Abstract for the Workshop Motion comfort of automated driving, August 28, 2019, TU Delft	
Name	Gunther Paul (1) & Heinz Ulbrich (2)
Email	Gunther.paul@jcu.edu.au
Affiliation	James Cook University (1), TU Muenchen (2)
Will you attend icc2019?	No
Will you present at icc2019?	No

Title & Summary of your overall research objectives and approach

Comfort Modelling, Digital Human Modelling, Occupational Respiratory Health, Human-Machine-Interfaces

Title & Summary of results or research plans you want to present at the workshop:
Active seat suspension enhancing driver comfort

One or two mass models (Fig.1) have been suggested to represent vehicle seat-occupant vibration behaviour, which contributes significantly to vehicle occupant comfort. Moreover it has been experimentally determined that vehicle seat vibration comfort mainly depends on vibration in a frequency range from f = 0-30 Hz. Subjective vibration comfort perception coincides with the two-mass models and finds resonance frequencies at around 4.5 Hz and 14-15 Hz.

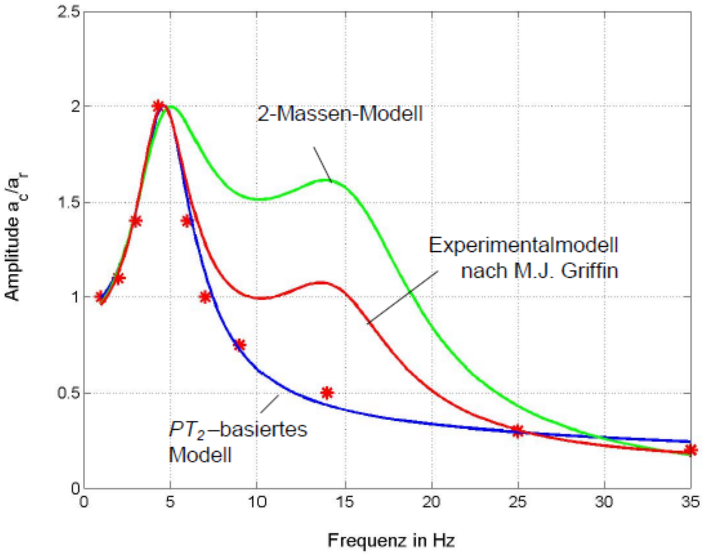


Fig.1 Single mass PT_2 and two-mass occupant-seat vibration models

To avoid adverse occupant effects in autonomous driving, seat vibration must be controlled (Fig.2).

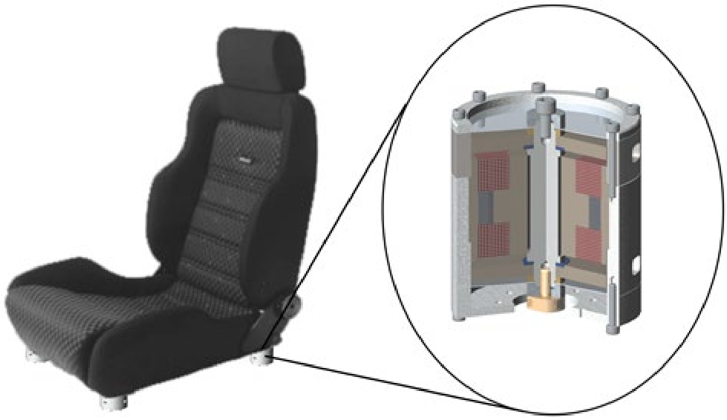


Fig.2 Active seat suspension actor

This can be achieved through four actors mounted between the seat and seat rails, effectively isolating the seat from vehicle vibration. The isolation performance for such an active vibration damper is shown in Fig.3 for a constant damping factor and three stiffnesses. Moreover, isolation performance depends on the operating displacement capacity (Fig.4).

