

**SIMPACK User Meeting
Baden-Baden 2006**

**Simulation of Advanced Chassis Concepts
for Motorcycles and Racing Cars**

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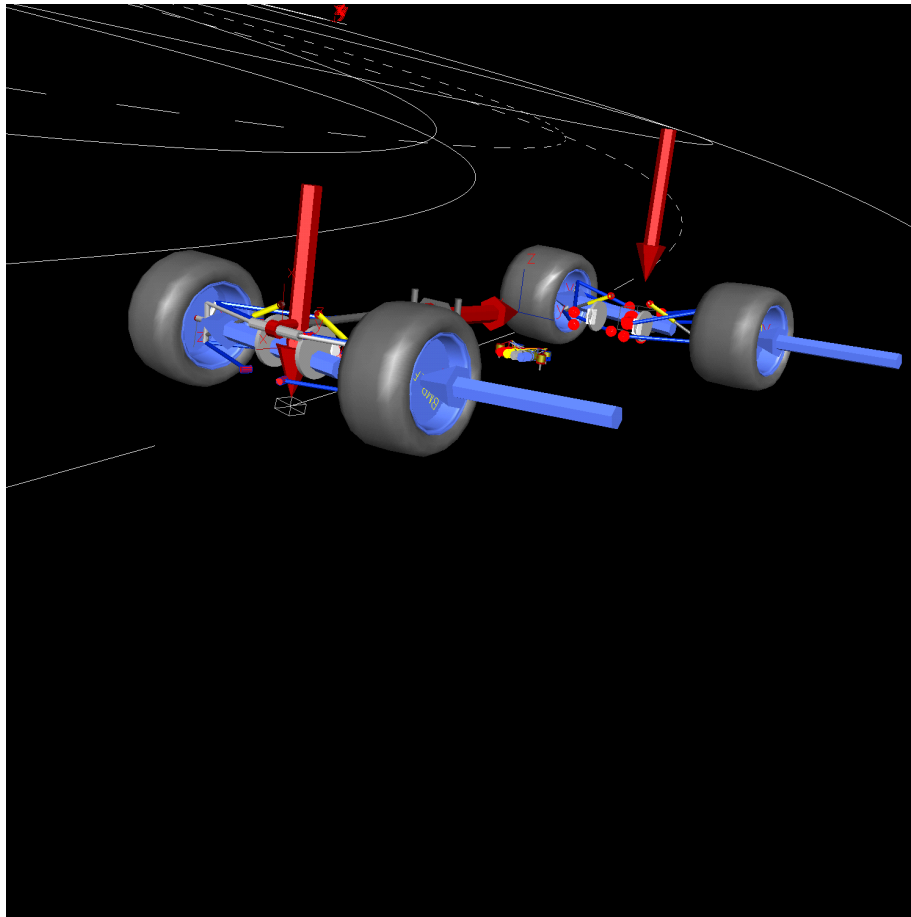
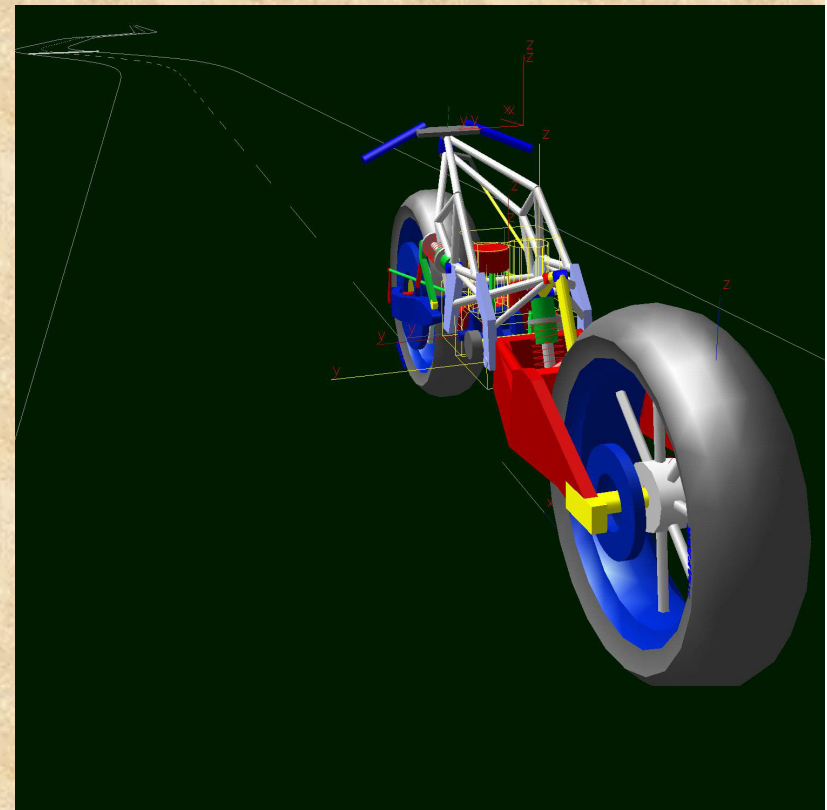


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Overview

motorcycle dynamics

simulation in motorcycle dynamics,
alternative approaches to motorcycle design,
front suspension systems, mechatronics



