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Mapping Diploma Engineering Curriculum to Automotive Assembly Line Operations: A Case Study of TCF1 Line at Tata Motors

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Abstract: ***The gap between engineering education and industry requirements is a significant challenge in technical skill development. This paper presents a systematic mapping of Diploma Semester 1 engineering curriculum topics to real-world operations observed on the TCF1 (Trim, Chassis, and Final) assembly line and Weld Shop at Tata Motors, Pune. Six core subjects are covered: Applied Mathematics, Manufacturing Technology, Basic Electrical Engineering, Measurement Systems, Sensors and Transducers, and Engineering Drawing. Results indicate that over 90% of Diploma Semester 1 topics have direct practical application in automotive assembly operations. This study serves as a reference for diploma students, educators, and industry trainers to bridge the curriculum-industry gap.***

Keywords: curriculum mapping, diploma engineering, automotive assembly, TCF1, Tata Motors, Weld Shop, skill development, industry-academia gap.

I. INTRODUCTION

The automobile manufacturing industry in India is one of the largest and fastest growing sectors, with companies like Tata Motors playing a key role in shaping workforce requirements. However, a common challenge faced by fresh diploma engineering graduates is the gap between what is taught in academic institutions and what is actually required on the shop floor.

Tata Motors' TCF1 (Trim, Chassis, and Final) assembly line at Pune is a highly structured production environment where vehicles go through multiple assembly stages including trim fitment, chassis mounting, and final inspection. Each stage requires workers to apply fundamental engineering knowledge such as torque calculations, electrical diagnostics, dimensional measurements, and assembly drawing interpretation.

This paper aims to bridge the academic-industry gap by systematically mapping Diploma Semester 1 curriculum topics to specific operational tasks observed on the TCF1 assembly line. The objective is to demonstrate to students, educators, and industry trainers that diploma-level education is directly relevant to real manufacturing operations.

II. LITERATURE REVIEW

The relationship between academic curriculum and industry skill requirements has been a subject of extensive research. Several studies have highlighted the existence of a significant skill gap between what engineering graduates learn in classrooms and what employers expect on the job.

Bhat et al. (2014) conducted a study on the employability of engineering graduates in India and found that a large proportion of fresh graduates lack job-ready skills. The study emphasized the need for curriculum reform incorporating practical, industry-aligned learning outcomes [1].

Singh and Sharma (2017) examined the gap between polytechnic diploma curriculum and actual shop floor requirements in the Indian automobile sector. Their findings revealed that while theoretical knowledge was adequate, students lacked the ability to apply concepts like torque calculations and electrical diagnostics in real environments [2].

Patil and Bhatt (2019) studied the role of internships in bridging the curriculum-industry gap. Their research demonstrated that students who completed structured internships showed significantly higher readiness to apply academic concepts in real-world settings [3].

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Kumar et al. (2020) analyzed the application of engineering fundamentals in automobile assembly line operations. The study found that concepts from mathematics, electrical engineering, and manufacturing technology are directly applied at every stage of vehicle assembly [4].

The present study builds upon this work by providing a structured, subject-wise mapping of Diploma Semester 1 curriculum to operational tasks on the TCF1 assembly line at Tata Motors, Pune.

III. METHODOLOGY

This study follows a qualitative case study methodology, combining direct observation, structured documentation, and systematic subject mapping. The research was conducted during a hands-on internship at the TCF1 assembly line at Tata Motors, Pune, Maharashtra.

A. Study Setting

The TCF1 assembly line at Tata Motors, Pune is a large-scale automotive manufacturing facility where vehicles undergo complete assembly. The line covers trim fitment, chassis assembly, electrical installation, and final quality inspection. The internship provided direct exposure to all stages of this process.

B. Data Collection

Data was collected through: (a) Direct Observation — participation in day-to-day operations at various workstations including use of torque tools, jigs, electrical testing equipment, and drawings. (b) Curriculum Analysis — systematic review of the Diploma Semester 1 syllabus across six subjects. (c) Mapping Exercise — each curriculum topic was analyzed against observed operations to identify direct applications.

C. Mapping Framework

Each curriculum topic is categorized under: diploma subject and unit, specific topic, corresponding TCF1 operation, and skill or competency developed.

D. Scope and Limitations

The scope is limited to Diploma Semester 1 topics and TCF1 assembly line operations during one internship cycle. Future studies may expand to Semester 2 and 3 subjects and incorporate quantitative data such as defect rates and takt time.

IV. RESULTS AND DISCUSSION

The mapping exercise revealed strong alignment between Diploma Semester 1 curriculum and TCF1 assembly operations across all six subjects. Table I presents a selected sample of the curriculum-to-industry mapping developed during the internship.

TABLE I
Curriculum-To-Industry Mapping (Selected Sample)

Subject	Topic	TCF1 Operation
Applied Maths	Statistics & Probability	Defect rate monitoring & quality control
Applied Maths	Calculus	Conveyor speed & takt time control
Mfg. Technology	Casting Defects	Component inspection before assembly
Mfg. Technology	Welding Processes	Structural joining in weld shop
Basic Electrical	Ohm's Law	Wiring harness fault diagnosis

Subject	Topic	TCF1 Operation
Basic Electrical	Kirchhoff's Laws	Circuit troubleshooting in vehicles
Measurement	Calibration	Gauge & instrument accuracy checks
Sensors	Temperature Sensors	Thermal monitoring during testing
Engg. Drawing	Orthographic Views	Assembly drawing reading at workstation
Engg. Drawing	Tolerances	Dimensional verification & fitment checks

A. Applied Mathematics

All six units of Applied Mathematics were found to have direct applications on TCF1. Algebraic simplification applies to takt time calculations. Trigonometric ratios are used in fixture angle settings. Statistical tools including mean, standard deviation, and probability are used in defect monitoring and quality control.

