



THE ENGINEERING EDUCATION WAY:

Redesigning How Engineers Are
Trained So They Can Be Industry-
Ready Nation Builders

OLADIMEJI OLUTIMEHIN

The Engineering Education Way

Redesigning How Engineers Are Trained To Be
Industry-Ready Nation Builders

The Engineering Education Way: Redesigning How
Engineers Are Trained To Be Industry-Ready
Nation Builders

Copyright © 2025 by Oladimeji Olutimehin

Engineers Without Borders Nigeria
10th Avenue Shagari Quarters
Akure, Ondo State
www.ewb.org.ng
[+2349071602727](tel:+2349071602727)

All rights reserved solely by the author. No part of this book may be reproduced in any form without the express written permission of the publisher. The contents and cover of this book may not be reproduced in whole or in part in any form without the express written consent of the author or Engineers Without Borders Nigeria.

Printed in Nigeria

Table of Content

Introduction

Chapter One
Customer-Centricity

Chapter Two
Think Like Corporation

Chapter Three
Mimicking Industry Production Process

Chapter Four
Embracing Continuous Improvement

Chapter Five
Faculty As Learning Organization

Chapter Six
Lean Thinking

Chapter Seven
Simulating Real-World Industry Projects

Epilogue
Preparing Students For Industry

Foreword

As a graduate of a Nigerian engineering faculty, I know firsthand the immense potential and the profound frustrations that define our educational landscape. We entered our programs with dreams of building, creating, and solving the pressing challenges of our nation. We emerged, five years later, with a head full of formulas and a degree in hand, yet often feeling profoundly disconnected from the very industries we were meant to serve. We were taught the *theory* of engineering, but we were not taught to think like engineers.

This gap between the classroom and the factory floor, between academic knowledge and industrial value, is the central challenge this powerful book, *The Engineering Education Way*, seeks to dismantle. In its pages, I found a compelling and long-overdue blueprint for the transformation I wished for as a student.

The author does not merely diagnose the problem; he presents a robust, practical system, the Outcome Driven Engineering Education (ODEE), that reimagines the faculty of engineering not as an ivory tower, but as a production line for nation-builders. The core argument is as simple as it is revolutionary: to produce industry-ready engineers, our universities must first learn to think like industry. This means adopting the principles of customer-centricity, continuous improvement, and lean thinking that drive the world's most successful companies.

Drawing on inspiring examples from global giants like Toyota and Amazon, and from forward-thinking institutions in China and Europe, the book provides a clear roadmap. It challenges our lecturers to become mentors and innovators, our curricula to become living documents shaped by industry needs, and our students to become active creators of value from their very first year. The concept of treating students not as passive recipients of knowledge, but as partners in a learning journey, is particularly resonant.

For too long, we have accepted a system that produces brilliant theorists who struggle to fit into the professional world. This book argues, convincingly, that we no longer have to. It is a call to action for every stakeholder, academics, policymakers, industry leaders, and students to collaborate in building a new generation of Nigerian engineers: not just degree holders, but problem-solvers, innovators, and value creators.

The Engineering Education Way is more than a book; it is a manifesto for national development. If its lessons are heeded, it has the power to transform our faculties into engines of talent, innovation, and economic growth. I commend it to every Nigerian who believes, as I do, that our engineers are key to building the future we deserve.

Engr. Mathias Luka Agbu
Founder, Luka Agbu Memorial Foundation
Houston, Texas

Introduction

Engineering is the backbone of every nation's development. From the bridges we cross, to the smartphones in our hands, to the factories that power economies—engineers are behind it all. Around the world, countries that understand this truth have invested heavily in how they train and produce their engineers.

Take China and India, for example. These countries have realized that national progress depends on the strength of their engineering talent. Their universities and technical institutions are closely linked to industry. Students don't just study theories—they learn how to solve real-world problems. They work on projects, visit factories, and experience firsthand how technology drives production and innovation. The result? Graduates who can step out of school and fit right into the workforce, ready to build, create, and compete globally.

Nigeria, on the other hand, is still finding its way. We have brilliant students and passionate lecturers, but our engineering education system often feels disconnected from the real world. Too many graduates know the formulas but not the factory; they understand the textbook but not the tools. To prepare industry-ready engineers, our faculties of engineering must do more than teach—they must equip, empower and transform.

This book, *The Engineering Education Way*, is the system approach to implementing the Outcome

Driven Engineering education. In it, I explore how engineering faculties can begin to think and act like industry. ODEE implementation requires a change in mindset.

It's about understanding how companies operate, the language they speak, and the principles that guide their success—then learning, copying, and adapting those methods into engineering education. Concepts like continuous improvement (Kaizen), teamwork, design thinking, and systems thinking shouldn't be foreign to engineering classrooms; they should define them.

The goal is simple: to build a generation of engineers who are not just degree holders, but problem solvers, value creators, innovators, and nation builders. Because when we get engineering education right, everything else—industry, infrastructure, economy—starts to grow right along with it.

The Purpose of Engineering Education

The purpose of engineering education is not just to produce graduates who can pass exams, but to raise builders and innovators who can solve real problems. Every bridge, car, factory, or power plant begins as an idea in the mind of an engineer. But if that mind has not been trained to think critically, design practically, and work collaboratively, the result is theory without transformation.

In China, for example, engineering students in many universities are required to complete real

manufacturing projects before graduation. They don't just learn about machines—they build and test them.

In India, institutions like the Indian Institutes of Technology (IITs) have innovation labs where students turn their ideas into prototypes and startups. This approach ensures that by the time they graduate, they are not just engineers on paper—they are creators ready for the world of work.

In Nigeria, we can take a cue from this. Our engineering education should be about solving the challenges that face our society—poor roads, unreliable electricity, waste management, and housing shortages. Every course, every lab, and every project should point toward improving lives and building the nation. That's the true purpose of engineering education. And this is why we develop ODEE model for engineering education.

How Industry Operates

Industry operates on systems, efficiency, and results. Every company has one focus: to create value, continuously improve, and remain competitive. In a car manufacturing plant, for instance, every process is timed, measured, and improved upon daily. All business activities create, deliver, protect and capture value.

Workers and engineers meet every morning to review what went wrong yesterday and how to

make it better today—this is the spirit of *Kaizen*, or continuous improvement, famously used by Toyota.

In the oil and gas sector, you'll find strict attention to safety, teamwork, and accountability. Every engineer knows their role and how it connects to the larger system. Mistakes are documented, analyzed, and used as lessons for growth. There is no “just manage it” culture—because a single mistake can cost lives or millions of dollars.

Industries operate as a feedback system that continuously learn from their environment. Someone said when the rate of change outside a system is more than the rate of change within it, the end has come. Companies have to keep learning and evolving in order to stay relevant.

Unlike Universities that focus on themselves and measure success by how close a graduate becomes like their selves, industries operate by focusing on their customers and making sure that their changing needs are met. Once a company stop focusing on its customers and starts focusing on itself, the end of it starts.

These habits—discipline, precision, collaboration, customer-centricity and innovation—are what make industries thrive. And these same habits should be what guide our engineering education.

Why Universities Need to Learn From Industry

For universities to produce graduates that meet industry needs, they must first understand how

industry thinks and operates. Too often, there is a wide gap between what is taught in the classroom and what happens in the real world.

An engineering student might learn about manufacturing processes in theory, yet never visit a factory before graduation. They might study project management but never experience a real project deadline. This disconnect is why many graduates struggle to fit into professional environments.

In South Korea, universities bridge this gap through strong industry-academia partnerships. Companies like Samsung and Hyundai collaborate with engineering faculties to design courses, offer internships, and even co-teach specialized modules. The result? Students graduate already familiar with the tools, language, and expectations of their future workplaces.

If Nigerian universities adopt a similar approach—by inviting industry experts to teach, setting up industry-sponsored labs, or aligning curricula with real market needs—our graduates will not only be employable, they will be in demand.

The future of engineering education lies in strong collaboration among three key players: universities, industry, and government. Each has a unique role, but together they can drive innovation and national growth.

Industry provides the real-world problems and technical know-how. Universities bring research, creativity, and fresh talent. Government supplies

the policy framework and funding support. When these three work together, everyone benefits.

For example, in Germany’s “Dual Education System,” engineering students split their time between university study and paid industry placements. The government supports this model, industries gain skilled interns who often become full-time employees, and universities stay aligned with current technologies. It’s a win-win system for all.

Nigeria can adapt this model. Faculties of engineering can sign Memorandums of Understanding (MOUs) with local industries and government agencies to co-create programs, share equipment, and jointly solve national challenges like power generation, food production, and infrastructure development.

This is what our Outcome Driven Engineering Education (ODEE) seeks to achieve. We want to transform how engineering education is taught and practiced in Nigeria. If our engineering education gets better, our nation will certainly improve too.

Through the ODEE, we are aligning education with the real needs of the nation. That way, we can transform engineering faculties into engines of talent production, economic growth and national transformation.

Chapter One

Customer-Centricity

“We’re not competitor obsessed, we’re customer obsessed. We start with what the customer needs and we work backwards.” — Jeff Bezos, Founder of Amazon

Amazon’s rise from a small online bookstore to one of the world’s most powerful companies is a story deeply rooted in customer-centricity. From the very beginning, Jeff Bezos built the company around a simple yet revolutionary philosophy — start with the customer and work backwards. This mindset has shaped every decision, innovation, and expansion Amazon has undertaken.

Unlike many companies that focus on competitors or internal efficiencies, Amazon’s compass has always pointed toward the customer. Bezos once remarked that customers are “divinely discontent” — their expectations always rise, and a company’s success depends on constantly anticipating and meeting those expectations. This belief became the foundation of Amazon’s culture and strategy.

When Amazon began selling books online, its initial goal wasn’t just to sell more titles than a physical bookstore. The goal was to make the buying experience easier, faster, and more reliable for readers everywhere.

By focusing on convenience, Amazon introduced features that made shopping effortless: personalized recommendations, one-click purchasing, and reliable home delivery. These were

not just technical innovations — they were customer-centric responses to the frustrations people faced while shopping.

Over time, Amazon’s obsession with customers drove it to expand into other categories. Every new product line or service — from electronics to groceries, from Prime to AWS — was introduced because Amazon identified a pain point and sought to solve it better than anyone else.

Amazon Prime, for example, wasn’t born as a marketing gimmick. It emerged from the recognition that customers hated waiting for deliveries and disliked paying extra shipping fees. By offering fast, free, and predictable delivery through a subscription model, Amazon turned a common customer frustration into one of its most powerful loyalty programs.

This relentless focus on the customer also shaped how Amazon approached technology and data. Instead of using data merely to track sales, Amazon used it to understand customers individually — their preferences, behaviors, and needs. Its recommendation system, one of the most advanced in the world, was designed not just to increase sales but to make every shopping experience feel personal and intuitive. Customers felt seen, understood, and served — which in turn drove loyalty and repeat business.

Another example of Amazon’s customer-centric thinking is its approach to pricing and profit. Bezos famously told shareholders that Amazon would

rather lose money in the short term if it meant gaining long-term customer trust. This approach baffled traditional investors, but it worked. By reinvesting profits into better infrastructure, faster delivery, and lower prices, Amazon built a reputation as a company that always put customers first — a brand people could rely on.

The company's customer-obsession also transformed its internal culture. Every meeting, no matter how technical, begins with an empty chair — symbolizing the customer's presence in every decision. Product development starts with writing a mock press release and FAQ that describe how the customer will benefit, long before any code is written or hardware is designed. This “working backwards” process ensures that every innovation serves a real human need.

As Amazon grew, its customer-centric DNA allowed it to scale without losing focus. Services like Alexa, Kindle, and AWS were not just new business ventures — they were extensions of Amazon's understanding of evolving customer needs: easier access to information, seamless entertainment, and reliable cloud computing. Even Amazon Web Services, a B2B product, emerged because Amazon realized that many businesses faced the same challenges it once did in managing IT infrastructure.

In essence, Amazon's dominance is not built on size, technology, or capital — it is built on trust. Every convenience Amazon offers, from easy

returns to 24/7 customer support, reinforces the belief that the company exists to serve. This trust has turned millions of customers into advocates, creating a self-reinforcing cycle of loyalty, growth, and innovation.

Customer-centricity didn't just help Amazon grow; it defined its growth path. It made the company agile, resilient, and adaptive to change. Competitors rise and fall, but Amazon continues to evolve because its focus remains constant — understanding the customer better than anyone else and delivering more value than they expect.

In a world where technology changes rapidly, Amazon's enduring advantage is not its algorithms or logistics network, but its unwavering commitment to the people who use them.

Engineering education can learn a great deal from how companies like Amazon embed customer-centricity into every part of their system.

Traditionally, engineering programs focus heavily on technical competence — equations, designs, and efficiency. While these are vital, they often overlook a key question: *Who are we engineering for?*

To adopt customer-centricity, faculties of engineering must teach students to think beyond the product and focus on the people who use it. Every project, lab, or design exercise should begin with understanding the user's needs, frustrations, and desired outcomes.

This means integrating design thinking, empathy mapping, and user journey analysis into engineering curricula. Students should be encouraged to engage with communities, industries, and real users to co-create solutions that matter.

Engineering education should also model customer-centricity in its own structure — making learning more student-centered. Just as Amazon constantly gathers feedback from customers, universities can gather feedback from students and industry partners to continuously refine teaching, curriculum, and project design.

By shifting from a “build it right” mindset to a “build the right thing” mindset, universities will produce engineers who not only design systems but also create meaningful value in society. These engineers will be equipped to bridge the gap between innovation and human need — the true essence of engineering.

Similarity Between Industry & Faculty of Engineering

Industry functions in a unique and purposeful way. Every process within it — from research and development to production, marketing, and distribution — is structured around one guiding principle: the customer’s need. Products are not made for their own sake; they are designed to solve problems, meet specific needs, and deliver value to well-defined target markets. This customer-centered model has driven innovation, efficiency,

and competitiveness across every successful industrial sector.

Faculties of engineering, however, often operate on a different model. Rather than adopting the responsiveness and adaptability that define industry, they tend to reproduce themselves. Their processes are built around disciplinary traditions and academic benchmarks rather than the evolving demands of industry and society. As a result, many engineering graduates are shaped to think and act like their professors, not like the innovators, designers, and problem-solvers that modern industries require.

It is time for faculties of engineering to learn from industry — not to become industries, but to adopt the principles that make industry effective. If we look deeply, both the industry and the university faculty share a similar function: production.

Industry produces goods and services; faculties of engineering produce graduates.

The industrial production line has its input (raw materials), process (manufacturing system), and output (finished products). Similarly, faculties have their input (students), process (training and education), and output (graduates).

The key question that faculties need to ask is: *What is the quality of our output, and how well does it meet the needs of the end users — the industries, organizations, and communities our graduates are meant to serve?*

Just as industry begins by identifying its customers and understanding their pain points, faculties must begin by identifying their target customers — employers, sectors, and societal challenges that engineers are expected to address. The curriculum, pedagogy, and experiential training should then be designed to meet those needs directly.

In the industrial world, success is measured not by the amount of raw material processed, but by the value the finished product delivers. Similarly, the success of engineering education should not be measured merely by the volume of content delivered, the number of lectures completed, or the credits earned.

It should be measured by the value the graduate creates — their ability to solve problems, innovate, and improve systems. This shift from knowledge transfer *to* value creation marks the true transformation of engineering education.

Graduates should not simply know what engineers know; they should think as engineers think — as *designers, makers, and innovators* who can bridge the gap between theory and practice.

By learning from industry, faculties of engineering can move from static institutions to dynamic production systems that continually refine their most important product — the engineer.

When engineering education begins with the needs of its customers, designs its processes with purpose, and continuously improves through feedback and

innovation, it will produce graduates who are not only employable but indispensable — engineers capable of building the future, not just working in it.

That is The Engineering Education Way — a way that learns, adapts, and innovates like the very industries it seeks to serve.

Who Are The Customers of Engineering Education?

Industry functions in a unique and disciplined way. Every product an industry creates is designed to meet the needs of a clearly defined target market. From research and development to production and quality assurance, every process is intentional, customer-focused, and continuously improved to stay relevant and competitive.

Faculties of engineering, however, often operate differently.

Instead of designing their “products” — the graduates — around the evolving needs of industry and society, they tend to reproduce more of themselves. Students are trained to become replicas of their professors rather than innovators ready to thrive in dynamic industrial and technological ecosystems.

It is time for faculties of engineering to learn from industry. The same production mindset that drives successful companies can transform the way engineers are educated. Just as industries begin with understanding what their customers need, faculties must start by identifying their *target*

customers — the industries, organizations, and societies their graduates will serve — and then design learning outcomes that directly address those needs.

Graduates are, in essence, the *products* of engineering faculties, and the *five-year training process* is the production line. By adapting the principles of industrial production — such as design thinking, quality control, customer feedback, process improvement, and innovation — faculties can produce graduates who are relevant, employable, and capable of creating value from day one.

However, the one most important question to ask is who are the customers of engineering? Can we safely posit that students are both the products and customers of engineering? If so, how is that so?

In industry, the first rule of success is “*know your customer.*” In education, however, universities have often lost sight of this principle — operating as if they exist primarily for themselves. Yet, just like a business, a university exists to serve specific stakeholders and fulfill specific needs.

In the context of engineering education, identifying the “customers” or “end users” helps us understand who benefits from and who depends on the outcomes of the educational system. While traditional education often views students merely as learners, adopting a customer-centric perspective requires seeing multiple stakeholders as

customers — each with distinct needs and expectations.

The customers of a university are not a single group but a network of interdependent stakeholders — each with its own expectations. Understanding them is the first step in making engineering education purposeful, relevant, and impactful.

I classify the following as customers of engineering education because, like in business:

1. They invest in education (through tuition, taxes, or trust).
2. They expect value — skills, innovation, employability, and societal progress.
3. They evaluate outcomes — based on performance, impact, and satisfaction.

Just as companies must serve multiple customer segments, engineering education must balance the needs of students, employers, and society — ensuring that what it delivers aligns with what each stakeholder values most.

1. Students – The Primary Customers

Students are the direct recipients of the university’s teaching, mentorship, and learning processes. They are the *core users* of the university’s educational “product.” They are the direct customers of engineering education. They invest their time, effort, and often significant financial resources in acquiring knowledge, skills, and credentials.

In return, they expect value — quality instruction, relevant skills, mentorship, and opportunities that prepare them for successful careers and meaningful contributions to society. When engineering faculties design curricula, teaching methods, and facilities, they should ask: “Does this experience help our students achieve their goals and thrive in the real world?”

Just as Amazon listens to its customers to improve service, faculties need to listen to students’ feedback and continuously improve learning experiences. A student-centered approach ensures that education remains relevant, engaging, and empowering.

It is important faculties understand the expectations of students and factor that into their programs. For instance, I found engineering education boring. I guess the designers don’t care about how I feel and my experience.

The way engineers are trained will determine how they feel and the impact they make. It’s important to take into cognizance their expectation. That is being customer-centric. Their expectations include:

1. High-quality learning experiences that prepare them for real-world success.
2. Relevant, up-to-date, and practical knowledge.
3. Mentorship, career guidance, and exposure to industry.
4. Skills that make them employable, innovative, and entrepreneurial.

5. A nurturing environment that supports personal and professional growth.

Students are not just “inputs” into the education system — they are *partners in learning*.

Engineering faculties must treat students the way Apple treats its users — understanding their aspirations, frustrations, and needs to design better learning experiences.

2. Industry and Employers – The End-User Customers

Industries, companies, and organizations that employ graduates or collaborate with the university on research and innovation. They are the *end-users* of the university’s “product” — the graduates.

There is a difference between students and graduates. While students are the customers of faculties of engineers, while graduates are the products that industry consumes. The primary product of the faculty of engineering is the courses (knowledge) they teach.

Employers — including companies, startups, and government agencies — are end users of the graduates that faculties of engineering produce. They depend on engineering schools to supply professionals who can apply theory to solve real-world problems.

When faculties fail to align with industry needs, graduates may leave school with knowledge that doesn’t match workplace realities. In a customer-centric education model, universities regularly

engage employers to identify skill gaps, emerging technologies, and desired competencies — then integrate these insights into the curriculum.

Just as industries rely on customer feedback to refine their products, engineering programs should rely on employer feedback to refine graduate outcomes. This ensures that students are not only employable but capable of driving innovation in their future workplaces.

The expectations of industry should feed what kind of graduates each faculty produces. Industry expects graduates who can think critically, solve problems, and work in teams. They want engineers who are ready for work — technically competent, creative, and adaptive. They should be able to research and innovations that address industry challenges. There should be opportunities for collaboration, co-creation, and talent development.

