

Instructional Design for Engineering Programs

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**What is the guiding force
to develop an engineering
program?**

Goal and Program Educational Objectives

Goal and Program Educational Objectives

- **Is there any stated goal of the program?**
 - **What are the Program Educational Objectives?**
 - **Has the industry prescribed any superior Program Objectives?**
 - **Has the department prescribed any set of course objectives?**
 - **Has the instructor specified any clear outcome statements?**
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**State a Model for an
Instructional Design for an
Engineering Program?**



5 ASSURE



Instructional model: “5 ASSURE”

A: Analyze the global context of learning

A: Analyze the industrial performance needs

A: Analyze the learner’s potential

A: Analyze the learner’s career needs

A: Analyze the technology application level of industries

**How does a global context
drive a program?**

Global Standards of Performance

Analyze the Global Context of Learning

- **21st Century is for knowledge capital development.**
- **India has attracted the global investment in design, software development and manufacturing.**
- **Industrial corridors have been established.**
- **India is becoming a source for human capital development.**
- **India is emerging as a center for design of products.**

What are the Industrial Needs?

Performance to Meet the Job Specification

Performance

- Investigation
 - Needs Analysis
 - Product Planning
 - Simulated analysis of components
 - Design
 - Estimation
 - Procurements of components
 - Proto type production
 - Testing
 - Evaluation
 - Improvement
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Analyze Industrial Needs

- **Analyze the needs of the MNCs**
 - **Analyze the needs of the regional consumers of products and services.**
 - **Analyze the national needs of industries.**
 - **Analyze the needs of the Global Industries/ consumers.**
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**How will you identify the
industrial needs?**

Job analysis, job description,
Job specification,
advertisements,
enquiries, online posting of jobs,
campus interviews

Basic Industrial Needs

- **Products have been designed to meet the global standards.**
 - **Manufacturing plants have been constructed.**
 - **Modern equipment have been commissioned.**
 - **Hi-tech production processes have been installed.**
 - **Trial production has been launched.**
 - **The skilled-workers, technicians, and engineers are being recruited.**
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**What are the roles of
shop floor engineers?**

Quality Manufacturing Skills

Engineers and Line Managers for Ensuring Production

- **Industry expects multi-skilled engineers**
- **Expects to have ability to manage the skilled workers.**
- **Expects to ensure high quality in production.**
- **Expects to achieve the pre-determined targets.**
- **Expects proper maintenance of machines.**
- **Expects to solve inter-personal conflicts as they arise.**

What are the Factors Contributing to High Performance?

Skills and Competencies,
Delegation, Decentralization,
Empowerment, Attitudes,
Accountability, Motivation,
Commitment for Quality

What Contributes to High Performance?

Factors Contributing to High Performance

- **Communication Skills**
 - **Planning skills**
 - **Designing skills**
 - **Production planning skills**
 - **Manufacturing skills**
 - **Human Relations and soft skills**
 - **Total Quality Management**
 - **Risk taking**
 - **Problem solving**
 - **Innovation**
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**What are the changes that
will produce in the
behavior of students due
to engineering education?**

Behavior

- Cognitive
 - Metacognitive
 - Human relations
 - Psychomotor
 - Affective
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Cognitive Domain of Learners

-Basics

- **Technical Terms, basic information**
 - **Description on raw materials,**
 - **Definitions, explanations**
 - **Physical properties of materials**
 - **Chemical properties of materials**
 - **Availability**
 - **Cost (material, labor, taxes, margins)**
 - **Government Rules and Regulations**
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Comprehension / Understanding

- **Capturing information in the mind.**
 - **Capable of visualization.**
 - **Capable of restating the information gathered without ambiguity.**
 - **Gives a proof of clear understanding through restating the principles learned.**
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Concrete Concepts

- **Relates to industrial products**
 - **Also relates to service products**
 - **Can define/ describe in clear terms**
 - **Can conceptually describe the physical shape of the products.**
 - **Can draw freehand sketches of the products.**
 - **Can give examples from real life.**
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Defined Concepts

- **Concepts made of definitions**
 - **Cannot be physically represented**
 - **Theoretical models**
 - **Has to be understood in the mind**
 - **Could be clearly stated and described**
 - **Essential for good performance.**
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Investigation/ Exploration

