

Chapter 1

INTRODUCTION

The opening chapter explains the concept of the Formula SAE (FSAE) competition and discusses the concept of a vehicle chassis in a race environment. Fundamental characteristics of a race car chassis are identified, which lead to the problem statement and objective.

1.1 BACKGROUND

Motorsport began during the 19th century soon after the construction of the first successful gasoline-fuelled automobiles (Gillespie, 1992). Since then it expanded rapidly into a multi-national, global business enterprise involving millions in capital and resources worldwide.

Whether motor racing is viewed as a sport or as a research and development activity of motor design, the aim will always be to be competitive on any given race track, absolutely (against a time constraint) and relatively (against the competition). To achieve the desired results in motorsport, it is crucial for the vehicle to be designed for an easy, adaptive driving style to maximise the driver-vehicle combination (Smith, 1985). The vehicle needs to satisfy certain fundamental characteristics to maximise its performance in terms of outright average speed and handling characteristics. In any conventional car, the chassis is the crucial component that acts as the bridgework and host for the attachment of all the other components. It is the very core of the racing vehicle (Milliken *et al.*, 2002; Aird, 2008).

For a chassis to perform optimally, it has to satisfy all the fundamental characteristics required for a racing car in its specific class. These characteristics should include a low centre of gravity, a high strength-to-weight ratio, adequate stiffness and prescribed safety features. The proper combination of these characteristics often, if not always, determines the success of racing vehicles (Smith, 1978). In the world of motorsport, there are several different competition classes. Classes include open-wheeled formula style vehicles (e.g. Formula One and Indycar), endurance prototypes (e.g. World Endurance series or Le Mans) as well as production race cars (World Touring Car Championship) (Aird, 2008).

The FSAE series is a student design competition organised by SAE International (formerly Society of Automotive Engineers). The concept behind FSAE is that a fictional manufacturing company contracts a design team to develop a small formula-type race car. Each student team is to design, build and test a prototype based on a set of rules, where the purpose is both to ensure on site event organisation and promote original problem solving ideas (SAE International, 2013).

Likewise, due to the nature of the FSAE competition, the concept and design of the FSAE chassis is regarded as an extremely important component as it is responsible for the race car's pre-race setup, structural qualities, and bridgework between components. It is also vital for overall vehicle performance and the driver's safety.

The FSAE chassis required for such a competition needs to comply with all the FSAE specifications, as well as fulfilling the fundamentals a race car requires, such as a low centre of gravity, minimum weight and a high torsional stiffness.

1.2 PROBLEM STATEMENT

The challenge is to apply engineering practice and design principals to enable the development of a low weight, high torsional stiffness FSAE chassis, through the design phases, up to and including the manufacturing of an experimental model complying with the FSAE regulations.

1.3 OBJECTIVE

This study endeavours to use finite element analysis techniques in order to develop a methodology to design, develop and test a chassis with competitive performance parameters complying with the FSAE regulations, by setting the following goals:

- Review literature regarding motorsport and chassis principals, design and development.
- Review FSAE regulations and apply chassis design and development.
- Design a competitive chassis with regards to torsional stiffness and weight.
- Simulate the designed model to quantify the torsional stiffness and weight.
- Validate the simulation quantifications with experimental results.
- Draw conclusions and devise recommendations regarding the use of finite element analysis software and chassis design.