeze it out of the price that the farmer gets for the product that he sells. In any case, something needs to be worked out because we do need him and her. If not, food prices are going to be a lot higher, and I think our way of life is going to be changed quite a bit.□

## AN EXTENSION SPECIALIST'S PERSPECTIVE

By Rollin D. Schnieder, M.S.  
Extension Safety Specialist, University of Nebraska

Dr. David S. Pratt: Rollin Schnieder has been in safety in American agriculture for 35 years. He is one of the real pioneers and leaders. He is someone I certainly have admired over a long period of time. Right now, he is professor of Biosystems Engineering at the University of Nebraska in Lincoln. For 35 years, he has been on staff there. He has helped to write the history of the Emergency Medical System (EMS) program and the communications program in Nebraska. Dr. Schnieder has written a great deal and been a major contributor to the understanding of safety in agriculture. He has also been collaborating with the people at the medical center in a way that is allowing the two branches at the university, in both Lincoln and Omaha, to collaborate with each other. Although the medical college and Lincoln campus have worked together before, they are hoping to blaze new trails. Today, Rollin is going to speak to us as only he can. He will speak to us from *An Extension Safety Specialist's Perspective* on this issue with a long history. Help me welcome Mr. Rollin Schnieder.

Dr. Pratt asked me to show this book to you. In 1965, when the Department of Transportation (DOT) was coming into being we had 16 parts of DOT. One of them was clean-up. One was the transportation of people.

I can remember vividly the night in September of 1965, in the Cornhusker Hotel, where we had a group of about twenty people that were looking at the EMS program and also the communications program. Looking at EMS, in 1983 or 1984, I told Dr. Ken Kimball, who was on this committee, and Brigadier General Don Penterman, who was looking at communications, that:

*We ought to write a book of what we know about the history of EMS and communications in the state.*

So we did.

This came out in 1985. It is a 264-page manual on the whole history.

There is only one other that I am aware of in the nation. That is Wyoming. They have a 190-page pictorial booklet. We put ours in the form of writing.

There will be another book coming out soon, probably 165 pages on farm accident rescue. The American Academy of Orthopedic Surgeons will publish it.

Dave Morgan from our staff, who is a tractor test engineer and EMT instructor in his own right, and I wrote this up. Hopefully, this will be published by late fall.

I am going to use a little different variation from Ray's (Crammond) presentation. I was most impressed with the speakers that we had yesterday. I wanted to add a few things as I sat there and listened.

### STATISTICS

Dr. Høglünd spoke of statistics. He said that there is a variation in statistics. You had better believe me; there is a variation

in statistics. When you try to compare the United States to Sweden to Denmark to England to Germany, there is a real variation.

Dr. Gary Erisman did not say it, but he and I have talked about this before. Gary's point was that we talk about the number of fatalities and the number of injuries we have. He has told me that "there are a lot more out there than we know about." I feel exactly the same way.

In 1978 or 1979, after OSHA had been in force for a few years, we had some people comment, "My gosh, here we have got OSHA and the statistics are going up." No, they were not going up. They were out there all the time.

People were just finding them. Gary and I were advisors to OSHA from 1972 to 1976 so we had a good background on what was taking place.

I remember that there was a new safety specialist in Colorado. He called and wanted to know if I would train him.

A few months later Sid said, "I am glad we don't have the problem that you have in Nebraska." I replied, "Sid, you have it in Colorado. I know my problem. I am going after the figures. You are not."

That is what happens. We also know that some of these statistics are hidden. So, I appreciate the comments regarding statistics.

I was back at a meeting with John Pollock and Dr. Pratt a few years ago. They had reinstated a farm injury study in New York.

It amazed them to know that they had 35 fatalities in that first year of their study. They were working with the Farm Bureau in New York. They could not believe that they had that many.

They were there all the time. They just found out where they were. When you live in a little community, you might hear about the one in your county. You do not hear about the ones statewide.

I can tell you that we have had 853 fatalities in Nebraska from 1969 through the present day. These are broken down by the type of accident. Even then I am sure that I might have missed a few.

Sometimes the victim gets transported across state lines to medical facilities. It may be a Nebraskan who is taken to a Sioux City Hospital. That report comes into Des Moines and it eventually gets back to Lincoln.

Sometimes there is a delayed one and I may not find it. So even I miss a few of those. So, to Gary and Sverker Hoglund, I appreciate your comments.

## DESIGN

John Etherton is sitting back here. It is John's job to come up with a statement about roll-over protective structures, retrofitting.