Universities must see industry not as a distant partner but as a *co-designer* of curricula. Just as manufacturers get feedback from customers to improve their products, faculties should integrate continuous feedback from employers to refine teaching, training, and assessment.

3. Society and Communities – The Ultimate Beneficiaries

The people and communities that benefit from the knowledge, technologies, and solutions engineers create. Society funds universities (through taxes or reputation) and depends on their output. The

society suffers if the engineers being trained are not equipped to work.

The broader society — communities, nations, and humanity at large — is the ultimate end user of engineering education. The bridges engineers design, the energy systems they build, and the technologies they develop all directly impact human life.

Therefore, society depends on universities to train engineers who are ethical, creative, and responsible, capable of designing solutions that improve quality of life, protect the environment, and promote sustainable development.

When universities produce engineers who can solve real societal problems — from clean water to green energy — they fulfill their highest mission: creating value for humanity.

The expect solutions to local and national problems (health, energy, food, environment), ethical, socially responsible engineers who improve living standards and faculties that contribute to sustainable development and innovation.

Engineering education must be community-centered. Projects should address real community problems; research should be relevant to social and economic needs.

Traditional engineering education often behave like factories that produce what they think is good — not what the market or society actually needs. To stay relevant, faculties — especially faculties of

engineering — must transition from being knowledge transmitters to value creators and innovators, guided by a clear understanding of who their customers are *and* what those customers expect.

When faculties begin to operate with this clarity — the way Apple understands its users or Toyota listens to its customers — engineering education will finally become what it was always meant to be: a system that produces engineers who meet real human and industrial needs.

Discovering Needs of Customers

I never knew that companies take time to find the needs of their customers and then produce products that meet that need. I grew up in a generation that believed that companies just produce what they want and people have no option but to buy it. Isn't that the same mindset our universities have?

Universities are not built to understand what anyone wants. Courses are just created for the sake of the universities to attract customers. I wanted to do my masters in engineering, not its silo, but I am sure if I mentioned it, I'd would have been told what they have rather than they crafting a course to meet my needs.

This is more like the mindset Henry Ford demonstrated when he was asked for a different color of Model T. His reply was that people should make do with the one color of the model. He should have listened to what people wanted.

In companies, discovering and uncovering the needs, jobs, gaps, and pains of customers is the foundation of innovation and continuous improvement. Successful organizations like Toyota, Amazon, and Apple do not assume they know what their customers want—they observe, listen, and engage deeply to understand them.

While studying engineering, I found the whole process boring. If the faculties have listened to their customers including themselves, they would have done something to meet those needs. If people had the choice, they won't go to universities that don't listen to them and know their needs.

People feel valued, cared for and respected when they feel listened to and their needs anticipated and met. That was how I felt when I visited the US Embassy for interview. I have previously visited the French embassy and my experience was that they don't care and value me as a person.

However, at the US embassy, they understood what I need and made sure that the journey and experience through the visa interview process was out of this world. The foundation of design is uncovering the needs of the customers and designing solutions that meet that.

Companies invest in market research, customer interviews, data analytics, and direct observation to uncover what customers are trying to achieve, the challenges they face, and the unspoken frustrations that shape their experiences. Faculties of

engineering can learn greatly from this mindset and process.

For faculties, the “customers” are not just students, but also the industry and society that depend on the graduates and research outputs they produce. Just as companies study their customer journey, faculties should study the educational and career journey of their students—from admission to employment.

This involves identifying what students, industry and society are trying to achieve (their “jobs to be done”), the barriers that prevent them from succeeding, and the experiences that either motivate or frustrate them. Courses and research should now be applied to help them achieve their goals.

Through surveys, focus groups, observations, alumni interviews, and employer feedback sessions, faculties can map the learning journey and uncover hidden gaps in skills, pedagogy, and relevance.

In industry, customer discovery is often a structured process—companies use tools like empathy maps, value chain analysis, and design thinking workshops to frame problems from the user’s point of view. Faculties can adopt similar approaches by creating “learning empathy maps” to visualize students’ emotions, thoughts, and goals during the educational process.

I have always advocated for people with business mindset to run universities, most especially the

faculties of engineering. There is no way you can produce products that industry will use without first having similar mindsets as industry.

This could be why most faculties of engineering are dependent financially on the University. It ought not to be so. When faculties adopt and adapt the ways of universities, they will be empowered to add value to industry. And that will attract their funding.

Faculties of engineering should know what their customers want to achieve, identify key obstacles and barriers that will stop them and come up with ways to transform those obstacles and barriers into opportunities.

Design thinking sessions that bring together students, lecturers, alumni, and industry partners can reveal systemic issues that data alone may not show—such as outdated course content, lack of practical exposure, or weak career guidance.

Companies also rely on customer data to anticipate emerging needs. Amazon, for example, uses analytics to understand behavioral patterns and tailor offerings. Similarly, faculties can analyze enrollment trends, course performance data, internship feedback, and graduate employment statistics to uncover patterns of need. For instance, a decline in graduate employability may signal a curriculum gap or a mismatch between academic preparation and industry requirements.

Moreover, successful companies engage customers continuously, not occasionally. They see discovery as an ongoing relationship rather than a one-time survey. Faculties should adopt this same principle by maintaining constant dialogue with students, industry, and society. Regular industry advisory boards, student innovation showcases, and community problem-solving projects can serve as listening posts where the faculty stays attuned to evolving needs.

In essence, discovering and uncovering needs, jobs, gaps, and pains requires faculties of engineering to think like customer-centric organizations. They must move from assumption to evidence, from teaching-centered to learner- and society-centered, and from internal focus to external engagement. Just as the most innovative companies design products around what customers are trying to achieve, faculties must design programs, research, and partnerships around what students, industries, and society need to achieve. When faculties adopt this mindset, they no longer merely educate engineers—they engineer education itself.

How Engineering Education Should Create Value

Faculties of engineering, like successful companies, create value for their customers—students, society, and industry—by addressing their most pressing needs and helping them thrive in an ever-changing world. Their role goes beyond teaching technical

knowledge; they serve as enablers of confidence, innovation, and capability.

This value creation can be understood in three major ways: eliminating fears, helping identify opportunities, and equipping individuals and organizations with the capabilities to capture them.

For all their customers, they should position themselves to do three things:

1. Eliminate their Fears

Everyone has what they fear. Obstacles and barriers can cause fears that we may not achieve our goals. Faculties of engineering are better positioned to conduct research and innovation to eliminate the fears of their customers. By eliminating fears, faculties of engineering will provide hope to their customers.

Every learner, industry, or society faces fears—fear of irrelevance, failure, or being left behind by technological change. Faculties of engineering create value when they deliberately eliminate these fears.

For students, this means creating a learning environment that replaces anxiety about employability with confidence through hands-on learning, mentorship, and exposure to real-world problems. For example, project-based learning programs, like those adopted at MIT and Stanford, help students overcome the fear of “not being good enough” by allowing them to learn through doing, failure, and iteration.

For industry, faculties can eliminate the fear of skill shortages or outdated methods by co-developing curricula and training modules that reflect emerging trends such as artificial intelligence, renewable energy, or automation. When a faculty partners with companies to design courses around real industrial challenges—such as a university working with a manufacturing firm to embed lean engineering or 3D printing into student projects—it gives industry confidence that graduates will be ready for their needs.

For society, faculties eliminate fear by tackling social and environmental problems through engineering research. When engineering departments engage in clean water projects, renewable energy prototypes, or low-cost housing innovations, they reduce societal fears of scarcity, pollution, and inequality.

2. Help Them Identify Opportunities

Faculties of engineering should help their customers identify opportunities. They provide them with a mindset that sees opportunities. The identification of opportunities results in excitement. That is because opportunities bridge the gap between where people are and where they want to go.

Once fears are removed, faculties must help their stakeholders see possibilities. Companies like Google or Amazon thrive by helping customers discover new ways to create value; similarly, faculties must open students' and industries' eyes to

new opportunities in technology, sustainability, and entrepreneurship.

For students, this means exposing them to interdisciplinary thinking and problem discovery. Engineering faculties can organize innovation challenges, hackathons, and internships that allow students to identify unmet needs in their communities. For instance, when students at the University of Lagos design renewable energy solutions for rural electrification, they are not just learning—they are identifying untapped opportunities to serve society.

For industry, faculties can act as innovation partners. By conducting applied research, offering consulting services, or hosting industry–academia innovation hubs, faculties help industries spot emerging technologies and market trends. For example, when a faculty’s research group collaborates with an automotive company to explore electric vehicle technology, it helps that company identify future opportunities in sustainable transport.

For society, faculties help governments and communities identify areas for improvement—such as infrastructure inefficiencies, environmental challenges, or digital divides—through engineering assessments and public research. By offering evidence-based insights, faculties enable policymakers to make smarter, more future-oriented decisions.

3. Equip and empower them to capture opportunities

Faculties of engineering provide confidence to their customers when they are equipped and empowered with capabilities that will enable them capture opportunities. It is one thing to see opportunities and another to capture it.

Opportunities are valuable only when people have the skills and systems to seize them. Faculties create their greatest value when they build these capabilities—through curriculum design, laboratories, mentorship, and lifelong learning programs.

For students, this means developing not just technical expertise but also creativity, leadership, and entrepreneurial capacity. Faculties that integrate design thinking, innovation management, and digital tools into their courses help students become problem-solvers, not just job-seekers. For example, Olin College of Engineering equips its students with entrepreneurial and collaborative skills, ensuring they can transform ideas into impact.

For industry, faculties can offer professional development programs, certification courses, and collaborative research that upskill engineers to adapt to emerging technologies. A faculty partnering with an oil and gas company to train engineers in renewable energy systems or data analytics enables that company to stay competitive in a changing energy landscape.

For society, faculties build capability through community engineering projects—training local artisans, supporting technology startups, or creating open-source solutions that improve quality of life. When universities design frugal innovations, such as affordable prosthetics or solar-powered water purifiers, they equip communities with the ability to capture opportunities and sustain progress.

In sum, faculties of engineering create value when they act as fear removers, opportunity enablers, *and* capability builders. Just as successful companies create value for customers by improving their lives, faculties do so by shaping confident, capable, and opportunity-driven individuals who, in turn, transform industries and societies. This is the true engineering of value—educating not only for knowledge, but for impact.

How Engineering Faculties Should Make Money

There are two specific quotes that every business follows to be relevant and sustainable. These quotes can help engineering education to become sell sustain. Most lecturers may not see what the faculties are doing as selling, but that is what it is. Engineering education by its nature should function as a business or industry.

Here are the two quotes:

Peter Drucker: “The purpose of business is to create and keep a customer.”

Dan Sullivan: “All money earned ethically is a by-product of value creation.”

We just identified how the faculties of engineering should be creating value, that means they should also be making money from it. When companies create and deliver value to their customers, they also capture value as payments or revenues from their customers.

Faculties of engineering, like any value-creating organization, have customers—students, industry, and society—and what they produce and sell goes beyond lectures or degrees. They create and deliver intellectual, human, and societal value through their outputs. In essence, faculties of engineering produce and sell knowledge, competence, innovation, and impact—each tailored to the unique needs of their different customers.

Just as companies produce products that meet market needs, faculties of engineering must continually refine their educational “products” to stay relevant. When they align what they produce with the evolving needs of their three key customers, they cease to be mere academic institutions and become innovation enterprises—engineering the future, one graduate and one idea at a time.

Engineering education, like any enterprise that creates and delivers value, has products and customers. Its products are not tangible goods but transformative outcomes—new ways of thinking, doing, and building. At its core, engineering

education sells *a better future, capabilities, and impact*. These are its real currencies in the marketplace of ideas, industries, and societies.

1. Engineering Education Sells a Better Future to Students through Courses

To students, engineering education is not just selling lectures, grades, or certificates—it is selling a better future. Every course, lab, and project represent a bridge between where the student is and who they aspire to become. Through structured learning, mentorship, and exposure to problem-solving, faculties of engineering offer students the promise of transformation—from uncertainty to competence, from curiosity to mastery, from potential to productivity.

It takes 10,000 hours of deliberate practice to gain mastery. Engineering students spend five of these years in the universities. Looking at it from this angle means that faculties have the responsibility of equipping students to gain mastery.

A well-designed engineering curriculum gives students the tools to shape their destinies. When a student takes a course in renewable energy, artificial intelligence, or materials science, they are not merely learning facts—they are investing in a future filled with opportunities to innovate, to lead, and to make a difference.

The “product” they receive is not knowledge alone, but the ability to design and influence the systems that shape tomorrow’s world. They are investing in

a future that guarantee's them employability, progress and prosperity. Unfortunately, this isn't what is obtainable.

Universities are failing to deliver this. That is because most graduates of engineering faculties are unemployable and will certainly leave the engineering profession for something else that will give them a better future.

No student cares about the course they are studying. To them it should be a stepping stone to the future they desire. If they know from the very start that it won't give them the future they desire, they won't register for it.

Engineering education therefore sells hope, purpose, and empowerment—the belief and ability that the future can be built, and that the student has the power to build it through the engineering field they chose to study.

2. Engineering Education Sells Capabilities to Industry through Graduates, Solutions, and Knowledge

To industry, the value proposition of engineering education is capability—the power to think critically, solve complex problems, and adapt to technological change. Faculties sell this capability in three main forms: graduates, solutions, and knowledge.

The faculty's "product" is applied knowledge and innovative solutions that fuel competitiveness and growth. Companies should rely on engineering

faculties for a steady pipeline of capable graduates, as well as for research that solves real-world technical and operational challenges.

Faculties should produce:

- a. Industry-ready talent—graduates with the skills and attitudes companies need.
- b. Research outputs—patents, prototypes, and applied innovations.
- c. Consulting and problem-solving services—technical expertise that improves industrial processes or product development.

Graduates are the primary product—each one a carrier of the university’s quality, culture, and competence. The Outcome Driven Engineering Education (ODEE) major objective is to produce industry-ready graduates.

A skilled graduate brings to industry not just technical knowledge, but also creativity, discipline, and problem-solving ability. When a company hires an engineer from a reputable university, it is purchasing the assurance of competence and the potential for innovation.

Beyond graduates, faculties also sell solutions through applied research and consultancy. When a faculty collaborates with a company to optimize a production line, develop a new material, or design a safer structure, it is transferring capability directly to industry.

For instance, when a faculty partners with an energy firm to design a more efficient turbine system or when it helps a manufacturing company implement lean practices, it is selling engineering solutions and intellectual capital. Industry “pays” for this through partnerships, endowments, consultancy contracts, and collaborative research funding.

In essence, what industry buys from engineering education is the capacity to innovate and stay relevant. Through knowledge dissemination, such as conferences, journals, and workshops, faculties empower industries to evolve. They sell intellectual currency—the ideas and methods that keep companies competitive in a rapidly changing world.

3. Engineering Education Sells Impact to Society through Innovation

To society, engineering education sells impact—the tangible and measurable improvements in quality of life that come from innovation. The work of engineers shape nearly every aspect of modern living: clean water, safe roads, efficient energy, digital connectivity, medical technology, and sustainable environments. Faculties of engineering are the incubators of such transformation.

Through research and community projects, engineering education creates technologies and systems that solve societal problems. A university that develops a solar-powered water purifier for rural areas or a cost-effective prosthetic limb for

amputees is not just teaching engineering—it is selling *social progress*.

Society “pays” for this through funding, trust, and recognition because it gains returns in the form of better infrastructure, healthier communities, and sustainable development. The impact of engineering education extends beyond classrooms and laboratories—it lives in the bridges that connect communities, the hospitals that save lives, and the innovations that protect the planet.

When faculties of engineering understand themselves as value creators rather than knowledge dispensers, education becomes an engine for growth, relevance, and societal transformation. In that sense, engineering education is not just about teaching people how to build things—it is about teaching them how to build the future.

How Faculties of Engineering Should Capture Value

Businesses create and deliver value. For this they are compensated. The compensation is the way they capture value. Engineering faculties, value capture goes far beyond tuition fees or government funding. However, when they don’t identify their customers and create value for them, they end up with tuition fees only.

Faculties generate immense value for their customers — students, industry, and society — and, like great companies, they also need to capture that value in multiple forms. , Traditionally, most

faculties of engineering only understand value capture in terms of tuition fees and dues that students pay, research grants, donations and government funding. It goes beyond that.

Dan Sullivan, the co-founder of Strategic Coach, identified five ways of faculties of engineering can capture value. This provides a powerful framework to understand how faculties of engineering should get paid for what they do.

1. Utilize — When People Use You

Faculties of engineering get paid when their knowledge, facilities, and systems are utilized. Every time students enroll in courses, attend workshops, or use laboratories, they are “using” the faculty’s intellectual and physical resources. Utilization keeps them relevant.

Industry also “uses” the faculty when it partners for research, testing, consultancy, or workforce development. For example, when an oil and gas company engage a university to conduct pipeline corrosion analysis or material testing, the faculty’s expertise is being utilized. This form of payment may not always come as money—it could be access to data, technology, or practical learning opportunities for students.

2. Enhance — When You Raise Their Level

Faculties get paid when they raise the level of their stakeholders—helping students become employable, enabling industries to solve problems, and equipping society with innovations that

improve lives. Students, industry and society get better results or become more successful because of what the engineering faculties are doing.

Faculties are enhanced when they raise their customers level of performance, productivity and confidence. They create transformative value, not just functional. When they enhance the value of others, they are invariably being enhanced. Enhancement builds their legacy.

Each engineering course, mentorship program, or innovation challenge enhances someone's capacity. For instance, when a faculty designs a new entrepreneurship program that turns final-year projects into viable startups, it's enhancing students' potential and industry's innovation pipeline. The "payment" here is reputation, employability statistics, and greater collaboration opportunities—forms of capital that multiply over time.

3. Appreciate — When You Are Valued and Recognized

Faculties of engineering are also paid through appreciation—when society, industry, and alumni recognize the value they bring. Appreciation shows up in the form of awards, testimonials, donations, or increased demand for admission. Appreciation grows their influence.

When a faculty produces outstanding graduates who win national competitions or create solutions that make the news, it earns social credibility and

institutional pride. Appreciation often precedes tangible rewards—it attracts grants, endowments, and partnerships.

4. Refer — When Others Send You Opportunities

A powerful way faculties get paid is through referrals. When employers recommend a university's graduates to other companies, or when alumni bring their firms back for collaborations, the faculty is being “paid” with opportunities. Referrals expand their reach.

For example, if a tech company that benefited from a joint research project refers another company to the same faculty for R&D support, that referral is a form of earned value. This kind of payment compounds—each successful engagement builds trust and opens new doors, creating a network-driven cycle of growth.

5. Reward — When You Receive Direct Monetary Return

Finally, there's the direct financial payment: tuition fees, grants, research funding, patents, and consulting income. These represent the cash reward for the value created. But this is usually the *result* of the other four forms of payment. Rewards sustain their mission.

When faculties are well-utilized, enhance their stakeholders, are appreciated, and earn referrals, money naturally follows. A faculty that builds strong ties with industry and maintains a reputation for excellence finds it easier to attract

sponsorships, donations, and high-value research contracts.

When these five forms of payment are recognized and nurtured, engineering education becomes not just a knowledge center—but a thriving value creation and capture system for all its customers: students, industry, and society.

Chapter Two

Think Like Corporation

“We are what we think, all that we are arises with our thoughts, with our thoughts we make the world.” Buddha

In the summer of 2025, something remarkable happened at Xi’an Jiaotong University (XJTU), one of China’s oldest and most respected faculties of engineering. On June 26th, the university signed a partnership agreement with Xiamen Funongsi Group, a rapidly growing industrial company known for its work in artificial intelligence and industrial applications.

To most observers, it looked like just another memorandum between a university and a private enterprise. But for those who understood the deeper shift taking place in Chinese engineering education, this collaboration represented something far more profound — a faculty learning to think like industry.

At the signing ceremony, the atmosphere was charged with excitement. Executives from Funongsi spoke of “business model innovation,” “AI-driven productivity,” and “value creation.” What was striking was how naturally the university professors echoed the same language. They no longer spoke only of “research outputs” or “academic publications.” Instead, they discussed *solutions*, *market readiness*, and *industrial transformation*. It was clear that both sides understood each other — not just in words, but in worldview.

The agreement established the AI Fusion Innovation Management Research Institute, a joint center designed to bridge the gap between academic theory and industrial practice. This was not a traditional research lab hidden behind university walls. It was a living ecosystem where engineers, data scientists, and business strategists worked side by side. The aim was not merely to study artificial intelligence but to apply it — to create intelligent systems that could transform manufacturing, healthcare, and energy production.

