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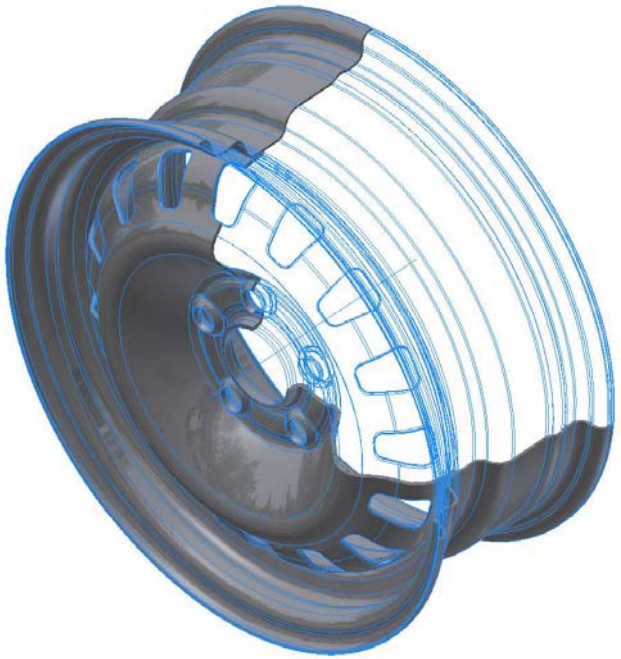
INTERNATIONAL BUSINESS DEVELOPMENT
METAL PROCESSING & METAL FORMING

Wheel Mass to Body Ratio

by Erik Waelchli



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The Questions

One Unit of Wheel Weight
is “worth” how much Body Weight?

- Internet research reveals claims of ratios from 2 to 10 times!
- Are these figures for real?
- What are the factors that influence this ratio?

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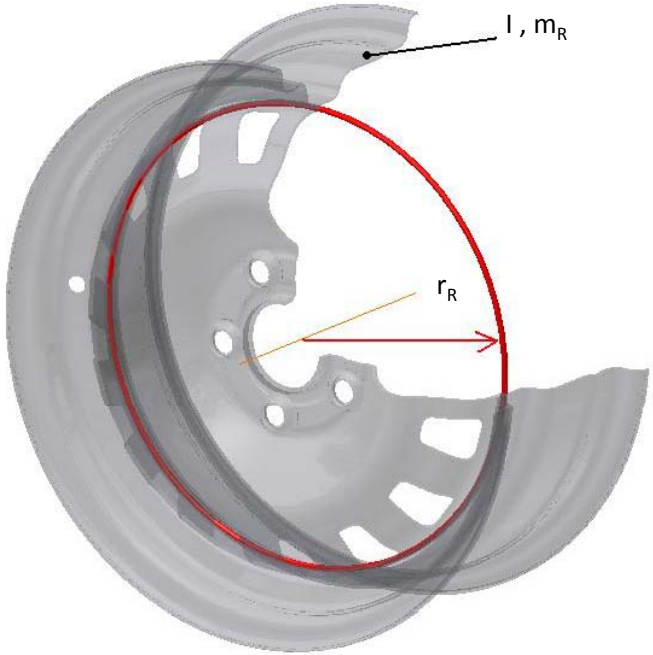
The Wheel-Rim Mass Radius

The need for a simple model

$$I = m \times r^2$$

- Concentrate the wheel mass to the "**Mass Radius**"

$$r_R = \sqrt[2]{I_{wheel} / m_{wheel}}$$



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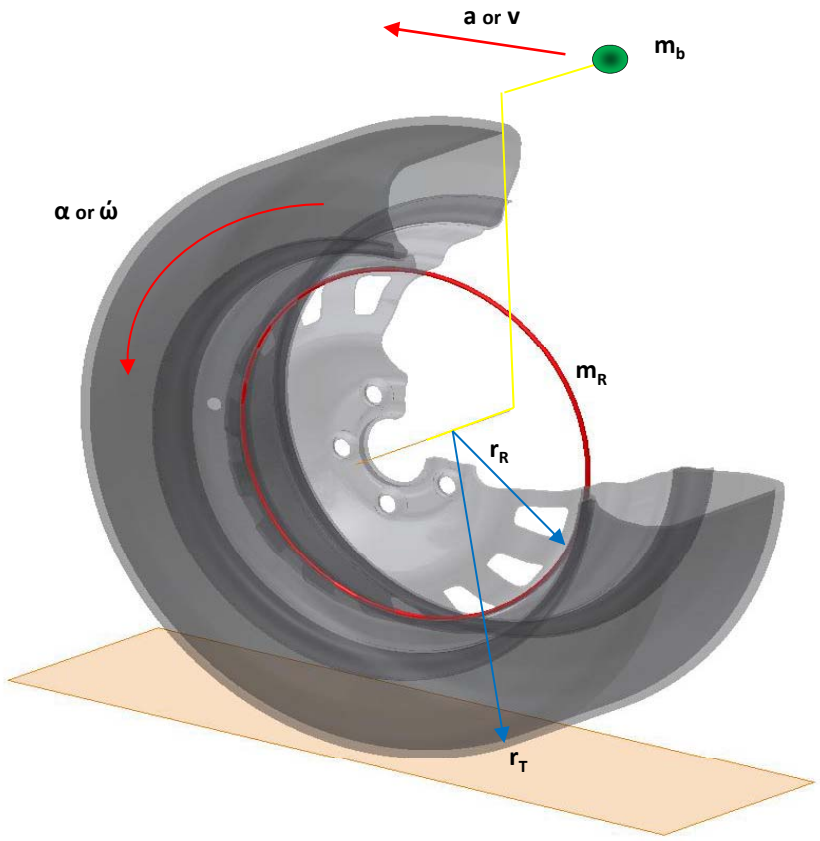
Physics & "The Relationship"

