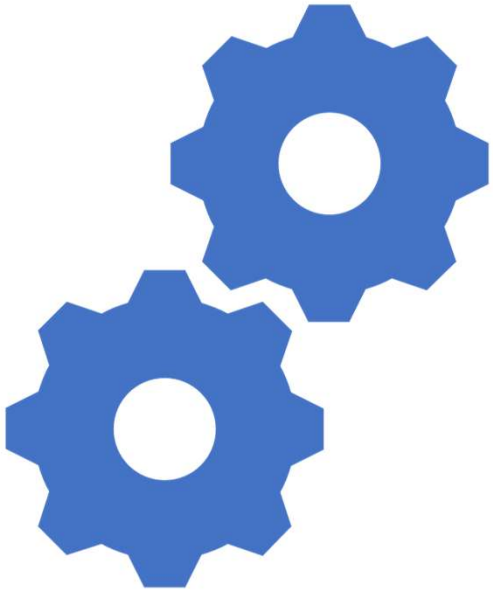
Mechanical Design Portfolio



Hruturaj Vartak

Lead Mechanical Engineer And Team Leader

Master of Mechanical Engineering and Business Administration

ABOUT ME

A resume alone cannot capture the full breadth of my skills and experiences. This portfolio showcases selected mechanical design projects that reflect my technical expertise, problem-solving approach, and passion for innovation. To respect confidentiality agreements with previous employers, some projects are presented conceptually. Together, these examples illustrate my design methodology, technical skills, and ability to deliver measurable results.

Technology evolves rapidly, but the principles of design, rooted in an understanding of people, remain timeless. I hope you find these projects as engaging to explore as I did to create.

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CONTENT

MINI EXCAVATOR FRAME – ZERO TAIL-SWING DESIGN

Project Goal

- Create robust, lightweight, highly maneuverable 3.5mT mini-excavator frame
- Meet safety & operational standards

Key Contributions

- Market research & benchmarking competitor designs
- CAD modeling in Creo; material optimization with high-strength steel
- Seamless integration with hydraulics, engine, and operator cabin

Analysis & Validation

- Conducted FEA on critical load cases (static, lateral, impact)
- Iteratively optimized frame to cut weight while maintaining durability

Impact

- Improved maneuverability in confined spaces (zero tail-swing)
- Delivered a competitive, user-friendly design

RESULTS AND IMPACT – MINI EXCAVATOR FRAME

A. FEA & Optimization

- Simulated static, dynamic, and impact load cases using ANSYS/Creo
- Iteratively refined design to reduce weight while maintaining durability

B. Results & Impact

- 15% lighter frame → improved fuel efficiency & handling
- Improved maneuverability → zero tail-swing design ideal for confined spaces
- Extended service life → withstood diverse operational stresses
- Market-ready → competitive, compliant, user-friendly design