For the faculty, this partnership demanded a new mindset. Professors began to design research projects with end users in mind. Students learned to see AI not as an abstract algorithm but as a tool for solving real industrial challenges. The focus shifted from publishing papers to producing prototypes, patents, and partnerships.

XJTU's dean of engineering later described the collaboration as a “mutual transformation.” The company, he said, brought speed, market insight, and customer focus; the university contributed deep technical expertise and analytical rigor. Together, they created something neither could achieve alone — a culture of co-innovation.

Within months, the institute launched pilot projects in smart manufacturing and energy optimization. Industry engineers and university students collaborated on developing intelligent systems for factory automation and energy management. What

emerged was not only technology but a shared language — the language of value.

This was the moment when the faculty began to speak fluently in the dialect of industry. They no longer approached companies as outsiders seeking sponsorship; they met them as equal partners in innovation. When a company executive visited the university, discussions were about time-to-market, efficiency gains, and customer experience — the vocabulary of business, not academia.

The partnership became a symbol of what it means for a faculty of engineering to think like a company. It showed that transformation begins not with money or policy, but with mindset alignment. When universities and companies start thinking alike — in terms of purpose, process, and performance — collaboration becomes effortless.

In the words of one of the project leaders, “We stopped trying to impress industry with our research. Instead, we started trying to solve their problems. And when that happened, they started listening.” That is what it means to think like industry.

Through this collaboration, Xi’an Jiaotong University did more than create an AI institute. It demonstrated a new way of being an engineering faculty — one where the goal is not just to teach knowledge, but to create value. And by learning to think like industry, they ensured that their graduates, their research, and their innovations

would remain relevant in a world driven by practical impact.

That is the essence of The Engineering Education Way — when education stops talking *at* industry and starts talking *with* it. This reminds me when I attended the Food Engineering Dept of University of Ilorin’s Outcome-Based Education accreditation. The dean of the faculty wanted partnership with the industrial players, but clearly, he doesn’t understand how industry thinks or even tried to understand them.

He was talking at industry rather than seeking to understand them. I had to interject and correct him. Most academics don’t understand how industries think, yet they want to partner with industry. All they want from industry is cash not value they can give. In every partnership with industry, academics need to ask, “What Value Are We Bringing To The Table?”

Thinking Like Industry

In today’s rapidly changing world, the boundaries between education and enterprise are blurring. The faculties of engineering that thrive are those that have learned not only to teach engineers but to think like industry — to align their mindset, language, and goals with the corporate world.

Nowhere is this transformation more visible than in China. Over the past two decades, Chinese faculties of engineering have redefined their role in society — not as knowledge dispensers but as innovation

partners. Their success offers a powerful model for any nation seeking to make its engineering education relevant, responsive, and impactful.

In Chinese engineering faculties, education and research are not ends in themselves; they are means to create value. Professors and students are encouraged to ask the same questions companies ask:

- 1. What problem does this solve?*
- 2. Who benefits from this innovation?*
- 3. How can we turn this idea into an applicable solution or product?*

This orientation transforms the classroom into a laboratory of relevance. Learning becomes purpose-driven, and research becomes a bridge between academic discovery and market demand. This will definitely require mind change on the part of universities, which most times is difficult.

Most academics hold the mindset that they know much as such industry should grovel to them. Where faculties made have become proud through accumulation of knowledge, industry is humble through the application of knowledge. Academics are good at talking about what they know but never how to transform what they know into value.

I was invited to serve as a panelist on a program. There were three professors on the platform. They talked about what other countries are doing. However, when it came to Nigeria, they started suggesting what government should do, not what

they should be doing. There is a gap between knowledge and value creation in our faculties.

Across China, universities and companies have established co-innovation centers, joint laboratories, and research parks. In these spaces, the traditional gap between academic theory and industrial practice disappears. Students work alongside company engineers; professors collaborate with product designers and production managers.

Together, they speak a common language — the language of solutions, outcomes, and value. It's a space where the whiteboard meets the assembly line.

Chinese faculties of engineering have embraced entrepreneurial thinking as part of their identity. Innovation hubs, maker spaces, and startup incubators are built within campuses, encouraging students to move from concept *to* company.

Many student projects evolve into real startups, often supported by faculty mentors and funded by industry partners. This process helps learners see that engineering is not only about making things work but also about making them valuable.

To ensure both worlds stay connected, China encourages faculty–industry exchange programs. Professors spend sabbaticals working in companies, while corporate experts teach courses in universities. We tried to create this in our partnership with PAN Nig Ltd. Apart from just

students, but lecturers also should spend time in industry to be able to think like them.

This two-way traffic keeps academic content fresh, relevant, and practical. It also trains students to think in industrial terms — cost efficiency, customer satisfaction, and scalability — the same metrics companies live by.

Rather than boasting about the number of research papers published, Chinese faculties highlight patents, prototypes, and partnerships. Their collaborations are measured by impact — technologies transferred, processes improved, and enterprises launched.

This outcome-based culture mirrors the Key Performance Indicators (KPIs) used in companies.

To a faculty, a measure of success maybe the number of students who get good grades. If they bring this into partnership with industry, it won't work. Grades and knowledge mean nothing to industry except they are transformed into value. When academia starts thinking like industry, they will evaluate success using a shared vocabulary of performance.

China promotes a framework they call the *Chan-Xue-Yan* framework. It is the integration of Industry, Academia, and Research. This system ensures that national priorities such as green energy, artificial intelligence, smart manufacturing, and biotechnology shape what faculties teach, research, and develop.

Through our Outcome Driven Engineering Education, we are bringing research and innovation, things that are valuable to industry, back into the faculty system. Industry has problems and need universities to solve them. The Engineering Education Way is one where research doesn't end as papers but as innovation that industry and society will find useful.

Unlike Nigeria, engineering education in China is not isolated; it is part of a living national ecosystem designed to power economic and technological progress. The greatest lesson from the Chinese model is simple yet profound: Only those who think alike can walk together.

Because Chinese faculties and industries think in alignment, they can collaborate effortlessly. I believe universities should start talking about collaboration rather than industry linkages. With collaboration, each team brings their strength. Faculties come with their unique strength to meet industries unique strength to create new forms of value.

By so doing, when a company executive meets a university dean, they speak the same language — one of innovation, efficiency, and value creation. This alignment allows engineering education to remain future-focused and market-relevant — a true driver of development rather than a passive observer.

By thinking like companies, faculties of engineering move through the stages of Utilize, Enhance, Appreciate, Refer, and Reward:

1. They are utilized by industry because they provide real solutions.
2. They enhance industrial capacity through innovation.
3. They are appreciated and recognized as partners.
4. They are referred to for future collaborations.
5. And ultimately, they are rewarded — in reputation, resources, and results.

They don't come with their needs but with value to partner with industry. This is the engineering education way — a model where academia, society and industry walk hand in hand, powered by shared understanding and united purpose.

To think like industry is not to abandon academia's ideals; it is to give them relevance in a world that demands results. The faculties of engineering that understand this truth are not just teaching the next generation — they are building the next civilization.

How Industry and Universities Differ in Their Views of Money and Value

As someone who has worked in the industry and have studied the university for years, I will say that the gap between universities and industries in Nigeria is the reason behind the inability to build relationships between the two. Understanding how each side views money and value is essential for

bridging the gap between academic production and industrial application.

In industry, money is the reward for creating value. Every organization operates on a simple and universal formula: Value leads to customer satisfaction, which generates revenue and drives growth. Industry defines value as anything that solves a real problem, meets a specific need, or improves efficiency. If a product fails to deliver value to the customer, it simply does not sell, no matter how technically brilliant it may appear.

For the industrial world, money is an outcome, not the goal. The real goal is to create something that people are willing to pay for because it makes their work or life better. Every activity — from design to production — is measured in terms of impact, efficiency, and customer delight.

An engineer or technologist working in industry quickly learns that a product which fails to perform as promised destroys trust, and with it, profitability. Continuous improvement, or *Kaizen*, keeps value relevant. Innovation, too, is not viewed as invention for invention's sake, but as the act of creating value that sustains business and improves lives. In short, industry sees money as a scorecard for value delivered.

In contrast, most universities, particularly in Nigeria, operate under a very different logic. In the academic setting, money does not necessarily follow value — it follows certificates, accreditation, and

enrollment. Students are told to get the best grades so they can get good jobs that lead to money.

The Universities tend to define value in terms of academic output, such as the number of publications produced, institutional rankings achieved, or graduates produced each year. The “customer” in this system is rarely viewed as the student or the industry that will one day employ them; instead, the university often focuses on satisfying governments, accreditation agencies, or donor organizations.

While businesses exist for their customers, universities exist for themselves. The joy of a business person is when their products satisfy their customers’ needs. The joy of a university is when it gets a better ranking not because its products satisfy industry.

This mindset universities possess leads to a form of education that emphasizes completion over application. Courses are designed to be finished rather than experienced. Research is pursued for publication, not implementation. There are so many papers written but haven’t been applied but the lecturers have been promoted. Graduates are trained for certification, not contribution. The flow of money within this system reinforces the problem.

Universities depend heavily on tuition fees, which students pay for access rather than guaranteed value, and on grants or government subventions, which reward compliance and documentation rather than measurable societal impact. Within this

model, value creation becomes internal — benefitting the university’s own structure and reputation more than the ecosystem it is meant to serve.

These two mindsets create an obvious tension. In industry, the purpose of money is to reward the solving of real-world problems, while in universities, money is mainly a means to sustain academic operations. For industry, value is defined through customer satisfaction, innovation, and market impact; for universities, value is found in knowledge dissemination, research output, and accreditation success.

The primary customer in industry is the market and end-users, while in universities it is the university itself. While industry are other’s centered, universities are self-centered: it’s all about them. Success in industry is measured by profit, growth, impact, and product relevance, whereas universities measure success by graduation rates, publications, and rankings.

Furthermore, the industrial world sees waste as anything that fails to add value to the customer, while academia often tolerates inefficiencies as necessary “process” or “academic rigor.” Industry prioritizes learning fast and applying faster, but universities tend to favor long, theory-heavy learning with limited practical application.

Industry’s time horizon is short- to medium-term, driven by market needs, while universities think in terms of long-term academic progression. These

differences define not only their priorities but also their pace of adaptation to change.

Because universities and industries perceive value differently, graduates often emerge with strong theoretical competence but weak market relevance. Research findings remain on shelves rather than in factories, startups, or public use.

This results in funding gaps widening because industries invest where value is measurable, not where it is only documented. Over time, universities risk turning into cost centers rather than value creators within the knowledge economy.

Most Universities are looking at how to reduce the number of workers they have. Covenant University recently relieved a number of their lecturers to cut cost. As long as universities don't think like industry, they will become cost centers.

Universities like MIT, Harvard, Stanford, IIT and Chinese Universities have integrated the industrial mindset into their DNA. As such, they have been able to build a business model that makes them independent of government and students. They are relevant to society and industry. They are constantly creating and delivering value.

To realign with industry, universities must begin by teaching value creation, not just knowledge accumulation. Every course should begin by answering the question, "Who benefits from this knowledge, and how?"

Students must be encouraged to solve real-world problems by working on projects designed in partnership with industries, communities, and startups. Universities also need to redefine their metrics for success, shifting the focus from the number of graduates produced to the number of graduates who create or contribute measurable value in society. Graduates should be value contributors to society and industry.

I was discussing this with a professor. He told me that the conversation is on the front burner in African University Network. Research should no longer end at publication but move toward commercialization and implementation, linking every research output to either an economic or social impact.

It's important that universities adopt lean and project-based learning systems that mirror the realities of industrial problem-solving. By doing so, students begin to think like entrepreneurs — seeing every assignment, project, and prototype as a potential innovation that can deliver tangible value.

Industry and universities are both in the business of value, but they define it differently. Industry sees money as proof of value delivered, while universities often see money as a prerequisite for creating value. The future, however, will belong to the institutions that can bridge this gap — those that teach engineers, scientists, and innovators to think like value creators first, and professionals second. When universities start viewing money as a

mirror of value delivered to society, education will cease to be a cost and will instead become an investment — one that yields dividends in innovation, productivity, and human progress.

Money Is Exchange of Value

In every conversation I have held with professors about industry, it is all about how they will need industry to give them funds. Rather than seek a symbiotic relationship with industry, they seek a parasitic one: what they can get without giving anything.

I have always said that how can industry trust the university when their major product, graduates, are not employable? The integrity of a company is based on the functionality and value its product can deliver. Since engineering graduates are not well equipped to add value to industry, it follows that the faculties cannot be trusted to deliver what industry wants.

One of the greatest misunderstandings in the relationship between universities and industry is the expectation that companies should *fund* universities simply because they exist or conduct research. Faculties feel entitled to industry funds. Faculties often assume that industries should “support education” or “sponsor research,” as if funding were an act of charity. But industry does not think that way — and never has.

To industry, money is an exchange of value, not a donation. No company pays until it sees value

created or clearly in view. While most universities operate on a prepaid model — where students or governments pay *before* learning occurs — industries work on a post-value model — they pay *after* value is delivered. That difference in thinking explains why so many university–industry partnerships remain shallow or short-lived.

When universities sign MOUs with industry, there is excitement about it. However, the excitement is short lived. While faculties expect funding to flow to them from industries, industry expect solutions and innovations to flow from industry to them. This disparity in expectations creates a gap that shipwreck the partnership.

If faculties of engineering truly want to attract industry investment, they must start thinking like industry. That means shifting from an “education for its own sake” mindset to one of value creation and delivery. Instead of asking, “*What can industry give us?*”, faculties must begin asking, “*What can we give industry that helps them win?*”

To develop a working relationship with industry, the first step is for faculties of engineering to understand the problems industries face — the inefficiencies, the technological bottlenecks, the skill gaps, and the future challenges they can already foresee. When faculties identify these pain points and direct their research toward solving them, they begin to function as innovation partners, not distant institutions.

The process of getting cash from industry starts with faculties becoming utilized when industries find them useful. Through their research and innovation, they enhance industrial performance when their research leads to better outcomes. They are appreciated when they help businesses grow and then referred to other companies who have similar challenges.

And finally, they are rewarded — financially and reputationally — when their work creates measurable value.

The moment faculties help industries succeed, industries will ensure faculties never lack anything again — funding, equipment, opportunities, or recognition. Because in the world of industry, value attracts value.

This means if universities want to receive money, they must stop waiting for donations and start creating value. When faculties think like industry, speak the language of value, and act as partners in progress, money becomes a natural consequence, not a negotiation.

Always have it in mind that money is the by-product of value creation. What comes first between money and value? Value comes first. When you create value, then money starts moving towards you. Money flows from a place of low value to a place of high value.

Curiosity Starts The Value Creation Process

Curiosity is the engine of discovery. It is what drives innovation, progress, and relevance. Yet, many universities design courses from tradition rather than from curiosity — building on what has always been taught instead of what the world currently needs.

If universities are to produce graduates who are relevant, employable, and impactful, they must first learn to ask questions before designing courses. Questions are the seeds of discovery; when the right questions are asked, the right solutions — and the right education — emerge.

The only challenge here is that universities sees answers as a measure of intelligence rather than questions. The lecturer gives questions after teaching a class and measures intelligence based on the answers given. They need to learn to start with questions rather than answers (knowledge).

Every invention, improvement, and transformation begins with a question. Why does this problem exist? What can be done better? What would happen if we tried another way? In education, curiosity serves the same purpose — it opens the door to insight.

One question that I continually ask are:

1. Why does it take five years to train an engineering graduate?
2. Who set it as such?
3. What if we decide to train engineering graduates in a year?

4. Can we train engineering graduates in a year instead of five?

5. How can we reduce the time it takes to train engineering graduates?

6. Is there a way we can have industry pay universities for training of students?

If we decided to find answers to these questions, we will discover a gold mine that can reinvent how universities create and deliver value. If we refuse to ask questions, we limit our ability to discover new things. This is why research starts with questions and assumptions not answers.

When universities begin the process of course design with curiosity, they avoid the trap of teaching content that has lost its relevance to the real world. Curiosity ensures that learning remains alive, responsive, and useful. It connects academia with the pulse of industry, society, and technology, ensuring that education becomes a living system rather than a static routine.

Unfortunately, many curricula are created by looking inward — by asking “What can we teach?” instead of “What should students learn to create value in the world?” The result is often an overload of theory with little translation to practice. To correct this, universities must reverse the process.

Before developing or revising a course, they must begin by asking the right industry-driven and future-focused questions that align education with

real-world needs and possibilities. Here are some questions faculties can ask

1. What is the need that industry wants?

Every course should be a response to a real need. Faculties of engineering must study industry pain points, technological gaps, and emerging opportunities. They need to know if the manufacturing sector struggles with automation integration, if energy companies are seeking solutions in sustainability, or if the healthcare sector requires more skilled biomedical engineers.

By asking what industry truly needs, universities can design courses that solve real problems rather than simply award degrees. If there is no need in society or industry, then it should not be taught.

2. What skills do graduates need to possess?

Industries do not hire based on course completion but on demonstrable skills. Faculties of engineering need to, therefore, identify the technical abilities such as design, data analysis, simulation, and prototyping; the professional skills such as teamwork, communication, and adaptability; and the mindset skills such as curiosity, innovation, and continuous learning.

Embedding these into the curriculum ensures that graduates are not merely trained after employment but are ready for industry from the start. Industry wants people who can add value not those who will take from them.

3. What do graduates need to know?

Knowledge remains vital, but it must be purposeful knowledge — the kind that enables effective practice. Faculties of engineering need to determine which concepts, theories, and principles are essential and which have become outdated or redundant. They must ensure that learning connects to real-world projects, internships, and applications. The goal is to move from content-heavy education to context-rich education.

4. What will be industry problems or needs in the next few years?

They must learn to anticipate rather than react. How will artificial intelligence, automation, and sustainability reshape engineering roles? What new fields will emerge in the next five years? How will global trends such as climate change, energy transition, and digitalization influence local industries? These questions help universities design future-ready curricula that produce graduates who lead change instead of chase it.

5. What number of different fields of engineering will be needed this year and in the near future?

This connects academic planning with workforce development. Understanding how many mechanical, electrical, civil, chemical, or computer engineers industries will require helps faculties of engineering balance enrollment, guide students toward emerging fields, and plan resources for laboratories, faculty, and partnerships. When faculties of engineering align their course output with national and regional workforce needs,

education becomes a strategic contributor to economic development.

Asking such questions transforms curriculum development from a content exercise into a process of value creation. Courses cease to be mere academic subjects; they become tools for transformation — for students, industry, and society.

When faculties design with curiosity, students learn to solve real problems, lecturers become facilitators of innovation rather than transmitters of theory, and industry begins to trust academia as a genuine partner in progress.

A curious faculty of engineering is a living university — one that learns, adapts, and evolves. Curiosity turns faculties of engineering into learning organizations capable of listening to signals from industry, translating those needs into learning outcomes, and continuously improving their programs. Curiosity doesn't just design better courses; it designs better futures.

The future of education will not belong to the faculties of engineering that know the most, but to those that ask the best questions. Before designing a course, faculties must pause and reflect: Who needs this? Why does it matter? How will it create value in the real world? When curiosity leads, relevance follows. And when relevance meets value, education becomes not just a process, but a promise fulfilled.

Be Strategic

Tsinghua University, long acknowledged as one of China's premier engineering and research institutions, did more than just form casual-ties with industry. It structured strategic, long-term frameworks that mirror how a company thinks — setting up partnership modes, dedicated funds, industrial collaboration offices, and joint research programs that align with national and industrial priorities.

For example, Tsinghua established the University-Industry Cooperation Committee (UICC) in 1995, with a mandate to engage enterprises systematically. It now counts as members some of China's largest industrial players (e.g., Huawei Technologies Co., Ltd.) and major state-owned enterprises.

In one initiative, Tsinghua's Department of Electrical Engineering and Applied Electronics (EEA) teamed up with Huawei's Power Digitalization Corps and other industry partners to address the challenge of the “new type power system” and organosilicon industry chain. This move demonstrates the faculty aligning its research agenda with an industry's future-oriented objective (in this case, China's energy transition and power-system transformation).

Tsinghua also uses joint funds and platform creation with both regional governments and enterprises to operationalize the strategy. It has set up several “university-industry research

collaboration funds,” and “industry-university-research offices,” each meant to orchestrate long-term partnerships rather than ad hoc engagements.