There are a lot of people who say, "Let's retrofit everything." This all sounds well and good, but you change a tractor when you do that.

For example, when we came out with the roll bar, people were complaining about the noise. You had the tuning fork concept or added noise. I had a lot of calls,

"What can we do?" We can dampen. Some were putting sand down in the up-rights to dampen the noise. Some were putting loaded springs across to dampen them, anything to get this noise down.

You can change characteristics of tractors. You have to realize that a lot of the equipment that we have in agriculture is not totally designed. This is what Ray (Crammond) was saying.

For example, the first totally designed tractor came into being in 1971. We had tractors that were designed; then we had after-market cabs put on. That was not a part of the design and there were some noise problems.

You have to realize that a lot of the equipment that we have in agriculture is not totally designed.

In 1971, there were two totally designed tractors. One was a Deere, the other one was Allis-Chalmers. They designed the whole unit and had the cab as part of it. They came in with a noise level of 80 or less. It was right around 80 db at that time. This was a whole new concept.

Now those tractors are running down around 74 db, because they are designed as a total unit.

This concept is true with other machinery. I was involved in a lawsuit 28 or 29 years ago, where a little boy lost a leg in an auger. The auger was built by one company; another part was built by another company.

There were four people who went together on this, and they all thought, "The other one is going to put the safety features on." Nobody did. You have to look at the totally designed system.

We can look at anhydrous ammonia as another example. You buy the running gear, order so many at a certain price. You buy the tank, order so many at a certain price. You buy the pop-off valves, so many at a certain price. Put a hose on. They are all component parts.

One of those is the weakest part of the system, and so we have problems. We have to look at the total problem, not components.

There is another thing we have to realize. It was alluded to yesterday. I do not know if it was Gary (Erisman) or Sverker (Hoglund). Many times engineering is overruled by advertising. I have seen this.

We are going to put a product on the market. It is maybe not what we want, but we are going to get it out there. I think of one tractor whose advertising said, "We're going to boost the pump up a little bit to get two more horsepower at the drawbar." When they did this, they also got more noise out of it.

Advertising wanted the horsepower; they did not care much about the noise. The engineers were put at a disadvantage.

They can do their best design, but they are put at a disadvantage if marketing makes the final decision. I think Steve Konz alluded to this in his presentation this morning.

## **PROTECTION**

Dr. Richard Fenske yesterday talked about protection. I am going by a few comments that people made. He talked about the closed tractor cabs for pesticide protection. This is good.

In fact, Cornell did some work on this in 1978 or 1979. It is of benefit. The thing we have to watch is that if people mix the pesticide and then get in the cab, they take it in on their clothing. I have been on a pesticide-training program since 1978.

Our recommendation is that if you have two people, have one do the mixing and one do the application. Or take your clothing off before you get in the cab if you are working alone.

There is another thing that Richard talked about yesterday. It regards a question that I get all the time. How do we tell when the cartridge or the canister is loaded? I give the same answer that he gave yesterday.

Right now we talk about time and concentration. We can look at acidity, and we take litmus paper and test for acidity.

Is there some way that an engineer, or epidemiologist, or somebody could design a cartridge or a canister that when the cation/anion process gets to 90 percent being loaded (somewhat like the working device for telling when the turkey is done), it could send up a little flag or a change in color? It is a very simple process, and maybe there is a way that we could take care of this question.

I made one comment. There was a question yesterday about coveralls in the green-

house and the material going through. Nothing was said about an apron.

One of the things we point out in our program is the need for hand protection, eye protection, and apron protection. We know that the hands constitute a major point of entry in to the body. The label still reigns supreme. It must be followed.

Another thing came up about re-entry into fields. We have had some close problems (poisoning) with county agents. We have had farmers who have asked county agents to look at their field for insects. I think of one that we had where the farmer did not tell the agent that the night before he had sprayed his field with parathion.

This has a 48-hour re-entry. The agent who was asked to go in there is 6 feet 5 inches and weighs 300 pounds. He was sick when he came out of that field. He was going to head back home. He did not. He sat along the roadway for about 2 hours.

We had another instance. A young man was asked to go into the field. His situation was almost identical.

I think back when I was a young lad. Dad and I would go along the back roads, and if we saw a cornfield that looked good, we would want to walk out and see how that corn was. We would walk out in that field and check the neighbor's corn. I would never think of doing that today because you do not know what the plants might have on them.

## **OTHER PROBLEMS**

This morning we heard a talk about vectors that was very interesting. We do not have some of those problems.

