Course Learning Outcomes for Unit IV

Upon completion of this unit, students should be able to:

7. Evaluate common controls for mitigating ergonomic related hazards.

Reading Assignment

Chapter 8:  
Macro-ergonomics: Task analysis and process mapping

Chapter 9:  
Computer simulation of processes and tasks

Unit Lesson

This unit focuses on task analysis and computer simulation. When we refer to task analysis, we are discussing the need to look at a specific task to see if, from an ergonomics point of view, it can be made better and ultimately safer. From the easiest task of picking up a penny to the most complicated task one can think of, there can be an analysis of that task. By using the ergonomics team, studying the task, and breaking it down into its absolute basic parts, the team can determine whether the task should be changed or a whole new task system should be developed.

There are several different methods of task analysis. The central theme for this lesson is to understand that the ergonomics team can use any variant of the methods described or even devise one of their own. The purpose is to break down the task into its component parts before analyzing each part to see if an improvement can be made. One way to do this is by recording a video of the task as it is completed by the operator. Then through slow motion or even still photography, we can look at each individual step of a task (each piece of the puzzle). One example of this is when television networks broadcast football games on Sundays. Each play is photographed and then submitted to the quarterback coach, who then meets with the quarterback to discuss the last series of downs. By completing this task analysis, the quarterback can see how the defense reacted to the play and determine how he can improve his performance.

One of the biggest hurdles to overcome is that of resistance to change. We have all heard it before, when someone suggests a new way to try something, another person says, "Well, we aren't going to change because that is the way we always did it!" This is heard throughout the industry and workplace. In general, people just do not want to change. In the firefighting profession during the 1970s and 1980s, there were significant changes made to personal protective equipment (PPE). The advent of the four-door enclosed cab on fire engines, bunker pants, Nomex hoods, and helmets were some of those changes. Yet, the older and more seasoned firefighters could be heard on the apparatus floor complaining about the new standards and changes. There were times when the self-contained breathing apparatus (SCBAs) were not used because the cigar or cigarette was sufficient for filtering out the smoke. During the movie Backdraft with Kurt Russell, in one scene at the beginning of the movie, the crew of Engine 17 was working a fire in a clothing warehouse facility. This was filmed in 1990 and 1991, so many of the updated PPE were in effect, except the bunker pants. As we watched the crew work the fire, we could see the rookie had his proper PPE on, but the veterans of the crew just did not bother. Near the end of the scene during the overhaul portion of the fire, the crews were actually passing out cigarettes to each other to help filter out the residual smoke and toxic gases left over during overhaul, rather than wearing SCBAs. This is an excellent example of resistance to change.

Another idea that is worth mentioning is tunnel vision. One of the biggest tools that safety professionals have at their disposal is the ability to observe. So often we get caught up in the obvious issues that we miss the less obvious. In medical school, the student doctors are taught the art of gross anatomy first, and then they
delve into the microscopic portions of anatomy. In safety, we call it *peeling the onion*—look at the onion as a whole first, and then start peeling away the layers to identify the component parts. A professor at the university has heard from a very seasoned fire officer once that when he first arrives at a fire scene, he commands the driver of the rig to slow down before arriving at a stop, so he can look over the entire scene prior to making decisions about who goes where and doing what. The fire officer is applying the task-analysis process. Slow down, get a view of the entire scene, and then dive deeper into the individual components. How many times have safety professionals tripped over safety issues right in front of them because all they can see are the distant issues? Avoid missing the frayed extension cord you stepped over to talk with someone who is not using hearing protection. Avoid tunnel vision by performing a task analysis.