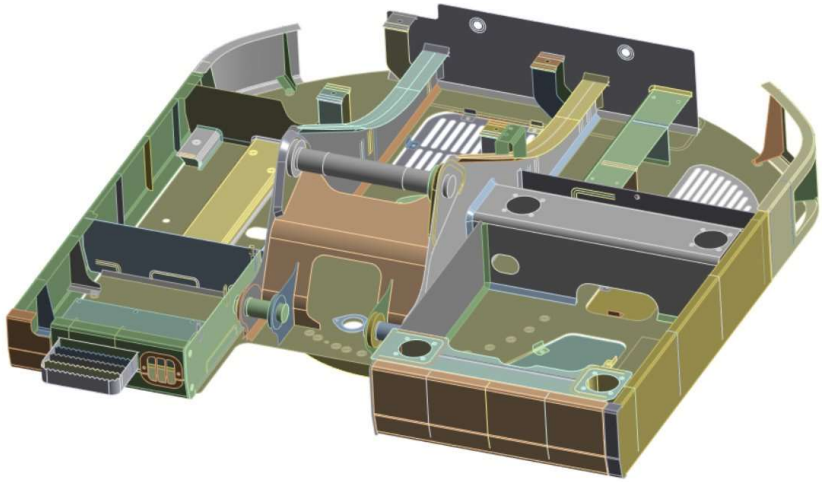
C. Skills Applied

- CAD: Creo | FEA: Simscape | Material Optimization | Structural Engineering

REDUCED TAIL-SWING EXCAVATOR FRAME – DESIGN PROCESS

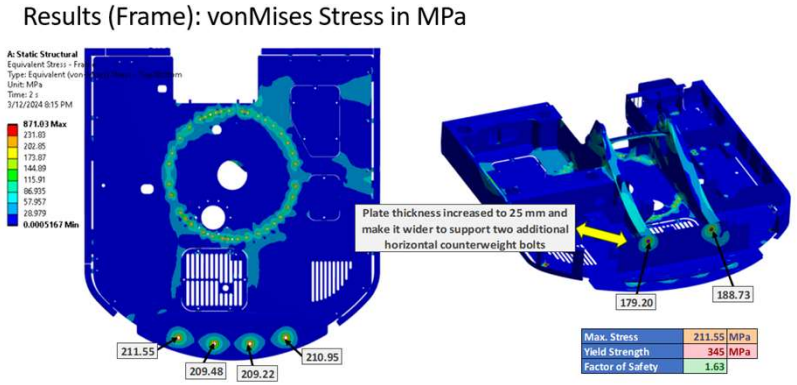
A. Project Goal

- Design 15.5mT reduced tail-swing excavator frame for confined spaces
- Maintain strength, stability, and manufacturability



B. Design Process

- Market Analysis: Collected customer feedback + benchmarked competitor models
- CAD Design: Built compact, efficient 3D models in Creo
- Material Selection: High-strength, lightweight steel alloys for durability & weight savings
- System Integration: Hydraulics, operator cabin, and controls fully incorporated



REDUCED TAIL-SWING EXCAVATOR FRAME – FEA AND RESULTS

A. FEA & Validation

- **Static Analysis:** Modeled heavy loads & uneven terrain → reinforced weak points
- **Modal Analysis:** Avoided resonance frequencies → reduced vibration & noise
- **Optimization:** Iteratively redistributed loads to minimize weight while maintaining durability

B. Results & Impact

- 15% lighter frame → improved fuel efficiency & handling
- Enhanced maneuverability in confined spaces
- Extended service life under diverse operational stresses
- Reduced vibration → improved operator comfort & longevity

C. Skills

- FEA – ANSYS | CAD – Creo | Structural Optimization

EXCAVATOR ARM DESIGN & STRUCTURAL OPTIMIZATION

Objective

- Design excavator arm (stick) with optimal pin geometry & contour for strength and reach

Approach

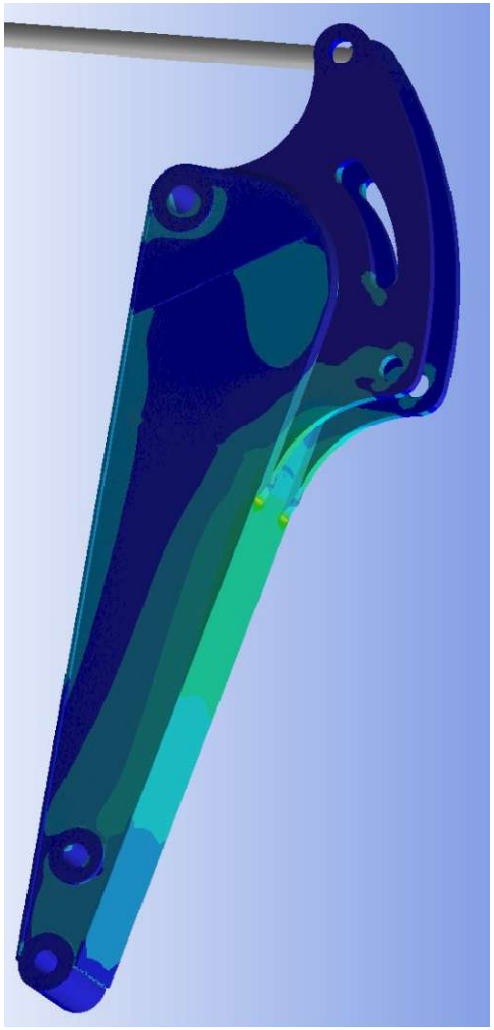
- Defined boom, bucket, and pin geometry for required reach
- Modeled contour and cross-section in Creo (box/trapezoidal shapes)
- Material: Q345 steel → balanced strength & weight
- Added tapers, gussets, and reinforcements based on FEA hot spots

Results

- Achieved required reach while maintaining structural integrity
- Optimized geometry reduced weight without loss of strength
- Improved dig force efficiency via pin geometry optimization

Skills:

CAD (Creo) | Structural Analysis | FEA | Material Optimization



ERGONOMIC AND VISIBILITY STUDY OF EXCAVATOR CABIN

Objective

- Improve operator comfort, visibility, and safety per ISO 5006 standards

Approach

- Ergonomic assessment using Creo Manikin for reach zones & control layout
- Visibility analysis: masking techniques, blind spot reduction, mirror & camera placement
- Stakeholder engagement: validated with operators & product management