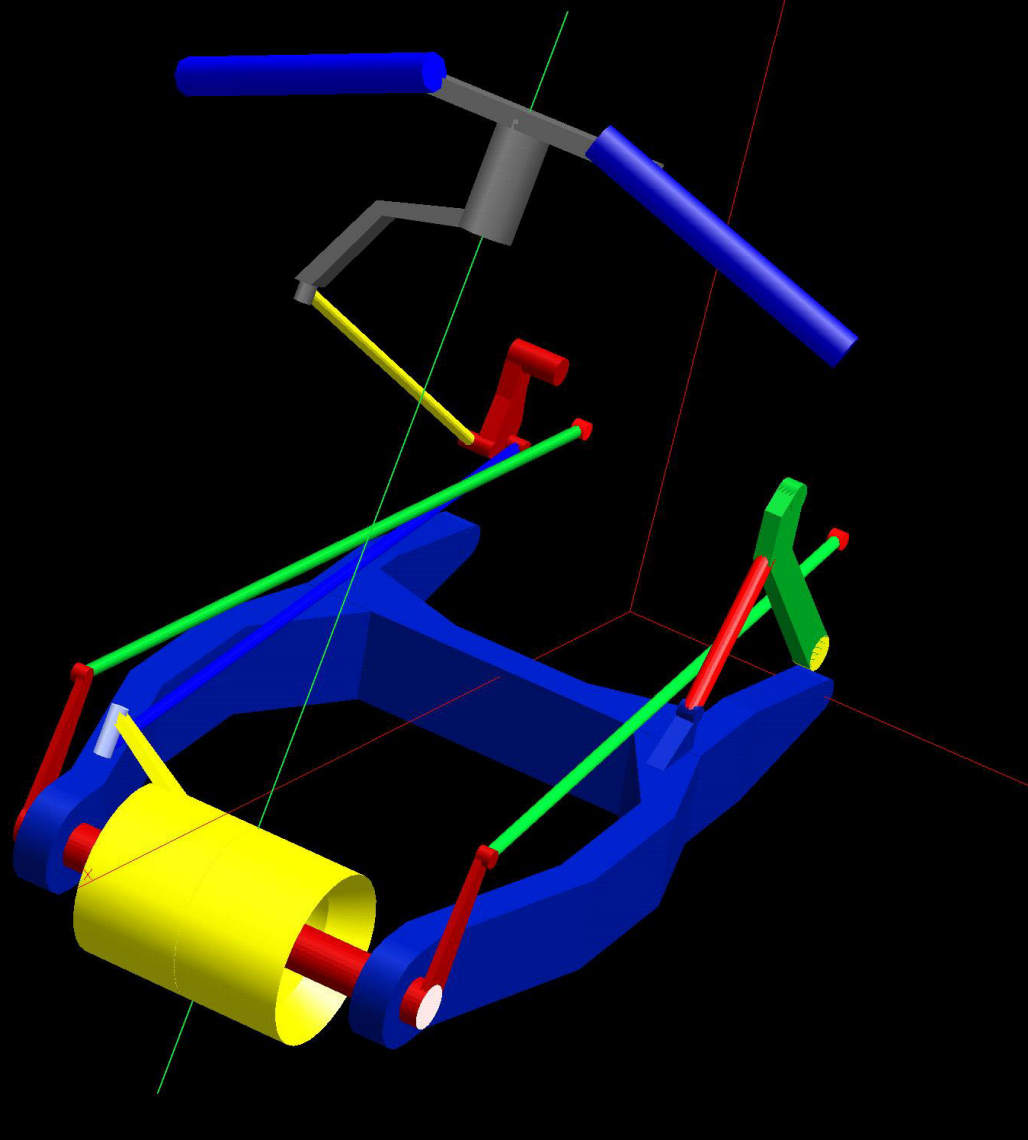
race car dynamics

passive mode decoupling suspension
roll elimination by use of gyro dynamics
simulation of advanced chassis concepts



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Alternative Front Suspension systems



why use them?

inefficiency of the telescopic forks:
stiction, excessive weight transfer,
high weight and inertia moments
limited geometry tuning abilities

general advantages of AFS:

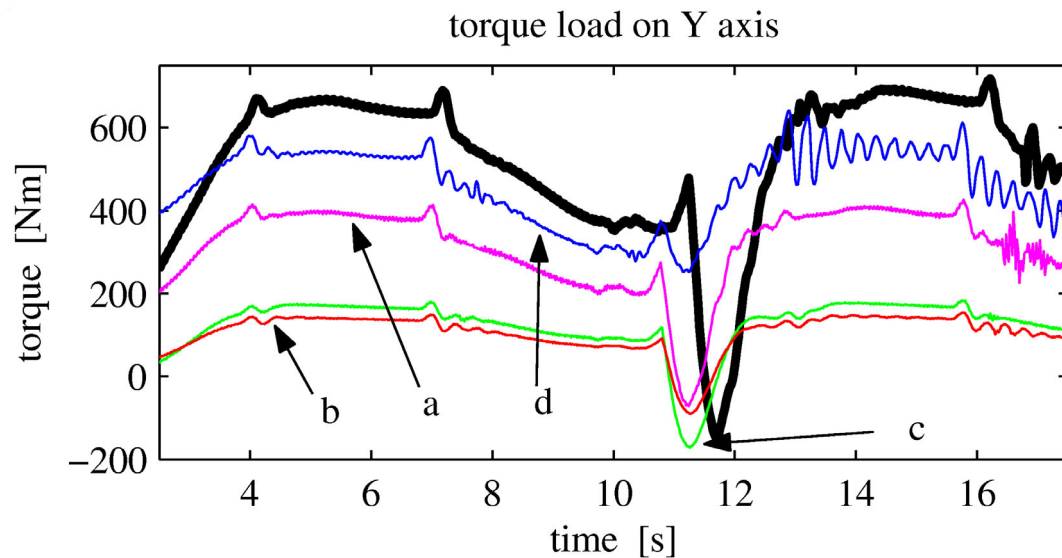
unsprung weight reduction,
superior dynamical behavior,
higher geometry parameters range,
direction of road forces towards the
frame center