You were talking on a world scale, an international scale, however, and that is big. We do not have much of a problem with equine encephalitis. When we do have it, we encourage the people to stay in.

In the Midwest our biggest problem with the farmer will be the infections they may get from being scraped when they work with confinement housing. Some of these can really be problems.

Tetanus is one of the things I talk more about than I do about the vectors; we do have some people that can be affected by anaphylactic shock, and this is the one where the bee stings will get the individuals. Again, I was glad that you were talking about the worldwide problem, because I know that Panama has a different problem than we have; we do have to look on a bigger scale.

Dr. Konz was talking about some of the problems of people. I think of milkers' knee. People say, "What is milkers' knee?"

Dairymen in New York know what milkers' knee is. We talk about tractor drivers' disease, and that is the one that is back-related.

Even stepping up on some of those 27-inch-high steps can be a real problem. I got to thinking about some of these things that are hidden from us.

We have a young lady here from the College of Medicine, Dr. Susanna Von Essen, who has been doing a lot of work on respiratory problems. We are glad to have her. I started looking at this community of respiratory therapists.

One of the things that blew my mind was when I found out that the Phelps County Hospital at Holdrege, Nebraska, last year had 370 cases of respiratory problems. That is a lot of people.

Yet our respiratory therapists are not organized. I was going to say they are loosely organized. They are not organized at all. We have a lot of people who we can gather all kinds of information from, but they are isolated because nobody has ever gotten them together. I am hoping that Susanna can do this. We have a lot of information out there that is just waiting to be gathered.

#### LESSONS FROM BILL STUCKEY

Dr. Erisman and I had a mentor, Bill Stuckey from Ohio State University. Ray Forsythe who is in attendance, did also. Bill Stuckey was an Extension Safety Specialist at Ohio State.

I will never forget a few things that Bill taught me. One of the things he taught me was "You never know until you ask." That is why when I go after statistics, a lot of people say I will get turned down. Well, you do not know until you ask. So I go ask them. I have never been turned down yet.

We have a new generation of people coming along. When you listened to Dr. Konz this morning, you almost thought he was anti-education. He is not anti-education.

Bill Stuckey had a little saying. He said there were those who "Knew not Joseph." What did this mean? Joseph was the king of a nice little kingdom for 48 years, and everybody loved Joseph. Joseph went out of power and a new king came in. Within

a year, there were those who knew not Joseph.

We have some little boys and girls being born today who know not safety. Somebody has to teach them. That is where we in extension come in. They have to "know Joseph"; they have to know safety.

### **TRAINING AND EDUCATION**

A couple of comments came up here about training people. It has been my idea that you train people with the right idea.

I have raised golden retriever dogs since 1958. I run them in trials. People say, "Okay, you are a dog trainer. How do you keep dogs from chasing cars?"

That is simple. I keep them kenneled up. I take them out and train them. I teach them what I want them to know. That is it. I do not worry about their chasing cars because they never run free. Those dogs are not imposed on because they love it when we get out. That is our time.

You heard the comment the other day by Dr. Johnsrud about 23,000 youth trained in Nebraska in tractor safety. There are going to be about 24,500 trained by the end of this year.

I raised two boys. I believe that young people have to work. They have the same needs that I have. They have a need for money so that they can buy things. This is why we have trained these young people.

Some interesting things. At North Platte, there are a lot of ranchers who will take the kids into the sand hills and keep them there for 2 weeks while they are putting up hay. They will not take a youth up there if they have not had the safety training.

One rancher told me 20 years ago that "One of your students was with me. The boy told me I was doing something wrong." He said, "That boy was right." He wanted trained students.

So we keep on training them. We lost two of our trainees in accidents, both in 1971. They were both extra riders; both 14. This was within a 3-week period. They were extra riders on tractors and fell off. That is it. I guess they did not listen too well.

Dr. Konz questioned in education that maybe we did not get the information across to them, maybe we did not educate well enough. Gary alluded to this yesterday.

This has been an excellent opportunity for me to comment on these five papers.□

## **AN AGRICULTURAL ENGINEERING PERSPECTIVE**

*By L. Dale Baker*  
Product Safety Engineer, J.I. Case Company

Dr. David S. Pratt: We next have L. Dale Baker. Dale is trained in agricultural engineering from the University of Nebraska. He spent two years at Michigan State University in the Agricultural Engineering Department. Closer to my home turf, he was in Ithaca at Cornell University as the Agricultural Extension Safety Engineer. He spent 10 years in product safety engineering with International Harvester and JI Case. Currently, he is the Manager of Safety and Legislation, Agricultural Equipment Group, with JI Case. Mr. Baker:

It is a pleasure to be here. I would like to tell you a little about my experience on the farm. Then you can evaluate the biases and perspective of my comments.

