

# A BRIEF INTRODUCTION TO PRODUCTION ENGINEERING: PART I



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Hey there, curious teens! Have you ever wondered how your beloved gadgets or those captivating cars are made? Well, production engineering might just be the answer you're looking for. It's an awesome field that combines creativity, technology, and problem-solving skills to make, well, pretty much everything! If you're thinking about future career paths, let's dive into the world of production engineering and explore why it could be an amazing choice. In this article, I'll walk you through what production engineering is all about, including program objectives, outcomes, subjects, and the hands-on experiences you'll get.

### Program Objectives and Outcomes

So, what's the goal of a production engineering program? Simply put, it's to turn you into a versatile engineer who can optimize production processes, improve efficiency, and ensure top-notch quality in various industries. According to ABET guidelines, the main objectives of this program are to:



1. Apply Engineering Principles: Learn how to use engineering concepts to analyze and enhance production systems, making sure resources are used effectively.
2. Optimize Production Processes: Identify and fix bottlenecks, analyze data, and implement strategies to boost the efficiency of manufacturing systems.
3. Quality Control and Assurance: Ensure products meet industry standards and customer expectations by implementing quality control measures.
4. Enhance Safety and Sustainability: Develop strategies to maintain workplace safety, minimize environmental impact, and promote sustainable production practices.
5. Project Management Skills: Acquire the skills needed to plan, execute, and monitor production projects efficiently.

Upon graduation, you will possess the necessary knowledge and skills to effectively address real-world production challenges and make valuable contributions to a variety of industries.

**Major Subjects for Production Engineering Students**

Let’s dive into the subjects you’ll be studying. A typical production engineering curriculum covers a wide range of topics to give you a solid foundation in the field. Aside from engineering’s foundation subjects, here are 25 major subjects that a production engineering student typically learns during their graduation:

1. Manufacturing Processes
2. Operations Research
3. Quality Assurance and Control
4. Supply Chain Management
5. Industrial Automation
6. Human Resource Management
7. Materials Science
8. Machine Design
9. Computer-Aided Design (CAD) and Manufacturing (CAM)
10. Robotics
11. Production Planning and Control
12. Metrology and Measurement
13. Thermodynamics and Fluid Mechanics
14. Mechanics of Materials
15. Engineering Mathematics
16. Electrical and Electronics Engineering
17. Industrial Engineering
18. Mechatronics
19. Lean Manufacturing
20. Six Sigma and Quality Management



21. Reliability Engineering
22. Simulation and Modeling
23. Project Management
24. Entrepreneurship and Innovation
25. Environmental and Sustainable Manufacturing

These subjects cover a wide range of topics, from the fundamentals of manufacturing processes and materials science to advanced topics like automation, robotics, and lean manufacturing. The curriculum also includes subjects related to management, such as project management, human resources, and entrepreneurship. Throughout the program, students gain hands-on experience through laboratory work and industry-sponsored projects, allowing them to apply their theoretical knowledge to real-world scenarios. This combination of theoretical and practical learning prepares production engineering graduates for diverse roles in manufacturing, consulting, and research and development.

**Laboratories: Experiential Learning for Production Engineering Students**

Here are 20 essential laboratories that provide experiential learning opportunities for production engineering students during their graduation:



1. **Manufacturing Processes Lab:** Equipped with various machines and tools to learn about different manufacturing techniques like machining, casting, welding, and forming.
2. **Computer-Aided Design (CAD) and Manufacturing (CAM) Lab:** Provides hands-on experience with CAD software and CNC machines for designing and manufacturing products.
3. **Robotics and Automation Lab:** Allows students to work with industrial robots, PLCs, and automation systems to understand their applications in manufacturing.
4. **Metrology and Quality Control Lab:** Equipped with precision measuring instruments and quality control tools to learn about inspection, testing, and quality assurance.
5. **Materials Science Lab:** Enables students to study the properties, structure, and behavior of various materials used in manufacturing.
6. **Fluid Mechanics and Hydraulics Lab:** Provides facilities to study fluid flow, hydraulic systems, and their applications in manufacturing processes.
7. **Thermodynamics and Heat Transfer Lab:** Allows students to experiment with heat engines, refrigeration systems, and heat exchangers to understand their principles and applications.
8. **Mechatronics Lab:** Integrates mechanical, electrical, and computer systems to teach students about automated system design and control.
9. **Rapid Prototyping and 3D Printing Lab:** Provides access to 3D printers and other rapid prototyping technologies for creating prototypes and small-scale production.