...disadvantages:

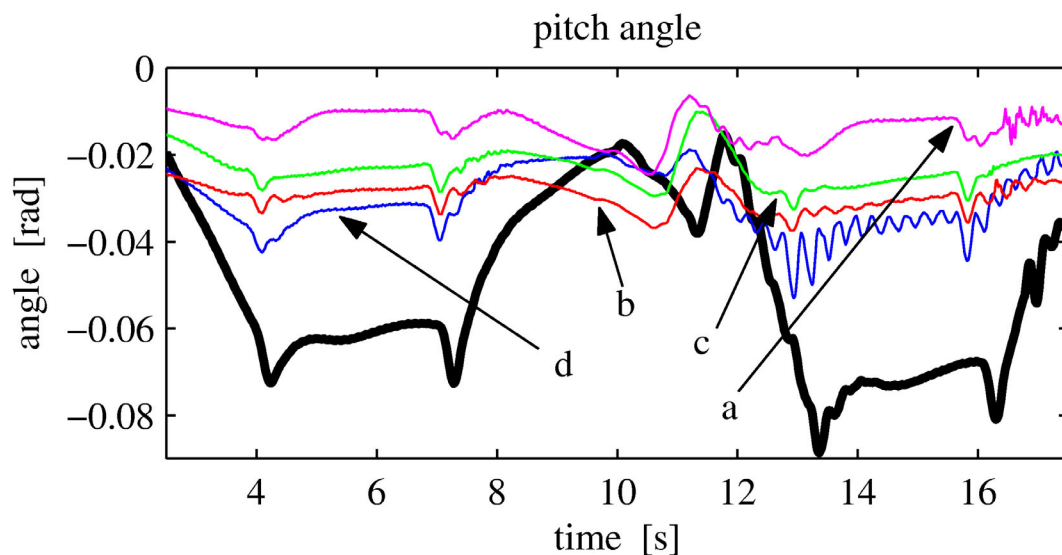
higher complexity in design and
tuning of the steering geometry,
may require different rider approach



Simulations: AFSS vs. Conventional Forks



resulting loads and magnitude of load change much greater in case of conventional forks are

