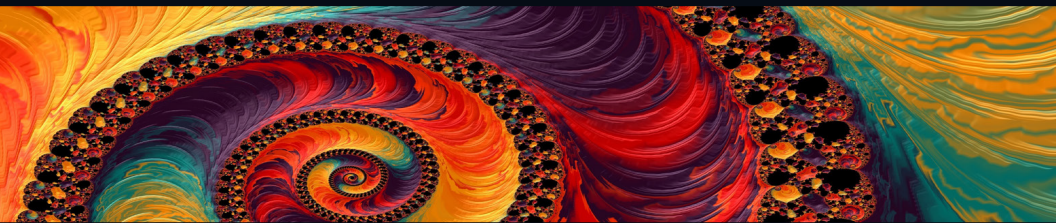


CRC FOCUS SERIES
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THE STORY OF INDUSTRIAL ENGINEERING

The Rise from Shop-Floor Management
to Modern Digital Engineering

Adedeji B. Badiru



CRC Press
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The Story of Industrial Engineering

**The Rise from Shop-Floor
Management to Modern
Digital Engineering**

Analytics and Control

Series Editor: Adedeji B. Badiru, Air Force Institute of Technology, Dayton, Ohio, USA

Mechanics of Project Management

Nuts and Bolts of Project Execution

Adedeji B. Badiru, S. Abidemi Badiru, and I. Adetokunboh Badiru

The Story of Industrial Engineering

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*To the memory of Gary E. Whitehouse,
who put me on the path of Industrial
Engineering stories and accomplishments*



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Preface

THIS FOCUS TEXT USES a storytelling approach to present the rich history of industrial engineering and its multitude of applications. This text traces the profession from its early days to the present day of digital engineering and additive manufacturing. The potpourri of stories includes the emergence of union movements, early human factors, early practices of ergonomics, the days of efficiency experts, the legend of cheaper by the dozen, the movement of scientific management, the evolution of manufacturing, the applications of management engineering, early management principles and movement, the emergence of formal industrial engineering, the diversification of industrial engineering, the risk of the fragmentation of industrial engineering, the offshoot professions and specializations, the struggle to keep the core (center) of industrial engineering, the mitigation of the splinter areas of the profession, the shadow functions of industrial engineering, the sustaining of the profession under a common core, the move into additive manufacturing applications, the concept of general digital engineering, and so on.

The text takes a relaxed and interesting storytelling tone to engage the interest of readers. The anecdotes recounted are based both on published literature as well as the author's own direct education, experience, and practice of the profession. This is not a textbook. Rather, it is a book of stories used to highlight the versatility and applicability of industrial engineering.



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I EXPRESS PROFOUND GRATITUDE TO several colleagues, former teachers, and former students of industrial engineering, through whose insights I learned so much to create the platform for writing this book. My particular special thanks go to Dr. Sid G. Gilbreath, who has continued to mentor and inspire me over the years. His contributions to this book are found in the various classical reference materials that he provided to me as foundational stories for the manuscript. He provided leads and links to the cool stories of industrial engineering. I also acknowledge and appreciate the friendship, mentoring, and inputs of Dr. Bob Braswell, who provided the encouragement to write this book as a documentation to advance the future of industrial engineering.



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Personal Background for Industrial Engineering

Think like an IE, act like an IE.

ADEDEJI BADIRU

INDUSTRIAL ENGINEERING OF TODAY is different from the industrial engineering of the past. The job shops of the past are now the digital shops of today. This speaks to the diversity and flexibility of the profession.

The main premise of writing this focus book is to recognize, celebrate, and promote the diversity and versatility of the unadulterated profession of industrial engineering. It is written from my own personal observation, education, experience, and direct practice. It is sort of an eyewitness account of the glory of industrial engineering. I envision that the storytelling approach of this focus book will inspire the study, practice, and spread of industrial engineering.

