INDUSTRIAL SOLUTIONS LABORATORY

Department Project Information

Department Name	*MEES - Motorsports*	**Date Submitted**	*07/12/2024*
Project Title	*Prototype Inboard Suspension for Formula SAE Car (FSAE_SHOCK)*	**Planned Starting Semester**	*Fall 2024*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	4-6	Electrical	
Computer		Systems	
Other ( )			

Project Overview:

The Mechanical Engineering and Engineering Sciences department, through the motorsports concentration, supports two Formula SAE student design competition teams. Teams are required to produce a new car every competition year, which limits the number and scale of new design developments that can be pursued in a given year. The teams could benefit from advances in vehicle suspension design, but would need a well-developed concept to design the vehicle around. This project is to produce a proof-of-concept inboard suspension design that future competition vehicles could be designed to accommodate.

A “Decoupled” suspension design is often used in Formula SAE competition. Such a design allows for spring and damper forces to be tuned and operate independently between roll (when one side of the suspension moves in the opposite direction of the other) and heave (when both sides of the suspension move in the same direction) movements. A commercially available solution for such a suspension exists, but the cost and reliability of this commercial product do not meet the teams’ requirements. A design that could make use of the team’s existing spring and damper components is desirable. The feasibility and benefit potential of adding an inerter or tuned mass damper mechanism is to be assessed.

Project Requirements:

The inboard suspension prototype must include all force generating components, actuators, and mounting hardware that exist inboard of the pull and/or pushrods. This would typically include items such as rockers, dampers, springs, anti-roll bars, drop links, and mounting hardware, but this list could vary depending on the chosen design. Prototypes for front and rear suspension are to be created.

The prototype must comply with the 2025 Formula SAE internal combustion and electric vehicle rules. It must package in a car that follows a similar size and design as the most recent cars produced from UNC Charlotte's Formula SAE teams. The design must be able to sustain loads typically encountered in Formula SAE operation.

The resulting inboard suspension must allow for full and independent tuning of spring and damper forces in roll and heave, as well as adjustments to spring preload and motion ratios. The inclusion of a tunable inertance mechanism should be evaluated for suitability. If it is found to be beneficial, such a mechanism should be included and tunable as well.

Desirable characteristics are low weight, compact packaging, and cost effectiveness. Analysis must be performed to produce documentation indicating the expected force generation characteristics of the design, and a simulation model that can be incorporated into the teams' vehicle dynamics simulations must be produced.

Expected Deliverables/Results:

Deliverables include:
- All senior design course deliverables
- Fully functioning physical prototypes of the front and rear inboard suspension components
- Dymola model package of inboard suspensions front and rear
- Complete 3D CAD Design and component sources
- BOM for sources
- Documentation and calculations
- Data acquired from testing

Disposition of Deliverables at the End of the Project:

Hardware developed is the property of the mentor and department. The work product is to be displayed at the Senior Design Expo then immediately handed over to the mentor.

List here any specific skills, requirements, specific courses, club affiliation, knowledge needed or suggested (If none please state none):

- Motorsports concentration – Not required, but motorsports concentration has priority
- Required skills/knowledge areas:
    - Dynamic mechanical systems analysis and control
    - Vehicle dynamics
        - Completion of the road vehicle dynamics course beneficial but not required
    - Kinematics
    - Design and fabrication of basic mechanical parts
- Software:
    - Must be proficient in CAD and FEA software
    - Experience with simulation software like Dymola beneficial but not required