Week 4

1. What is an acceptable robot modification?

None of the above.

1. If a robot strikes a person, a severe injury could occur. What factors contribute to the total amount of energy available to cause injury?

All of the above

1. Identify the type of robot programming by teaching method: An operator established physical contact with the robot and drove the robot's arm through the desired positions within the working envelope.

Walk-through programming

1. Identify the type of path generated: The robot's arm follows a predictable orientation and trajectory as it navigates in the work envelope.

Controlled path

1. During normal operation, the operator intruded into the tooling area of the running collaborative robot system. The cobot's workpiece accidentally clamped the operator's shoulder joint resulting in a force of 220 N. Calculate the maximum permissible force for the contact and determine if it is compliant with requirements of RIA Technical Report R15.606-2016.

For quasi-static contact, the maximum permissible force for shoulder joint is 210 N, and the contact is not compliant with RIA technical report requirements.

1. You're an engineer tasked with facilitating a task-based risk assessment for a collaborative robot. During a facilitation session, your team discovered the cobot's screwdriver end effector threats. The team came up with the following: An hourly exposure per day with inadequate warning time potentially resulting in a non-reversible accident. Based on this input, estimate the risk level.

High risk

1. Based on the above example and collaborative work cell, propose one risk reduction measure compliant with the RIA TR R15.306-2016 table 4 on minimum risk reduction measures as a function of the risk level.

answer:

1. To temporarily pause the collaborative robot, the operator modified the robot's electrical component. Is this an acceptable modification?

Yes, since the modification may damage the cobot, reduce system safety and reliability, or shorten the life of the robot.

1. Recognize the risk mitigation device in the cobot workcell of the video presented in Module

Awareness device

10 . An operator was resting his palm at his workstation when a collaborative robot accidentally trapped the operator's arm against the workstation. The cobot exerted a pressure of 200 N/cm^2 until the trapping condition alleviated. Is the contact condition compliant with the safety requirements of the RIA TR R15.606-2016?

Yes, the maximum permissible pressure for a quasi-static contact for palm is 260 N/cm^2. Hence, the condition is complaint with the RIA technical report requirements.

11 . A table mounts a collaborative robot. During its regular operation, a production worker was facing away from the robot while the cobot accidentally hit the worker's fifth lumbar vertebra. However, the worker quickly reacted and recoiled from the robot without trapping his contacted body area. What is the maximum permissible pressure multiplier for this contact condition?

2 Pt

12. A collaborative robot's moving arm impacts an electrician's abdominal muscle during regular maintenance without trapping the personnel's contacted body area. The contact lasted for a very short duration. Identify the type of contact and corresponding maximum pressure multiplier.

Dynamic impact and and 2 Pt

13 . An untrained operator reaches into work cell while a collaborative robot is moving and collides with the operator. Maximum free space collision force is 50 N. In another instance, an untrained operator reaches into work cell while the robot is moving into instrument tray and hand is trapped between the robot and instrument tray. Maximum trapping force in downwards Z direction at 50 mm/ sec is 50 N. Based on the above two scenarios, perform a risk assessment and derive a PL.

S1, E1, and A1, and PL = b

14. Pressure equals force divided by area. A collaborative robot has a sharp end effector with an area of 0.25 cm^2. During a routine operation, the robot's end effector exerts a 50 N force in the downwards Z direction on the back of an operator's hand. Analyze the pinch point and determine if it is compliant with the RIA TR R15.606-2016 requirements.

A 50 N force in the downwards Z direction and an end effector area of 0.15 cm^2 yields 333.3 N/cm^2 pressure. This contact pressure is way above the maximum permissible pressure of 200 N/cm^2 for the back of the hand and is not compliant with the technical report requirements.