# Integrating Focus Factories Initiatives as part of Engineering Education in Developing and Underdeveloped Countries

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## Abstract

The purpose of this study is to integrate a flexible Focus Factory System as part of the engineering education in developing and underdeveloped countries, with the goal of providing students with world class engineering education anchored in combination of theoretical and real-life applications. The components of the flexible Focus Factory System may include supply chain management, product design/development, manufacturing operations, total quality management, technological innovation, transportation and logistics, program/project management, process design/development and execution, product packaging, transportation, logistics, infrastructure development as well as execution of lean and six-sigma tools.

Based on the issues confronting many developing and underdeveloped societies, with regards to educating students with the practical knowledge of product development, hands on manufacturing, project management, engineering and infrastructure development, Integrating Flexible Focus Factory initiatives as part of the Engineering curriculum will be beneficial in mitigating and eliminating acute problems that we currently have in synergistically aligning theoretical education and practical applications. The flexible engineering Focus factory system being proposed as part of academic engineering academic curriculum is not the same as engineering Laboratories that are already part of the academic curriculum. These flexible Focus Factories are real life operating facilities with manufacturing or production facilities, and/or specific infrastructure projects with full capabilities to develop and manufacture specific products that may be sellable to the consumer or can be optimized at a future date for consumption by the general public.

The System will be operated by the students under the direct supervision and guidance of professors, lecturers and if possible, an outside operation's expert. They are specifically set up for production of specific products or execution of specific infrastructure projects. They are tailored to be utilized for providing real life experience for engineering students and others engaged in dual engineering and business management programs. The engineering disciplines that may benefit may include the following; agricultural, chemical, civil, industrial, electrical, mechanical, computer engineering and computer science, petroleum/petrochemical, and biomedical engineering. This type of educational program makes it easier for students to gain the real-life application knowledge in school prior to graduation, as well as become a conduit for developing engineering students and others with problem solving capabilities and entrepreneurship mindsets.

## Keywords

Flexible, Focus-Factory, Facilities, Engineering Education, System, Mindset, Problems, Entrepreneurial, Application. Developing-Countries, Underdeveloped-Countries, Challenges.

## Introduction

Engineering Education Flexible Focus Factory System is a flexible manufacturing and practical production system that integrates areas of engineering, project management, product strategy, manufacturing and supply chain management for the purpose of teaching students how to integrate theory and practice to develop products and processes that leads to development of infrastructure projects, such as roads and bridges, as well as manufacturing of saleable and consumable products such as soap, cooking oil, agricultural or farm equipment, vehicles, medical equipment, computers, medications and other consumable products that their societies needs for its sustainability. The goal of this type of engineering education is to educate and train engineers that lives school with theoretical, practical

and real-life applications experience with emphasis in product/process development, design, specification development, manufacturing, facilities development, applications of operations excellence and total quality management. This study will present a general overview of the proposed approach of integrating flexible Focus Factory System into the existing curriculum of engineering education programs in developing and underdeveloped countries starting from the first to the 5th or 6th year of the student's engineering education. Shown in Figure 1, below is the diagram showing the integration of Flexible Focus Factory System with Current Engineering Academic Curriculum to produce the new engineer with both theorical and real-life application knowledge prior to graduation.