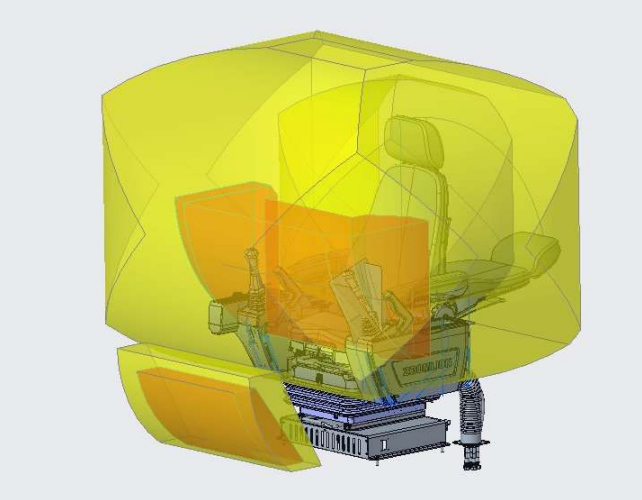
Results

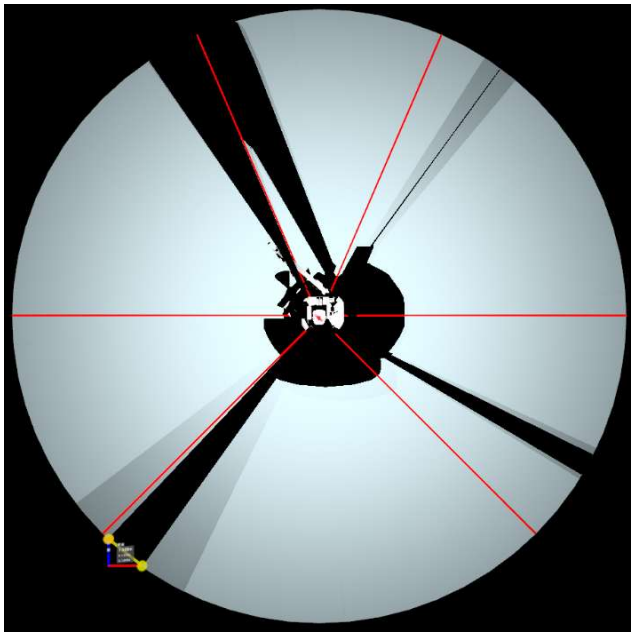
- **+15%** positive user feedback
- **–10%** operator fatigue incidents
- Improved compliance & operator satisfaction

Skills Applied

CAD (Creo), Ergonomic Simulation, ISO 5006, Human-Centered Design

Demonstrated ability to lead user-centered engineering initiatives, balancing safety, comfort, and regulatory compliance.





TOPOLOGY OPTIMIZATION OF EXCAVATOR FRAME

Objective

- Reduce frame weight while maintaining durability and safety

Approach

- Performed topology optimization on high-stress regions
- Validated with static & fatigue FEA simulations
- Implemented reinforced geometry in production

Results

- 15% lighter frame → annual cost savings
- Improved fuel efficiency & payload capacity
- Maintained structural reliability under field conditions

Skills Applied

ANSYS | Structural Optimization | Lightweight Design

IOT-ENABLED DIGITAL TWIN FOR STRUCTURAL SYSTEMS

Objective

- Ensure durability and reliability of heavy structural systems under dynamic loads

Approach

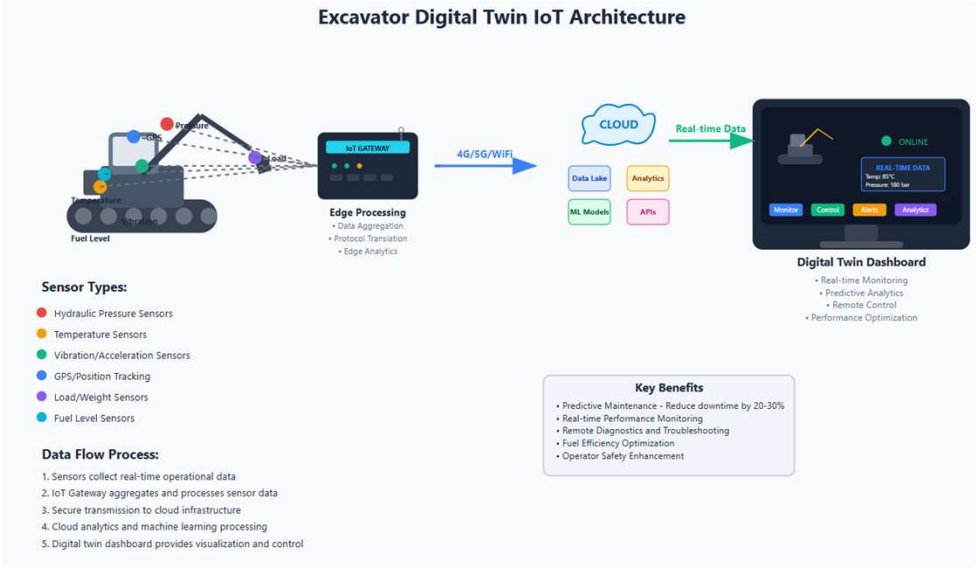
- Deployed sensor network (strain, vibration, pressure) on structural components
- Integrated IoT gateways for real-time monitoring & cloud data analysis
- Developed digital twin model for anomaly detection & lifecycle prediction

