Problem

The Virtual Combat Convoy Trainer (VCCT) is a simulated training system used by the military. The trainer is equipped with a humvee and virtual screens that give our military personnel a realistic feel for combat. The VCCT is located inside of a trailer that requires a rigorous set-up process in order for the system to be fully operational. The trailer allows the VCCT to be transported to bases throughout the country. Figure 1 shows a picture of the trailer ready for transport and Figure 2 shows a picture of the trailer ready for simulation.

Figure 1: Undeployed VCCT

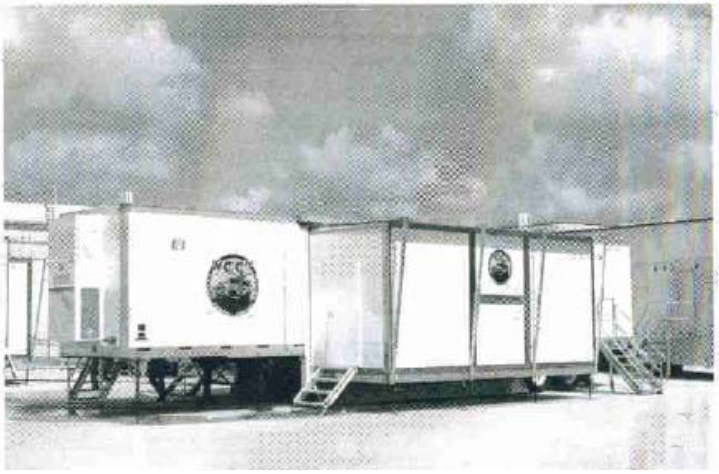

Figure 2: Deployed VCCT

The original VCCT development program was conducted as a very fast response to an urgent need to deliver a convoy trainer to the troops. Since then, more VCCT's have been produced. As a result of multiple set-ups and teardowns, some safety concerns have

arisen due to the personnel-intensive methods of setup and teardown. This project is being conducted to improve the current operational conditions of the VCCT.

Many safety concerns have risen from the setup and teardown process for the training system. Within the teardown process, the "roof collapsing" portion is the most difficult and the hazardous event. Below is a description of the teardown and setup processes and related hazards within them, as stated in a recent safety study.

Teardown Process

During the process of dropping the roof, several people (4-6) are holding up the roof with the vertical support poles and two personnel are under the roof facing away from the trailer. The personnel on the support poles walk away from the trailer while supporting the roof with the attached poles. As they back away, the two people under the roof, equipped with 2x4's approximately 4 ft. long, try to catch the roof and engage the channel located toward the free end and support the roof as it collapses onto them. As the pole handlers move away, the roof reaches a "tipping point" after which time they have little control over its descent. The two people under the roof are trying to control the roof's fall with the 2x4's while backing up and ducking so as not to get trapped between the roof and the side of the trailer. All of this effort requires teamwork, which is coordinated by one assigned person who counts and provides orders to the others on when to lift, etc. During two of the four times this procedure was witnessed, at least one of the two people under the roof slipped while backing up. During two of the four times, the 2x4's have slipped off the surface contributing to the roof coming down faster than expected. On one occasion the teardown was being conducted in the rain causing the wood and the roof to be wet, making a difficult situation even worse. Fortunately, in all cases they were able to duck and hold the roof up enough to keep from getting smashed by it. In two of the four cases, the vast majority of the weight has ended up on one person, while at the same time that person was ducking so not to be struck by the collapsing roof. The current 2x4's are only about 4 ft. long, which is too short; the personnel can't engage the roof/channel due to its height and therefore are trying to "catch" it as it comes down.

Setup process

While the setup of the roof on the VCCT trailer is a more controlled operation than the teardown, many observations similar to those on teardown were noted. The critical, and most difficult, part of the operation is the effort needed to move the roof from its resting position hanging on the side of the trailer into a horizontal position supported by the support poles. Similar to the teardown operation, this part of the setup uses four to six people on the support poles and two personnel facing out from the trailer using 2x4's to push up on the roof while the personnel on the roof support poles lift and walk backwards pulling the roof away from the trailer. When they reach the critical "tipping point", they reverse directions and transfer the force they are exerting into a pushing force to raise the roof while walking forward. All of this effort, as with the teardown, requires teamwork, which is coordinated by one assigned person who counts

and provides orders to keep the group working together. Figure 3 shows the intermediate step of the setup process.

Figure 3: Intermediate Step

While the roof setup does appear to be easier and less hazardous than teardown, it does present hazards to the personnel involved. The most critical hazard is to the personnel with the 2x4's who are under the roof pushing on it while the roof is being hoisted into the horizontal position. While no incidents were observed or reported, it would not be hard to envision a situation where the personnel on the roof support poles miss the tipping point and the roof falls back down to its vertical hanging position against the trailer wall, possibly crushing the two personnel with 2x4's as it collapses. This risk is real since there are several people on the support poles all of whom must act in concert to raise the roof while changing both their direction of travel and the forces they are using from pulling to pushing. A slip that occurs at the tipping point may result in injury to the two personnel who are under the roof during this operation.

Another potential for injury during this operation is the possibility of a lifting injury to the backs of the people who are assigned to the roof support poles. Changing directions of movement while simultaneously changing directions of force, as well as lifting considerable weight (~225 lbs.) contributes to the potential for back injury. Currently six employees are needed to raise and lower the wing roof of a Virtual Combat Convoy Trainer. Economically funding six people to perform this task at different locations have proven to be an unnecessary burden on the customer.

Spring Scope

The design of a device that will open and close the roof independently was completed during the Fall semester. This device is a type of pneumatic cylinder that is powered by compressed air to open and close the roof. This design should decrease the need of personnel from 6 to 3, which will decrease most of the cost associated with setting up and tearing down the roof. This is also a much safer method due to the fact that the workers have much more control over the system. One worker will control the air flow from an air canister, while the other two workers will "guide" the roof to its

position. These two workers will be lifting the roof however the cylinder will be doing nearly all of the work. They will be there to make sure the process goes smoothly.

Since the actual VCCT's are in Orlando and are very expensive, it would be nearly impossible to test the device on the actual trailers. Also, since this program is with the Department of Defense, Lockheed Martin must follow stringent safety codes, so the device would have to go through months of evaluation before it ever comes close to the trailer. This does not bode well for the team because we would not get to see if our design will actually work. In response to this, it was decided that a mock-up version of the roof will be built, so the device can be tested. Since the roof is so big (~ 25ft x 7.5ft x 1in and 500lbs) a scaled down version will be built. This version will be approximately a 1/5 scale of the actual roof. So the model roof will be approximately 5ft x 1.5ft x 0.2in and 100lbs.