



PHOENICIA UNIVERSITY

The Design & Manufacturing Field

How engineers turn concepts into products and mechanical systems that are safe, reliable, and efficient.

Mechanical Engineering Program | Foundations of Design & Manufacturing



What Is the Design & Manufacturing Field?

The Design and Manufacturing field focuses on developing products and mechanical systems that are safe, reliable, and efficient.

Students study material science, mechanics of materials, machine design, and manufacturing processes to transform conceptual ideas into physical components.

FOUR CORE DISCIPLINES

Material Science

Understanding how a material's structure determines its real-world properties.

Mechanics of Materials

Predicting how components deform and fail under stress.

Machine Design

Turning functional requirements into working mechanical systems.

Manufacturing Processes

Turning a design into a physical, produced part.



2

Building Engineering on Physics Fundamentals

Every principle in this field builds directly on conservation laws you already know — engineering just formalizes them into tools for designing and building real products.

Energy → Crash Safety Design

The conservation of energy is applied to design vehicle structures that safely absorb collision energy, protecting passengers in a crash.

Momentum → Statics and Dynamics

Newton's laws of motion and the conservation of momentum are the foundation of statics and dynamics, letting engineers analyze machines and robotic systems under different loads.

Mass → Manufacturing Processes

The conservation of mass is utilized in manufacturing processes such as casting, machining, and additive manufacturing like 3D printing.

3

Designing for Crash Safety

What Engineers Design For

Energy conservation means crash energy doesn't disappear — it has to go somewhere. Vehicle structures are engineered with crumple zones and energy-absorbing materials that convert crash energy into controlled deformation, away from the passenger compartment.

ENGINEERING APPLICATION

Crumple Zones and Controlled Deformation

Applied vehicle safety engineering

Modern vehicle frames use front and rear sections designed to progressively fold and absorb impact energy, while a rigid passenger safety cell resists deformation — converting a sudden, violent stop into a slower, more survivable one.

Why It Matters

Every crash-test rating traces back to how well a structure's energy absorption matches the forces it's designed to survive.

Lesson: safety isn't about making a structure indestructible — it's about controlling exactly where and how it gives way.



4

Statics, Dynamics, and Newton's Laws

What They State

Newton's laws of motion and the conservation of momentum form the foundation of statics (forces on structures at rest) and dynamics (forces on moving systems), letting engineers predict exactly how a machine or robot responds to a given load.

ENGINEERING APPLICATION

Analyzing Machines and Robotic Systems

Applied statics and dynamics

Engineers use statics to ensure a crane or bridge component won't fail under its expected load, and dynamics to predict how a robotic arm accelerates, decelerates, and balances forces as it moves through a task.

Why It Matters

A machine designed without a correct load analysis risks failure under stress it was never actually tested to withstand.

Lesson: a structure that looks strong and a structure that's proven strong are not the same thing.



5

Manufacturing and the Conservation of Mass

What It States

The conservation of mass means material doesn't vanish during manufacturing — it's removed, reshaped, or added. Casting reshapes molten material, machining removes material to reach a final form, and additive manufacturing builds a part up layer by layer.

ENGINEERING APPLICATION

Casting, Machining, and 3D Printing

Applied manufacturing processes

Casting pours molten material into a mold to form a shape; machining cuts away material from a solid block; additive manufacturing (3D printing) builds a part directly from digital design data, adding only the material a part actually needs.

Why It Matters

Choosing the right process changes how much raw material is wasted, and how much a final part actually costs to produce.

Lesson: every manufacturing process is really just a different answer to the same question — where should the material go?



6 Three Governing Principles, Side by Side

Conservation Law	Engineering Discipline	Key Applications
Conservation of Energy	Crash Safety Design	Vehicle crumple zones, passenger protection
Newton's Laws & Momentum	Statics and Dynamics	Machines, robotic systems, structural loading
Conservation of Mass	Manufacturing Processes	Casting, machining, 3D printing

7 Modern Tools: CAD and Additive Manufacturing

Computer-aided design (CAD) lets engineers model, test, and refine a product digitally before a single physical part is made.

Additive manufacturing builds parts directly from digital designs, adding material only where a part actually needs it.

THE PAYOFF

Improved Performance

Digital modeling and simulation let engineers optimize a design's strength and function before it's built.

Reduced Cost

Efficient use of material lowers both raw material and production costs.

Reduced Environmental Impact

Minimizing waste means less material used, and less discarded.

8 Why This Matters for Future Mechanical Engineers

Builds on What You Know

High school concepts of energy, force, and mass become the exact tools used to design real, physical products.

Protects Real People

Every safe vehicle, machine, and structure depends on engineers applying these principles correctly.

Shapes How Things Are Made

From casting to 3D printing, these principles decide how efficiently — and sustainably — a product comes to life.





Thank you