Results

- 92% prediction accuracy of structural fatigue/failures
- 30% reduction in downtime due to early detection
- 20% lower maintenance cost with condition-based servicing

Skills Applied

Structural Monitoring | IoT Integration | Digital Twins | Predictive Maintenance

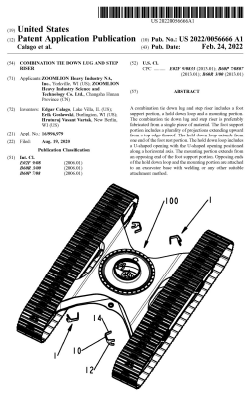


Excavator Digital Twin IoT Architecture (Conceptual)

PATENTS

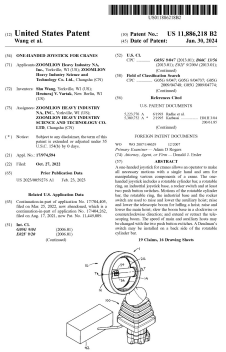
Combination Tie Down Lug And Step Riser

A combination tie down lug and step riser includes a foot support portion, a hold down loop and a mounting portion. The combination tie down lug and step riser is preferably fabricated from a single piece of material. The foot support portion includes a plurality of projections extending upward from a top edge thereof. The hold down loop extends from one end of the footrest portion. The hold down loop includes a U-shaped opening with the U-shaped opening positioned along a horizontal axis. The mounting portion extends from an opposing end of the foot support portion. Opposing ends of the hold down loop and the mounting portion are attached to an excavator base with welding or any other suitable attachment method.



One-handed joystick for cranes

A one-handed joystick for cranes allows an operator to make all necessary motions with a single hand and arm for manipulating various components of a crane. The one-handed joystick includes a rotatable cylinder bar, a rotatable ring, an industrial joystick base, a rocker switch and at least two push button switches. Motions of the rotatable cylinder bar, the rotatable ring, the industrial base and the rocker switch are used to raise and lower the auxiliary hoist; raise and lower the telescopic boom for luffing a hoist; raise and lower the main hoist; slew the boom base in a clockwise or counterclockwise direction; and extend or retract the telescoping boom. The speed of main and auxiliary hosts may be changed with the two push button switches. A Deadman's switch may be installed on a back side of the rotatable cylinder bar.



MY SKILLS FOR BELTWAYS' MISSION

Beltways' Needs

- Own the full lifecycle of mechanical design: concept, CAD, prototyping, testing, documentation, and launch.
- Lead cost reduction and DFM for scalable production (sheet metal, casting, etc.).
- Use CAD tools, primarily NX, for mechanical design and analysis.
- Learn and apply relevant codes and standards (especially ASME A17.1).
- Participate in technical and cross-functional reviews with software and systems teams.
- Troubleshoot and mentor hands-on, supporting teammates at all levels.

My Skills

- 15+ yrs structural design & FEA expertise (excavators, heavy systems)
- Delivered 15% weight savings, annual cost savings via topology optimization
- Pioneered digital twin with IoT sensors (92% prediction accuracy, –30% downtime)
- Cut prototyping lead time 6 weeks → 2 weeks using additive manufacturing
- Drove operator safety improvements (15% higher satisfaction, 10% lower fatigue)
- Managed and mentored teams of 12+ engineers across continents

WHAT LEADERS SAY ABOUT MY WORK

Quote 1 – Erik Goslawski (Director, Siemens Digital Industries Software)
"Raj quickly supported our team in developing new Earth Moving products. His communication skills and ability to see the bigger picture made him a strong leader. I highly recommend him in roles of technical and personnel leadership."

Quote 2 – Guy A. Moore, PE (Director of Engineering)
"Raj demonstrated impressive abilities and transitioned seamlessly from individual contributor to Engineering Manager. He motivated his team, removed roadblocks, and fostered continuous learning — a rare quality in engineering leadership."

Quote 3 – Jack Wang (Technology Researcher & Former President Zoomlion NA)
"Raj led a 15-member structural team, driving urgent projects to successful launch. His leadership enabled innovation, including two patents. I confidently believe he will be a successful leader and innovator in the industry."