- **Environmental investigation**
 - **Soil Investigation**
 - **Economics Investigation**
 - **Consumer Needs**
 - **Energy Needs**
 - **Realistic assessment of the true utility of the proposed products.**
 - **Investigation of uncertainties.**
 - **Should follow the established procedures.**
 - **Establishing long-term utility.**
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**How will you prescribe the
depth of learning?**

Program educational objectives,
course outcomes are based on
the prescribed performance in the
real life

Performance

- Performance in Real Life (Investigation, Planning, Analysis, Design, Production, Testing, Improving, Maintenance, Evaluation, Innovation...)
 - Simulated Performance in the Laboratory
 - Industry Specific Standards
 - Simulated Standards and Benchmarking
 - Solving Case Studies
 - Skills and Competencies
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Program Educational Objectives

- Planning to meet performance standards
 - Designing the curriculum to meet PEOs
 - Planning the instruction to meet PEOs
 - Evaluating the performance against PEOs
 - Evaluating the curriculum against the PEOs and current requirements
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State the Course/ Instructional Objectives

- **Specify the expected performance at the end of the course (Outcome).**
 - **Relate to global industrial standards.**
 - **Specify key performance objectives.**
 - **State the conditions of the performance.**
 - **Internal and external conditions**
 - **State the initial and ultimate criteria for acceptance.**
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**What is the relation
between the course
objectives and jobs?**

Course objectives are based on
the job and task analyses

Validate the Course & Instructional Objectives

- **Is the performance stated clearly?**
 - **Are there any external conditions which are essential for performance?**
 - **Are there any internal conditions?**
 - **Is there any pre-requisite?**
 - **Is there any link between the pre-requisite learning to the expected performance?**
 - **Are there any acceptable standards of initial performance?**
 - **Is the criterion achievable at entry level?**
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**How will you predict the
behaviour of components?**

Design rules

- Cause and effect
 - Derived
 - Man made for safety
 - Specified safe performance
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Rules...

- **Derivations based on cause and effect**
 - **Known to unknown**
 - **Empirical rules based on experiments**
 - **Based on mathematical principles**
 - **Based on chemical reactions**
 - **Based on human behaviour.**
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**What is the prime
performance of engineers?**

Basic Planning of Products and Services

Basic Planning of Products

- **Based on the needs of the users**
 - **Confirms to established rules and safety, regulations**
 - **Should confirm to safety of the users**
 - **Should enhance easy operation**
 - **Should enable trouble free operation**
 - **Should incorporate in-built safety.**
 - **Economical and value added.**
 - **Acceptable life span.**
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What are the critical skills/ competencies of the engineers?

Technical Analysis

Technical Analysis

- **Based on the established analytical procedure**
 - **Should be performed as per the sequence**
 - **Should follow the established standards, norms and regulations.**
 - **Could use computer software packages.**
 - **Should meet various regulations like safety, elongation, deflection / sagging, limited vibrations etc.**
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**What are the roles of
engineers in designing the
products?**

Design for High Quality Performance

Design

- **Design of the components, products, and services**
 - **Should meet the predetermined standards, norms, and regulations**
 - **Should be cost effective**
 - **Should be innovative**
 - **Should incorporate easy maintenance**
 - **Should incorporate auto checks and warning if it malfunctions**
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**What is the role of
engineers in production of
the goods and services?**

Production / Manufacturing /
Fabrication / Construction

Production

- **Based on the established needs of the users**
- **Based on the complete investigation**
- **Based on the accepted standards of performance**
- **Should be cost effective**
- **Should be innovative**
- **Should be aesthetic**
- **Should be trouble free**
- **Should be economical**
- **Should be reliable**
- **Should be user friendly**



What is next?