$$m_B / m_R = 1 + r_R^2/r_T^2$$

i.e. the Mass-Ratio

or $m_B = m_R \times (1 + r_R^2/r_T^2)$

or $m_R = m_B / (1 + r_R^2/r_T^2)$



Numerical Limits and Ranges

$$m_B / m_R = 1 + r_R^2 / r_T^2$$

- **Minimum Limit** $m_B / m_R = 1.0$
- **Maximum Limit** $m_B / m_R = 2.0$

- **Typical Range for Wheels** $m_B / m_R = 1.2 \ldots 1.5$
  dependant on aspect ratio of tire

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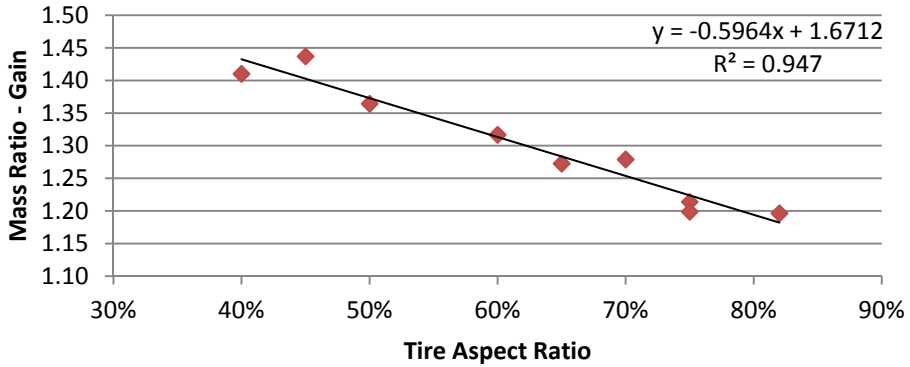
"Rotating-to-Body Mass Ratio" Comparison with different Tire Aspect Ratios

Vehicle		*Corvette*	*Camaro*	*Cadillac STS*	*Pass-Car*	*Silverado*	*Pass-Car*	*Hummer H3*
Rim		**18 x 8.5**	**20 x 8**	**18 x 8**	**J14 x 5.5**	**J8 x 18**	**J14 x 5.5**	**16 x 7.5**
Tire		**P245/40ZR18**	**P245/45ZR20**	**P235/50ZR18**	**P185/60R14**	**P265/65R18**	**P185/70R14**	**P265/75R16**
Aspect Ratio		**40%**	**45%**	**50%**	**60%**	**65%**	**70%**	**75%**
Tire Rolling Radius	mm	306.9	330.4	325.7	271.7	376.5	289.5	377.9
Wheel-Rim Mass Radius	mm	196.6	218.4	196.6	152.9	196.6	152.9	174.8
Mass Ratio = $1+ R_R^2/R_T^2$	**[-]**	**1.41**	**1.44**	**1.36**	**1.32**	**1.27**	**1.28**	**1.21**



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The interesting Weight is Outside

		Original	*Outer Section*	*Inner Section*	
Inertia	**I**	138,783	128,938	137,302	kg-mm^2
Wheel Mass	**m_R**	5.86	5.61	5.61	kg
Delta Wheel Mass	**dm_R**		0.250	0.250	kg
Mass Radius	**r_R**	153.9	151.6	156.44	mm
Tire Radius	**r_T**	266	266	266	mm
Ratio	**m_B/m_R**	1.335	1.325	1.346	[-]
Wheel Mass refl. to Body		7.82	7.43	7.55	kg
Delta equiv. Body Mass			0.389	0.271	kg
%-age Gain to delta Wheel Mass			**55.7%**	**8.4%**	

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The Answers

How much more is One Unit of Wheel Weight "worth" than Body Weight is influenced by:

- **Where the Weight is on the Wheel**
  - **How far away is the wheel-mass from the wheel's rotational axis**
- **Aspect Ratio of the Tire**
  - **How far way is the wheel-mass from the road**
- **Typical Wheel-Mass-to-Body Ratio m_B/m_R = 1.2 to 1.6**
  - **<u>Possible Mass Gains from 20% to 60%</u>** i.e. (factors of > 2 are false!)

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for Feedback and Questions
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