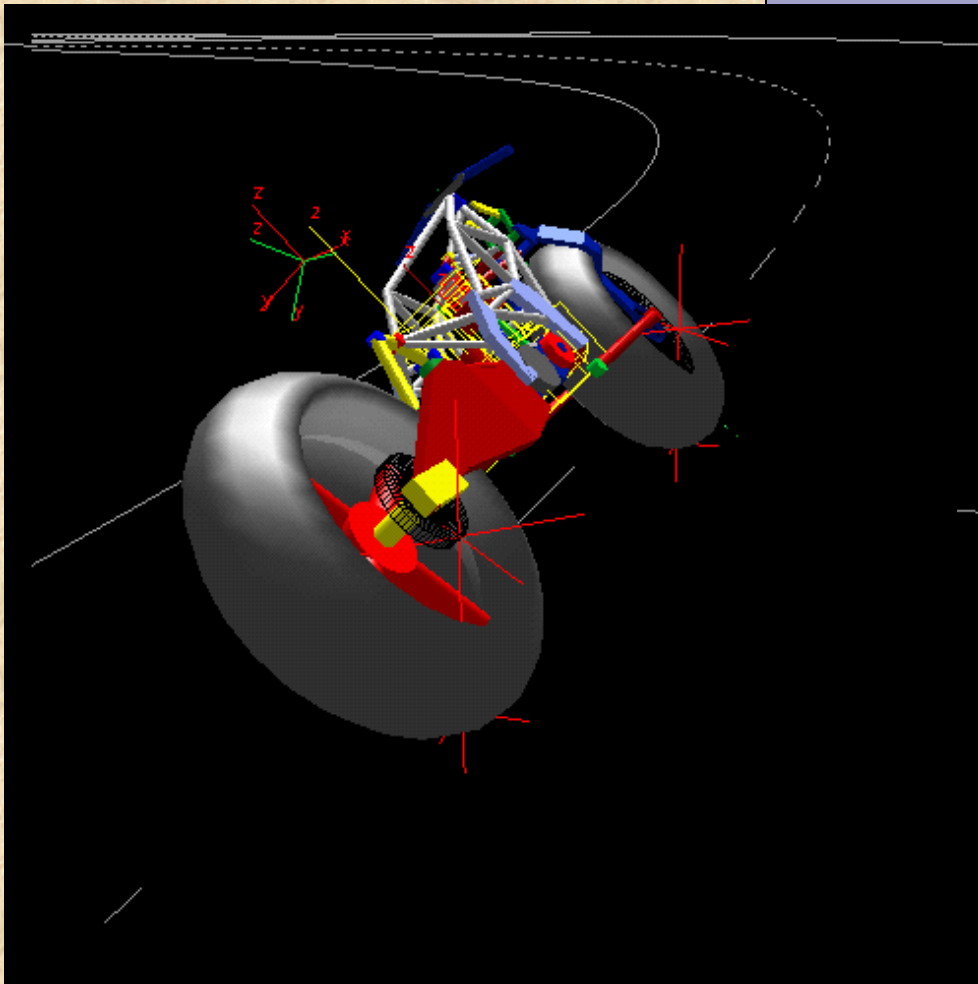


much lower pitch angle variations under braking-acceleration excessive load transfer in conventional forks

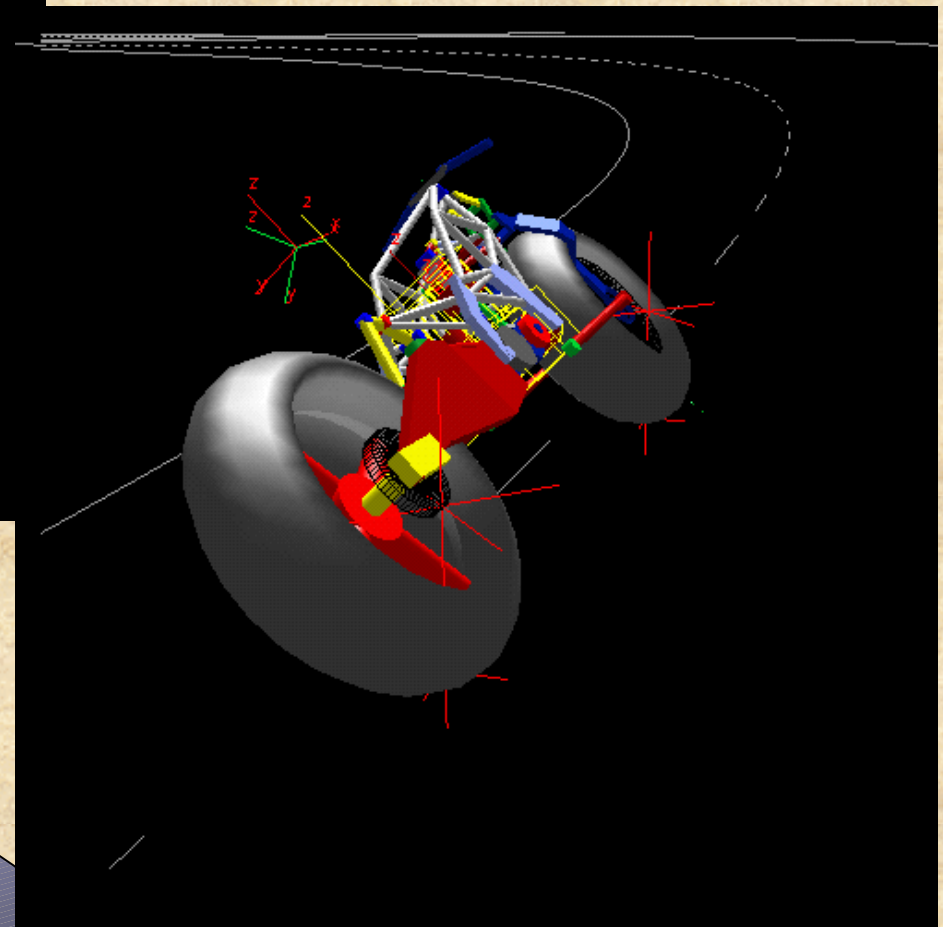


Active Roll Control

manipulation of the roll angle through application of roll torque by use of Control Moment Gyros