In order to understand my fervent advocacy for industrial engineering, you will need to understand the story of how and why I was attracted to the profession in the first place, many decades ago. It is a very interesting background story. My first exposure to an industrial environment started in December 1972 in Lagos, Nigeria. Upon completion of my secondary school education at the famed Saint Finbarr's College, Akoka, Yaba, Lagos, Nigeria, I was employed as a factory supervisor at Associated Industries Limited (AIL) at Apapa, a mainland suburb of Lagos. The company made mints (peppermint). I got the employment barely two weeks after graduation from the secondary school. So, I did not have much time to decompress from the rigidly controlled educational regimen of Saint Finbarr's College, which was run as a tight ship by the principal, Reverend Father Denis Slattery, an Irish Priest. Father Slattery was popular throughout Nigeria at that time for his uncompromising commitment to seeing the school excel in academics, discipline, and sports. Fortunately, these three requirements fit my own personal attributes. So, I was a star scholar at the school. The discipline received under Father Slattery is still manifested today in my commitment to self-discipline. My Finbarr's-sparked interest in sports, focused primarily on soccer, has continued to this day. My focus on academics at the school later transferred into the pursuit of advanced degrees. The fact that I easily and quickly secured employment at Associated Industries soon after leaving high school was due to the fact that I graduated from Saint Finbarr's College with a Grade I Distinction in the West African Examination Council (WAEC) general external examination, which was required for graduation from high school in Nigeria at that time.

It was at AIL that I had my first taste of what would later become my profession of industrial engineering. At that time, I was not even aware of what industrial engineering was. What I knew was that some sort of better management was needed for AIL's production operations. I was assigned to the sugar-milling department. My job was to supervise casual labor employees in

the process of pouring 100-pound bags of sugar into a large drum for the milling operation, which was one of the first stages of the peppermint production process. The factory engineer was an expatriate, who would always get furiously mad at me whenever the laborers mistakenly poured wet sugar into the machine, thereby causing a clog in the machine, which then necessitated production line shutdown. All of my workers were illiterate casual laborers, who did not know what was going on except that they were required to heave 100-pound bags of sugar over their heads to pour into the giant rotating drum, very much like a cement mixer. The workers could not peek into the drum to see what was going on inside of it.

It happened that wetness in the middle of the large bags of sugar could not be easily detected until the overhead pouring of the sugar into the large drum had started. Once gravity had taken over the downward flow of the granulated sugar, there was no manual avenue of stopping the flow without making a giant mess of spilled sugar all over the floor, which was a worse occurrence due to the unsalvageable loss of the raw material, the “almighty” costly sugar.

Visual or manual wetness inspection of the bags could not provide *a priori* foolproof assessment of the deep interior of each bag of sugar. There was no winning on the part of the workers. It was like a lottery pour each time. So, my team was usually at a loggerhead with the engineer. I suspected that the source of wetness in the bags of sugar was due to the poor storage facilities and the crude inventory system. Sometimes, retrieving the bags from storage to the production floor was a matter of last-in first-out, which was convenient, but not optimal.

On one of his usual tirades after a clogged machine, the engineer threatened to “throw” me, as the responsible floor supervisor, out the window of the second floor of the factory building, should wet sugar be found in the machine again. It was right there and then that I decided to resign from AIL in March 1973. It was my pride and arrogance from my Saint Finbarr’s College education that made me want to quit and not subject myself to any further

insult from the engineer. Graduates of Saint Finbarr's College were highly regarded and respected throughout Lagos in those days. We all went around town with our heads held high with pride. After all, we were the pupils and products of the prestigious school started in 1956 by Reverend Father Denis Slattery. Father Slattery was iconic throughout Lagos and many parts of Nigeria due to his multifaceted involvement in a variety of public issues, including being a school proprietor, a soccer referee, a coach, and a newspaper editor. So, for someone to assuage our reputation in public was the ultimate insult, which I was not ready to accept. So, I quit! In the United States a few years later, I analogized that quitting act to the scenes from Dolly Parton's *9 to 5* movie.