Hence, rather than waiting for industry to approach them with funding, Tsinghua’s engineering and research faculties approach industry — and governmental industry strategy — with a clear vision, mission, measurable objectives, and structures to deliver. They think in value creation terms of “*What industry needs next?*” and “*How can we help build that?*” rather than entitlement terms, “*Please fund our research.*”

It is important that faculties of engineering develop a vision that explicitly states how they intend to serve industry — not simply educate, but to build partnerships, deliver solutions, and create value.

They should set a mission that frames their faculty as an innovation partner of industry — building talent, technology, and solutions that align with industrial growth. This will involve defining objectives over a 3-5-year horizon: e.g., number of joint industry projects, startups created, patents transferred, talent placed in industry, etc.

Being strategic includes structuring activities and outputs around industry-relevant metrics: prototypes, testbed deployments, technology transfer, cost-reduction for industry rather than papers. This way they will connect with industry at a deeper level.

For connection between industry and academia to happen, academia has to leave their turf and venture into the world where industry lives. That is empathy. John C. Maxwell mentioned this in his book, *Many Communicate, Few Connect*. To connect we are to make the other party's agenda our agenda. The problem of industry should become the focus of faculties of engineering.

Faculties should align research agendas with industry and national priorities: pick areas where industry is going (e.g., power systems, AI, low-carbon technology) and position themselves faculty accordingly to help them and be utilized.

To think like industry is not merely to talk like industry. It is to plan, act, and measure like industry. It is to be strategic. In my observation of traditional faculties of engineering, one major weakness stands out — they are rarely strategic. They operate semester to semester, driven by academic calendars rather than long-term vision. Their activities are largely reactive — responding to curriculum reviews, accreditation visits, or short-term funding calls. But industries do not operate that way.

Industry begins with a vision — a picture of what they want to become. They define a mission — why they exist. They set objectives — what they must achieve to fulfill that mission. They then design activities to reach those objectives, producing outputs that lead to measurable outcomes. Every project, partnership, and investment is guided by a

clear sense of direction. That is what it means to be strategic.

This is where conflict often arises between industry and academia. When an industry leader sits across the table from a university dean, their minds are calibrated differently. The industry executive is thinking in terms of five-year outcomes, market positioning, growth metrics, and competitive advantage. The dean is often thinking in terms of the next semester's timetable, faculty promotions, or student enrollment numbers. Their time horizons and success measures simply don't align — and when thinking is misaligned, partnership becomes impossible.

For partnerships to flourish, faculties of engineering must therefore adopt a strategic mindset. They must learn to think beyond courses, projects, and publications — and begin to articulate who they want to become in the next five or ten years.

Imagine if a faculty of engineering had a five-year strategic plan that read like a company's business plan:

1. **Vision:** To be the leading engineering innovation partner for national industry.
2. **Mission:** To produce technologies, talent, and ideas that make industry more competitive.
3. **Objectives:** To co-develop 10 industry-driven research projects per year, to incubate 5 start-ups

annually, and to train 1,000 engineers with dual academic–industrial competencies.

4. **Activities:** Joint research programs, industrial sabbaticals for faculty, co-innovation labs, and technology transfer workshops.

5. **Outputs:** Patents, prototypes, market-ready solutions.

6. **Outcomes:** Stronger industries, employable graduates, and a self-sustaining engineering ecosystem.

Such a faculty would be impossible for industry to ignore — because it would speak the same strategic language.

When faculties become strategic, they stop viewing themselves as passive institutions waiting for funding and start functioning as engineering enterprises — purpose-driven organizations that produce measurable value. Their partnerships then move from *transactional* (“give us money”) to *transformational* (“let’s build something together”).

Strategic thinking also brings clarity and continuity. Industry respects consistency — the ability to pursue a goal over years, adjusting the route, iterating, but not the destination. Faculties that change direction with every new dean or funding round appear unreliable. Those that maintain a clear strategy, however, attract trust and long-term partnerships.

In essence, strategy is the bridge between academic intention and industrial relevance. It translates educational effort into economic and societal impact.

If faculties of engineering will think like companies — setting visions, defining missions, pursuing measurable objectives, and evaluating results — they will begin to experience the same rewards companies do: growth, sustainability, and influence.

That is the Engineering Education Way: A way that replaces routine with strategy, isolation with alignment, and expectation with value creation. When academia learns to think like industry, they stop waiting to be funded and start being *invested in*.

Measure To Improve

One of the greatest secrets behind industry's consistent growth and innovation is simple: they measure everything. You can only improve what you measure. I am not sure, faculties of engineering set measurable objectives since their activities are the same every year.

From customer satisfaction to production efficiency, from employee engagement to product performance, every aspect of an industry's operation is tracked, analyzed, and improved. Industry knows that what is not measured cannot be improved, and what is not improved will eventually become obsolete.

H James Harrington said, “Measurement is the first step that leads to control and eventually to improvement. If you can’t measure something, you can’t understand it. If you can’t understand it, you can’t control it. If you can’t control it, you can’t improve it.” Whatever is measured gets attention. What gets attention gets done.

That is why companies invest heavily in data, metrics, and feedback systems. W. Edward Deming put it right when he said, “In God we trust, all others bring data.” When a company wants to increase productivity, it first measures current output. When it seeks to reduce waste, it collects data on where inefficiencies occur. Progress in industry is rarely accidental — it is intentional, guided by insight, evaluation, and iteration.

Unfortunately, most faculties of engineering do not think this way. They are often run-on emotion, tradition, and personal preference, rather than on data and evidence. Decisions are made based on opinions rather than outcomes, and policies are changed at the whim of management rather than through structured evaluation.

The result is that many faculties have remained stagnant for decades — repeating old methods, reusing outdated syllabi, and recycling old goals without knowing whether they have truly advanced or not.

In industry, every new quarter is a test of improvement. In most faculties, every new semester is merely a repetition of the last.

To bridge this gap, faculties of engineering must adopt a measurement culture — one that treats progress not as a feeling but as a fact. They must begin to think in terms of Key Performance Indicators (KPIs), not just academic rituals.

Imagine if a faculty of engineering tracked its performance the way companies track theirs, these questions will be asked:

1. How many of our graduates are productively employed in their fields within a year?
2. How many of our research projects have been translated into industry applications or patents?
3. What percentage of our teaching content has been updated to reflect new technologies or industry standards?
4. How often do we review the effectiveness of our laboratories, workshops, or curricula?
5. What measurable improvements have we made in student innovation, faculty productivity, or community impact year after year?

Such data would not only reveal the truth about performance but would guide transformation. When faculties begin to measure their real progress, they can identify what is working and what is not, what needs reinforcement and what needs replacement.

Measurement also introduces accountability — the same principle that drives corporate excellence. In a company, every department knows its targets and

reports on its outcomes. In a faculty, the same approach can create transparency: every unit — academic, administrative, or research — can have clear, measurable goals tied to the faculty’s overall vision.

A culture of measurement shifts the focus from activity to impact. It changes the question from *“What are we doing?”* to *“Is what we are doing making a difference for our customers?”*

When a faculty starts evaluating its performance regularly — using data dashboards, annual performance reviews, innovation indices, and outcome-based metrics — it begins to mature from an institution of learning to an organization of improvement.

The truth is that data is not just for research; it is for leadership.

Just as engineers use data to design better machines, faculties must use data to design better systems of education. The same analytical rigor used in engineering design must be applied to the governance of engineering education itself.

When faculties adopt measurement as a way of thinking, improvement becomes natural. Decisions become informed, growth becomes intentional, and excellence becomes repeatable.

That is the difference between motion and progress. Motion is doing something new every semester. Progress is knowing whether what you did actually made things better.

To build the engineering faculties of the future, we must move from emotion-driven management *to* evidence-based leadership. Because in truth, we can only improve what we measure — and only sustain what we evaluate.

Chapter Three

Mimicking Industry Production Process

“Imitation is the sincerest flattery.” Mahatma Gandhi

Can we build engineering graduates the way companies build their products?

Apple’s product development process has become a global benchmark for innovation, precision, and user-centered design. Behind every iPhone, MacBook, or AirPods is a culture of relentless curiosity, interdisciplinary collaboration, and obsession with detail. Apple does not merely make products—it crafts experiences.

Each product is born from a deep understanding of human needs, refined through iterative design, and perfected through uncompromising engineering discipline. This same process offers a powerful blueprint for how engineering faculties can cultivate engineers who are not just technically competent, but also creative, empathetic, and industry-ready.

Apple begins its product development with design thinking—an approach that prioritizes understanding the user before building anything. Teams spend time studying how people live, work, and interact with technology. They ask fundamental questions: What do users struggle with? What could be simpler, faster, or more delightful? This insight-driven approach ensures that solutions are meaningful, not just functional.

In an engineering faculty, this translates to empathizing with their customers to know what they want. Rather than teaching engineering as the mastery of tools and equations alone, faculties can make empathy, observation, and problem definition the foundation of the engineering education process.

From ideation, Apple moves to cross-functional collaboration. Designers, engineers, material scientists, and marketers work together from the start. Boundaries blur—design informs engineering, and engineering shapes design. This integrated approach ensures that innovation is practical and manufacturable.

Engineering faculties can mirror this by breaking down departmental silos. Civil, mechanical, electrical, and software engineering students can collaborate on interdisciplinary projects where they learn to integrate systems and communicate across disciplines. Such collaboration prepares them for the real-world environments where companies expect engineers to operate as part of creative, cross-functional teams rather than isolated experts.

Apple also exemplifies the iterative prototyping culture. Before a final product is approved, countless prototypes are built, tested, rejected, and refined. Failure is not avoided; it is engineered into the process. This mindset—of learning by doing, testing by failing—should define how engineering faculties train their students.

Rather than grading purely on correctness, faculties should assess the ability to test, iterate, and improve designs based on feedback from industry. Internship or SIWES and final year projects should be the prototyping stages to get feedback from industry. Laboratories and workshops can be transformed into innovation studios where experimentation is continuous, not limited to a single project submission.

A key to Apple's success is its attention to materials, precision, and production scalability. Every curve, hinge, and finish is considered, not as an afterthought but as part of the design philosophy. For engineering education, this means students should be exposed not just to theoretical design but also to manufacturability, sustainability, and cost-awareness. Companies today value engineers who can design elegant solutions that are efficient, durable, and market-ready. Integrating manufacturing simulations, design-for-sustainability modules, and exposure to industry-grade tools can align graduates with these expectations.

Furthermore, Apple thrives on a culture of secrecy, discipline, and accountability. Teams are small, focused, and responsible for delivering excellence at every stage. This discipline of execution is what turns bold ideas into reliable products.

Engineering faculties can instill similar discipline by requiring students to take ownership of real-world problems from conception to completion—

seeing not just the science but also the responsibility behind what they build.

Ultimately, Apple's process is about harmonizing creativity and engineering. It transforms technology into something deeply human. Engineering faculties can adopt this same spirit to produce engineers who do more than build systems—they build solutions that matter.

By cultivating empathy, fostering collaboration, embracing iteration, and emphasizing craftsmanship, faculties can develop graduates equipped for the multiple forms of value companies seek today: those who can utilize technology effectively, enhance user experiences, earn appreciation through impactful work, attract referrals through excellence, and ultimately be rewarded for creating value that endures.

In essence, Apple's process is not just about developing iconic products—it is about shaping a mindset. If engineering education mirrors this mindset, it will no longer merely produce graduates; it will produce innovators capable of redefining industries.

Copying The Production Line

Steve Jobs said, “Good artists copy, great artist steal.” There are lots of ideas can faculties of engineering can copy or steal from industry and adapt into their engineering education process. One of such is the production line of manufacturing companies.

Copying and stealing ideas from industry—when done with understanding and integrity—is not about imitation but about adaptation and transformation. This means observing what works in the real world, understanding the principles behind it, and reimagining how those principles can improve how engineers are trained.

Industry operates in a fast-paced environment where efficiency, innovation, and user value drive every decision. By “stealing” ideas from such settings—like agile product development, design thinking, customer-centric problem-solving, or cross-functional teamwork—engineering faculties can inject relevance, dynamism, and practicality into their teaching models. The goal is not to duplicate corporate systems but to adapt their essence into academic environments that prepare students for real-world performance.

For example, engineering programs can borrow from tech companies’ innovation processes to create multidisciplinary project hubs, where students design solutions for real clients. They can adopt industry-style mentorship, peer review, and rapid prototyping as part of their curriculum. When education mirrors the creative tension and problem-driven culture of industry, students begin to think not just like engineers, but like innovators and entrepreneurs.

Ultimately, copying from industry is not theft—it is learning from success. The best educators, like the best engineers, are those who can take proven

ideas, reinterpret them, and build something even more transformative within their own context. One of such ideas we are stealing is the production line process.

Industries don't produce their product for their own consumption primarily. Even though they may use their products, their primary target is their customers. If engineering faculties are producing engineers primarily for industry's utility, then they need to know the why, how and what industry by asking these questions:

1. Why does industry want engineers? – Purpose
2. How do industry wants them trained? – Process
3. What does industry want them to know and do? -

Industry operates on principles of efficiency, relevance, quality, and innovation. Every activity is tied to outcomes that create value for customers and sustain competitiveness. Faculties of engineering can learn a great deal from these principles – not to imitate factories, but to adopt their mindset of purposeful design and continuous improvement.

If industry is defined by how, it creates and delivers value to customers, then universities – particularly faculties of engineering – must begin to see themselves through the same lens.

The Engineering Education Production Line

Just like a manufacturing company has a value chain that turns raw materials into finished

products that meet customer needs, a faculty of engineering has a value chain that transforms students (inputs) into competent, innovative engineers (outputs) who create value for industry and society.

The Toyota Production System (TPS) is one of the most studied and admired manufacturing philosophies in the world. It is built on precision, efficiency, and continuous improvement—known in Japanese as *Kaizen*. Every stage of Toyota’s production process, from input to feedback, is designed to eliminate waste, enhance quality, and maximize value for the customer.

The input stage begins with the careful selection and coordination of materials, components, human resources, and information. Toyota emphasizes “just-in-time” delivery—meaning materials arrive only when needed and in the exact quantity required. This reduces inventory waste and ensures that production is responsive to real demand. Inputs also include trained workers, well-maintained machines, and data from previous production cycles—all of which form the foundation for efficiency and quality.

The process stage represents the transformation of raw materials into finished vehicles through a highly organized, continuous flow. Every workstation is synchronized, and each employee has a clearly defined role. Standardized work procedures ensure consistency, while visual management tools—like the *kanban* system—help

monitor progress and signal when materials or parts are needed. The process is designed to be flexible enough to adapt to changes in model specifications or customer orders without halting the entire production line.

Quality control is not treated as a separate department but as an embedded discipline throughout the production process. Toyota's philosophy of *jidoka*—meaning “automation with a human touch”—empowers workers and machines to detect abnormalities immediately and stop the line if something goes wrong. Every employee has the authority and responsibility to address defects before they move downstream. This ensures that quality is built into the product, not inspected in after the fact.

The output is a vehicle that meets Toyota's high standards of reliability, performance, and customer satisfaction. Because quality is assured at every stage, rework and waste are minimized, leading to cost efficiency and shorter production cycles. The output is not just a finished car, but also a reflection of the company's philosophy—products that embody precision, consistency, and customer trust.

Finally, the feedback loop is what keeps the system alive and evolving. After vehicles reach customers, Toyota actively gathers feedback from dealers, service centers, and end users. This information flows back into design, engineering, and production teams, who analyze the data to identify potential improvements. Within the factory, daily reflection

meetings (*hansei*) and performance reviews provide internal feedback, helping workers refine methods and eliminate inefficiencies.

In essence, the Toyota Production System operates as a living organism—inputs carefully managed, processes continuously optimized, quality self-enforced, outputs meticulously crafted, and feedback constantly driving improvement. This integrated loop is what makes Toyota not just a car manufacturer, but a model of how disciplined engineering and continuous learning can sustain excellence over decades.

Understanding, adapting and optimizing this value chain is what will make The Engineering Education Way a reality.

1. Input Stage

In a company, raw materials define the quality of the final product. High-performing companies carefully select and source the best materials for their processes. In Engineering Education, the “raw materials” are students — their curiosity, problem-solving ability, and motivation.

The faculty’s first responsibility is to attract and admit quality students who show passion for engineering, not just high exam scores. Universities should market engineering as a creative and impactful career — just as companies market products to attract customers.

2. Process Design Stage

In production, a company creates a design and process plan before manufacturing. It specifies standards, workflow, and quality checkpoints. When adapted to engineering Education, the curriculum becomes the process blueprint — it determines what kind of engineers will be produced. The way the curriculum is delivered also matters.

The design must start with market needs — what industry, government, and society expect from graduates. It should then define the skills, attitudes, and knowledge needed to meet those expectations.

3. Production Stage

In the factory, production is where inputs are transformed into finished goods through processes, technology, and skilled operators. However, in engineering education, it is the teaching and learning phase, where knowledge and skills are built and delivered. It includes lectures, labs, workshops, internships, and projects. The focus should shift from knowledge transfer *to* capability development.

4. Quality Control Stage

In manufacturing, products undergo strict quality testing before release. Continuous feedback ensures defects are corrected early. However, applied in engineering education, assessments serve as the quality control system. Traditional exams test memory, but not creativity or competence. Effective

quality control means evaluating design ability, teamwork, ethics, and real-world performance.

5. Output Stage

Finished products are delivered to customers and must perform well in the market to build brand reputation. In engineering education, the graduates are the final output. Their performance in industry, research, entrepreneurship, or community service reflects the university's value.

6. Feedback Loop

In successful industries like Toyota, feedback from customers drives continuous product and process improvement. Applying this to engineering education means feedback from students, employers, and society should feed back into the educational design. The faculty must operate like a learning organization, always refining its methods and content.

When faculties of engineering adopt this value chain mindset, they transform from institutions of instruction into industries of learning. Each process becomes intentional, customer-driven, and quality-oriented. Students are developed, not just taught. Curricula evolve, not remain static. Learning becomes a production of value, not just a delivery of content.

Seven Qualities of Graduate Production

To build engineers who can truly create value in the modern world, faculties of engineering must learn from how the best industries produce—not just

goods, but excellence. Industries operate with clear quality standards, continuous feedback loops, and a focus on outcomes that serve real needs.

Similarly, engineering education must see itself as a system of production where the input is students and the end product—the graduate—is not just certified but capable. What happens at the process stage determines the kind of graduates that are produced.

I identified seven qualities that should enable the faculties of engineering to produce excellent industry-ready graduates. These qualities are drawn from the discipline of industry and the creativity of innovation.

We must get to a point where engineering graduates are not termed unemployable. They should be sought after by industry. And they should not be given technicians and technologists roles in industry but rather serve as engineers.

I believe the key challenge here is that since they are not trained and equipped to be engineers, they are trained by industries to take on technician and technologist's roles. Most companies delegate their engineering roles to either expatriates or they outsource it from other countries.

1. Think Systems

Everything in engineering is connected—from design to user experience, from materials to sustainability. A graduate must think in terms of *systems*, not isolated parts. This means

understanding how choices in one area affect outcomes in another. Just as industries design entire ecosystems of production, engineers must learn to design solutions holistically—where technology, environment, economics, and humanity all connect. Thinking systems is what turns a project into a sustainable solution.

2. Iterate Relentlessly

In industry, no product is ever truly “finished.” The culture of iteration—continuous improvement—is embedded in every stage of design and manufacturing. Faculties must teach students that perfection comes through cycles of learning. Mathematical solutions may look perfect but they still have assumptions and approximations in them. Prototypes, feedback, failure, and refinement are the engines of mastery. The best engineers don’t seek instant perfection—they seek progress, relentlessly.

3. Learn by Building

Theory without practice is paralysis. Real learning happens when hands touch tools, and ideas meet resistance in the real world. Building transforms knowledge into competence. Faculties that adopt a “learn-by-building” philosophy produce graduates who understand materials, processes, and systems through firsthand experience.

Just as factories test designs through prototypes, so should engineering classrooms become micro-labs of creation.

4. Engineers With Empathy

Engineering is ultimately for people. Great engineers understand not just machines but users, communities, and societies. They design with empathy—seeing the world through others’ eyes. Faculties must train students to listen, observe, and translate human needs into engineering specifications most especially final year students starting their final year projects.

Engineers build for people so they need to understand people. My book, *Design Solutions for Humans*, addresses this in a great length. Empathy bridges the gap between invention and relevance. Without it, even the most advanced technologies remain unused or misunderstood.