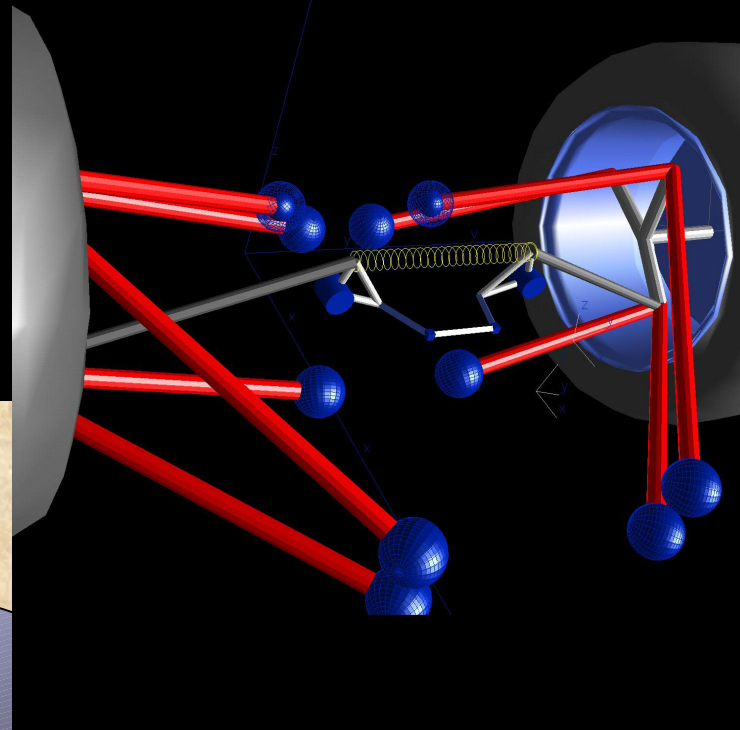
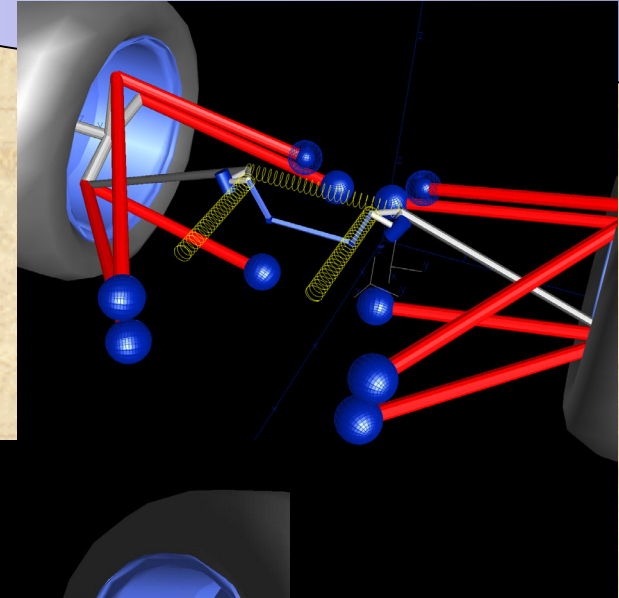
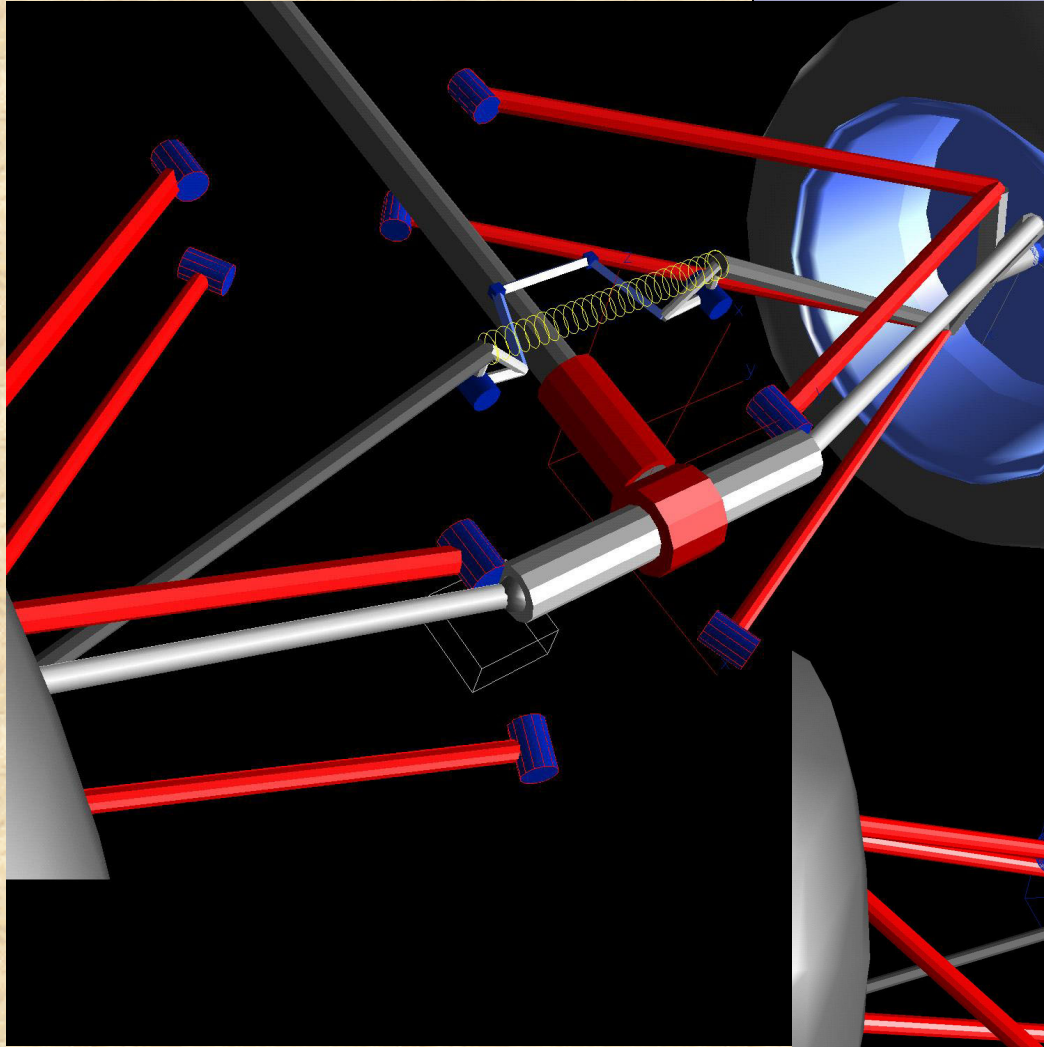


placed in tandem counter-rotating
example of vehicle sustaining mid-bend bump



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Conventional Passive Suspensions