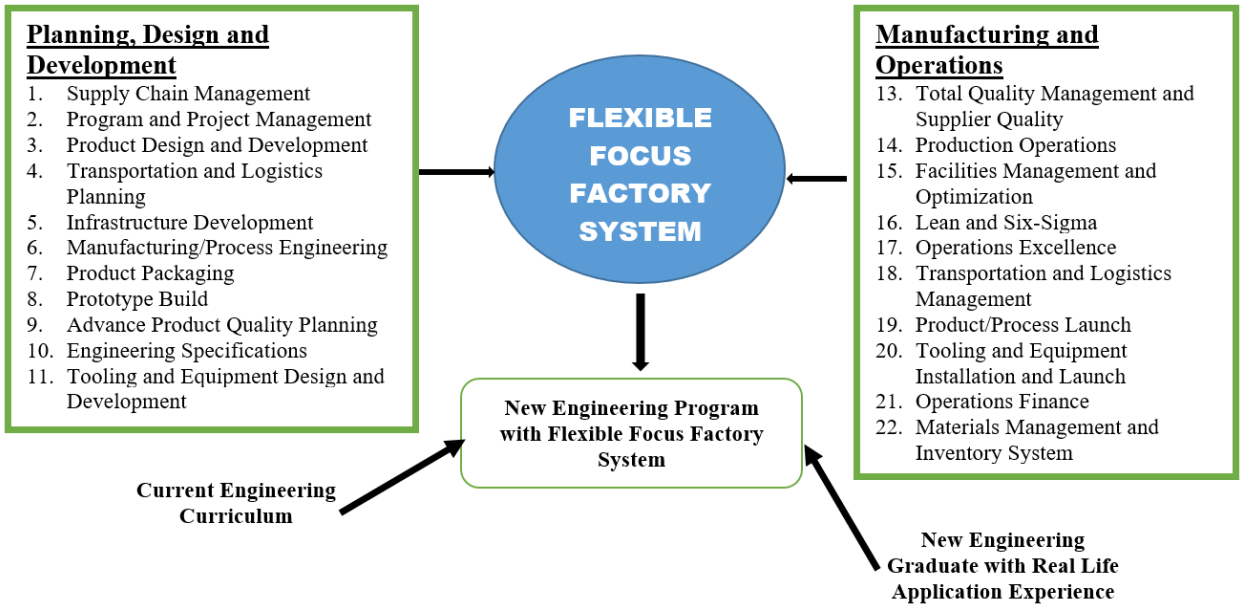


Figure 1: New Engineering Program with Flexible Focus Factory System

## Research Approach

This study will utilize the following approach: 1. Goals of the engineering education with Flexible Focus Factory System; 2. Challenges facing engineering education programs in developing countries; 3. Proposed general frame-work for a five-year engineering education program with Flexible Focus Factory System integrated as part of the educational curriculum; 4. Areas included in the Flexible Focus Factory System; and 5. The merits and demerits of integrating Flexible Focus Factory System as part of engineering education curriculum. The proposed curriculum frame-work is a mere suggestion by this researcher for the purpose of this study. It can be modified to suit the specific need of each institution depending on their academic curriculum and societal and institutional needs. The overall goal is to integrate theoretical knowledge with practical or real-life applications for the students that for the most part do not have opportunities for internship, and industrial training that students from advanced countries like US, Germany, UK, and Japan etc., have during their engineering education prior to their graduation from engineering schools.

## Goals of Engineering Education Program with Flexible Focus Factory System

In general, the goal is to focus on the improvement of engineering education in developing and underdeveloped countries with emphasis in integrating both theoretical and real-life applications in the engineering curriculums where necessary. The quest to a sustainable national development and growth depends on the extent of transforming and revamping engineering education for global competition (Ajimotokan etal, 2010). For developing and underdeveloped countries with limited industrial base to support internships, integrating Flexible Focus Factory System into the engineering education presents a feasible and effective option. This will afford the students the opportunities to gain real life and hands on experience and understand the importance of integrating theory and practice. This type of engineering education, will assist both the students and faculty to expand their ability, capability in executing real life programs and projects that deals with design, prototype, manufacturing, operations and supply chain. It will encourage cross functional learning approach as seen in the industry and give the students the opportunity to participate in product creation and all aspects of manufacturing engineering, quality management, transportation and logistics. It will provide

a platform for business incubation in the university that can be transferred to society at large, and provide opportunity for engineers to learn how to supervise, manage and lead real life projects from concept to execution

## Challenges or Problems Facing Engineering Education in Developing/Underdeveloped Countries

Akintola, et ali. (2002) and Ojiako (1986), in their articles titled "Problems of Engineering Education in developing countries: Nigeria as a case study", and "University Engineering Education and Training in Nigeria: Development, Weakness and Improvement" respectively pointed out the following reasons behind the challenges facing engineering education in developing countries. These challenges include; Lack of proper engineering knowledge (acquired through appropriate structures), impacts the attainment of a high level of technological advancement due to the inability of many developing and underdeveloped to impact adequate knowledge and training to engineers at different levels of training due to the following challenges; Poor funding, inadequate equipment, lack of high-quality manpower including trainers and lecturers, inadequate industrial training or internship, poor attitude of employers as the dominant problems faced by engineering education in Nigeria, lack of proper intervention by professional engineering organizations and international bodies through provision of financial and material assistance as well inappropriate government policies that hampers engineering education in these countries.