10. **Industrial Engineering Lab:** Equipped with tools and software for studying work measurement, ergonomics, facility layout, and process optimization.
11. **Simulation and Modeling Lab:** This lab allows students to use simulation software to model and analyze manufacturing systems and processes.
12. **Electrical and Electronics Lab:** Provides facilities to study electrical circuits, motors, drives, and control systems used in manufacturing.
13. **Mechanical Vibrations and Dynamics Lab:** It enables students to study vibration analysis, balancing, and noise control in machines and structures.
14. **Tribology Lab:** This lab allows students to study friction, wear, and lubrication in machine components and manufacturing processes.
15. **Renewable Energy and Sustainability Lab:** Provides facilities to study and experiment with renewable energy technologies and sustainable manufacturing practices.
16. **Industry 4.0 and IoT Lab:** Equipped with smart sensors, data acquisition systems, and cloud computing tools to learn about the application of Industry 4.0 technologies in manufacturing.
17. **Lean Manufacturing and Six Sigma Lab:** It provides a platform to learn and implement lean manufacturing principles and Six Sigma methodologies for process improvement.
18. **Reliability Engineering Lab:** This lab allows students to study failure analysis, reliability testing, and maintenance strategies for manufacturing systems and products.

**19. Additive Manufacturing Lab:** It provides access to advanced 3D printing technologies like SLS, SLM, and FDM for learning about additive manufacturing processes.

**20. Project and Innovation Lab:** It is a multidisciplinary space for students to work on capstone projects, research, and innovative product development in collaboration with industry partners.

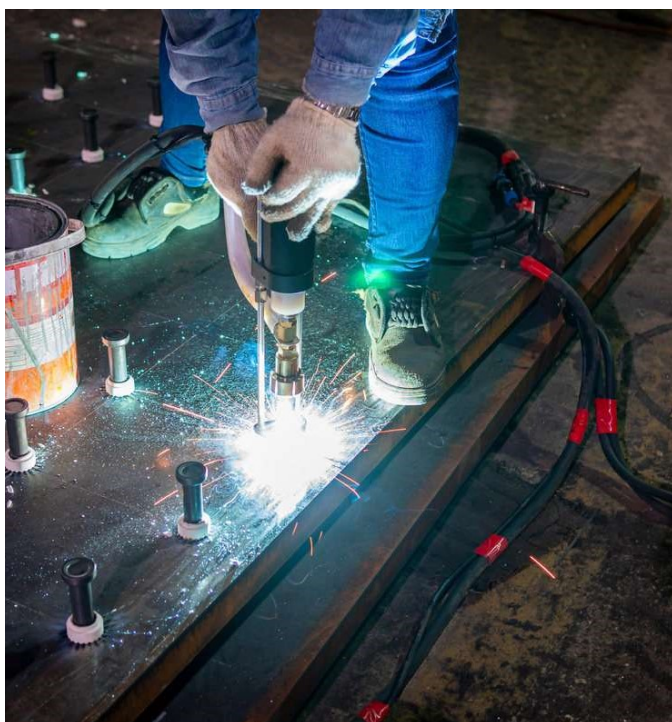
These laboratories provide students with hands-on experience, practical skills, and exposure to real-world manufacturing challenges, preparing them for successful careers in production engineering.