pushrods &
rockers

lin. / rot.
spring-damper

anti-roll bar

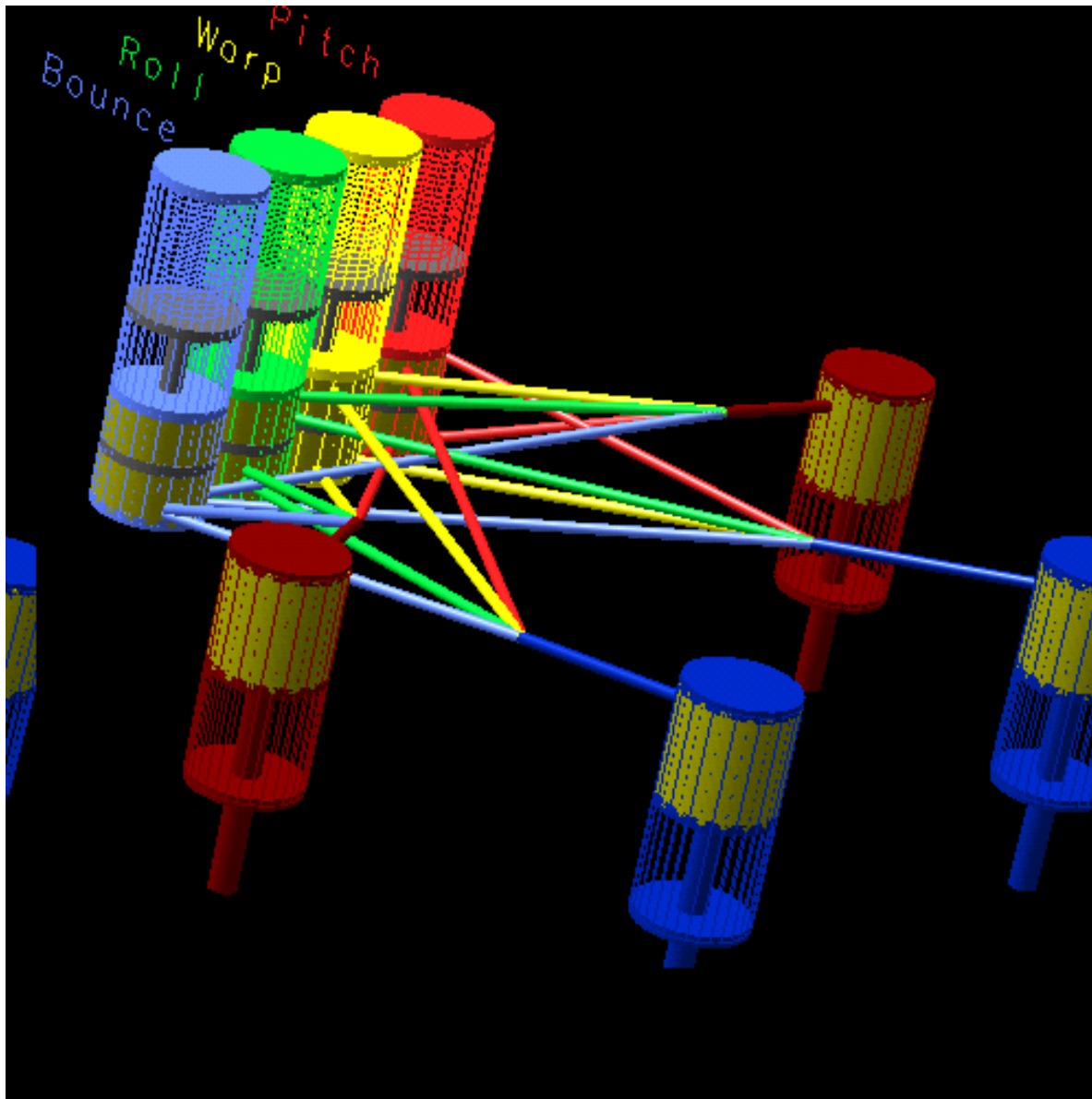
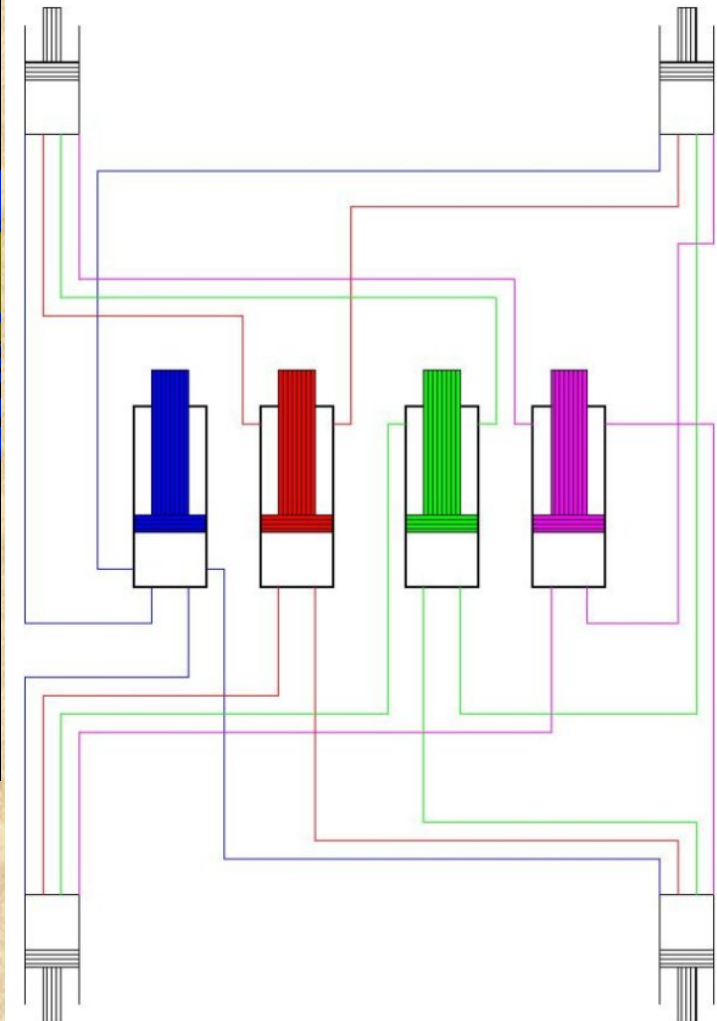
third
spring-damper