I am from Brandon, Manitoba, Canada. With few exceptions, farming near Brandon is no different from farming in North Dakota. Farm life and farm issues are much the same.

I grew up on a family farm that was passed to my father and my uncle from the grandparents. It was a traditional succession in farms in those days. They operated that farm as a partnership.

There were two houses on that farm, a couple of hundred yards apart. I had two older brothers and in the other family there were four children, three boys and a girl. I was the youngest of seven children.

Somewhat by the accident of birth, being the youngest, I was the one who had to leave home. The choice was made on an economic basis, rather than any concern for personal safety.

Today, my brother operates the farm that he has expanded to about 2,000 acres. The farm is on the upper slopes that sur-

rounded a glacial lake bed, many thousands of years ago.

The land at the bottom of the lake bed will provide adequate income for the farm family. On the surrounding land, it is difficult to obtain adequate crop yields to financially survive. Therefore, my brother and his wife also have full-time jobs off-the-farm.

My brother works full-time as a welding instructor at the local community college. His wife is a full professor at the local university. With that income, they are able to sustain the lifestyle that they chose, to live on the farm.

My brother has some beef cattle and grows grain primarily to support the cattle. They also raise malting barley, as there is a premium for malting barley.

My sister-in-law likes to raise horses, train those horses for riding, and sell them. She has a total herd of about 45 horses.

One of those cousins who grew up with me has been in a relatively new business for about 15 years. He is collecting pregnant mares' urine. He has a herd of about sixty horses that he puts in the barn every fall.

They are strapped to a harness that collects the urine from those pregnant mares. That urine is refined for estrogen. This is not traditional agriculture.

That snapshot leads to several observations that illustrate the bias of my comments about safety on the farm:

- Farming is becoming a very diversified business.
- Many farmers are in an economic squeeze but continue to live and work on the farm as a choice in life-style.
- This is a family-farm environment where there are no migrant workers.
- Many farmers are relatively well-educated.
- It is generally the family who is the purchaser and operator of agricultural equipment.

## HUMAN FACTORS

In commenting on the presentation by Dr. Konz, I agree with the concepts that were presented this morning. We, as an industry, wish to promote and are promoting human factors or ergonomics in our products.

I am a member of the Human Factors Society. There are quite a number of practitioners or consultants at work in our industry. I agree with the concept, as a design philosophy, that the machine should adjust to the man.

We should be designing the machine to fit the man. As a design philosophy, we are working to do that.

When I get concerned is if someone makes the assumption that this design philosophy should be the legal requirement. As an example, it is impossible to build a machine that may resemble a tractor that will not roll over. Such a machine will not function as a tractor. I am not yet aware of how we can build a functioning tractor that will not overturn.

I repeat, however, that we are in agreement with those ideas and concerns in ergonomics as a design philosophy. You will see those kinds of concepts on new products.

I am not yet aware of how we can build a functioning tractor that will not overturn.

## OLD AND NEW TECHNOLOGY

Let us take a moment to compare tractors in use today with automobiles in use today. Consider a 1971 automobile and a 1991 automobile. They are quite different.

Items on new cars include the center-mounted stop lamp, rear-impact bumpers, improved door latches, anti-lock brakes, crush resistance in the roof, side protection in the door panel, and improved tires. These are all innovations that are significant to the development of the 1991 automobile.

A 1991 tractor is also quite a different creature than the tractor that was built 20 years ago. Many of the same innovations on cars are used on tractors. The ingress/egress, control, steering, and interior styling of many new tractors are comparable to 1991 automobiles.

What do we see in terms of 20-year-old automobiles on the highway? How many do you see? Five percent? I think it is less than that.

I think that when you do see them that they are on display or going from one auto show to another. They are antiques. How many of the tractors that are in use today are more than 20 years old?

About a third of the tractors out there, in use today. That is, probably a million tractors, for a round number, are more than 20 years old.

Another interesting phenomenon is that a tractor design can survive for about 15 years; it may go a little longer. You will find considerable variation in the design of new tractors on the dealer's lot due to this delay in the design cycle.

Some of the features that Gary (Erisman) mentioned are already available on some tractors. Hydraulic controls, couplers, and hoses are labeled with numbers and flow direction on most newly designed tractors.