5. Simplify Everything

Complexity is not sophistication; clarity is. In a world overflowing with problems, engineers who can simplify are invaluable. Simplification is an act of mastery—it means understanding a system deeply enough to make it elegant. Faculties should teach students to reduce clutter, strip away the unnecessary, and communicate solutions in language everyone understands. The best engineering solutions are often the simplest ones that work reliably.

6. Build What Matters

Engineering education must be tied to purpose. Students should learn to anchor every project to real industrial, human, or societal value. Whether

improving an energy system, optimizing a production line, or enhancing daily life, engineers must always ask: Why does this matter? Just as industries produce what markets need, faculties must train engineers to solve what society needs. Purpose-driven engineering creates relevance—and relevance sustains innovation.

7. Creative Confidence

True innovation begins when engineers believe they can create. Faculties must foster creative confidence (a concept popularized by Tom Kelley, co-founder IDEO)—the freedom and courage to explore ideas without fear of failure. In industry, teams that innovate are those that are trusted to experiment.

Similarly, students should experience the liberty to think differently, question assumptions, and pursue unique paths to solutions. Confidence fuels curiosity, and curiosity fuels invention. This is what the Outcome Driven Engineering Education is out to achieve.

The future of engineering education lies in adopting an industrial mindset for human development. Graduates are the products of a faculty's system—designed, refined, and continuously improved. If the graduates are unemployable, then it means the process is faulty and needs to be repaired or improve.

Industrial, societal and students needs changes. Businesses stay in touch with their customers and their needs so they can continually improve and

evolve their processes to produce what their customers need.

This means engineering faculties must stay in touch with their customers to understand those changing needs, so as to keep iterating and improving their production process in order to meet their customers changing needs.

When engineering faculties integrate these seven qualities into their processes, they stop merely producing degree holders and start producing creators of value—engineers who think systemically, build courageously, and shape the world meaningfully.

Producing Graduates Who Are Valuable

One question engineering faculties should keep asking is this: Who are we serving? Continually asking and answering this question will keep with the design of the process through which their raw materials pass through to become the finished products. The process determines whether transformation happens or not.

Most of the processes we have are transactional and not transformative. Process design and development starts from knowing what your customers need and what you want to produce to meet that needs. Curriculum development and delivery are part of the process. Identifying the needs of key stakeholders or customers should be the driving force behind programs design and development.

This is the way to create and deliver value. However, since people pay before they get value from universities, they are held at ransom. They have to accept whatever is dished to them. Recently, a graduate of Ladoke Akintola University of Technology, Ogbomosho, had to return his certificate for full refund simply because he alleged that the degree hasn't delivered value to him. If he were to pay after service was delivered, I am not sure he would have.

What he did was feedback to the university that the process involved in transforming input into output needs to be improved. It should consider what the students want to do when he graduates. Only very few want to end up in academia.

Value is never self-declared; it is always perceived by the receiver. In every marketplace—whether of products, services, or people—value exists only in the eyes of those who receive it. For faculties of engineering, this means that producing valuable graduates begins not with what they teach, but with whom they serve.

To produce graduates who are truly valuable, faculties must first understand their customers—the industries that employ engineers, the communities that rely on their solutions, the society that expects progress, and the students themselves who trust the system to prepare them for relevance. Each of these groups defines value differently, and a faculty that seeks to remain relevant must empathize with all of them.

In the same way industries study customers before designing products, engineering faculties must study the evolving needs of the world. What problems do industries face? What skills are scarce in the workforce? What kind of engineers can transform challenges into opportunities?

When faculties design their curriculum, teaching methods, and experiences around these questions, they stop producing graduates for exams and start producing graduates for impact. This customer-centric approach ensures that every course, project, and collaboration directly contribute to the graduate's ability to create value.

Every production system begins with a design blueprint. For faculties, that blueprint is the graduate profile. A valuable graduate is not just academically strong, but socially aware, economically productive, and humanly grounded.

1. Academically valuable graduates understand the scientific and technical principles of engineering.
2. Socially valuable graduates can work in teams, communicate ideas, and solve real community problems.
3. Economically valuable graduates are productive, innovative, and ready to contribute to industry performance and entrepreneurship.
4. Humanly valuable graduates possess integrity, empathy, and a sense of responsibility toward society and the environment.

Designing the educational process to integrate all four dimensions ensures that faculties are not just granting degrees—they are developing well-rounded creators of value.

Empathy must be the foundation of the entire educational process. Just as industries use customer feedback to refine their products, faculties must continuously engage with their stakeholders—through industry collaborations, alumni networks, and societal partnerships.

Listening to employers reveals skill gaps. Engaging communities reveals real-world needs. Involving students in co-creating their learning journey builds ownership. With empathy as a compass, faculties stay responsive, relevant, and regenerative in their graduate production process.

In industry, the worth of a product is determined not by how well it was made, but by how well it performs in the real world. The same applies to graduates. The real test of a faculty's value is seen in how its graduates perform—how they think, create, collaborate, and contribute.

Faculties that produce valuable graduates don't focus only on marks, grades, or certificates. They focus on outcomes: employability, innovation, entrepreneurship, leadership, and societal impact. These are the true indicators of educational excellence.

Producing valuable graduates is not an act of chance—it is the result of design. Faculties of

engineering must see themselves as value-creation systems: empathizing with their stakeholders, understanding needs, and aligning every process toward producing graduates who make a difference.

When graduates are academically solid, socially aware, economically productive, and humanly grounded, they don't just fit into the world—they reshape it. And that is the ultimate measure of value.

Just as industries continuously improve to satisfy customers, engineering faculties must continuously innovate to meet the needs of students, industries, and society.

That is The Engineering Education Way — a system of learning modeled after the best of industry practice, designed to produce engineers who shape the future.

Chapter Four

Embracing Continuous Improvement

“Samm daily improvements over time lead to stunning results.” Robin Sharma

Toyota’s continuous improvement journey began not as a corporate strategy, but as a cultural philosophy deeply rooted in its post-war struggle for survival. After World War II, Toyota faced scarcity—of resources, of capital, and of time. Unlike American car manufacturers who could afford large inventories and mass production, Toyota had to find a smarter, leaner way to build cars.

Out of this necessity was born what became known as the Toyota Production System (TPS)—a revolutionary approach to manufacturing that emphasized efficiency, quality, and learning.

At the heart of TPS was a simple but powerful idea: there is always a better way to do any job. This idea evolved into the practice of Kaizen, which means “change for better.” Kaizen wasn’t about massive, disruptive reforms; it was about small, continuous improvements made by everyone, every day.

Line workers were encouraged to stop production when they noticed a defect, study the problem, and suggest ways to prevent it from recurring. Managers were expected to listen, learn, and remove barriers to improvement. This culture turned Toyota’s factories into living laboratories—

places where people learned by doing, experimenting, and refining.

The company institutionalized learning through structured methods such as the Plan-Do-Check-Act (PDCA) cycle, problem-solving routines known as A3 thinking, and the principle of Genchi Genbutsu—“go and see for yourself.” These methods ensured that improvements were not just random acts but informed by observation, analysis, and shared learning.

Over time, Toyota transformed its employees into thinkers, not just workers, and its factories into learning environments, not just production lines. The result was astonishing: Toyota became the world’s benchmark for quality, reliability, and efficiency.

Through continuous improvement, Toyota built more than cars—it built a culture. Each improvement, no matter how small, became a stepping stone toward excellence. Each mistake became an opportunity to learn. And each employee became a contributor to innovation. This mindset allowed Toyota to weather crises, recover faster than competitors, and maintain leadership in an industry where change is constant.

The same philosophy holds profound lessons for engineering education. Faculties that embrace continuous improvement stop treating education as a fixed process and start treating it as a living system—one that learns and adapts. Just as Toyota’s workers improve their work daily,

educators and students can improve learning experiences continuously.

Faculty members can reflect on what teaching methods produce the best understanding, gather feedback from students and industry partners, test new approaches, and iterate. Students can be trained to think critically about their work, identify gaps, and find better ways to solve problems. Over time, this cultivates not just better programs, but better thinkers—engineers who can adapt, innovate, and improve the systems they touch.

Continuous improvement turned Toyota from a struggling manufacturer into a global leader. If engineering faculties adopt the same mindset, they too can evolve into living organizations that produce graduates who are not just knowledgeable, but capable of learning and improving endlessly—the true hallmark of valuable engineers in a changing world.

What's Kaizen?

Kaizen, a Japanese term meaning “change for better,” is a philosophy and practice focused on continuous, incremental improvement in all aspects of life—especially in business and manufacturing. It emphasizes small, consistent changes that collectively lead to significant long-term improvements in productivity, quality, and efficiency.

It was developed in post-WWII Japan and became a core part of the Toyota Production System and later

spread globally as a key Lean manufacturing principle.

It is based on the philosophy that everyone—from top executives to frontline workers—is encouraged to contribute ideas for improvement. And its major goals are to eliminate waste, improve quality, boost morale, and enhance customer satisfaction through continuous, incremental changes.

I got to know about kaizen more than decade ago as a consultant to the auditor general of Ondo State. It resonated with me because I understand that perfection is a work in progress. We have to keep improving to get to perfection. Perfection is never a destination but a journey that never ends.

What we may see as perfection today, may likely become obsolete or imperfect tomorrow. To most faculties what they presently have is a perfect system, that is why nothing has changed even though industry has been complaining. Kaizen is not embedded in the faculties DNA.

It's an irony that Universities don't have a system to collect, accept and process feedbacks, but they want industry and everyone to listen to them. If faculties of engineering will adopt kaizen, they will need to build a feedback loop that ensures they get feedback from their alumni, industry, society and students.

Here are the five foundational principles that drive Kaizen:

1. **Teamwork:** Collaboration across all levels of the organization to solve problems and implement improvements.
2. **Personal Discipline:** Encouraging self-discipline and accountability in daily tasks.
3. **Improved Morale:** Creating a positive work environment where employees feel valued and motivated.
4. **Quality at the Source:** Ensuring that quality is built into the process, not inspected in afterward.
5. **Continuous Suggestions:** Encouraging employees to regularly propose small improvements.

How Kaizen Is Done

Kaizen is typically implemented through structured activities and cultural shifts:

- **Kaizen Events (or Blitzes):** Short-term, focused improvement projects targeting specific processes or problems.
- **PDCA Cycle (Plan-Do-Check-Act):**
 - **Plan:** Identify an area for improvement and plan the change.
 - **Do:** Implement the change on a small scale.
 - **Check:** Measure and analyze the results.
 - **Act:** Standardize the successful change or iterate again.

- Gemba Walks: Managers go to the “real place” (Gemba) where work happens to observe and engage with employees.
- Standardization: Once improvements are validated, they’re documented and standardized to ensure consistency.

Adopting Kaizen in Engineering Education

Continuous improvement offers engineering faculties a practical pathway to transform their educational processes into dynamic, adaptive systems that produce graduates of consistent and growing value.

Just as Toyota used continuous improvement to perfect the production of cars, faculties of engineering can use it to perfect the “production” of engineers. At its heart, continuous improvement is not about fixing what is broken, but about constantly finding better ways to create value—value for students, industry partners, and society.

When engineering faculties adopt the philosophy of continuous improvement, they begin to view every part of their system—curriculum design, teaching delivery, laboratory practice, industry collaboration, and student support—as processes that can be refined.

The goal becomes progress, not perfection. It encourages faculties to ask, “How can we make this better?” every day. Over time, this steady effort leads to remarkable transformation in the quality, relevance, and impact of engineering education.

Continuous improvement can be applied across several critical areas in engineering education to ensure the maximum performance of the entire system. One key area is curriculum development.

Rather than designing a curriculum once and letting it age, faculties can continuously collect feedback from employers, alumni, and students to assess how well it meets current industrial and societal needs. With every feedback cycle, the curriculum evolves—introducing new technologies, methods, and sustainability concerns as the engineering landscape changes.

Another vital area is teaching and learning methods. Continuous improvement invites lecturers to experiment with different pedagogical approaches, measure learning outcomes, and refine their techniques.

The Outcome Driven Engineering Education (ODEE), a project-based learning method, is a method that is based on the present gaps in engineering education. It is an improvement of what already exists and also a system that delivers engineering education with the understanding that engineering labs are not well funded.

When we introduced this method, we monitored, evaluated and adjusted it based on student engagement and industry needs. Through such reflection and data-driven adjustment, we made it a process of learning in itself—producing educators who, like engineers, iterate and improve.

Faculties often struggle with aging equipment and outdated experiments, but continuous improvement promotes a mindset of innovation even within limitations. Students and technicians can be encouraged to propose improvements in experimental setups, maintenance routines, or safety systems. This turns laboratories into spaces of discovery and creativity, mirroring real engineering workplaces.

It ensures that research agendas are not static but responsive—aligned with national priorities, industry challenges, and technological trends. It also encourages reviewing supervision practices, collaboration models, and publication strategies to maximize impact and learning.

I also noticed that SIWES has been the same way for decades since its introduction. Apart from the increase in stipend to students, almost everything has remained the same way. Using the concept of kaizen, we collected data and looked for ways to improve it.

We actually conducted an experiment with students. The students were open to making it better. Industry seems to just accept students for the sake of the program and allow them go through their system till the time elapsed. This shows that there is room for innovation and improvement. I wrote a book, *The Engineering Intern*, on this improvement.

By continuously seeking feedback from industries that employ their graduates, faculties can close the

loop between education and practice. Internship programs, capstone projects, and industrial visits can be regularly evaluated and enhanced to provide more meaningful exposure for students. This feedback loop keeps the faculty aligned with real-world engineering needs.

In essence, continuous improvement transforms an engineering faculty from a rigid academic institution into a learning system—one that continuously questions, adapts, and evolves. It creates a culture where everyone, from professors to students, becomes responsible for learning and improvement. Over time, this results in an education process that is more efficient, more relevant, and more impactful—producing engineers who not only solve problems but also improve the systems around them.

By making improvement a habit rather than a reaction, engineering faculties can achieve what Toyota achieved in manufacturing: consistent excellence through learning, reflection, and adaptation. This is the spirit of kaizen: that every process can be made better.

Everyone's Idea Matters

Toyota discovered early on that the people closest to the work are often the ones who best understand where problems lie and what small changes can make big differences. When every worker is encouraged to observe, think, and suggest improvements, the entire organization becomes a living, learning organism.

At Toyota, every employee, from the assembly line to top management, is empowered to stop a process if something seems wrong, suggest better ways to perform a task, or propose ideas to save time, reduce waste, or enhance safety. These ideas are taken seriously. Managers do not dismiss small observations; instead, they treat each idea as a seed that can grow into a larger improvement.

In many cases, what appears as a minor adjustment—changing the position of a tool, rearranging a sequence, modifying a procedure—leads to significant increases in efficiency and quality. This collective mindset ensures that no one feels powerless and that innovation becomes part of everyday work, not a special event.

This principle of everyone’s idea matters can profoundly reshape engineering education if faculties adopt it as part of their own Kaizen culture. In traditional academic systems, decision-making and innovation are often centralized—curriculum design, teaching strategies, and policies are decided by committees or administrators, while students and junior staff play passive roles.

This limits the faculty’s capacity to learn and evolve. But when everyone—lecturers, laboratory staff, students, and even administrative personnel—is encouraged to share ideas for improvement, the system begins to grow from within.

Imagine a classroom where students are invited not only to learn engineering principles but also to suggest better ways of teaching or applying them.

Every complaint is a call for improvement. A laboratory where technicians propose new ways to organize experiments or maintain equipment.

A faculty meeting where junior lecturers feel confident enough to share their observations about student learning patterns. When such openness becomes the norm, the faculty starts operating as a community of learners—constantly improving itself through small, shared insights.

Adopting the everyone’s idea matters philosophy in engineering education means creating a structure and culture that values feedback, experimentation, and collaboration. Faculties can set up improvement suggestion systems, regular reflection meetings, or innovation forums where all members can contribute. The focus should not only be on grand innovations but on the accumulation of small, practical ideas that make the learning environment better, smoother, and more engaging.

Over time, these small contributions compound into significant transformation. Students develop a sense of ownership and responsibility toward their learning environment, educators gain new insights into effective teaching, and the entire faculty becomes more agile, responsive, and creative.

This culture mirrors the engineering mindset itself—seeing problems, analyzing them, proposing solutions, testing, and refining. It becomes a model that students observe and become part of. That way it becomes part of their experience and skills they develop.

When everyone's idea matters, a faculty ceases to be a place where knowledge is merely transmitted; it becomes a place where knowledge and systems are continually co-created.

Professor Anthony N. Nzeako, the founding Dean of the Faculty of Engineering, Veritas University, once said that “we are not tapping into the potentials of the students we have.” And that is true. However, under our ODEE, we ensure that is done.

Just as Toyota built its strength on the collective intelligence of its people, engineering education can achieve excellence by harnessing the collective creativity of its community.

Kaizen reminds us that improvement does not depend on hierarchy or status—it depends on the willingness to listen, learn, and act on ideas, no matter where they come from.

If It's Not Broken, Improve It

One of the most limiting mindsets that holds back progress in many engineering faculties is the belief that improvement is only necessary when something goes wrong. Departments wait until accreditation visits are near before reviewing programs. Laboratories are upgraded only when equipment stops working. Teaching methods are reconsidered only after students fail or complain.

It is a nature we picked from the society. If its not broken, there is no need to do anything. For instance, we wait until our power lines develop

faults before we think of working on them. As long as its working, we are okay with it.

This reactive culture teaches students to think that action is only needed when there is failure. Yet true excellence—whether in engineering practice or education—emerges not from reacting to problems, but from continuously improving what already works.

The Kaizen philosophy, which has driven Toyota’s rise to global excellence, operates on a simple but radical belief: If it’s not broken, improve it. In Kaizen, the absence of visible problems does not mean perfection—it simply means there are opportunities for hidden improvements waiting to be discovered.

Something can always be made safer, faster, cheaper, more reliable, or more enjoyable to use. This mindset turns stability into a starting point for innovation rather than an excuse for complacency.

At Toyota, workers are not told to maintain processes only when they fail; they are encouraged to find small ways to make them better every day, even when everything seems to be functioning well. A worker may suggest moving a tool two inches closer to save a few seconds per cycle, or redesigning a checklist to make a process more intuitive.

These small, almost invisible changes accumulate over time, leading to remarkable gains in productivity, quality, and morale. The lesson is

clear—improvement is not a reaction to breakdown; it is a daily discipline of curiosity and creativity.

Engineering faculties can adopt this same principle by embedding continuous improvement into every aspect of their operation. Here are examples of how these can be evaluated through questions:

1. When a lecture goes well, the lecturer should still ask: *How can I make it more engaging next time?*
2. When a laboratory experiment yields consistent results, the technician should still ask: *How can we make this setup safer, faster, or more meaningful to students?*
3. When a student performs well, mentors should still ask: *How can we further stretch this potential?*

Such questions shift the focus from maintenance to mastery. My dad will always tell us that “The room for improvement is the biggest.” Even if you get the best scores, he always pushes you to improve. You must not rest on your laurels.

This mindset not only enhances institutional performance but also shapes how students think about engineering itself. Students who are trained in environments that practice continuous improvement internalize the belief that no design, process, or system is ever final.

They learn that good engineers don’t wait for failures before acting—they anticipate, refine, and innovate. This cultivates proactive thinkers who seek progress, not comfort; who build resilience instead of excuses.

Of course, when something does break—whether it is a teaching method that no longer works, a piece of equipment that fails, or a process that becomes outdated—the response should not be merely to repair it back to its original state. Kaizen teaches that repair is only the first step; the deeper goal is to learn from the failure and improve beyond where things stood before. Every breakdown becomes an opportunity to examine root causes, redesign the process, and emerge stronger.

By adopting the Kaizen principle of *If it's not broken, improve it*, faculties of engineering can shift from a culture of reaction to one of reflection and reinvention. Over time, this approach builds a system that never waits for crises to grow, never settles for “good enough,” and never stops learning.

It produces institutions—and graduates—that embody the spirit of true engineering: the relentless pursuit of better ways to build, think, and serve society.

Small Daily Improvements in Engineering Education

Robin Sharma often says that small daily improvements lead to stunning long-term results. This principle, which echoes the Kaizen philosophy, teaches that greatness is not achieved through grand overhauls or rare bursts of brilliance, but through steady, consistent refinement of everyday practices.

When applied to engineering education, this idea becomes a powerful tool for transformation. Faculties that improve a little each day—by refining how they teach, organize, assess, and innovate—create an environment where learning continually deepens, relevance grows, and customers (students, industries, and society) remain satisfied.