**Experiments and Experiential Learning Activities for a Production Engineering Student**

Here are 20 major experiments and experiential learning activities that a production engineering student might undertake during their graduation:

**1. Manufacturing Process Experiments:**

- Machining experiments to study cutting forces, tool wear, and surface finish
- Casting experiments to understand mold design, solidification, and defects
- Welding experiments to study joint strength, microstructure, and distortion
- Forming experiments to analyze material behavior, springback, and formability



**2. Computer-Aided Design (CAD) and Manufacturing (CAM) Projects:**

- Designing and simulating products using CAD software
- Generating CNC programs and manufacturing parts using CAM software

**3. Robotics and Automation Experiments:**

- Programming industrial robots for pick-and-place, welding, or assembly tasks
- Designing and implementing automated assembly lines using PLCs and sensors

**4. Quality Control and Metrology Experiments:**

- Conducting dimensional inspections using precision measuring instruments
- Performing statistical process control (SPC) studies to monitor process stability
- Designing and executing quality audits and capability studies

**5. Materials Science Experiments:**

- Studying the microstructure, properties, and behavior of metals, polymers, and composites
- Conducting heat treatment experiments to modify material properties
- Analyzing material failures using techniques like tensile testing and hardness testing

**6. Fluid Mechanics and Hydraulics Experiments:**

- Studying fluid flow characteristics in pipes and channels
- Analyzing the performance of pumps, valves, and hydraulic systems
- Conducting experiments on heat exchangers and cooling systems



7. Thermodynamics and Heat Transfer Experiments:

- Studying the performance of heat engines and refrigeration systems
- Analyzing heat transfer in manufacturing processes like casting and welding
- Conducting experiments on insulation materials and thermal management systems

8. Mechatronics Projects:

- Designing and building automated systems that integrate mechanical, electrical, and software components
- Developing control algorithms for robotic manipulators or mobile robots

9. Rapid Prototyping and 3D Printing Projects:

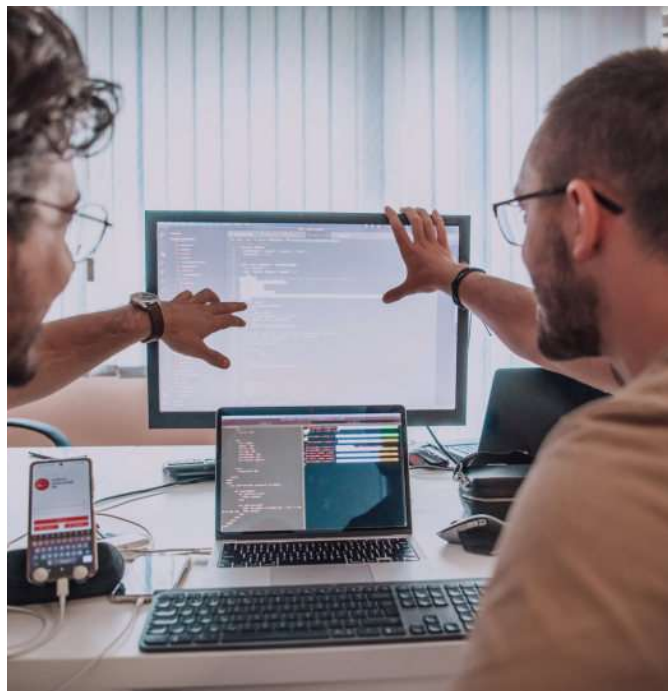
- Designing and fabricating prototypes using 3D printing technologies
- Optimizing process parameters for different 3D printing materials and techniques

10. Industrial Engineering Experiments:

- Conducting time and motion studies to improve work methods and efficiency
- Designing ergonomic workstations and analyzing manual material handling tasks
- Optimizing facility layouts using simulation and modeling techniques

11. Simulation and Modeling Projects:

- Developing discrete event simulations of manufacturing systems using software like Arena or FlexSim
- Optimizing production schedules and resource allocation using mathematical modeling



12. Electrical and Electronics Experiments:

- Studying the performance of electric motors, drives, and control systems
- Designing and implementing sensor networks for process monitoring and control

13. Mechanical Vibrations and Dynamics Experiments:

- Analyzing the vibration characteristics of machines and structures
- Conducting experiments on balancing, isolation, and damping techniques.