Based on the above issues, it is obvious to me that integration of Flexible Focus Factory System as part of engineering education will help in eliminating many of the challenges. Azubuike et al. (2019), in their article titled "Engineering Education in Nigeria: Challenges and Recommendations", pointed out that the challenges associated with short duration of projects, inadequate internship programs, use of obsolete lab scheme of work and equipment and unstable power supply contributes to the challenges facing engineering education. Many of these issues can be eliminated if universities adopt the Flexible Focus Factory System approach to engineering education because the students will have the opportunity to develop, design and manufacture most of the equipment needed instead of waiting for government funds that is needed to procure the equipment and spare parts needed for engineering labs, power supplies and other items needed by the department of engineering and other departments at the universities.

## Frame-Work for a 5 Year Engineering Education Program with Flexible Focus Factory System

The suggested general curriculum for integrating Flexible Focus Factory System into engineering education are shown below. This is a five-year engineering program that may take six years to complete. Once a student graduates from this program, they will possess both the theoretical and real-life experience they need to jump into the work force and become instant contributors to the companies that employs them.

| 1st Year | 2nd Year | 3rd Year |
|---|---|---|
| ❖ First year Engineering Courses, labs and electives<br>❖ Introduction of Flexible Focus Factory Concept<br>❖ Introduction of Product Design and Development | ❖ Second year Engineering Courses, labs and electives<br>❖ Formation of Product and Manufacturing Teams<br>❖ Courses on Product and Process Development<br>❖ Selection of Focus Factory Products by each team<br>❖ Research of Products and Processes<br>❖ Courses on Manufacturing Strategy development and deployment | ❖ Third year Engineering Courses, labs and electives<br>❖ Course/s on roles and responsibilities<br>❖ Assign roles and responsibilities to team members<br>❖ Develop Product and Process Strategy<br>❖ Start and finalize product design and development<br>❖ Start Process Development including development of product/process standards and specifications |
| **4th Year** | **5th Year** | |
| ❖ Fourth year engineering courses, labs and electives | ❖ Finalize Tooling, Equipment/Machines and Processes | |

| | | |
|---|---|---|
| ❖ Supply Chain Management, Operations Management and Supervision Courses<br>❖ Finalize process, tooling Equipment, equipment/machine design<br>❖ Fabricate and build tooling and equipment/Machines<br>❖ Finalize Design and start prototype tooling<br>❖ Build, test and validate prototypes if required. | ❖ Install tools, equipment/machines and then debug and tryout<br>❖ Prepare Bill of Materials (BOM) including all components, tools, equipment and processes<br>❖ Prepare the facilities and work stations for production run<br>❖ If outside employees are needed, students will hire and train them.<br>❖ Pre-Production and final production start<br>❖ Write team report on Lesson's learned, prepare team final presentation to a committee of professors and outside operations professionals. ---<br>**GRADUATION** | |

## 1. Flexible Focus Factory Areas

In the view of this researcher, the traditional engineering curriculum has not for the most part delivered the best results in developing and underdeveloped countries that lacks the extensive manufacturing and non-manufacturing organizations that is ready and willing to provide internship or industrial training opportunities required to gain some engineering experience prior to graduation. Due to this reason, many engineering graduates do not have the requisite real-life experience to navigate the mucky waters of industries that decides to employ them. Many of these newly minted graduates may not have any understanding of the components of design, development and manufacturing operations shown in figure 2 below prior to leaving the four walls of their academic institutions. Integrating this type of Flexible Focus Factory System into the engineering education will be beneficial to the student, universities and societies at large. It will provide the needed real-life experience that corporate entities require for their new hires. Also, the new graduates would have developed the minimal skills, capabilities and experience required to become a contributor right from day one at their respective companies. The areas shown below will be executed by the students from the conceptualization phases of the products or projects to the launch or execution phases. This is where the rubber meets the roads and the engineering student will be involved at every phase of the projects.