This section contains just a few comments on the principles in Chapter 8. Use nature to your advantage when surveying a task and deciding if it is necessary to make the change. For instance, use gravity if it works for you. Try to make the change in the process simpler, not more complex. Making activities flow together makes far more sense than not. One example of this involves the firefighter who operates the ladder truck. This operator (firefighter) has three basic steps in raising the aerial device off of its bed and extending it to the working area. There are three levers involved: (a) one for lifting the aerial device, (b) one for turning the turntable, and (c) one for extending the ladder. A good operator can work all three levers at once to accomplish this task. In some cases, a joystick is used to take out the three levers. Airplanes are also seeing this conservation of actuators. In older model aircraft and general aviation planes, there was a stick-and-rudder system to fly the plane. If you wanted the plane to climb in altitude, you pulled back on the stick. If you wanted to go down in altitude, you pushed the stick forward. If you wanted to turn right or left, then you would move the stick right or left. And the rudder pedals were aligned so that as you pushed the pedal, the plane would move in that direction. In today’s modern general aviation aircraft, the stick-and-rudder system has been replaced by an electronic joystick for the left hand and the throttle for the right. The rudder is still functions as it did before. The process of flying has become so simple while also containing less effort due to repeatedly performing task analyses.

The one area that is brought up again here and is seen in other areas of safety is the fault-tree analysis, the failure modes, and effects analysis. These are tools that can be used in the root-cause analysis of an incident or the breaking down of the task in question. The fault tree uses and/or gates to signify how things can come together. Pay particular attention to this idea. An easy example of this would be going to your car in the parking lot of the mall, where there are several other models just like yours. You need to find your car and start it. That is the goal. In order to find the car, you have to know what it looks like, and you have to remember where you parked it, and you must have the correct key to operate it. This is what we call “and” gates. But, what if you forgot where you parked it? Then the ‘or’ gate could come into play. You know what it looks like and you have the key to operate it. To find your car, you could hit the lock button on the remote to activate the lights and horn. Or, you could press the alarm button to find the car. In both scenarios, your goal of finding the car was accomplished using the ‘and-or’ method of fault tree.

The method of using failure modes and effects analysis (FMEA) is another investigative tool to help with either the task analysis or the incident root-cause determination. This system considers the failure of one or several components, and how that failure can affect the outcome. For instance, think about the tires on a car. Typically, they are good for approximately 30,000 miles, according to the manufacturer. How do they determine this? Well, they perform tests and record measurements. The FMEA system goes one step further. For instance, a vehicle has been in a crash, and the investigation reveals that one of the tires failed. After examining the tire, it is discovered that the tire has traveled for more than 30,000 miles. Therefore, it has traveled beyond its life span of safe operating conditions. The investigation also showed that the vehicle owner did not recognize the hazard of traveling on a tire beyond its safe conditions. Not one person identified the faulty tire for the owner, so the owner did not have that valuable information. By predicting the effects of the failure in advance, the manufacturer of the vehicle, the seller of the vehicle, and the owner could have made a better choice as to when the tires should be replaced prior to failure. It would certainly be a great thing for those people in horror movies who go get the flashlight from the kitchen drawer because they heard a strange noise and went to investigate. And just when they needed the light, it fails. Had they known the life span of the flashlight battery, they would have been able to change out the batteries and have a working flashlight before the zombie arrives to have lunch!

Also outlined in this unit is computer simulation for the evaluation of processes and tasks. The important factor for computer simulation is that the team of ergonomists can build the scenario and run it many times before actually making the changes. The simulator is used extensively in training and refreshers for operators of all sorts of equipment. Using the simulator allows the user to see how the changes will affect the outcomes.
without injuries, fatal losses, or property damages. There are several things to consider here. Variance and validity are significant issues that should be addressed when discussing the use of simulators. Varying the simulation allows the observers the opportunity to see how the final outcome might look. Plus, the team needs to have validity with simulations. Can the results be proven valid no matter who is operating the simulation? That is what the team needs to verify. Using simulations allows the team and the operators to run through the process as many times as necessary up to—and including—the failure of certain parts of the new system.

Therefore, the process of task analysis and simulations is a significant part of the ergonomics team’s tools. Such tools can make the process of breaking down the task in question to its most basic parts and then simulating when and how those parts react under load, pressure, time, and environmental constraints. All of this can be done with today’s computer programs and the technology available to the modern ergonomics team. Sometimes the simple answer is to create a flow chart and/or line diagram on paper while also having discussions and brainstorming sessions. Asking the what-if questions can really help the team get the answers they are looking for as it pertains to task analysis and simulations.