B. Manufacturing Technology

Casting, metal forming, machining, and welding topics were mapped to component inspection and weld shop operations. Workers handle cast engine housings, forged shafts, and pressed sheet metal. Defect identification skills from this subject are critical on both TCF1 and Weld Shop.

C. Basic Electrical Engineering

Ohm's Law, Kirchhoff's Laws, and electromagnetic induction are directly applied during electrical testing and wiring harness inspection. Workers identify faults in series and parallel circuits and validate sensor and alternator outputs.

D. Measurement Systems and Sensors

Calibration, instrument characteristics, temperature and pressure sensors are relevant to quality inspection. Precision gauges and torque tools are used at every TCF1 station. Understanding measurement error improves quality control accuracy.

E. Engineering Drawing

Orthographic projections, sectional views, isometric drawing, and tolerances apply in reading assembly drawings at every workstation. Operators use 2D and 3D drawings for fitment, dimensional verification, and gap checking.

F. Overall Findings

More than 90% of Diploma Semester 1 topics examined have a direct, identifiable application in TCF1 assembly and Weld Shop operations. The primary gap is not in curriculum content but in structured practical application during academic studies.

V. CONCLUSION

This study presented a detailed mapping of Diploma Semester 1 curriculum to real-world tasks on the TCF1 assembly line and Weld Shop at Tata Motors, Pune. The mapping covers Applied Mathematics, Manufacturing Technology, Basic Electrical Engineering, Measurement Systems, Sensors and Transducers, and Engineering Drawing.

Diploma-level engineering education is substantially aligned with automotive manufacturing requirements. This mapping serves as a practical reference for students, educators, and HR training teams to reduce onboarding time and improve workforce readiness.

Future research may extend this to Semester 2 and 3 subjects and incorporate quantitative performance data from multiple assembly plants.

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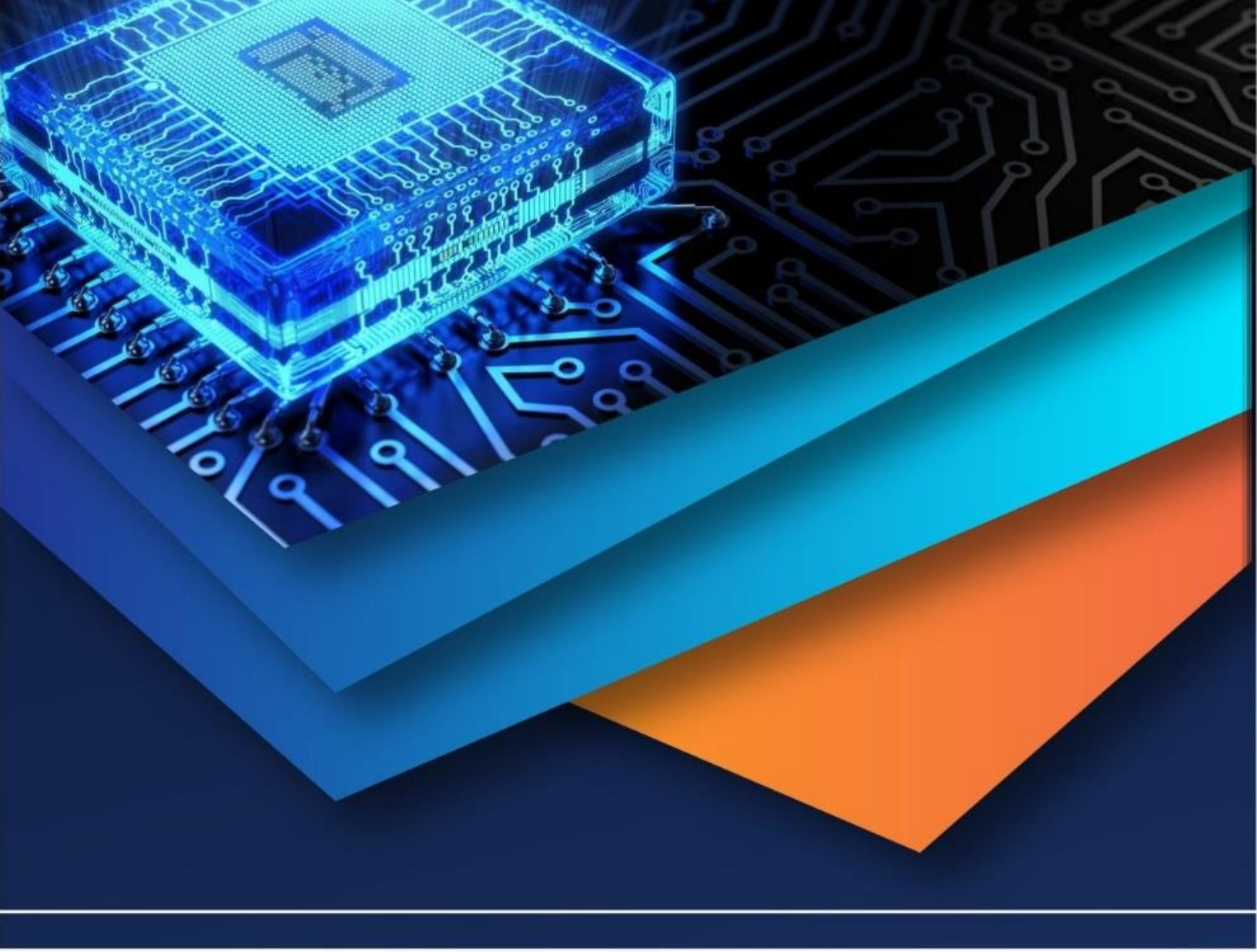
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