To bring this mindset alive, faculties can commit to small daily improvements in four key areas:

1. Process: Refining How Work Gets Done

In engineering education, processes include everything from lesson preparation and lab organization to student advising and research supervision. Too often, these processes are repeated semester after semester without questioning their effectiveness. Small daily improvements begin when educators and administrators start observing their routines critically.

- a. A lecturer might spend a few minutes each day reflecting on what part of a class worked best and what confused students most, then adjust the next lecture accordingly.
- b. A lab instructor might reorganize tools to reduce time wasted in setup.
- c. An administrator might streamline how students submit assignments or access feedback.

Each of these actions seems small, but their cumulative effect is immense: smoother operations, less frustration, and higher quality experiences.

Over time, improving processes daily ensures that waste—of time, effort, or resources—is gradually eliminated. This makes the faculty more efficient and responsive, much like Toyota’s production lines that evolve through countless small refinements rather than large, disruptive changes.

2. Systems: Making the Whole Work Better Together

Processes live within *systems*, and systems determine how well the different parts of a faculty connect—teaching, administration, laboratories, and industry engagement. Many engineering faculties struggle because their systems are fragmented; teaching, research, and student support often work in isolation.

A small change in one part of a system will result in a shift in balance of that system. If the faculty is not intentional in improving the system, by nature the system will tend towards entropy and inefficiency. Improving it makes sure it is moving towards the right goal.

Small daily improvements at the system level begin with better integration. For instance, setting up a simple daily or weekly coordination between lecturers and lab staff can ensure that experiments align perfectly with classroom topics. Updating a shared database of student progress can help mentors identify those who need extra support early. Gradually, these small connections tighten the entire ecosystem.

Each day's improvement might be a single better feedback form, a clearer communication channel, or a new collaboration between departments. Though minor on their own, they create a system where knowledge, people, and processes flow more smoothly—resulting in a more coherent and adaptive educational experience.

3. Performance: Elevating Results through Reflection

Performance improvement in engineering education is not just about producing higher grades but achieving deeper understanding, greater innovation, and stronger employability. Small daily improvements here involve developing habits of reflection and measurement.

A lecturer might ask students to rate how well they understood a topic at the end of each class. A student might spend a few minutes reviewing what was learned each day and identifying one area to improve tomorrow. Faculty leaders might track simple performance indicators—like attendance, project completion, or feedback scores—and review them regularly to make incremental adjustments.

The power lies in the routine. Improvement becomes part of the culture, not a reaction to poor results. As performance metrics rise gradually, confidence and competence grow—for both students and teachers. Customers, especially employers, notice the difference: graduates become not only knowledgeable but adaptive and improvement-driven.

4. Courses: Keeping Content Relevant and Alive

Courses are the core of engineering education, yet many are taught the same way year after year, even as industry evolves. Small daily improvements prevent stagnation and ensure continued relevance.

A lecturer might spend ten minutes each day scanning industry news or professional forums for emerging technologies or challenges that can be woven into upcoming lessons. Course teams can review one module at a time—updating examples, rethinking assignments, or integrating real-world case studies. Even something as simple as rephrasing a question to spark deeper thinking can enhance learning.

Using case studies and scenarios in teaching can be a great improvement. This ensures that students continually link what they are learning to how it affects industries and societies.

When this approach becomes habitual, courses evolve naturally without waiting for major curriculum reviews. They stay alive—connected to industry needs, new research, and student curiosity. Over semesters, this steady updating ensures that graduates are prepared for the world they are entering, not the one that existed when the course was first designed.

Small daily improvements may seem insignificant at first, but over time they produce an extraordinary transformation. They cultivate a culture where everyone—faculty, staff, and students—takes

responsibility for progress. The result is an engineering faculty that operates more efficiently, teaches more effectively, and produces graduates who are better prepared to create value in the real world.

Just as Robin Sharma teaches that consistent micro-wins compound into mastery, the Kaizen spirit in engineering education turns ordinary days into building blocks of lasting excellence. When faculties choose to improve a little each day, they stop waiting for problems to act and start creating progress on purpose—keeping every customer, from student to employer, truly happy.

Chapter Five

Faculty As Learning Organization

“A learning organization is an organization that is continually expanding its capacity to create its future.” Peter Senge

Microsoft is a learning organization because it constantly learns, adapts, and improves based on new ideas, experiences, and feedback from its people and the world around it. A learning organization is one that encourages curiosity, experimentation, and growth rather than sticking to old ways. Microsoft shows this by allowing employees to explore new ideas, learn from mistakes, and share knowledge freely across teams.

What makes Microsoft a true learning organization is its culture of “growth mindset.” This means believing that people can always get better through effort, feedback, and learning—not just rely on fixed talent.

The company invests heavily in employee learning programs, open collaboration, and continuous improvement. Instead of punishing failure, Microsoft encourages teams to learn from what went wrong and try again smarter. This mindset has led to innovations in cloud computing, artificial intelligence, and digital services.

However, during Steve Ballmer’s time as CEO, Microsoft lost much of that learning culture. The company became more focused on defending its existing products like Windows and Office, rather

than exploring new ideas. The workplace was competitive and siloed—teams were often fighting each other instead of sharing knowledge.

This made Microsoft slower to adapt to major changes in the tech world, such as the rise of smartphones, mobile apps, and cloud computing. The company was reacting rather than learning. This is in line with what Peter Senge said, “A learning organization is an organization that is continually expanding its capacity to create its future.”

As soon as Microsoft stopped being a learning organization, its future began to shrink. However, when Satya Nadella came in as CEO, he returned the company back to its root: learning organization. As a result, it found itself and expanded its future.

He shifted the company’s culture from a “know-it-all” attitude to a “learn-it-all” mindset. Under his leadership, Microsoft started listening more—to customers, employees, and even competitors.

It embraced cloud technology fully, opened up its software to work on other platforms, and began collaborating widely with other companies. This openness and commitment to learning helped Microsoft grow again, regain its reputation for innovation, and become one of the world’s most valuable and admired companies.

In short, Microsoft’s return to being a learning organization transformed it from a struggling giant into a thriving, forward-looking company built on

curiosity, collaboration, and continuous improvement.

How Faculties Can Be Learning Organization

Peter Senge said, “Through learning we re-create ourselves. Through learning we become able to do something we never were able to do. Through learning we re-perceive the world and our relationship to it. Through learning we extend our capacity to create, to be part of the generative process of life.” When faculties of engineering open up to learning new things, they will be able to do more than they are currently doing. The more we learn, the more we become and do.

Faculties of engineering can become learning organizations by creating an environment where everyone—lecturers, students, and administrators—continuously learns, shares knowledge, and improves. A learning organization is not just a place that teaches; it is a place that learns how to teach better, design better systems, and respond faster to changes in the world.

To become a learning organization, a faculty of engineering must first shift its mindset from “we already know” to “we can always learn more.” This means lecturers should not only teach theories but also learn from industry, from students, and from the results of their own teaching. Every lecture, project, and student experience should be treated as feedback that helps the faculty improve.

In such a faculty, mistakes are not hidden—they are studied to find lessons. When a course doesn't produce the desired learning outcome, or when students struggle with applying knowledge, the faculty sees it as a signal to reflect and redesign the process. Lecturers should meet regularly to discuss what works and what doesn't, and share best practices rather than working in isolation.

Partnerships with industry also play a major role. Engineering changes fast, and faculties must learn from current industry trends, technologies, and practices. By collaborating with companies, research centers, and alumni, faculties can keep their teaching relevant and practical. This continuous exchange of knowledge helps students graduate with skills that match real-world needs.

Technology can also support a learning culture. Digital platforms for course feedback, online workshops, and data-driven decision-making can help faculties understand where improvement is needed. For example, using analytics to track student performance over time can reveal which topics or teaching methods need adjustment.

Leadership is key in making all this work. Deans and heads of departments must create a culture where curiosity, experimentation, and collaboration are rewarded. Instead of focusing only on rules and rankings, leaders should focus on growth—helping people develop themselves and improve their systems.

When a faculty of engineering becomes a learning organization, it stops reacting only when problems arise and starts improving constantly. It learns from its students, from its environment, and from its own experiences. Over time, it produces not just engineers, but reflective thinkers who know how to keep learning and improving—engineers built for a changing world.

Learning Organization Characteristics

Learning organizations have certain characteristics that make them different from ordinary institutions. They are flexible, curious, and always improving. For faculties of engineering, adopting these characteristics can transform them from slow, traditional systems into innovative, forward-thinking institutions that prepare students for real-world challenges.

One key characteristic of a learning organization is continuous learning. People at all levels are always learning new things—through research, collaboration, and reflection. Faculties of engineering can adopt this by encouraging lecturers to regularly update their knowledge, attend industry workshops, and integrate new technologies or methods into their teaching. Students can also be part of this culture through Outcome Driven Engineering Education’s project-based learning, internships, and competitions that expose them to real engineering problems.

Another important characteristic is systems thinking. Learning organizations see the big picture

and understand how different parts connect. Faculties of engineering can apply this by treating teaching, research, administration, and student engagement as interconnected systems. For example, if students perform poorly, the solution might not be just in better teaching—it could also lie in curriculum design, psychology, environmental, course likability, assessment methods, or support systems. Seeing the faculty as one complete system helps leaders make smarter improvements.

Shared vision is another strong feature. In a learning organization, everyone works toward a common goal. Faculties can build this by creating a clear and inspiring vision that everyone understands—perhaps to “produce globally competent engineers who create solutions for local problems.” When lecturers, students, and administrators all buy into this vision, their daily actions become aligned and purposeful.

Team learning is also vital. Learning organizations believe that people learn better together. Engineering faculties can strengthen teamwork among lecturers and students by promoting collaborative projects, multidisciplinary courses, and regular knowledge-sharing sessions. For example, a civil engineer and a computer engineer can work together on a smart-city project, learning from each other’s expertise.

Another defining trait is open communication and feedback. In learning organizations, information

flows freely, and feedback is valued, not feared. Faculties of engineering can build this by creating safe spaces where students can share feedback about courses, and lecturers can discuss what works or fails in teaching. This openness helps identify problems early and drives improvement.

Finally, learning organizations embrace adaptability and innovation. They experiment, learn from results, and adjust quickly. Faculties of engineering can mirror this by piloting new teaching methods and evaluating their impact. The goal is to move from “we’ve always done it this way” to “how can we make it better?”

By adopting these characteristics faculties of engineering can evolve into true learning organizations. Such faculties will not just teach engineering but will model the very process of engineering itself; learning, designing, testing, and improving continuously to achieve better results for students, industry and society.

Know-It-All Vs Learn-It-All

The difference between a Know-It-All and a Learn-It-All lies in mindset—and that difference determines whether an organization grows or becomes stuck. Mindset and attitude are everything.

We focus so much on the technical aspect of engineering that we forget it is also a mindset. The attitude of engineers will determine what they can

do. Engineers should always have the can-do attitude and possibility mindset.

A Know-It-All organization believes it already has the answers. This is a reflection of the attitude of most faculties of engineering. They value authority, tradition, and existing knowledge more than curiosity or learning.

In such an environment, people feel the need to appear smart rather than to become smarter. Mistakes are seen as weaknesses, not learning opportunities. Failure is punished and mistakes are looked down on. This creates fear, resistance to change, and a culture where innovation struggles to survive.

Many faculties of engineering today operate like Know-It-Alls. They rely heavily on long-established methods, outdated syllabuses, and rigid hierarchies. Professors often believe their way of teaching is the best because “that’s how it’s always been done.”

Students, seeing this attitude, learn to follow instructions instead of exploring or questioning. As a result, these faculties produce graduates who know theories but struggle to apply them creatively or adapt to modern engineering challenges.

In such environment, if a student discovers a new way that is way different from the ways the lecturer is used to or have taught them, the student gets failed. I have experienced that before. I have always taught that as good as knowledge is, it is in the past

(it expands the past), but learning is in the future (expands the future).

On the other hand, a Learn-It-All organization is driven by curiosity and improvement. It doesn't assume it knows everything—it keeps asking, “What can we learn? How can we make this better?”

Mistakes are seen as feedback, and every challenge becomes a learning opportunity. People in a Learn-It-All environment listen, share, experiment, and grow together.

Microsoft under Satya Nadella became a perfect example of a Learn-It-All organization. The company changed from defending what it already known to exploring what it could learn—from customers, competitors, and its own failures. This shift opened the door to innovation, collaboration, and continuous growth.

Faculties of engineering can experience the same transformation. Instead of protecting their old ways, they can start learning from industries, alumni, students, and new technologies. Lecturers can admit when they don't know something and work with students to discover it together. Courses can evolve based on feedback and new developments in the engineering world.

When a faculty moves from being a Know-It-All to a Learn-It-All, it becomes alive again. It starts producing graduates who are not just knowledgeable, but adaptable, curious, and creative—engineers who keep learning long after graduation. The shift is not just about teaching

better; it's about building a culture where learning never stops.

Using Case Studies & Scenarios

Using case studies and scenarios in engineering education is one of the most powerful ways for faculties of engineering to become true learning organizations. Case studies bring real-world problems into the classroom, while scenarios help students think through how to apply what they've learned in practical, changing situations. Together, they connect theory to practice and make learning more active, reflective, and relevant.

Using case studies means that faculties will have to learn from industry. Most lecturers assume that its industries that need to learn from them not the other way around. Faculty of engineering understands the theory while industry has the applications. Becoming a learning organization takes humility.

Instead of focusing only on textbook knowledge, faculties should study how engineering challenges are solved in industries—why some projects succeed, why others fail, and what lessons can be learned. This continuous process of studying and reflecting mirrors what learning organizations do: they observe, analyze, adapt, and improve.

For lecturers, using case studies transforms their role from being mere transmitters of knowledge to facilitators of learning. They no longer stand as “know-it-all” who give answers, but as “learn-it-

alls” who guide students in discovering answers through inquiry and discussion.

This process helps lecturers stay connected to current industry practices and technologies. It also encourages them to keep updating their knowledge as they gather new cases and insights. Over time, this builds a culture of shared learning among lecturers, where everyone contributes examples, experiences, and lessons from both academia and industry.

For students, case studies and scenarios make learning come alive. Instead of just solving abstract equations or memorizing theories, they see how those concepts are used in real projects—bridges being built, machines being designed, energy systems being optimized, and technologies being improved. This approach teaches them how to think like engineers: to analyze problems, weigh options, collaborate in teams, and make decisions based on real constraints and consequences.

When students learn this way, they become more “industry-ready.” They develop not just academic intelligence but also practical judgment, problem-solving ability, and professional confidence. They begin to understand how classroom knowledge translates into workplace solutions. This alignment between education and practice is what industries value most.

By using case studies and scenarios consistently, faculties of engineering become more responsive and connected to the real world. They learn from

their own graduates, from company partnerships, and from global engineering challenges. The result is a continuous learning loop—where the faculty improves its teaching, lecturers grow professionally, and students graduate ready to create value in industry.

In essence, case studies turn classrooms into mini-labs of innovation and reflection. They help engineering faculties evolve from static teaching institutions into vibrant learning organizations that think, adapt, and grow alongside the industries they serve.

Chapter Six

Lean Thinking

“The most dangerous kind of waste is the waste we do not recognize.” Shingeo Shingo

John Deere, one of the world’s leading manufacturers of agricultural and construction equipment, has long embraced lean thinking as a cornerstone of its operational excellence. Lean thinking, derived from the Toyota Production System, focuses on maximizing value for customers while minimizing waste.

For John Deere, this approach has not only improved efficiency but also strengthened its culture of continuous improvement and innovation across global operations.

They adapted this concept and developed their own version of lean principles known as “The John Deere Production System (JDPS).” This system emphasizes flow, pull, and continuous improvement across every stage of production — from sourcing raw materials to delivering finished equipment to farmers and contractors.

The company uses value stream mapping to visualize the flow of materials and information, helping teams identify non-value-adding steps. It applies 5S (Sort, Set in order, Shine, Standardize, Sustain) to maintain organized and efficient workspaces.

Continuous improvement (Kaizen) events are held regularly to engage employees in solving daily

operational challenges. In its manufacturing plants, they have implemented Just-In-Time (JIT) production to align output with customer demand, reducing excess inventory and lead times.

Components are delivered to assembly lines precisely when needed, which reduces storage costs and ensures flexibility in responding to market changes.

Through cellular manufacturing, processes are organized around product families, allowing smaller, cross-functional teams to take ownership of quality and performance.

The company's lean supply chain approach also emphasizes close collaboration with suppliers. By sharing forecasts and improvement goals, John Deere ensures consistent quality and reliability, leading to stronger partnerships and lower total costs.

A major pillar of lean at John Deere is respect for people — empowering every employee to identify problems and suggest improvements. Workers are encouraged to stop the production line if a defect is detected (a concept borrowed from Toyota's *jidoka*), ensuring quality is built into every product rather than inspected at the end.

Lean training programs equip employees with tools like root cause analysis, PDCA (Plan-Do-Check-Act), and visual management. This engagement creates a culture where every worker feels

responsible for productivity and customer satisfaction.

Lean thinking has delivered measurable progress for John Deere over the years:

Reduced lead times: Production cycles that once took weeks are now completed in days, enabling faster response to customer orders.

Lower waste and costs: Through value stream optimization and better inventory control, waste has been reduced across plants, contributing to higher profitability.

Improved product quality: Early problem detection and standardization have led to fewer defects and returns.

Higher customer satisfaction: Faster delivery, more reliable equipment, and consistent performance have strengthened the John Deere brand globally.

John Deere has extended lean beyond manufacturing into product development and customer service. Using lean product development, design teams work iteratively, reducing time-to-market for new innovations like smart tractors and precision agriculture technologies. Lean has also guided the company's digital transformation, ensuring that new technologies — such as AI, IoT, and automation — serve real customer needs efficiently.

John Deere's success with lean thinking shows that it's not just a set of tools but a way of thinking and acting. By embedding lean principles into its

culture, the company has achieved operational excellence, fostered innovation, and delivered lasting value to its customers. Lean has helped John Deere stay true to its purpose — helping those who feed, clothe, and build the world — while continuously improving how that mission is fulfilled.

When lean thinking is applied in a faculty of engineering, it transforms the institution into a more efficient, adaptive, and student-centered learning organization. Lean thinking, which is built on the principles of continuous improvement and respect for people, helps the faculty focus on what truly adds value — to students, industry partners, and society — while eliminating activities that waste time, effort, or resources.

By adopting lean principles, the faculty begins to see its operations much like a production system where the goal is to develop industry-ready graduates. This perspective encourages every department and lecturer to continuously ask: what processes add value to the learning experience, and which ones merely consume energy without improving outcomes? For example, curriculum design becomes more responsive to industry needs, classroom activities become more experiential, and administrative processes become smoother and faster.

Lean thinking empowers lecturers and students to work collaboratively in solving real problems. When students are encouraged to identify inefficiencies in

their projects, laboratories, or learning processes, they develop critical thinking and problem-solving skills similar to what industries expect in their workplaces. Lecturers, on the other hand, benefit from lean by engaging in regular reflection and small daily improvements — whether in teaching delivery, assessment methods, or research management — which enhance overall academic performance and relevance.

Moreover, lean fosters a culture of continuous feedback and learning. Instead of waiting for external evaluations or crises before making changes, the faculty becomes proactive in seeking improvement. Courses are refined based on student feedback, industry input, and performance data. The result is a dynamic system where quality, innovation, and efficiency are built into the fabric of education rather than added as afterthoughts.

Ultimately, the application of lean thinking in a faculty of engineering leads to better use of resources, improved staff morale, higher student engagement, and stronger alignment with industry expectations. It ensures that graduates are not only technically competent but also capable of thinking critically, solving problems creatively, and contributing meaningfully to the continuous improvement culture that drives modern engineering industries.

The Five Principles of Lean Thinking and Their Application in Engineering Education

Lean thinking, developed from the Toyota Production System, is built on five guiding principles that help organizations create more value with fewer resources. In other words, this means the try to maximize the value to the customers while eliminating waste (anything that will distract from achieving this goal).

This is something engineers are taught in the course Engineering Economics. Lean thinking can simply be described as maximization and minimization. While we focus on maximizing value for the customers, we minimize anything that will impede that.

The ultimate goal is to deliver what the customer wants, at the lowest cost, with the highest quality, and in the shortest time without stressing human resources. Part of the waste will be human efforts.

If it will require putting in maximum human effort, it is not lean thinking. Human effort must be reduced also to produce maximum results. In most cases, the human effort contributes to the waste.

These principles of lean thinking are not limited to manufacturing. They can be applied also to engineering education. When applied in engineering education can help faculties become more efficient, innovative, and aligned with the needs of industry and society.