After leaving AIL, subsequently, between April 1973 and December 1975, I worked as an accounts clerk at Union Trading Company; a graphic artist and clerical officer at the Lagos State Ministry of Education, Audio Visual Aids Section; and a bank clerk at the Central Bank of Nigeria. All through the almost three years of working elsewhere after AIL, I still felt the injustice meted out to the manual workers at AIL. Sometimes, I would feel guilty for not sticking it out at the plant so that I could continue to protect the workers from the factory engineer. I wondered what level of oppressive treatment the workers would continue to endure if their new supervisor could not protect them against the engineer like I tried to do. My experience and observations of the treatment of the low-level workers at AIL would later form my attraction to the profession of industrial engineering, through which I envisioned I would become a staunch advocate for industrial workers.

Based on my excellent high school examination result, employers always suspected that I would depart their employment in favor of pursuing further studies at a university. It was usually a matter of consternation for everyone to see me working with only a high school diploma instead of immediately going to a university. But, in fact, I had my plan of when and how I would move forward to some sort of university-level education. I had earlier met my future spouse, Iswat, while we both worked at the Lagos State Ministry of

Education in 1973–1974. It was while I was working at the Central Bank of Nigeria that I received several merit-based academic scholarships. One scholarship was for studying mechanical engineering in Germany. One scholarship was for studying fine arts at the University of Nigeria, Nsukka. One scholarship was for studying medicine in Nigeria. One scholarship was for studying industrial engineering in the United States. Although I did not fully understand what industrial engineering entailed at that time, I was still attracted to it because of the “industrial” component in the name and my lingering loathing of what I observed at AIL production lines. It was much later that I would understand the linkage of bad worker treatments to the emergence of unions for the purpose of protecting workers’ rights.

Faced with the opportunities of several fully paid scholarships, I chose to accept the scholarship for the study of industrial engineering in the United States. In addition to satisfying my “industrial” urge, the thrill of traveling to the United States played a role in my choice of which scholarship to accept. With a full scholarship from the Federal Republic of Nigeria, I could have gone to any university of my choice in the United States, with the normal admission process, of course. In my search for a U.S. university, I looked at names that rang a bell for me along the lines of “technological,” “technical,” “Institute,” “Tech,” etc. I did not discriminate among schools, because I did not know better regarding what constituted a better school in the United States. To me at that time, all U.S. schools were equally appealing; after all, they were all located in the great United States. So, the discriminant in my decision was the technical-sounding name of the school. It was for this reason that I applied to Tennessee Technological University just as well as I applied to Massachusetts Institute of Technology, Georgia Institute of Technology, California Institute of Technology, and Virginia Polytechnic Institute. Although I got accepted to several prestigious universities, I chose Tennessee Technological University. In my naïve mind of those days, it had the best-sounding name, and it accorded me the fastest and most

responsive communication in the back-and-forth snail-mail iterations of the admissions process of the mid-1970s.

EXERCISING IE THINKING

The opening quote at the beginning of this chapter typifies how I have practiced, taught, mentored, and lectured industrial engineering for decades. Industrial engineers are known for making things better. In effect, industrial engineers make products better. I pride myself on being a product advocate, always thinking of how to help manufacturers make their products better. Many a time, I have directly contacted manufacturers to give them constructive feedback on my direct experience with their products and how I believe the products could be improved.

I shudder when consumers complain about products without offering constructive product-improvement suggestions based on direct usage experience. Product quality is a two-way affair. Quality, as designed and manufactured by the producer, is one thing. Quality, as practiced and perceived by the consumer, is a different thing. When a disconnect happens, many times it is because the user does not follow the user's guide provided by the manufacturer.

No product is ever made perfect from the beginning. Good quality often evolves over time and over several iterations of incremental improvements. A product that a manufacturer attempts to make perfect at the first introduction may never reach the market. A case example occurred when I visited a local Wuse Market in Abuja, Nigeria in 1994 with the goal of buying locally-made products as a part of my proactive product assessment efforts for the purpose of identifying flaws, the feedback for which could be used by the producers to improve their products. The seller insisted that I should buy an imported brand because it offered better quality. She was baffled when I insisted that it was the local brand that I desired to buy, not because of lower cost, but because that was my preference.

My views and thinking about product reviews are shaped by my industrial engineering education as narrated in the chapters that follow.

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