Over the years, **K Gyan Design Lab** has successfully delivered a wide range of complex engineering projects and resolved critical technical challenges across industries.
The following examples highlight some of the key solutions, innovations, and precision-driven developments achieved through our experience and expertise.

Our Engineering Excellence:

1. **High Precision Engineering**

   a) **Patented crash mechanism for machine safety**

      i. Developed a **sacrificial layer-based crash architecture** designed to minimize damage to high-value and critical hardware during unexpected impact events.
      ii. Engineered a **ceramic-compatible crash mechanism** that significantly reduces the risk of fracture or crack propagation under crash loads.
      iii. Utilized **specialized engineering materials** capable of absorbing approximately **25 kN of impact force** without yielding, fracturing and minimum particle generation — ideal for **ultra-clean vacuum applications**.
      iv. Designed the **crash hardware as a modular, service-friendly unit**, enabling easy replacement only when required, thereby minimizing maintenance time and cost.

   b) **High-Acceleration Magnetically Levitated Stage**

      i. Developed a **160 kg, 6-degree-of-freedom stage** achieving **32G acceleration** at **5.2 m/s**, purpose-built for high-speed precision applications.
      ii. Engineered for a **fatigue life of over 2 billion cycles** across a 7-year operational span, ensuring long-term reliability.
      iii. Optimized for **ultra-clean vacuum environments**, with an **ultra-low outgassing profile** and exceptional dynamic stability.
      iv. Incorporated **active water-cooling systems** and **eddy current suppression features** to maintain thermal and electromagnetic performance.
      v. Developed **robust cable and hose management systems**, including secure electrical and fluid interfaces, to meet demanding functional and environmental requirements.

   c) **Vacuum-Potted canned Halbach Magnet Array**

      i. Engineered a high-performance **orthotropic Halbach magnet array**, with precisely controlled **polarization angles and magnetic pitch tolerances** to ensure optimal magnetic field uniformity.
      ii. Employed **computational fluid dynamics (CFD)** to achieve **over 99% adhesive potting efficiency**, ensuring mechanical integrity and thermal stability in demanding environments.

iii. Developed an **automated assembly process** for consistently producing **high-strength bonded magnet arrays**, reducing human error, and increasing repeatability.
iv. Implemented a specialized **cleaning protocol and surface treatment process** to enhance adhesive bonding strength and long-term durability of the magnet-glue interface.

d) Multi Axis high precision optical module alignment stage

i. **Dual-axis** mechanism through Parallel **kinematic coupling** using **single actuator**
ii. **Nanometer** range **resolution** & high **positional accuracy** system designed to meet **micron** level requirement
iii. Dynamic cable **routing** through purpose designed features to **maintain repeatable** cable **geometry** to **avoid** parasitic **forces** due to loose cables
iv. **High stiffness** components designed for **dynamic stability** viz FEA-driven geometry optimization

e) 3 DoF sub-micron sensor positioning module for optical measurements

i. Designed system for **low thermal sensitivity, high resolution** through **innovative geometry** and **smart material** selection
ii. Thermal **FEA** to **predict worst-case** positional **drift** across **expected** operating **temperature range**, including gradient **thermal loading** scenarios
iii. **Smart material selection** based on specific **stiffness** requirements and **thermal** loading analysis results
iv. **Crash architecture** designed for **low deceleration** & **crash force** to ensure machine and product **safety**
v. **Electro-mechanical design** to integrate **encoders** & **sensors** across all motion axes for **real time calibration**
vi. Sensor mounting features designed for repeatable installation and field replaceable maintenance access

f) Mechatronic balance mass isolating vacuum to atmosphere, bridging static & dynamic world

i. Design of thermally stable **3000** kgs & **4 sq mtr stainless steel body**, suspended on **flexures** with **1-DoF**
ii. Designed **height adapting mechanism** to minimize moments by **aligning center of force w.r.t center of mass**
iii. Balance mass body **designed** to **house electrical & fluid interfaces** and isolate **vacuum** and **atmospheric** environments in system

g) Strike Crash Plate Optimization

i. **Redesigned** the crash plate architecture to improve structural performance, **reduce** manufacturing **complexity**, and **optimize cost** while maintaining the existing installation envelope.
ii. **Smart material selection** for **negligible magnetic influence**, and ultra-**low particle generation** suitable for **precision** vacuum applications.
iii. Re-engineered the fastening strategy by **replacing Inconel fasteners** with **standard fasteners** within the **same design space**, **eliminating flexure** design components while improving assembly robustness and manufacturability.
iv. Performed **Finite Element Analysis (FEA)** to evaluate **load distribution** and **reaction forces** at bolted joints, ensuring **structural integrity** and **reliable** crash **performance** under operational loading.

h) Adaptive Cable & Hose Clamp

i. Developed a **dynamic** preload retention mechanism to compensate for **long-term** cable creep and **maintain preload** throughout the **operational** life of the system.
ii. **Investigated** and **evaluated** multiple compliant **design concepts**, including helical springs, custom flexures, and linear wave springs, to identify the most **effective** preload compensation **solution**.
iii. Performed analytical **calculations** to optimize **flexure** geometry and **establish** the **required preload** across the expected range of cable diameter variations.
iv. **Engineered** the **clamping system** to maintain controlled cable routing and **reliable retention** for service life exceeding seven years without measurable loss of preload.

2. Advanced Robotics

a) Mobile platform for automated Ship Hull welding Robot

i. Researched and developed a **platform to maneuver the robot within the ship hull.**
ii. Designed the chassis, transmission system, and powertrain within **stringent volume constraints**.
iii. **Calibrated** and designed the **system's kinematics and dynamics** to ensure hardware stability across all use cases.
iv. Innovatively developed a dual-purpose **sprocket to** both **transmit power** and **absorb shock**.

b) High-strength, light-weight lunar rover

i. Designed with **redundant systems** to eliminate single points of failure, ensuring continuous operation in critical lunar exploration missions.
ii. Conducted **simulation testing using lunar regolith analogs** on Earth, ensuring the system is optimized to withstand the harsh and varied terrain of the Moon's surface.
iii. Incorporated a series of **labyrinth seals** to protect motors and bearings from the ingress of fine lunar regolith, preventing potential blockages or system malfunctions.
iv. Engineered the rover with a **high-stiffness, low-mass assembly**, ensuring robustness against high acceleration loads while maintaining mobility and performance in extreme conditions.

c) Engineered framework for high performance Exoskeleton

i. **Prototyped and tested** chest, back, and leg harnesses using **carbon fiber** and **rapid prototyping** for optimized strength and flexibility.
ii. Designed for **flexibility, high fatigue life**, **lightweight**, and **robustness**.
iii. Incorporated **bearings and ropes** within the system to precisely **actuate human movements**, ensuring seamless motion assistance without compromising comfort or mobility.
iv. **Evaluated the effectiveness of assistance** by monitoring **breathing patterns**, providing insights into the exoskeleton's ability to reduce physical strain and enhance user performance during dynamic tasks.