14. Tribology Experiments:

- Investigating friction, wear, and lubrication in machine components
- Conducting experiments on surface treatments and coatings to improve tribological performance

15. Renewable Energy and Sustainability Projects:

- Designing and testing renewable energy systems like solar panels or wind turbines
- Conducting life cycle assessment (LCA) studies to evaluate the environmental impact of products and processes

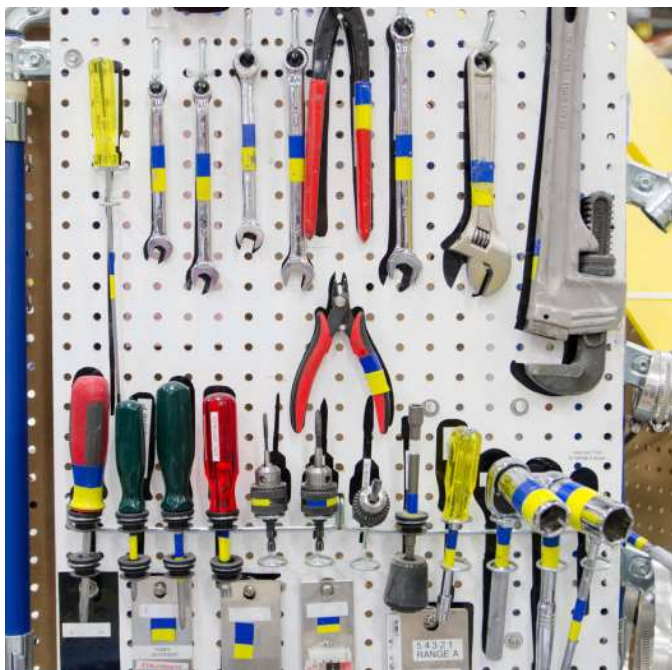
16. Industry 4.0 and IoT Projects:

- Implementing smart sensors and data acquisition systems for real-time process monitoring
- Developing cloud-based platforms for data analytics and machine learning applications



- 17. Lean Manufacturing and Six Sigma Projects:
  - Conducting value stream mapping exercises to identify and eliminate waste
  - Implementing lean tools like 5S, Kaizen, and Poka-Yoke to improve process efficiency
  - Executing Six Sigma DMAIC projects to reduce defects and variability
- 18. Reliability Engineering Experiments:
  - Conducting accelerated life testing and failure mode and effects analysis (FMEA)
  - Designing and implementing predictive maintenance strategies using condition monitoring techniques
- 19. Additive Manufacturing Projects:
  - Designing and fabricating complex geometries using advanced 3D printing technologies like SLS, SLM, or FDM
  - Optimizing process parameters and studying the mechanical properties of 3D printed parts
- 20. Capstone Projects and Industry-Sponsored Projects:
  - Collaborating with industry partners to solve real-world manufacturing problems
  - Developing innovative products or processes and presenting the results to stakeholders

These experiments and projects provide hands-on learning experiences that help production engineering students develop practical skills, apply theoretical knowledge, and prepare for their future careers in the manufacturing industry.



Stay tuned for the next issue, in which I will discuss the exciting job roles you can land after graduation, and highlight some major recruiters and famous production engineers who have made a mark in history.

**About author :** Ojas, 23, is an avid engineer with keen interests particularly in Manufacturing, Production, Industrial Engineering & Management. He has successfully completed his B. Tech-Production Engineering from VIT, Pune and is currently pursuing M. Tech in Project Management from COEP Technological University, Pune. He has worked in multiple manufacturing organisations as an intern during his engineering days and has prior work experience in leading process quality at Fabrication BU- Excavator Line in JCB India Ltd.

Apart from this, he has done multiple projects for manufacturing and operational improvement. He is a voracious reader, history enthusiast, and nurtures football and cricket as his passion.