Product testing

- Functional testing
 - Performance testing
 - Fatigue testing
 - Utility testing
 - Preventive maintenance
 - Break down maintenance
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**What is the role of
engineers in pricing the
product?**



Estimation / Costing / Valuation



Estimation

- **Based on the realistic data on market cost.**
 - **Based on the detailed analysis.**
 - **Based on the current input cost of labour.**
 - **Based on the established cost analysis, cost of utility of machines / rate per hour of the human resources employed.**
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**When will you go for
value analysis?**



Market needs



Value Analysis

- **Performed when there is a need to effect cost reduction without affecting the value of the product.**
 - **Implemented when there is a stiff market competition.**
 - **Look for alternate materials.**
 - **Aids to improve the market share.**
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END OF PART I



PART II

COURSE OBJECTIVES

How will you plan your instruction to inculcate skills in the learners?

Course/ Instructional Objectives

State the Course Instructional Objectives

- **Compare with industrial performance standards.**
 - **Consider real life situation.**
 - **Consider the resources, equipment, and materials that would be available.**
 - **Consider the industrial challenges.**
 - **Generate key instructional objectives.**
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**Are there any distinct
steps through which you
can develop a competent
engineer?**

Taxonomy / Steps / Hierarchy

Learning Hierarchy in Cognitive Domain

- **Published information / verbal information**
 - **Comprehension and thorough understanding**
 - **Concrete concepts in science, mathematics, humanities, engineering, technology, and environment.**
 - **Defined concepts in science, mathematics, humanities, engineering, technology, and environment.**
 - **Investigation principles for products / services to be offered.**
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Learning Hierarchy in Cognitive Domain...

- **Basic rules in science, mathematics, engineering, technology, humanities, and environment.**
 - **Basic planning processes.**
 - **Technical analysis under expected loadings.**
 - **Engineering design principles.**
 - **Modern production / manufacturing processes.**
 - **Ethics and Human Relations.**
 - **Environmental concern.**
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Learning Hierarchy in Cognitive Domain...

- **Realistic cost estimation**
 - **Evaluation of the existing knowledge, design and production.**
 - **Creativity, leading to Innovations and Break through.**
 - **Tackling unsolved problems.**
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PART III

Manufacturing Skills (Psychomotor Domain)



**How will you provide
standardized
manufacturing skills?**

Psychomotor domain coupled with cognitive domain

- **Performance based on the intensions and instructions.**
 - **Ultimate achievement to meet predetermined performance standards.**
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**Is there any roadmap for
skill development?**

Steps in Acquiring Performance Skills

Step – 1 : Following hand holding – An act of copying

- Internal & external conditioning
 - Clearly following the sequence of movement
 - Body postures, controlled movement of fingers.
 - Developing mental frame work.
 - Application of pre-determined pressures / forces.
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Steps in Acquiring Performance Skills...

Step – 2 : Trail Following hand holding...

- Incorporating the safety.
 - Careful, slow movement as directed.
 - Maintenance of balance.
 - Marks the specimen.
 - Mounts the specimen on the machines.
 - Checks the initial setting of gear.
 - Checks the initial setting of the dials.
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Steps in Acquiring Performance Skills...

Step – 3 : Initial Trail / Operation

- Practice with acquired confidence.
 - Operate the controls under guidance only.
 - Follow the logical sequence carefully.
 - Incapable of increasing the speed of operation.
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Steps in Acquiring Performance Skills...

Step – 4 : Improved trail (Second Trail / Operation)...

- Learning to increase the speed in steps with more practices.
 - Needs the safety guidance.
 - Incorporate accuracy.
 - Eliminates errors based on the external feedback.
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Steps in Acquiring Performance Skills...

Step – 5 : Articulation (Improved Trial)

- No randomness; follows the sequence of the movement
 - Combines the right sequence of operation
 - Develops confidence in operating switches, gears, change of tools, fixing the dials, etc.
 - Independently sets the dials.
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Steps in Acquiring Performance Skills...

Step – 6 : Advanced Articulation (Advanced Trial)...