Here are the principles of lean thinking and how they enable engineering education to deliver maximum value:

1. Value – Defining What Truly Matters

The first principle of lean thinking is identifying value from the perspective of the customer. We discussed this in chapter one. Production starts from understanding the needs of customers. Faculties must clearly understand and define what their customers are paying for (the problem they want to solve, the goal they want to achieve, the job they want done) and ignore everything else.

In the context of engineering education, the “customers” are students, employers, industries, and society. Value is found in producing graduates who can solve real-world problems, innovate responsibly, and contribute meaningfully to development.

For faculties, this means constantly asking: What skills, knowledge, and attitudes do our students need to be valuable in the modern world? Courses, projects, and teaching methods should then be designed around this definition of value rather than academic tradition or convenience.

2. Value Stream – Mapping the Journey of Learning

The second principle focuses on mapping the value stream — the entire process through which value is created and delivered. In an engineering faculty, the value stream begins with student admission and continues through coursework, laboratories, industrial training, research, and graduation.

By mapping this journey, faculties can identify processes that add value to learning (like hands-on

labs or industry projects) and those that waste time or resources (like outdated assessment methods or unnecessary bureaucracy). The map will certainly should the steps that add value and those that don't add value (waste). Once waste is identified, it can be reduced or eliminated to make education more effective and engaging.

3. Flow – Making Learning Smooth and Continuous

Lean thinking emphasizes creating a smooth, uninterrupted flow of value. In engineering education, this means ensuring that learning progresses naturally from theory to practice without unnecessary interruptions, delays or disconnections.

A lean faculty ensures that courses are well-sequenced, projects are well defined, and students can apply concepts immediately after learning them. For example, instead of long gaps between theoretical lectures and practical exposure, students could work on continuous design-build-test projects that simulate real engineering work. This promotes understanding, engagement, and retention.

4. Pull – Responding to Demand, Not Forcing Supply

The pull principle means producing only what is needed, when it is needed, and in the amount needed. In truth, most faculties produce much more graduate than the industry and society needs. They

also produce graduates that are not even needed year in year out.

However, when this is applied to engineering education, this principle encourages faculties to design flexible learning pathways that respond to student and industry demand rather than rigid academic supply. Courses should reflect what is need in industry. That will mean faculties will have to anticipate the needs of industry ahead.

This could also mean offering elective courses that reflect emerging technologies, creating opportunities for students to pursue industry-driven projects, and allowing for personalized learning where students can “pull” the skills and experiences most relevant to their goals. It shifts the focus from pushing content to facilitating meaningful learning experiences.

5. Perfection – Striving for Continuous Improvement

The final principle of lean thinking is the pursuit of perfection — the idea that there is always room for improvement. In a lean engineering faculty, everyone becomes part of a continuous improvement culture. Lecturers refine their teaching methods, students give constructive feedback, and administrators regularly review processes to make them simpler and more effective.

This mindset mirrors the engineering design process itself: plan, test, learn, and improve. Over time, it builds a learning organization where

excellence becomes a habit, and innovation is constant. Lean is a continuous never-ending journey. It is a cycle.

When engineering faculties apply the five principles of lean thinking, they transform from rigid academic institutions into dynamic learning systems. By defining value through the eyes of their stakeholders, streamlining processes, ensuring smooth learning flow, responding to real-world demand, and continuously improving, they produce graduates who are not just engineers by qualification, but by mindset — capable of thinking critically, working efficiently, and contributing meaningfully to the progress of industry and society.

Eliminating Waste in the Graduate Production Process

Peter F Drucker, the management guru, said “There is nothing so useless as doing efficiently that which should not be done at all.” It is important that faculties focus on what is important and matters. It is a waste of time training students in courses that doesn’t matter to industry.

For instance, most industries in Nigeria have rich supply of technologists and technicians but universities continually train engineers to play that role. These companies need engineers who will research problems to come up with solutions, design and develop the technologies, create value and innovate.

However, since most faculties don't have contact with industry, they don't have an idea what industry needs. They may even teach a course that is obsolete. For instance, what is the essence of teaching materials science without teaching sustainability and circular economy?

These are modern needs of industry. They want to know what to do with the waste they generate and how they can introduce circular design to keep the materials they produce in loop within their system.

In many faculties of engineering, a significant amount of time, energy, and resources is spent on activities that do not directly contribute to the main goal — producing competent, industry-ready graduates. These distractions often take the form of unnecessary meetings, redundant paperwork, outdated teaching practices, or irrelevant coursework.

Over time, they dilute focus and slow progress toward excellence. To become more effective and impactful, faculties must learn to identify and eliminate these forms of waste, just as lean organizations do in their production systems.

Lean thinking teaches that waste is anything that does not add value from the perspective of the customer. In the context of engineering education, the “customers” are students, employers, industries, and society. Therefore, any activity that does not enhance students' ability to solve real-world engineering problems, think critically, or innovate is waste.

This might include excessive administrative tasks that burden lecturers, long and unproductive committee sessions, theoretical overloads without practical connection, or outdated laboratory exercises that no longer reflect industry practice.

Faculties should start by mapping their graduate production process — from admission to graduation — to see clearly where time and resources are being consumed. This visual mapping exposes points where effort does not translate into improved learning outcomes or employability.

For example, if a student spends more time writing lengthy reports that are never reviewed than engaging in problem-solving or project design, that is educational waste. Similarly, when lecturers are overloaded with non-teaching duties, their ability to mentor and inspire students suffers.

Eliminating waste also requires courage and focus. As Steve Jobs once said, *“Focusing is about saying no.”* He understood that success comes not only from doing the right things but also from refusing to do the wrong ones that distract from the goal.

Faculties of engineering must apply this wisdom by saying “no” to practices that do not serve the purpose of developing quality graduates. This could mean reducing unnecessary bureaucracy, streamlining assessments, integrating courses that overlap, and discontinuing programs that no longer align with the evolving needs of society and industry.

When waste is removed, attention naturally returns to what truly matters — teaching that connects theory with practice, research that solves real problems, and partnerships that prepare students for the workplace. Lecturers can focus on mentoring students, improving curriculum relevance, and fostering innovation. Students, in turn, experience a learning environment that is purposeful, engaging, and transformative.

By learning to identify and eliminate waste, faculties of engineering can reclaim their time, restore focus, and realign their processes with their mission. The outcome is not just efficiency but excellence — a faculty that consistently produces graduates who embody the true value of engineering: creating solutions that improve life, industry, and the world.

Not Utilizing Student’s Potential Is A Waste

Peter Senge, the author of *The Fifth Discipline*, said, “An organization that will truly excel in the future will be the organization that discover how to tap people’s commitment and capacity to learn at all levels in an organization.”

Whenever I look at the vast human resources in the university, I keep wondering why they remain untapped. For engineering education, students will remain in school for at least five years. Yet within those five years, they are spoon-fed knowledge that doesn’t add to their potential.

One of the greatest wastes in many universities today is the failure to fully utilize the vast potential of their students. Every student enters the university with creativity, curiosity, and energy — qualities that, if properly engaged, can lead to innovation and progress.

Yet, in many faculties of engineering, this potential remains largely untapped. Students often become passive learners, memorizing theories instead of applying them, following instructions instead of solving problems, and completing courses without discovering what they are truly capable of.

In the language of lean thinking, this is a form of human potential waste — one of the most serious kinds of waste, because it represents the loss of creativity, innovation, and motivation that could have been used to create value.

When faculties fail to challenge and engage students meaningfully, they not only waste the students' time but also deprive society of solutions that those students could have developed. The result is a system that produces graduates who are qualified on paper but underdeveloped in practical competence, confidence, and creativity.

This is where Outcome-Driven Engineering Education (ODEE) becomes useful. It seeks to correct this by making students active participants in the learning process. Instead of focusing on what teachers teach, it emphasizes what students are able to *do* with what they learn.

This approach engages students in projects, design challenges, internships, research, and innovation projects that require them to apply classroom knowledge to real problems and real world industrial scenarios. Through this, their technical, creative, and leadership potential is discovered, refined, and directed toward productive outcomes.

When student potential is fully utilized, value is created on multiple levels. Students become more confident, capable, and employable because they see how their learning connects to real-world applications.

Industry benefits from graduates who can think critically, design efficiently, and contribute from day one on the job. Society gains from the solutions, innovations, and community-impact projects that emerge when students work on real engineering challenges.

Peter Senge understood this clearly. He added that, “Learning organization is an organization where people continually expand their capacity to create the results, they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together.” Its important we turn the faculties of engineering into learning organizations.

A faculty of engineering that adopts outcome-driven engineering education (ODEE) stops wasting potential and starts cultivating it. Every lecture becomes an opportunity for discovery, every

laboratory a space for invention, and every student a contributor to progress.

By channeling student potential into purposeful learning and creation, universities transform from knowledge dispensers into engines of innovation — fulfilling their true mission of developing human capacity for the advancement of society.

To utilize the potential of students, a lecturer can identify a problem that industry has and then engage students to research and develop the solutions and implement it in industry. The students learn how to solve problems, design solutions and implement it and the industry gain solutions.

This also makes the faculties a pipeline for the production of engineering talent for industrial employment. This will certainly increase the value of the faculty and the university.

Chapter Seven

Simulating Real-World Industry Projects

“Tell me and I forget. Teach me and I remember.
Involve me and I learn.” Benjamin Franklin

Eindhoven University of Technology (TU/e) in the Netherlands has developed one of the most dynamic and innovative models of university–industry collaboration through its system of “Student Teams.” These teams form the backbone of TU/e’s approach to applied learning, innovation, and entrepreneurship.

With over thirty highly organized interdisciplinary teams, the university has created a structure that allows students to work on real-world challenges drawn from society, industry, and emerging global issues such as sustainable mobility, renewable energy, health technology, and smart manufacturing.

Each team functions like a startup company within the university ecosystem. They are composed of students from different engineering, science, and business disciplines who voluntarily join forces to solve pressing societal problems using technology and innovation.

The university provides the enabling environment — including facilities, mentorship, and administrative support — while industry partners contribute technical expertise, funding, materials, and access to research networks. TU/e has built a network of more than 700 external partners and sponsors, including major corporations, small and

medium enterprises, government agencies, and research institutions.

These partners serve as collaborators and customers, giving students a taste of how innovation happens in the real world.

Different teams focus on different challenges. For instance, Solar Team Eindhoven designs solar-powered vehicles and has gained international recognition for creating self-sustaining electric cars that can generate their own energy from sunlight.

InnoSpace focuses on building innovative systems for space exploration and satellite technology. Team CORE works on developing circular technologies for waste recycling, while Team FAST has explored sustainable fuel alternatives. Medical-related teams, such as Team HeartBeat and Team Red, focus on biomedical devices and diagnostics, tackling complex health challenges using engineering principles.

Each of these teams mirrors the structure of a real engineering enterprise — with roles spanning research and development, design, marketing, business development, and operations — allowing students to experience the full innovation lifecycle from concept to product.

The outcomes of this system have been remarkable. Many of the student projects have evolved into successful startups that continue to operate beyond the university. One of the most notable examples is Lightyear, a company that originated from Solar

Team Eindhoven and now designs and produces solar-powered cars for the global market.

Other spin-offs have emerged in areas such as clean energy, robotics, and artificial intelligence, contributing to the regional innovation ecosystem around Eindhoven, which is often referred to as “Brainport” — one of Europe’s leading high-tech clusters.

The university’s student team model has also transformed how learning takes place. It bridges theory and practice by letting students apply what they learn in the classroom to real engineering challenges that have social and commercial impact. Faculty members serve as mentors rather than lecturers, guiding teams through research, experimentation, and iterative development.

This hands-on, project-based environment cultivates teamwork, leadership, entrepreneurial thinking, and resilience — qualities highly valued by industry. It also strengthens the university’s relationship with the business community, as companies see firsthand the creativity and problem-solving skills of TU/e students.

Through this integrated ecosystem of student-led innovation, Eindhoven University of Technology has successfully positioned itself not only as a center for academic excellence but also as a living laboratory for technological advancement. The student teams model continues to inspire other universities worldwide to rethink how engineering education can be a platform for industry

collaboration, societal transformation, and the creation of future-ready engineers.

Outcome Driven Engineering Education

The Outcome Driven Engineering Education (ODEE) model, developed and executed by Engineers Without Borders Nigeria, is designed to move engineering training beyond theory and classroom instruction into a dynamic ecosystem of research, innovation, and venture creation. In this system, students are organized into ten interdisciplinary teams, each focusing on a specific domain that reflects both societal priorities and industry challenges.

These teams act as living laboratories where students learn by researching, designing, building, and commercializing solutions that create tangible value for society and industry. The structure ensures that learning outcomes are not limited to academic performance but are measured by real-world impact, innovation, and sustainable value creation.

The teams include

The **Waste Team** focuses on the circular economy — turning waste into resources, energy, or new products. Students work with industries and communities on projects that reduce waste streams, develop recycling technologies, and design sustainable materials. Their goal is to demonstrate how engineering innovation can close the loop in

production processes while promoting environmental responsibility.

The **Energy Team** researches and develops renewable energy solutions and energy efficiency systems. From solar microgrids and smart batteries to hydrogen applications and clean energy storage, the team partners with power companies and startups to accelerate the transition to sustainable energy systems. Students are encouraged to build prototypes and test scalable models that can transform energy generation and consumption patterns.

In the **Food and Agriculture Team**, students tackle challenges in sustainable food systems, agricultural automation, and smart farming. Working closely with agribusinesses, they develop technologies such as precision irrigation, drone-based monitoring, bioengineering, and food preservation systems. This team ensures that engineering students contribute meaningfully to food security and resource optimization.

The **Logistics and Mobility Team** addresses the movement of people, goods, and services with an emphasis on efficiency, sustainability, and intelligent systems. Projects in this area include electric and autonomous vehicles, smart transport infrastructure, and supply chain optimization. Through partnerships with automotive and logistics companies, students gain exposure to real-world mobility challenges while innovating for future transportation systems.

The **Healthcare Team** integrates engineering, data science, and biotechnology to improve human health and medical care delivery. Students design diagnostic devices, health monitoring systems, and assistive technologies for hospitals and communities. Collaborations with medical centers and health startups allow them to test and refine their innovations in real clinical settings, leading to high-impact health solutions.

Through the **Climate Actions Team**, students research and implement strategies for climate adaptation and mitigation. They work on carbon capture technologies, climate modeling, green infrastructure, and resilience planning. The team partners with environmental agencies and industries to ensure their work aligns with sustainability goals and supports the global climate agenda.

The **Work Team** explores how technology can enhance productivity, collaboration, and human well-being in workplaces. Students design tools, robotics, automation systems, and digital platforms that improve how work is organized and performed. They also study the social and ethical dimensions of technology at work, preparing for the future of industry and labor.

In the **Education Team**, students focus on improving how learning happens — both within the university and beyond. They design digital learning platforms, simulation tools, and adaptive learning systems that enhance teaching and skill acquisition.

By collaborating with schools, edtech companies, and training organizations, they help transform education into a more interactive and personalized experience.

The **Everyday Products Team** focuses on innovation for daily living — from household appliances to wearable technologies and consumer electronics. Students apply human-centered design and sustainability principles to create products that improve comfort, safety, and quality of life. These projects often result in prototypes that can be commercialized as student-led startups or licensed to partner companies.

Finally, the **Sustainable Campus and Cities Team** works on creating smarter, greener, and more livable environments. Students design and test systems for energy-efficient buildings, waste management, green mobility, and digital urban services. They collaborate with city authorities, construction firms, and campus facilities to make the university itself a living laboratory for sustainable development.

Together, these ten teams form the core of the Outcome Driven Engineering Education ecosystem. Each team is guided by mentors from academia and industry, operates with startup-like autonomy, and measures success through outcomes such as solutions, product ideas, patents, prototypes, social impact, and venture creation.

This approach transforms the university into a hub of innovation where students don't just learn

engineering — they practice it, live it, and use it to solve real problems. Through this structure, graduates emerge not only as engineers but as innovators, entrepreneurs, and changemakers capable of designing the future.

Internship or SIWES

The Engineering Intern within the Outcome Driven Engineering Education model is designed to transform the traditional SIWES (Student Industrial Work Experience Scheme) into a powerful platform for research, problem-solving, innovation, and value creation.

Rather than viewing SIWES merely as an attachment or observation period, this model positions the internship as a co-creation partnership between the university, students, and industry — where learning and innovation happen side by side.

Under this system, engineering students are not just sent to industries to watch or assist; they are strategically placed to research real problems, propose solutions, and implement innovations that create measurable value.

Before deployment, students undergo preparation where they are trained in design thinking, systems analysis, and innovation management. They learn how to identify pain points within organizations, gather data, and develop practical solutions using engineering principles and entrepreneurial thinking.

Once in the industry, the Engineering Intern becomes a bridge between the university's knowledge base and the organization's operational realities. Students are encouraged to identify improvement opportunities — whether in production processes, system efficiency, energy use, waste management, logistics, or product design — and to design innovative responses.

Their projects are often aligned with the university's thematic innovation areas such as energy, waste, healthcare, mobility, and sustainability. This alignment ensures that each internship contributes both to the student's development and to the university's broader research and innovation goals.

Through this model, the student's role expands from that of a trainee to that of a problem-solver and value creator. They engage in mini-research projects, conduct tests, build prototypes, or apply analytical tools to improve existing systems.

Industries, in turn, benefit from the fresh perspectives, technical insights, and creative ideas that students bring. Some organizations even adopt student-developed solutions, leading to cost savings, improved efficiency, or new product ideas.

At the same time, the university–industry relationship deepens. As companies witness the impact of students' work, they begin to see the university not merely as a source of graduates but as a partner in innovation and talent development.

This often leads to joint research projects, access to industry data for academic study, co-supervision of student projects, and even the establishment of industry-funded laboratories or innovation hubs on campus.

The Engineering Intern model thus becomes a mutually beneficial ecosystem. Students gain the confidence, experience, and creativity that come from solving real problems. They learn how engineering connects to business outcomes and societal needs.

Industries, in return, gain access to emerging talent and innovative thinking. The university, positioned at the center, strengthens its relevance, reputation, and capacity for applied research.

By transforming SIWES into a platform for engineering research, innovation, and value creation, faculties of engineering move closer to producing graduates who are not only technically sound but also adaptive, entrepreneurial, and industry-ready — the kind of engineers who can create solutions, drive progress, and sustain long-term partnerships between academia, industry, and society.

100 Level Weekly Projects

Prof Haolin Zhu started a program for freshmen engineering at the Arizona State University teaching them the Engineering Design Process. He is also the Co-Director of the Grand Challenges Scholars Program (GCSP). Through this program,

100 level students embark on projects. First year engineering students incorporate design activities to practice applying the design process in either simulated or real-world situations.

100 level engineering students are not left out of the ODEE project implementation plans. They are introduced early to the scientific method and mathematical modeling as tools for solving problems, they begin their journey as engineers on the right foundation. This way they get to understand why engineering is the application of science and mathematics.

Instead of being passive learners taking abstract science courses, they actively apply scientific reasoning and mathematical thinking to real-world challenges weekly. This approach turns their first year into a period of discovery, creativity, and problem-based learning.

One key benefit is that students develop an engineering mindset from the very beginning. By learning how to define problems, make observations, form hypotheses, test ideas, and interpret results, they understand that engineering is not just about memorizing formulas but about using knowledge to design and improve solutions.

The scientific method gives them a disciplined way to think critically and make decisions based on evidence. It helps them move from “what” to “why” and “how,” making their understanding deeper and more purposeful.

Using mathematical modeling strengthens their ability to translate real-world problems into quantifiable systems that can be analyzed and optimized. They learn how mathematics becomes the language of engineering — a tool for predicting outcomes, designing systems, and improving performance.

This helps them see the connection between theory and practice early on, which makes subsequent engineering courses in mechanics, thermodynamics, and circuits more intuitive and meaningful.

Weekly projects give them the opportunity to learn by doing. These projects—no matter how small—train them in teamwork, experimentation, and design thinking. Students learn how to identify a problem, collect data, analyze patterns, and propose workable solutions using science and math.

For instance, they might model water flow, energy efficiency, or material strength, using what they've learned in physics and mathematics. Such experiences make learning active, enjoyable, and memorable, while also improving their communication and presentation skills as they explain their findings.

This approach also helps them build confidence and creativity early. Instead of waiting until higher levels to engage in design or innovation, they begin to see themselves as engineers from day one—people who can create, test, and improve systems.

This nurtures a sense of ownership and curiosity that motivates them throughout their studies.

