tify problems and solve them with ergonomics. This is one of the first documented programs to use participatory ergonomics programs to reduce injuries among health care workers.
Method. Three EMAT groups were formed among employees of a large urban hospital. The EMATs represent three different worker groups—orderlies, intensive care nurses, and laboratory technicians. Each group consists of 4-6 members plus technical advisors. Baseline, one year, and two-year follow-up data will be available for this presentation.

Technique #3: Ergonomics Component in a Wellness Program
Purpose. To reduce workers' compensation costs and improve employee comfort.
Method. A team of novice technicians will provide ergonomic services for as many employees in the hospital system as possible in one year. Records of the quantity and type of intervention will be recorded. Workers compensation costs and injury rates will measure success. Four-month data will be available for this presentation.

Results. Discussion of all three techniques will include impact that ergonomic interventions had on workers' compensations costs, injury rates, self reported symptoms, pain and comfort ratings, costs per injury, and productivity.

Conclusion. A comparison of three very different techniques of implementing human factors principles with hospital employees will be evaluated. Technique #1 with professional ergonomists has been proven but can be too costly for some interventions. Technique #2 using participatory teams can work in some settings but does not seem to be successful in areas with direct patient contact. Technique #3 is still under investigation but has promise due to the combination of approaches that will be implemented.

Session 22: Computer Simulation and Modeling

Ergonomics Analysis Using Computer Animation—Sistler F, Waly SM, Husser R

Computer animation was used to perform an ergonomic analysis and re-design of an eight-piece, cut-up saw workstation in a poultry processing plant. The joint angles of the upper extremities and the back were measured for the existing workstation configurations and for the OSHA recommended height. Both situations created undesirable joint angles during some portions of the cut-up operation. The OSHA recommended height was not acceptable because the worker had to bend too far to view the blade as it was cutting the chicken.

A three-camera video digitizing system was used to collect joint angle data to analyze the tested configurations and to validate the accuracy of the animations. Data was collected on three workers, each with several years' experience on a cut-up saw workstation. The shortest, tallest, and an average-size worker were used. Each was measured at the present in-plant configuration (3-4 inches above OSHA recommended height), at the OSHA height, and two inches below the OSHA height. The standard deviation between the joint angles in the animation and the actual worker movements was less than the standard deviation of the joint angles among the chickens cut by the same person with the same saw configuration. There was a natural variation of motion when a person performed the same task multiple times. Since the variation between the anima-

tion and the average, actual performance of the task was less than the natural variation when a skilled human performed the same task several times, the model was considered to be operating at an acceptable level of accuracy.

The elbow and shoulder angles were more extreme at the in-plant saw height than at the OSHA-recommended height. When the workstation was changed to the OSHA height, the back bending became more severe. The worker had to bend over more to see the blade at the OSHA height. Animation software was used to create a three-dimensional model of the workstation including the saw, stand, chain conveyor, bag and bag holder, and the conveyor for holding the filled bags. Three-dimensional human models were acquired and modified to match the measurements of the workers.

A workstation design was needed where the saw's guide bar could be lowered to reduce shoulder and elbow movements, and still allow the worker to see the blade as it cut the chicken. This was accomplished by lowering the saw and rotating the guide bar. Rotation angles of 10, 20, and 30 degrees were evaluated. An angle of 20 degrees was found to produce the most ergonomically desirable configuration. The average rotation angles for the elbows, shoulders, and back were all reduced.

Mining Equipment Safety Analysis Using Computer Modeling Research Tools—Ambrose DH

NIOSH, Pittsburgh Research Center recreates and analyzes mine accidents and incidents involving mining equipment using 3D computer graphics modeling research tools. The objective is to examine, evaluate, and determine changes that need to be made to mining equipment or human interaction with the equipment to provide worker safety. Comprehensive accident or incident reports are used to developed an accurate visual 3D computer graphics representation of accidents/incident, including the equipment, environment and worker. Computer simulations are used to analyze the accident/incident to predict equipment problems that have contributed toward the accident/incident. The human interaction with the equipment is also analyzed using simulation software. Software packages DADS and JACK are used for simulation and analysis. This paper discusses several completed examples of the use of 3D computer graphics modeling research tools, specifically with mine hoist and elevator systems and underground coal mine roof bolter machines.

Occupational Traumatic Injury Prevention Using Virtual Reality—Dotson B, Hsiao H, Chiou SS, DiPasquale JJ

In the area of safety research, it would be useful to measure the physical responses of workers in their work environment. The physical response data could then be used to compose recommendations to achieve safer work environments. In many cases this is not possible due to various problems. One such problem is that the measurement systems may not function properly in a work environment. Another concern, is that using the measurement system may add risk of injury to an already dangerous job. At the National Institute for Occupational Safety and Health (NIOSH), researchers are looking at a solution to this problem, where the subject is placed in a computer generated virtual environment. This solution uses state-of-the-art virtual reality devices to give the subject the illusion of being in a work environment. Using virtual environments alleviates the space constraint problems that physical mockup may have, but most important is the reduction of the risk of injury for the subject. NIOSH researchers are using virtual