- Capable of mounting the specimen on the machine independently.
 - Selects the control gears
 - Increases in the speed within the limit.
 - Increases in the accuracy
 - Minimizes the number of mistakes
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Precision

- Exhibits complete confidence, careful
 - Acceptable speed in operation
 - Completes the work within the prescribed time
 - Almost no mistakes; Maximum accurate
 - Capable of safe working without supervision
 - Reliability and quality in the work.
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Naturalization (Mastery)

- **Complete expertise in handling the machine / equipment**
 - **High quality in operation**
 - **Personal errors are eliminated**
 - **Selection of right tools**
 - **Selection of working range**
 - **Capable of independent working**
 - **Needs no guidance**
 - **Reached saturation**
 - **Highest productivity.**
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**How will you reinforce
the skill acquisition?**

Develop field work, workshop activities and laboratory work

- **Follow the skill acquisition process**
 - **Provide appropriate guidelines**
 - **Demonstrate**
 - **Correct the mistakes**
 - **Identify the individual feedback**
 - **Use video recording and replay for self observation.**
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**How will you reinforce
skill demonstration?**

Provide opportunity to develop appropriate skill demonstration

- **Devise innovative project in skill demonstration and creativity**
 - **Let the learners choose the equipment and measuring devices**
 - **Let them choose methods to control errors**
 - **Eliminate personal errors**
 - **Let them record the values**
 - **Analyze the data**
 - **Draw inferences and conclusions.**
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**What is next to skill
acquisition?**

Affective domain / attitudes/
concern for the current and future
users and the environment

Attitude Development

- **Receiving the instruction / information faithfully**
 - **Recognizing the need for ethics in the engineering profession**
 - **Value the safety of the shop floor workers, maintenance people, users and the society at large**
 - **Organize the safe production process**
 - **Make the products safe for the environment**
 - **Characterize the professional standards in market competition and display concern for ethics**
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PART IV

MACRO PLANNING

How will you deal with the quantum of teaching load?

Course Plan (Semester Plan)

- **Plan complete the programme implementation within the stipulated period.**
 - **Manage the time for tests, feedbacks, industrial visits and revision**
 - **Incorporate appropriate field visits.**
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**Is there a method to
transfer the knowledge?**

Unit Plan / Chapter Plan

- **Prepare unit plan by considering the instructional objectives.**
 - **Check the availability of time.**
 - **Select reference materials**
 - **Prescribe appropriate text books to meet the curriculum**
 - **Use appropriate case studies for improving analytical ability of the learners**
 - **Use instructional manuals for the given curriculum**
 - **Provide course materials.**
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**How will you train to
engineers to solve real
world problems?**

Case Studies

- **Should reflect on the current industrial challenges**
 - **Based on the problems faced in the technology, raw materials, alternate materials, design, production and market share.**
 - **Based on the innovations in the products.**
 - **Based on the global crisis that are arising.**
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**If you find the existing
books are inadequate,
what will you do?**

Course Materials

- **Based on the instructional objectives**
 - **Should provide current industrial practices**
 - **Should include exposure to problem solving**
 - **Should incorporate analytical procedures**
 - **Should provide sample open ended problems**
 - **Should inculcate creativity.**
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**How will you check the
level of performance?**

Item Banks / Question Banks

- **Should consist of previous university questions, entrance tests for jobs**
 - **Should also reflect the current industrial trends, case studies**
 - **Should meet the field demands**
 - **Should be validated**
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**How will you monitor the
learning progress?**

Testing and Internal Assessment

- **Use short answer questions for tests**
 - **Wherever possible include objective tests**
 - **Develop test items around key performance areas of industrial practices**
 - **Provide mini project works.**
 - **Provide structured easy questions**
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**How will you inculcate
discovery skills?**

Action Research

- **Include typical industrial trends in the design and production**
 - **Production based on the field problems**
 - **Guide the learners to search for information from publications through Internet**
 - **Guide to prepare a research report.**
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**How will you ensure TQM
in instructional design and
delivery?**

Total Quality Management in Instructional Design

- **Validated curriculum by the industries**
 - **Appropriate instructional materials duly validated by the faculty and the learners**
 - **Validated item bank**
 - **Design problems based on the current industrial practice**
 - **Appropriate industrial visits**
 - **Focus on industry specific competencies.**
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Total Quality Management in Instructional Design...

- **Frequent feedback on the performance of the learners**
- **Inbuilt activities to enhance the soft skills**
- **In-depth expertise in the use of IT applications**
- **Focus on problem solving skills**
- **Encouragement to acquire competencies.**

Prepare for Lifelong Learning

**Practice what you
preach and Reward
the Learners**

Thank you

- Your questions please
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