Individually (not as a team) perform one of the following analyses for the design contest. Describe the assumptions you make and briefly justify them. It is usually best to make conservative assumptions, i.e., assume a coefficient of friction which is less than is likely, so that your results become a sort of worst case scenario, and your actual device will probably perform at least this well.

1. Analyze the time needed to drive up a ramp of an assumed slope and length using an assumed combination of motors and transmission elements. Assume reasonable values for the coefficient of friction of your wheels on the tabletop, and take into account the time and distance needed to accelerate and decelerate. Remember to stop at the top. Examine other transmission ratios to see the effect on the total transit time. (Note: Given a particular motor/transmission combination you can determine the maximum acceleration and top speed of the device, and the distance needed to reach top speed from any given initial speed. Divide the total path into regions of maximum acceleration, motion at constant top speed, maximum deceleration, etc., and find the time for each segment.)

2. Analyze the time needed for a hoist/winch type device to lift one or more SI's the lower level to a scoring zone. Assume appropriate transmission elements for the hoist/winch. Remember that the SI(s) must be accelerated from rest and brought back to rest at the top. What overturning moment must be resisted by the hoist/winch support, assuming reasonable device dimensions? How does the choice of transmission ratios and winch drum diameters affect the time required to lift the SI(s)? How do these choices and the resulting changing accelerations affect the overturning moment for the hoist/winch?

3. Determine the steepest slope that a device can drive up. Assume a reasonable coefficient of friction and vehicle mass. Where should the center of mass of the device be located? Select appropriate transmission and drive elements and determine the maximum speed and acceleration attainable. How much motor torque is required to simply remain stationary on the slope? How much time is required to drive to the top of the arena from the bottom?

4. Analyze the forces and accelerations likely to occur during a fall your device might experience during the contest. Assume reasonable masses, and estimate the impact forces and accelerations on the tabletop surface using reasonable assumptions about
the stiffness of the surface or the contact time. Since these values are not known with any certainty, vary them over a fairly wide range of reasonable values and determine the effect on your result. Based on this, determine what you believe to be a reasonable upper bound on the impact force and acceleration your device might experience. Based on this upper bound, design and analyze appropriate restraints for the battery pack and the control module so that they will survive repeated impacts.

5. Analyze a vertical “scissors-jack” mechanism that is designed to extend up the contest table surface to a particular scoring zone, while pushing one or more SI’s. Determine the deployment distance as a function of time using a lead screw drive. What transmission ratio and lead-screw pitch did you choose? Why? How would you optimize your choice? What is the affect of adding additional stages? What is the affect of changing the link lengths? In your analysis use a material density that is appropriate to your material choice.

6. Create an analysis problem which is directly pertinent to your own device design, but which is similar to the examples above in terms of complexity and scope. Email your proposed problem statement to the instructor for approval before proceeding with this option.