Changes in technology allow us to do things now that were not possible 20 years ago or 10 years ago. Many of you will remember the problems that President Carter had in trying to send some helicopters into Iran in 1979. About ten helicopters were sent. Many of them had problems and the mission was abandoned.

Compare that with what just happened in Desert Storm. There were tremendous changes in the reliability of the equipment.

In those days (pre-1979), transistors were experiencing 100 percent burn-in. That means that when you bought an electronic controller, "the black box," you would

check 100 percent of those transistors. Now, the transistors are not checked at all because there is fantastic reliability of the transistors coming from the supplier.

Because the electronic "black box" now available is very reliable, new electronic-based systems can now be added to farm equipment. One example is an operator's presence system now used on combines. If the operator is out of the combine seat for more than 5 seconds, the combine header will shut off.

Other new applications of electronic technology will depend on the development of reliable sensor technology. The sensor must be as reliable as the electronic control box. This reliability should develop much like the reliability of transistors has evolved.

Another important development is the customer acceptance of this new technology. There seems to be a general acceptance of new safety innovations that may stem, in part, from Lee Iacocca advertising air bags.

## **ROLL-OVER PROTECTION**

We have had a great deal of discussion, in this session, about Roll-over Protection Structures (ROPS). We have all seen the slide, many times, of the success of ROPS in Sweden.

In 1985, we had a commitment by the North American tractor manufacturers to make ROPS standard on all tractors. With a few exceptions of tractors that are being imported into this country and those that are for orchard applications, all tractors since that time are equipped with ROPS.

By 1970, ROPS in this country became available on virtually all major manufacturers' product lines. There was no demand for them. Therefore, we have a significant number of tractors in operation in the U.S. that were built in that interval between 1970 and 1985 that are not equipped with ROPS.

I would suggest, in gross terms, that there are about a million tractors that are equipped with ROPS or that have ROPS structures built into the cab. About a million tractors that are out there could have a ROPS installed on them but do not.

Another million tractors that are in use were built prior to this introduction of ROPS and here installation of ROPS becomes a real technological issue. Now we should look at those two issues separately.

### **Pre-1970 Tractors**

In putting ROPS onto tractors that were built prior to 1970, there are some significant technical issues. Will the tractor structure survive an impact with this ROPS attached? The structure was not built for that kind of use.

New frames could be designed, possibly, to accommodate the design by sharing the load forward to the transmission housing.

There is now a need to develop that new structure. There were many applications for those old tractors where implements were attached to the same location that we would attach this ROPS structure. If you destroy that, you have destroyed the utility of that tractor.

There is also the issue of the economics of putting those ROPS on old tractors. If there is to be a program of that nature, it

is going to have to start with the development of some public policy change that will create that demand. Is anyone going to invest the time and effort to develop new designs unless there is, in fact, a demand?

### **1970-1985 Tractors**

The issue for tractors built in the interval between 1970 and 1985 where a ROPS can be installed becomes an issue of how to create an environment where the public demands those ROPS. They are available.

A demand undoubtedly could bring down the cost that was mentioned earlier. Until there is a demand, there will not be any initiative that will cause that to happen. It is the chicken and the egg situation.

If you could decrease the cost, maybe you could increase the demand. You cannot decrease the cost, however, until there is a demand. We are now again looking at what is a public policy issue of how you create that demand.

Is anyone going to invest the time and effort to develop new designs unless there is, in fact, a demand?

I would say to you that my brother is aware of the issues of ROPS and tractor overturns. But fatal tractor overturns are a rare event (a farmer is far more likely to be killed in a car accident than a tractor overturn).

Virtually all farmers are aware of the issue of fatal tractor overturns in the same sense that farmers (and the general public) are aware of the issue of cigarette smoking

causing cancer. What does it take to cause people to stop smoking cigarettes?

We could also talk about our desire, as a general public, to drive cars, which have an air bag and have anti-lock brakes. Clearly, as a general population, we are safer if all of the cars in use by 1995 have air bags and anti-lock brakes. What does it take to make you and me invest in new cars or stop smoking? Solving these same kinds of issues, I think, solves the issues for the farm population.

### CONCLUSION

I would make one quick comment on statistics. In virtually all the groups at this

conference, we have been talking about this issue of statistics. We are all talking about such diverse numbers that some of us are loathe to mention any numbers at all.

Injury statistics should be a number one priority. I hope that this message is coming through from all of the other groups.

What are the recommendations that I would make based on what we have heard in this conference, especially in this room? I think we are looking at some significant *public policy issues* in which the *farm population* needs to be involved in creating the answers.□