Another major benefit is that it reduces the disconnect between science and engineering. Many first-year students struggle to see how abstract scientific principles apply to engineering practice. By linking both through projects and modeling, they understand that science provides the foundation, while engineering applies it to meet human and industrial needs.

This kind of foundation fosters a culture of problem-solving and innovation. Students who learn to use the scientific method and mathematical modeling early become more analytical, systematic, and innovative in higher-level courses. They are better prepared to handle complex systems, multidisciplinary challenges, and industry problems.

In essence, this model transforms the 100-level experience from a passive academic year into an active engineering apprenticeship—where students begin to think, act, and grow as real engineers who use science and mathematics not just to learn, but to solve, create, and add value.

Final Year Project

We were discussing with the dean faculty of Engineering, University of Regina and he mentioned that all final year projects are based on the challenges faced by local industries. This gave me the understanding that final year projects of

engineering students should not be abstract but rather focused on specific challenges faced by industry and society.

In the Outcome Driven Engineering Education model, the final year project is not just an academic requirement — it is the culmination of a student’s journey from learning to innovating, from solving theoretical problems to creating real-world value.

Each project emerges from one of three key sources: the student’s SIWES (industrial attachment) experience, the team or research group they belong to, or a pressing need they observe in society. This approach ensures that the final year project is anchored in reality, inspired by genuine challenges, and capable of creating meaningful impact for people, industry, and the environment.

When a student’s project grows out of their SIWES experience, it often addresses a gap or inefficiency they discovered while working in industry. The student returns to the university with firsthand understanding of a real engineering challenge, and their final year project becomes a continuation of that problem-solving process.

This strengthens the bridge between the faculty and industry, as organizations see the university not just as an academic body but as a partner in research and innovation. Many of these projects result in improvements in productivity, energy efficiency, or process design for the host companies — creating tangible value while deepening trust and collaboration.

For students whose projects emerge from their team activities within the university's innovation ecosystem — such as the Energy Team, Waste Team, or Healthcare Team — their final year project becomes an opportunity to advance ongoing research or develop prototypes that can be tested and scaled.

This continuity of work from lower levels to the final year enables mastery, teamwork, and focus. It also allows students to build expertise in a particular domain and contribute to the university's larger portfolio of innovation. The projects from these teams often evolve into startups or social enterprises, led by the students who conceived them, with support from mentors and industry partners.

Projects based on societal needs are equally powerful. When students identify real problems within their communities — from waste management and water purification to renewable energy or affordable healthcare — they learn to design solutions that are technically sound, economically viable, and socially relevant. Such projects reconnect the university with the very society it serves, demonstrating that engineering education is a tool for improving lives and driving sustainable development.

This project simulation approach offers several benefits. It transforms the final year project into a mini-innovation lab, where students apply everything they have learned — scientific principles,

mathematical modeling, design, and business thinking — to create products or systems that can be implemented beyond the campus.

Instead of being shelved after defense, projects are developed into prototypes, patented inventions, or business ventures. The faculty becomes a hub of innovation, where students' ideas can attract industry partnerships, research grants, or startup incubation support.

For students, this model nurtures deep learning and confidence. They no longer see projects as a formality but as opportunities to engineer solutions that matter. They learn how to work with real constraints, collaborate with external stakeholders, and think about market readiness and sustainability. The process develops their entrepreneurial mindset, preparing them not only for employment but for creating jobs and new ventures.

For the faculty, these projects create living relationships with industry and society. As students engage with organizations and communities to solve problems, the university's reputation for relevance, creativity, and impact grows. Companies begin to collaborate more actively — funding projects, co-supervising students, and commercializing innovations. Society, in turn, sees the university as a partner in solving local and national challenges.

This project simulation turns the final year experience into a launchpad for innovation and

entrepreneurship. It ensures that engineering education produces not just graduates, but creators — young engineers who can identify needs, design solutions, and bring them to life through startups, social ventures, and industry collaborations.

It closes the loop between learning, research, and value creation, making the faculty of engineering a living engine of development and transformation.

Mentorship Integration

In my first-year engineering, I felt lost. I was taking courses in the faculty of science. I felt abandoned because there was no contact with seniors. It would have greatly helped to be mentored by a senior who has been there and done all I am doing. To me it is a gap that needs to be filled.

As such while designing the Outcome Driven Engineering Education model, mentorship became a central pillar that connects students across levels in a continuous cycle of learning, collaboration, and innovation. One of the most effective forms of this is the peer mentorship structure, where 100-level students serve as research and innovation assistants to 500-level students working on their final year projects.

This arrangement not only strengthens project outcomes but also builds a powerful culture of teamwork, leadership, and early exposure to the research and innovation process.

In this model, each final-year student or project group is paired with one or more 100-level students

who act as junior research assistants. The senior students provide mentorship, guidance, and practical training, while the younger students contribute with curiosity, energy, and a willingness to learn.

Through this system, final-year students assign the 100-level students' specific tasks such as literature reviews, data collection, basic experiments, report writing, prototype assembly, and presentation preparation. The juniors also participate in project initiation, planning, scheduling, and execution, gaining hands-on experience of what it takes to turn an idea into a finished engineering solution.

This mentorship dynamic produces a range of mutual benefits for both groups among which are:

For the 500-level students, it develops leadership, management, and teaching skills that are essential for professional engineering practice. They learn how to delegate responsibilities, communicate complex ideas clearly, and motivate others toward shared goals — skills that are invaluable in the workplace.

Guiding younger students also deepens their understanding of their own project, as teaching and explaining concepts often reinforce mastery. Moreover, having assistants allows final-year students to accomplish more ambitious projects, since they can distribute tasks and focus on higher-level analysis, system design, and innovation. The experience of managing a small research team also

prepares them for leadership roles in industry, academia, or entrepreneurship.

For the 100-level students, on the other hand, the benefits are equally transformative. They gain early exposure to research, innovation, and engineering design, which demystifies what lies ahead in their academic journey. Instead of being confined to theoretical science courses, they see how scientific and mathematical principles are applied to solve real engineering problems.

This makes their learning more meaningful and helps them develop a clearer sense of purpose. Working under senior students introduces them to project planning tools, teamwork, and communication practices — experiences that build confidence and spark curiosity about innovation. They also begin to develop the technical and creative mindset needed to eventually lead projects of their own.

Beyond individual benefits, this mentorship structure creates a culture of collaboration and continuity within the faculty. Projects become intergenerational, as knowledge, ideas, and methods are passed down from one level to another. When the senior students graduate, the juniors are already familiar with ongoing work and can continue or improve upon it, ensuring that innovation within the faculty does not end with each graduating class.

This system also builds stronger social and academic connections between students, reducing

isolation and fostering a sense of belonging and shared identity as engineers.

Ultimately, this model transforms the faculty into a living learning community where knowledge flows freely across levels, and every student contributes to the cycle of discovery and creation.

The 500-level students graduate as leaders capable of managing people and projects, while the 100-level students advance with vision, experience, and excitement about their future in engineering. Together, they strengthen the link between learning, mentorship, and innovation, ensuring that engineering education remains vibrant, relevant, and deeply human.

Epilogue

Preparing Engineering Students For Industry

Engineering is one of the few professions where the bridge between theory and practice determines success. A graduate may understand thermodynamics, design principles, or circuit theory perfectly — but if they cannot apply that knowledge to solve real problems, lead teams, communicate with clients, and manage projects, their education remains incomplete.

This is the focus of this book, to explore how Nigerian universities can evolve to meet the growing demand for engineers who are industry-ready — graduates who combine strong technical foundations with professional competence, business acumen, creativity, leadership, and the confidence to operate in real-world settings.

For decades, the traditional model of engineering education has been classroom-centered and theory-heavy. Students spend years mastering formulas and lab experiments but rarely see how those concepts connect to industrial practice. When they graduate, they often encounter a workplace culture that values speed, teamwork, customer needs, and continuous improvement — none of which are emphasized strongly in typical lecture-based programs.

Industry leaders frequently express concern that graduates need significant retraining before they can contribute meaningfully. Employers look for

engineers who can not only calculate, but also research, communicate, innovate, *and* collaborate. Bridging this gap requires that universities transform from knowledge transmitters into learning ecosystems that simulate the real engineering environment.

Preparing students for industry involves three key shifts:

a. From theory-based to experience-based learning: Students must engage in authentic, hands-on projects that mirror industry challenges.

b. From isolated disciplines to multidisciplinary collaboration: Real problems rarely fit neatly within one field.

c. From individual performance to teamwork and leadership: Modern engineering projects are team-based, requiring communication, ethics, and project management skills.

Universities that have successfully embraced these shifts offer valuable lessons for others worldwide. Here are some universities that are integrating this

a. The University of Waterloo (Canada): Co-op Education at Scale

The University of Waterloo is globally recognized as a pioneer in cooperative education (co-op). Engineering students alternate between academic terms and paid work placements with industry partners throughout their degree. By graduation, many students have up to two years of professional experience.

This model ensures that students continuously connect theory with practice. They learn workplace culture, develop soft skills, and return to campus with insights that enrich their classroom learning. Employers, in turn, benefit from a pipeline of well-prepared, pre-trained graduates. Waterloo's approach proves that integrating industry exposure *within* the academic structure, rather than after it, can transform employability outcomes.

b. Arizona State University (USA): Project-Based and Community-Driven Learning

Arizona State University (ASU) has redefined engineering education through its emphasis on project-based learning and community engagement. Programs like EPICS — Engineering Projects in Community Service — allow students to work in multidisciplinary teams to design solutions for real problems faced by communities, NGOs, and companies.

For instance, ASU engineering students have developed affordable water filtration systems for rural areas, assistive technologies for people with disabilities, and solar-powered devices for local schools. These experiences teach students to think like engineers serving real clients, not just solving textbook problems.

ASU also partners directly with industries through “Practice Labs,” where companies sponsor projects, mentor students, and co-develop solutions. This creates a learning environment that mirrors

professional engineering practice — iterative, collaborative, and impact-oriented.

c. Massachusetts Institute of Technology (MIT, USA): Research and Industry Synergy

At MIT, the Undergraduate Research Opportunities Program (UROP) connects students with research groups and industry-sponsored labs from their early years. This approach blurs the line between academic learning and industrial innovation. Students learn how to define problems, experiment, fail, and iterate — the same cycle that drives innovation in industry.

Beyond UROP, MIT's Industrial Liaison Program (ILP) links companies directly with faculty and students, enabling research partnerships, internships, and technology commercialization. Students experience firsthand how research ideas translate into startups, patents, and market-ready solutions.

Across these institutions, several shared principles emerge:

- Embedded Industry Experience: Whether through co-op, internships, or sponsored projects, practical exposure is part of the curriculum, not an afterthought.
- Real Problems, Real Clients: Students work on authentic challenges, which builds professional confidence and problem-solving agility.

- Faculty–Industry Collaboration: Professors and engineers co-design projects, aligning academic rigor with industrial relevance.

- Reflection and Mentorship: Students are encouraged to reflect on what they learn from practice — turning experience into wisdom.

For countries like Nigeria and other emerging economies, these global models offer inspiration — but they must be adapted to local realities. Full co-op systems like Waterloo’s may be difficult to implement initially, but smaller-scale versions can work. Through our Outcome Driven Engineering Education program, we are:

a. Creating session-long community projects where students solve defined problems for communities in collaboration with domestic and foreign engineering students.

b. Changing how students go on internship. They are trained to deliver value.

Universities can also establish Industry Advisory Boards to guide curriculum updates, ensuring that emerging technologies and industrial needs are reflected in teaching.

Faculty are the key drivers of change. Preparing students for industry means lecturers must go beyond traditional instruction to become facilitators, mentors, and design coaches. Curriculum should include:

- Industry-sponsored final year projects

- Multidisciplinary team assignments
- Business, environmental, legal, human, communication and leadership modules integrated into technical courses
- Entrepreneurship and innovation labs that encourage students to commercialize ideas

Through such reforms, engineering education becomes not only about mastering science and math but about creating value. To achieve this, universities need to understand what differentiates them from industry and then design programs that will bring the gap.

Here are some of the differences identified by Charles Baukal et al in their paper titled, *Preparing Engineering Students for Industry*:

1. Nature of Problems: From Well-Defined to Real-World Complexity

Introduction

In universities, students typically solve structured textbook problems with known data and single correct answers. However, industry problems are often messy — incomplete information, changing parameters, and multiple feasible solutions. Preparing students for this shift requires exposing them to the uncertainty and ambiguity of real-world engineering work.

University (Academia)	Industry (Workplace)
Problems are well-defined and have a single correct answer.	Problems are ill-defined, open-ended, and may have multiple acceptable solutions.
Focus on theory and derivation.	Focus on application and optimization.
Evaluation based on correctness of answer.	Evaluation based on performance, feasibility, and safety of solution.

Engineering education can incorporate project-based and problem-based learning (PBL) where students work on open-ended, community or industry problems. Courses should include case studies, design challenges, and capstone projects that mimic real-life ambiguity. Faculty can grade based on justification and reasoning, not just final answers.

2. Learning and Work Culture: From Individualism to Collaboration

While academia rewards individual performance and intellectual independence, industry thrives on collaboration, teamwork, and shared accountability. Engineering graduates must therefore develop interpersonal and team skills alongside technical competence.

University	Industry
Emphasis on individual grades and effort.	Success depends on teamwork and cross-disciplinary collaboration.
Frequent structured feedback from professors.	Limited formal feedback; performance reviewed periodically.
Learning driven by syllabus and deadlines.	Work driven by project goals, client needs, and outcomes.

Courses should feature team-based projects with diverse roles (project manager, analyst, designer, communicator). Students should learn team communication, conflict resolution, and role delegation. Instructors can simulate industry reviews instead of only grading submissions, providing peer evaluations and progress meetings like in real workplaces.

3. Evaluation and Accountability: From Grades to Performance Outcomes

Academic evaluation systems prioritize comprehension and process, often rewarding partial correctness. Industry, however, demands results — an inaccurate design can lead to costly or unsafe consequences. Students need to shift from "learning to pass" to "learning to perform."

University	Industry
Partial credit given for effort even when answers are wrong.	Errors can be costly — accuracy and reliability are paramount.
“Good enough” performance can earn a high grade.	“Almost correct” is often unacceptable.
Deadlines are flexible.	Deadlines are strict and linked to deliverables and budgets.

Introduce performance-based assessments where students must produce working prototypes, validated simulations, or tested designs. Include strict submission deadlines, peer review, and industrial evaluation panels to simulate real accountability.

4. Problem-Solving Culture: From Correct Answers to Sound Judgment

Engineering problems in industry rarely have one solution — instead, engineers must weigh cost, time, safety, and social factors. Developing sound judgment is as crucial as analytical skill.

University	Industry
Solves problems with fixed assumptions.	Solves problems with changing conditions and constraints.
Focuses on technical correctness.	Balances technical, economic, and ethical considerations.
Uses standard examples and closed systems.	Works within complex, evolving systems.

Embed systems thinking and engineering ethics within problem-solving courses. Encourage students to perform trade-off analyses and justify decisions in terms of cost, safety, and sustainability. This can be built into design courses and multidisciplinary studio sessions.

5. Tools and Resources: From Memorization to Professional Practice

While academic success often depends on memorization and manual derivations, industry emphasizes knowing where to find and how to use the right tools, codes, and standards. Engineers must be adept at digital tools, technical documentation, and regulations.

University	Industry
Students memorize formulas and derive equations.	Engineers use reference materials, standards, and design codes.
Limited exposure to professional tools.	Heavy use of simulation, modeling, and design software.
Emphasis on theory validation.	Emphasis on solution verification and documentation.

Integrate professional tools (e.g., MATLAB, SolidWorks, AutoCAD, Python) early in the curriculum. Require use of industry standards (IEEE, ISO, SON) in assignments. Include technical documentation and reporting as part of grading.

6. Work Environment and Culture: From Flexibility to Structure

Introduction

Students in universities manage flexible schedules and short-term assignments, while industry demands consistent work hours, project discipline, and long-term commitment. Adjusting to structured environments is often a shock for new graduates.

University	Industry
Flexible schedules, independent study time.	Fixed work hours, structured supervision.
Short-term semesters and quick project cycles.	Long-term projects that can last months or years.
Informal peer relationships.	Formal workplace hierarchy and accountability.

Simulate industry-like project management in final-year projects — requiring Gantt charts, task reports, milestones, and weekly progress meetings.

Introduce industrial internships or co-op semesters to acclimate students to workplace structure and communication norms.

7. Mindset and Responsibility: From Learning to Value Creation

Introduction

In academia, students are learners. In industry, they must be contributors who generate measurable value. This mental shift—from “being taught” to “taking responsibility”—is essential for success.

University	Industry
Goal: Mastery of knowledge.	Goal: Application of knowledge to deliver value.
Mistakes have low consequences.	Mistakes can cause financial or safety impacts.
Learning is theoretical and exploratory.	Work is outcome-driven and accountable.

Embed entrepreneurial thinking and value creation exercises in design and innovation courses.

Encourage students to quantify the impact of their designs — energy saved, cost reduced, or efficiency improved. Use industry mentors to evaluate outcomes, not just academic faculty.

8. Communication and Soft Skills: From Reports to Real Conversations

Technical competence is necessary, but engineers spend much of their professional life communicating — writing reports, presenting designs, and negotiating with non-engineers. This is often underdeveloped in traditional curricula.

University	Industry
Communication limited to lab reports and papers.	Requires reports, memos, meetings, and client presentations.
Informal peer collaboration.	Structured documentation and communication with diverse teams.
Rarely defend ideas publicly.	Must justify design choices to clients, managers, and regulators.

Include presentation-based grading, client-style defenses, and peer review. Introduce modules on technical writing, proposal development, and stakeholder communication. Simulated design review boards can give students a taste of industrial scrutiny.

9. Exposure and Experience: From Simulated to Real

Universities often isolate theory from practice. Industry, however, demands engineers who can connect both — understanding standards, safety, costs, and implementation realities.

University	Industry
Limited exposure to standards and codes.	Constant use of standards, safety codes, and compliance rules.

University	Industry
Projects end at design or simulation.	Projects end in fabrication, testing, and field deployment.
Performance judged by grades.	Performance judged by cost, safety, and reliability.

Expand industry partnerships through project-based programs, internships, and sponsored capstones. Invite industry engineers for workshops on standards, cost estimation, and field testing. Encourage students to prototype and test designs wherever possible.

10. Mentorship and Professional Growth: From Teachers to Mentors

While professors guide students academically, professional growth in industry depends on mentorship and peer learning. Early-career engineers need guidance not only on technical issues but also on communication, workplace ethics, and decision-making.

University	Industry
Professors teach and grade.	Mentors guide and develop employees.
Peers are of similar age and skill.	Teams are diverse in experience and background.

University	Industry
Focus on subject knowledge.	Focus on professional development and judgment.

Develop mentorship programs pairing students with industry professionals or alumni. Encourage reflective journals and career development sessions where students learn from experienced practitioners. Include peer mentoring within project teams.

To close the academia–industry gap, the engineering education way must involve:

- a. The introduction of authentic, open-ended projects in purely theoretical exercises.
- b. The integration of industry collaboration at every level — from guest lectures to co-supervised capstones.
- c. Teach students not only how to calculate, *but* how to think, decide, and deliver.

The goal of engineering education is no longer just to produce job-seekers, but problem-solvers, innovators, and leaders. The modern engineer must navigate sustainability, ethics, globalization, and digital transformation — all while creating solutions that improve lives.

Universities that understand this mission are redesigning their programs to act as bridges, not silos. When faculties of engineering partner authentically with industry, students graduate with

a mindset of innovation and lifelong learning — ready to lead, not follow, the next industrial transformation.

The Engineering Education Way is ultimately about reimagining what it means to prepare an engineer. As the examples from Waterloo, ASU, and MIT show, bridging the gap between academia and industry is possible — when learning is practical, collaborative, and purpose-driven.

For developing nations, especially, this is the next frontier: to educate engineers who can turn ideas into impact, classrooms into innovation spaces, and education into a force for national transformation. That is how we build the engineering education way — one that truly prepares students for the world they are called to engineer.

Other Books By The Author

What Value Are You Bringing To The Table?

Value Giver

Value Giver Way

Truly Human Leadership

Truly Human School

Truly Human Company

Truly Human Employee

Understanding Engineering

Problem Solving for Engineers

Design Solutions for Humans

Value Creation for Engineers

Outcome Driven Engineering Education

The Engineering Intern

The Value Effect Matrix

Closing The Loop

The Transformative Nurse