WICHITA STATE UNIVERSITY

# Static and Dynamic Stiffness of the Milling Machine

Department of Industrial, Systems and Manufacturing Engineering

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# Research work

- Robot Link Crack Detection using Vibration Data and Deep Learning (NCAA)
- Detecting Misalignments of Drilled Holes using Machine Vision (EAI ICAST 2023)

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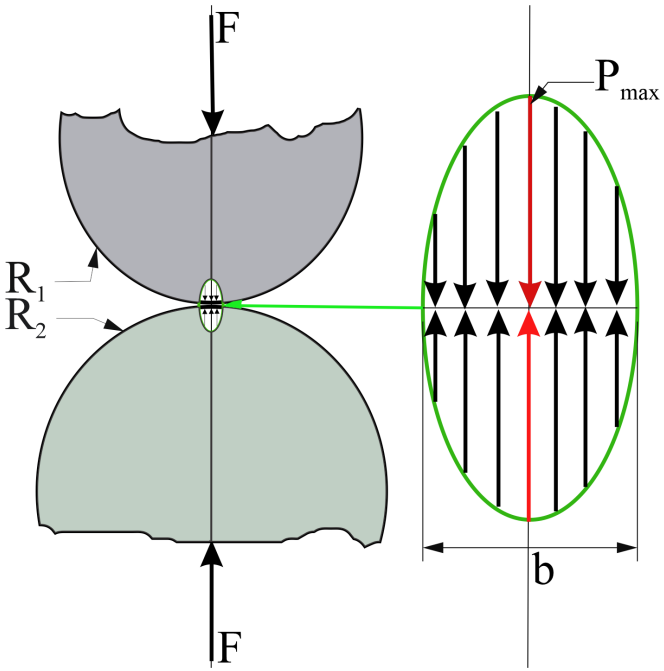
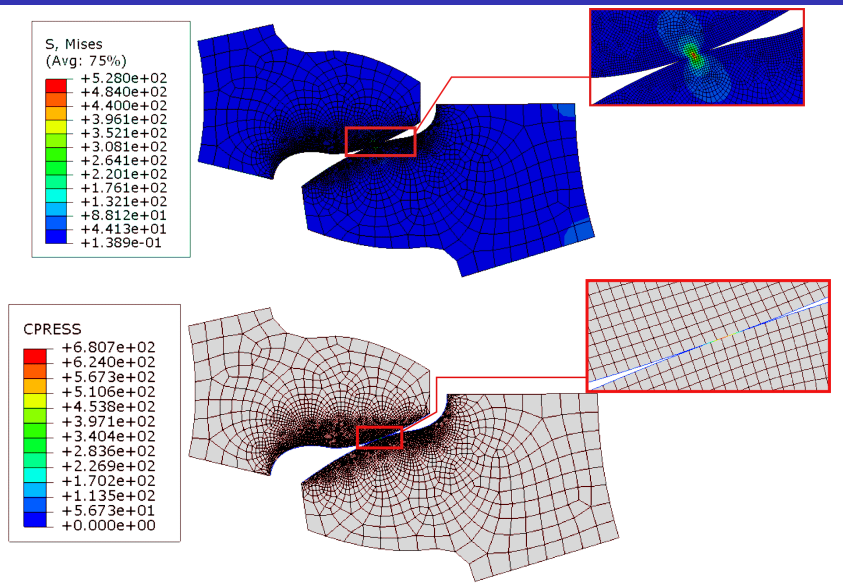
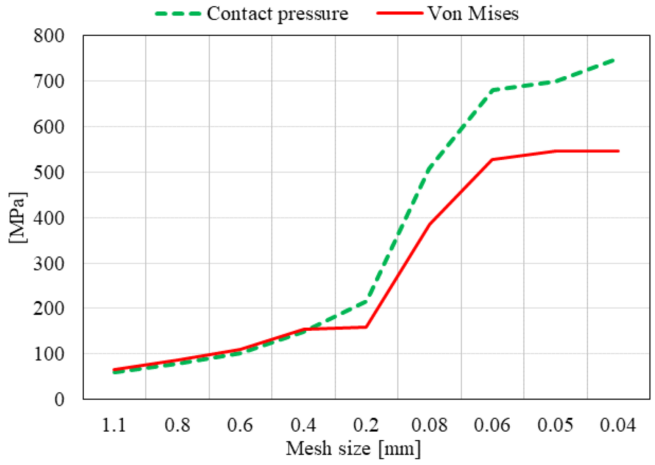
- Numerical Stress Analysis and Fatigue Life Prediction of the Classical External Geneva Mechanism, 2022
- Contact temperature analysis of the classical Geneva mechanism through numerical methods, 2022
- Effect of backlash on transmission error and time-varying mesh stiffness, 2020
- Numerical study of the effect of backlash on flash temperature of spur gear, 2020
- Dynamic Analysis of Spur Gear with Backlash using ADAMS, 2020
- The Performance of Gear with Backlash: A Review, 2020