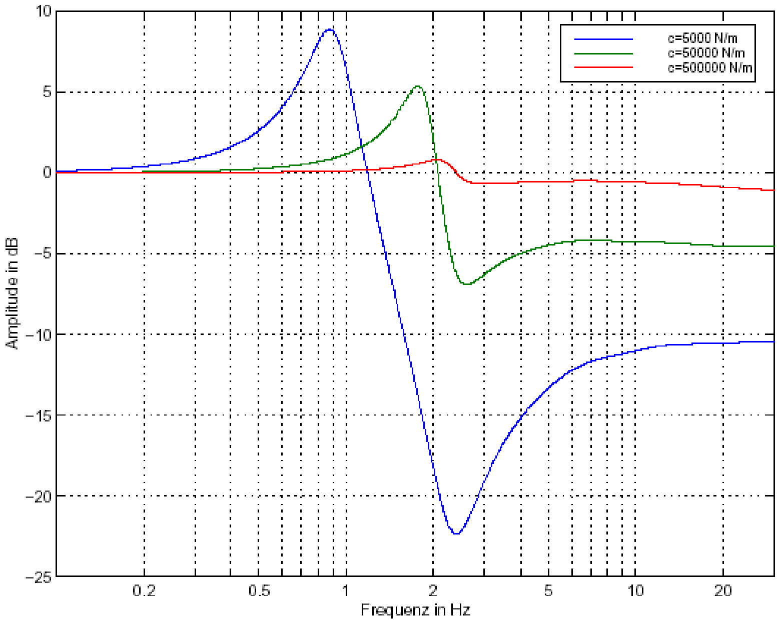


Fig.3 Isolation at constant damping D=0.2 and variable stiffness

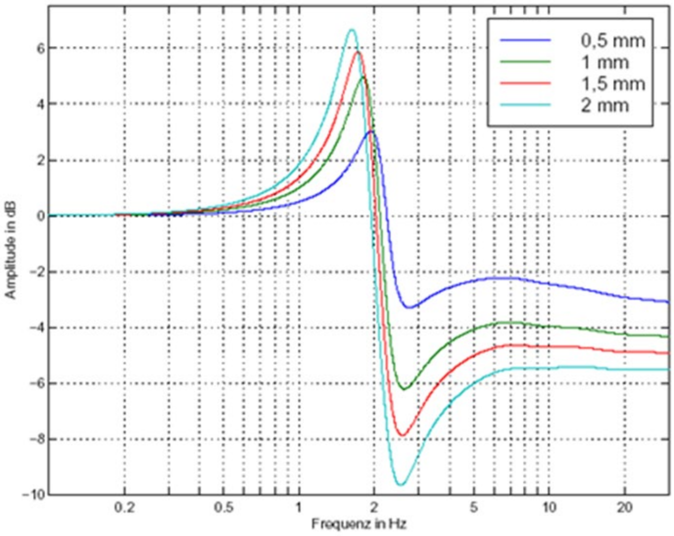
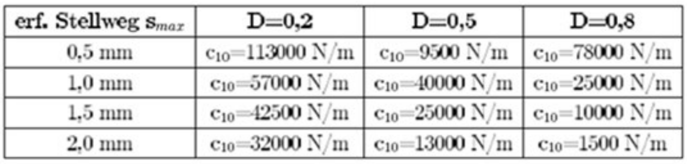


Fig.4 Isolation at constant damping D=0.2 and variable operating displacement

Small actor displacement drives high stiffness; vice–versa the higher the stiffness, the smaller the actor displacement. The higher the stiffness, the higher is also the required actor power, and the stiffer the system, the worse the vibration isolation. The larger the actor displacement, the smaller the resonance frequency, which is desirable. The higher the damping, the higher is also the required actor power, and the smaller the resonance amplitude. On the other hand, the smaller the damping and the higher the actor displacement, the better the vibration isolation above 4 Hz. Vibration isolation below 1 Hz is not possible. Hence to optimize the system large actor displacement, small stiffness and medium to high damping must be achieved (Fig.5).



erf. Stellweg s_{max}	D=0,2	D=0,5	D=0,8
0,5 mm	c_{10}=113000 N/m	c_{10}=9500 N/m	c_{10}=78000 N/m
1,0 mm	c_{10}=57000 N/m	c_{10}=40000 N/m	c_{10}=25000 N/m
1,5 mm	c_{10}=42500 N/m	c_{10}=25000 N/m	c_{10}=10000 N/m
2,0 mm	c_{10}=32000 N/m	c_{10}=13000 N/m	c_{10}=1500 N/m

Fig.5 Active vibration damping system parameter relationships