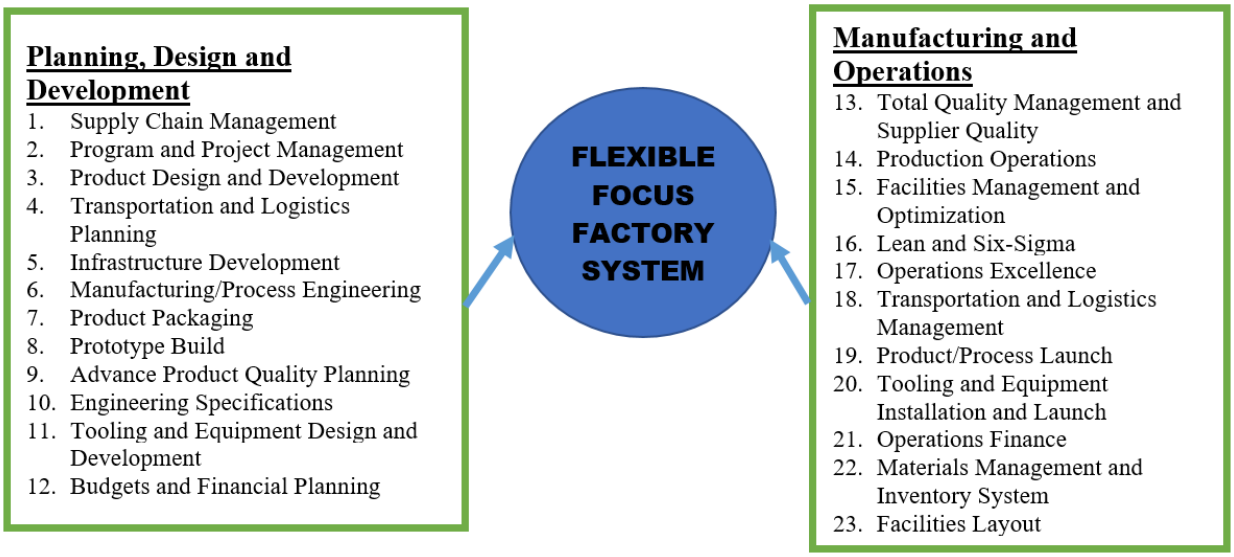


Figure 2: Flexible Focus Factory Components

## Merits and demerits of Integrating Flexible Focus Factory into Engineering Education in Developing and Underdeveloped Countries

Like in everything else that humans are involved, there are merits and demerits. In this case, this researcher believes that the merits of integrating a Flexible Focus Factory System as part of engineering education in developing and underdeveloped countries outweighs the demerits. This will assist the engineers that graduates from this type of engineering education to be more productive right from day one than their counterpart in the same countries from the current traditional engineering education programs. Wickham Skinner (May, 1974) stated in his article titled "The Focused Factory" that Seeing the problem not as "How we can increase productivity" but as "How we can compete". I firmly believe that this system if implemented will lead to graduating engineering students that will be productive and at the same compete favorable with their counterparts from developed countries with extensive corporate entities that offer internships and industrial training programs for engineering students in their countries of operation. Listed below are the merits and demerits of this type of academic program.

### Merits:

- Afford students the opportunity to gain practical and hands on experience (Real world Application)
- Help students to understand the integration of theory and practice
- Help students and faculty to expand their ability and capability in the areas of design, prototyping, manufacturing, operations and supply chain
- Encourage cross functional learning approach between different engineering disciplines and other areas such as business and management education
- Give the students the opportunity to participate in product creation and manufacturing operations
- Provide a platform for business incubation in engineering department that can transfer to the society at large
- Opportunity for students to learn lead, manage and supervise real life Projects
- Learning to structure the basic policies and procedures for development and execution of product design/development, program/project management, manufacturing/operations, supply chain management and total quality management.