# Hertzian contact stress



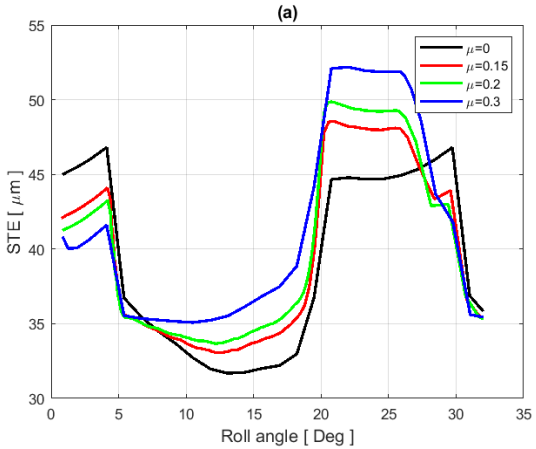




- Contact width: $b = \sqrt{\frac{8wR'}{\pi E'}}$
- Contact pressure: $P_{max} = \frac{2w}{\pi b}$




Mesh sensitivity (A quadrilateral element (CPE4) type with 0.06 mm mesh size is used for simulation)[1]

# S/DTE analysis

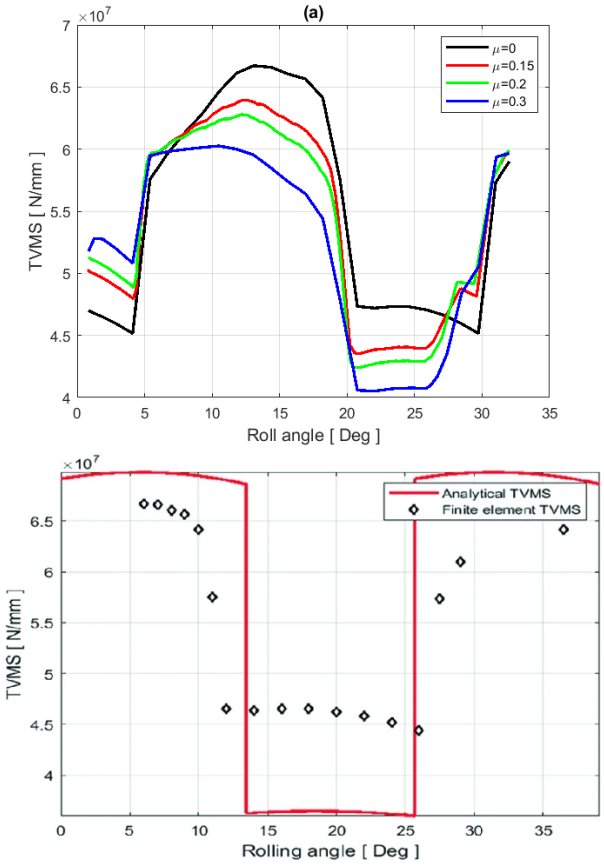



$$TE(\omega) = \theta_P(\omega) - \frac{N_G}{N_P}\theta_G(\omega)$$

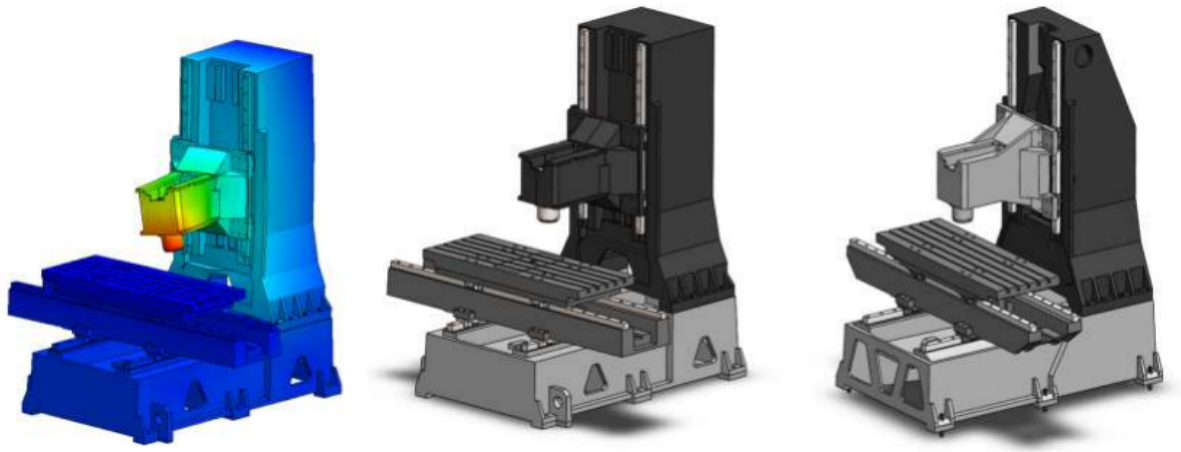
$$TE(\mu m) = \frac{1}{2}\left[D_P\theta_P - D_G\theta_G\right]$$