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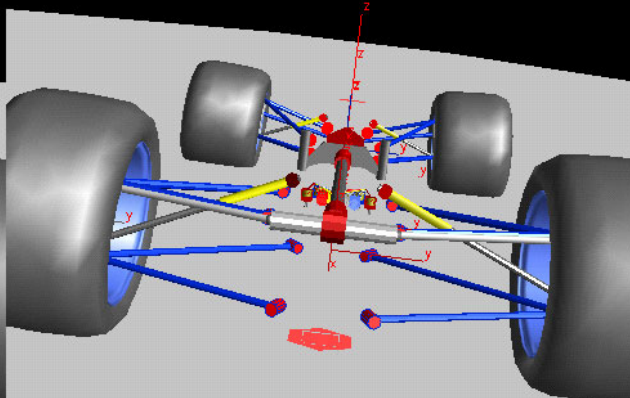
Mode Decoupling Suspension System

hydraulic interconnections

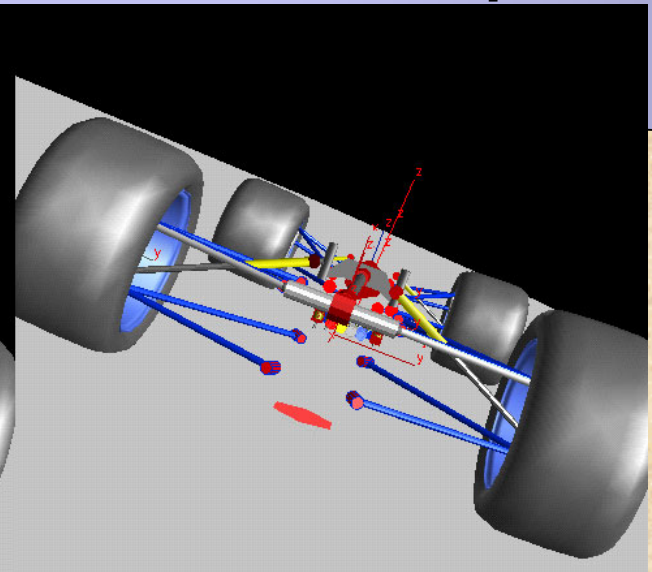


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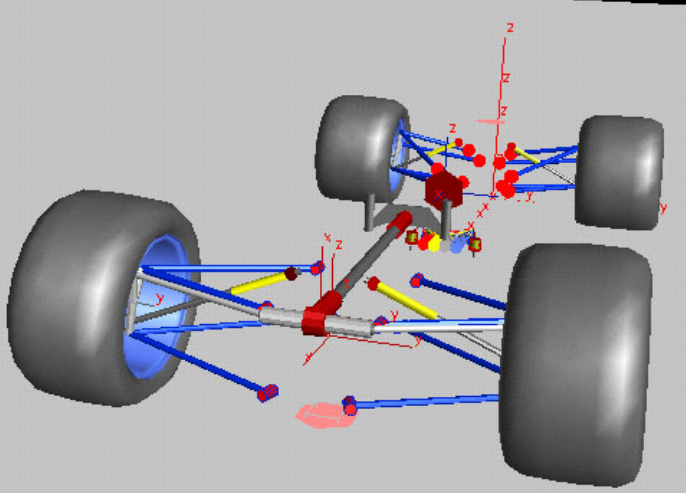
Decoupled Modes