### Demerits

- Funding Constraints
- Government policies with regards to engineering education
- Additional year added to the program and makes the program a potential 5-year program versus the current 4-year program
- Lack of experienced faculty and other supporting staff
- Resistance from faculty, university administrators

## Conclusion

In conclusion, I will like to point out that this new approach to engineering education for developing and underdeveloped countries will make it possible for the students to gain the real-life experience that may be missing today in their current engineering programs. It will help universities to utilize their student talents to produce some useable products for the country as well as for the university. The university will be come a hub for incubating new business ideas and training students to become inventors, entrepreneurs and productive employees right from day one in the organizations that hire them after graduation. The Flexible Focus Factory will make easier for every engineering student that goes through its program to gain the experience that others gain from internships or industrial trainings at corporate entities. Infarct, this approach will be preferable for undergraduate students since most internships and industrial trainings do not give students the opportunity in participating effectively as product design and development as well manufacturing operations team members. Most of them are used as errand staff to support the engineers tasked with the responsibility of developing and executing the projects.

Though, there is cost associated in setting up this type of program, but once it is set up and running, it will pay for itself because some of the products that the university buys from other sources will be developed by the Flexible Focus Factory System which saves money. Also, some projects such as university road and utility infrastructure maintenance, as well as design and construction of new roads and building infrastructures can be done by the students and their professors. In my opinion, minting out new engineering graduates that do not have the proper tools to execute engineering projects may be responsible for these countries having to depend on foreign training engineers for design and development of their infrastructure projects. This phenomenon lives them at a disadvantaged position in technological and infrastructural development and advancement. The disadvantage, leads to high unemployment for engineering graduates and poor maintenance of the infrastructures built by expatriate that left the country long after the projects were completed.

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## Bio

Dr. Joseph M. Ogundu is the president /CEO of Emerald Global Consulting Inc., a Farmington Hills, Michigan based consulting firm. Dr. Ogundu has extensive experience in academia, leadership, project management, business process excellence, lean transformation, six-sigma, supply chain management and supplier quality, change management, operations, industrial engineering, manufacturing and process engineering, quality engineering and quality assurance. Dr. Ogundu is a lean practitioner and six-sigma practitioner that sees lean six-sigma as operations management philosophy that is based on the relationship between waste reduction and elimination, quality improvement and operations performance measures.

Dr. Ogundu was Adjunct professor, Industrial and Systems Engineering at both Lawrence Technological University, Southfield Michigan and Oakland University, Rochester Michigan, as well Adjunct Professor: Business Administration, Kettering University, Flint Michigan. He thought courses in both undergraduate and graduate levels and the courses were Lean Systems Application, Quality Assurance and Control, Total Quality Management, Operations Research and Stochastic Processes, Manufacturing Processes, Advanced Quality Planning, Supplier

Quality, Business Statistics, Lean Six-Sigma, Production Planning and Control, Materials and Inventory Management and Operations Management, Dr. Ogundu worked in the following industries, Automotive, Oil and Gas, Manufacturing, Consulting, Energy and Health Care. Dr. Ogundu is the author of the book "The Relationship between Types of Waste and Operating Performance Measures.

Dr. Ogundu graduated with a Doctorate Degree in engineering and manufacturing systems, Masters in business administration from Lawrence Technological University, Master's Degree in Manufacturing Engineering from Wayne State University and a Bachelor's Degree in Industrial Engineering from University of Tennessee. Knoxville, Tennessee. Dr. Ogundu spent the earlier years of his career in engineering, leader and senior management positions as director and executive director at Country Coach Inc, process engineering manager at DaimlerChrysler AG, Senior Operations leader at Chrysler Corporation, facilities engineer and project manager at Ford Motor Company and Senior Product Engineer at General Motors Corporation. Dr. Ogundu has served as board member of Lawrence Tech University College of Management Alumni Association, Finer Cabinetry & Woodwork Inc., Citation Plastics, LLC., River State Foundation Inc., as well as Board member of Health Care Management department at South University Novi, Michigan Campus. Also, he served as Vice President of Chapter Development Institute of Industrial Engineers SE Michigan/Toledo Chapter from 1991 to 1992.