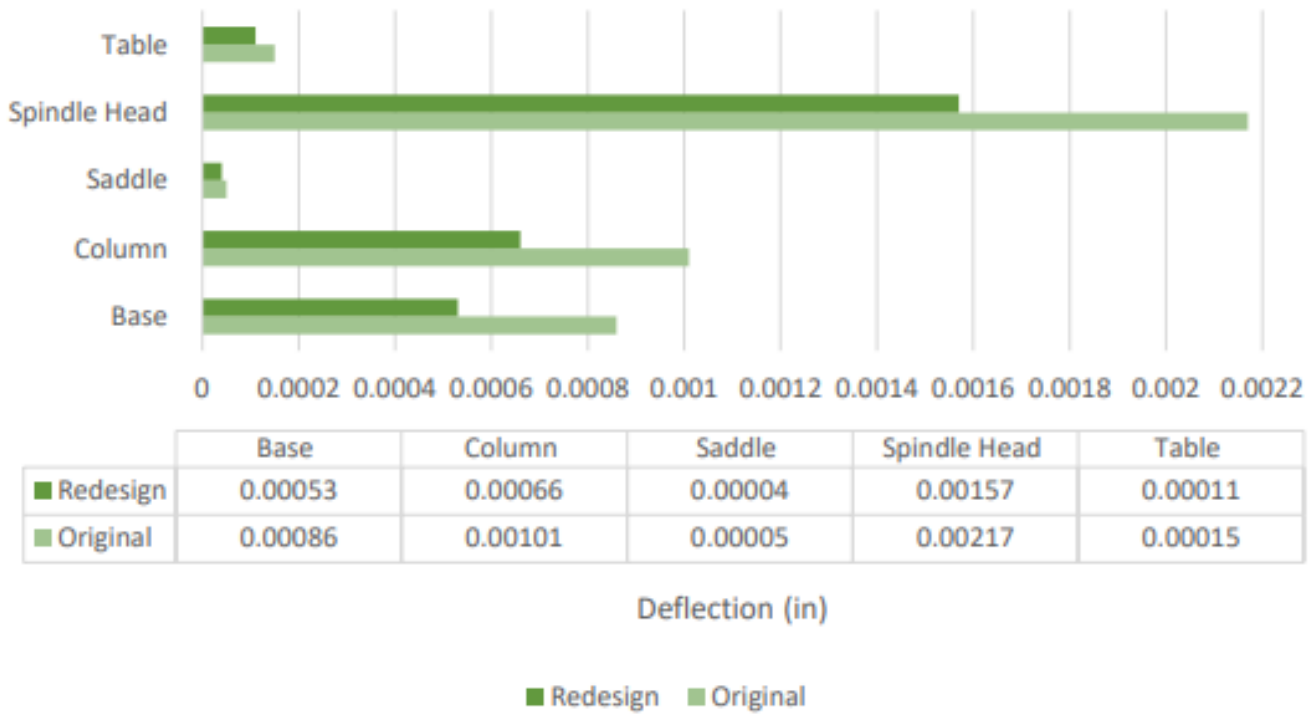
# Numerical Analysis TMS

- Hertzian contact deformation
- Tooth beam induced deformation
- Tooth foundation induced deformation



- VMC core structure optimization for improved performance [2]






| | Base | Column | Saddle | Spindle Head | Table |
|---|---|---|---|---|---|
| Redesign | 0.00053 | 0.00066 | 0.00004 | 0.00157 | 0.00011 |
| Original | 0.00086 | 0.00101 | 0.00005 | 0.00217 | 0.00015 |

# References I


[1] G. A. Ambaye and H. G. Lemu, "Effect of backlash on transmission error and time varying mesh stiffness," in *International Workshop of Advanced Manufacturing and Automation*, pp. 18–28, Springer, 2020.

[2] B. Patterson, *VMC Core Structure Optimization for Improved Performance*. PhD thesis, California State University, Northridge, 2023.


Thank You !