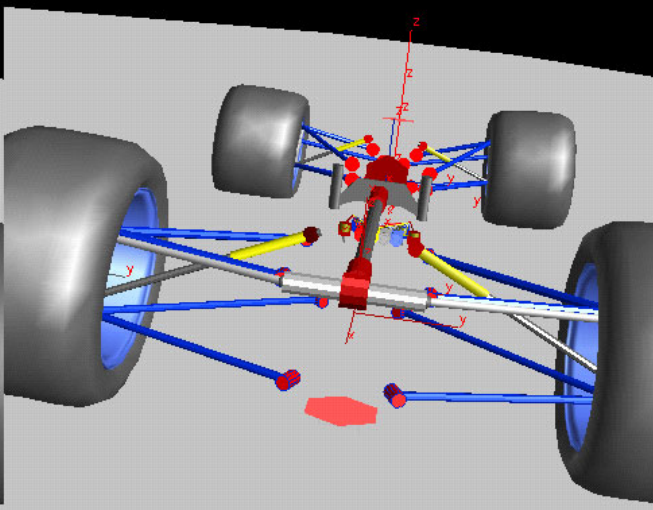
bounce mode



roll mode



pitch mode



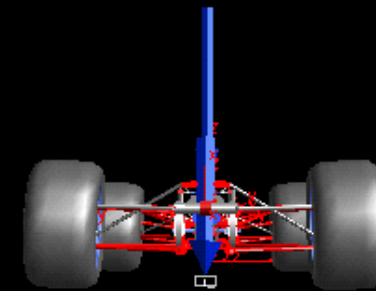
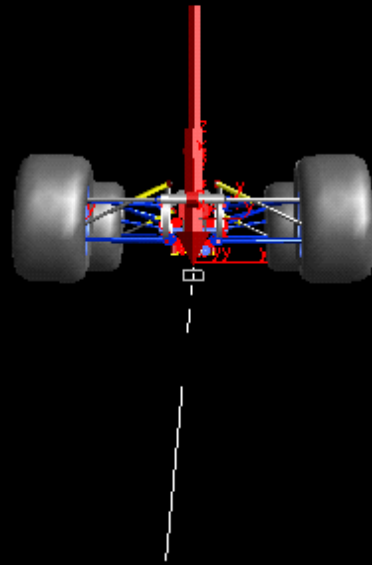
warp mode



both vehicles at 80m/s,
kerb simulated as sinusoidal obstacle

riding over a kerb in chicane

conventional suspension
overly stiff and underdamped roll and warp



decoupled suspension

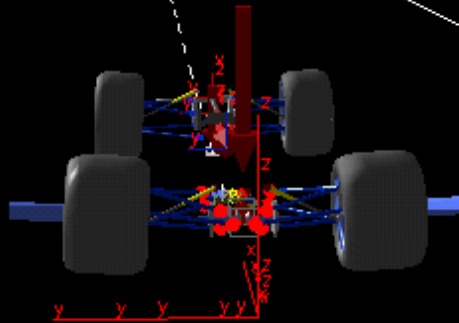


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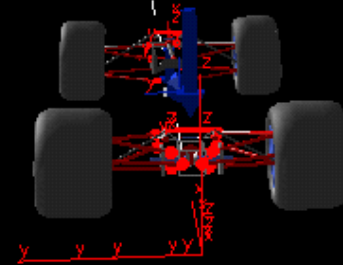
both vehicles at 65m/s

Handling Limitations

conventional suspension
high rear pitch frequency

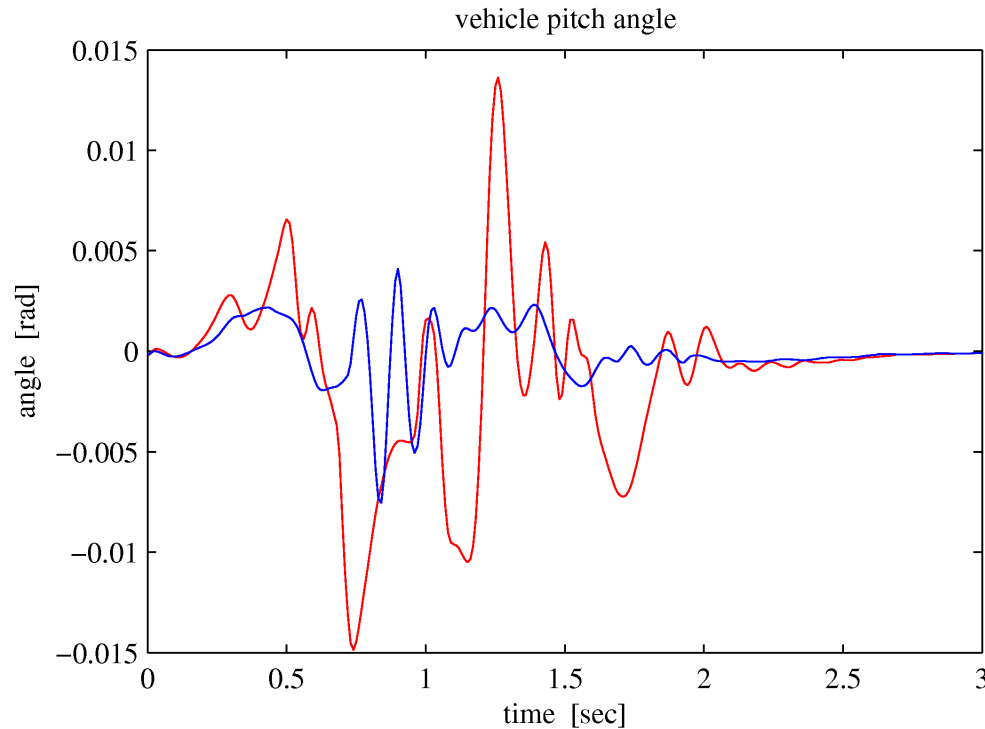


decoupled suspension



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riding over a kerb in chicane, results



The vehicle equipped with the mode decoupling suspension system presents vastly superior body control due to **high pitch and roll damping**, yet due to the **soft warp** rides smoothly over the kerb.

