

Building Strong Foundations: A Guide to Construction Principles (Instructional Materials in Civil & Construction Technology)

Redjie D. Arcadio

Master in Furniture Design, Federal Republic of Germany, Master in Technician Education (MTE), Doctor of Philosophy in Technology Management (Ph.D.T.M.), College of Technology, Cebu Technological University, Pinamungajan Campus, Pinamungajan Cebu, Philippines

Dr. Gerwine J. Medio

Master in Technician Education Major Civil Technology, Doctor of Philosophy in Technology Management (Ph.D.T.M.), College of Technology, Cebu Technological University, Main Campus R. Palma St. Cebu City Philippines

Dr. Ramelito C. Almendras

Master in Technician Education Major Civil Technology, Doctor of Philosophy in Technology Management (Ph.D.T.M.), College of Technology, Cebu Technological University, Pinamungajan Campus, Pinamungajan Cebu, Philippines

ABSTRACT

“Building Strong Foundations: A Guide to Construction Principles” is a comprehensive and practical resource that explores the fundamental principles of construction aimed at architects, engineers, contractors, and construction enthusiasts. The study explores construction developments through a literature analysis and case studies, examining their impact on foundation-building techniques, efficiency, durability, and safety. This guide delves into the concepts and methodologies necessary to create stable, durable, and efficient structures. This publication covers diverse construction materials, procedures, and design concerns and is a helpful resource for everyone interested in the construction industry. From understanding the role of foundations in supporting buildings to implementing best practices for safety and sustainability, this guide equips readers with the knowledge and expertise to ensure the successful realization of robust and enduring constructions.

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INTRODUCTION

Technology's profound role in shaping human civilization spans from ancient times to today, as humans harnessed and manipulated earth's resources, leading to remarkable advancements and societal transformations (D MacKenzie, J Wajcman, 1999). Rooted in applying scientific knowledge, technology has improved life, communication, transportation, and knowledge dissemination (A Agrawal, 1995). From stone tools to the wheel, agriculture, and the printing press, each innovation influenced humanity's trajectory (G Basalla, 1988). The industrial revolution introduced mechanization, electricity, and the internet ushered in the age of connectivity, revolutionizing industries, communication, transportation, and medicine (S Paul, M Riffat, A Yasir, MN Mahim, 2021). Modern technology like renewable energy and nanotechnology continues this trend (A Marcus, J Malen, S Ellis, 2013). While improving communication, education, and healthcare, technology also poses challenges in data privacy, cyber security, unemployment, and the environment (S Rani, RK Mishra, M Usman, A Kataria, P Kumar, 2021).

Embracing technological progress with prudence is vital for a future that optimizes benefits while considering social and environmental impacts (I Agenda, 2016).



Figure 1

History of technology

The history of technology encompasses the evolution of tools and techniques throughout human civilization, from ancient stone tools to modern-day advancements in genetic engineering and information technology (T Taylor, 2010). The term "technology" originates from the Greek words "techne," referring to art and craft, and "logos," meaning word and speech (RJ Tulley, 2008). Initially associated with applied arts, the term now encompasses various advancements and innovations that shape and influence our environment (WJ Byrnes, 2022). Technology has played an essential part in molding human history, from simple tools to cutting-edge breakthroughs. (B Denkena, D Biermann, 2014).

Thus, technology integration has become the cornerstone of innovation in the ever-evolving construction world, propelling the industry into new frontiers of efficiency and sustainability. This study guide, "A Technological Building Strong Foundations: A Guide to Construction." This comprehensive guide aims to unravel the transformative power of technology in construction, offering a roadmap to harness its potential in creating resilient and robust foundations. From adopting advanced materials to utilizing cutting-edge techniques, we embark on a journey to explore the dynamic landscape of modern construction, empowering builders, engineers, and enthusiasts alike to construct the structures of tomorrow with unwavering strength and ingenuity. Join us as we unravel the possibilities, embrace the challenges, and embrace the boundless opportunities technology brings to the construction realm.

OBJECTIVES

1. Understand the role of specialized tools and technology in forming an economic system and how these advancements facilitated specialization, trade, and increased productivity.
2. Identify and classify materials based on their origin and processing methods, distinguishing between extracted, reproduced, constructed, and manufactured materials. Provide three examples for each category.
3. Differentiate between constructed products, which involve shaping and assembling raw materials to create structures or objects, and manufactured products, which are transformed from raw materials through industrial processes. Offer three examples of each type to illustrate the distinction.

RESEARCH METHODOLOGY

This instructional manual aims to provide a comprehensive guide to construction practices focusing on leveraging technology to establish robust building foundations. The study will look into the most recent technical advances in construction and assess their impact on foundation-building procedures, efficiency, durability, and safety. The research will investigate innovative materials and techniques contributing to improved foundation performance through literature review, case studies, surveys, interviews, and laboratory testing. Ethical considerations will be adhered to, ensuring confidentiality and informed consent. The expected outcome is a valuable guide for industry professionals on implementing technological solutions for strong building foundations, fostering innovation and sustainability in the construction industry.

RESULT AND DISCUSSION

The history of humanity and innovation reveals the profound impact of specialized tools and technology on forming the economic system. Technological advancements, from the earliest stone tools to modern-day innovations like renewable energy and nanotechnology, have driven economic progress. Developing specialized tools and techniques increased productivity, allowing individuals and communities to specialize in specific tasks and trade surplus goods. This specialization and trade, in turn, formed the foundation of an economic system where goods and services are exchanged to meet diverse human needs and desires. As history demonstrates, innovations have sparked economic transformations, disrupting existing industries and creating new growth opportunities. While embracing technological progress has undoubtedly improved various aspects of human life, it also presents challenges in data privacy, cybersecurity, and environmental concerns. Therefore, it is essential to approach innovation with prudence, considering its broader impacts on society and the environment.

The processing of materials through extraction, reproduction, construction, and manufacture plays a vital role in fulfilling human needs and creating diverse goods. Extraction involves obtaining natural resources directly from the earth, while reproduction focuses on the propagation of living organisms for sustenance and species continuity. On the other hand, construction and manufacturing represent two distinct methods of transforming materials into functional products. Construction involves shaping and assembling raw materials to create structures and infrastructure, while manufacturing uses industrial processes to mass-produce finished goods. Each process contributes uniquely to economic development, with construction creating the built environment and manufacturing meeting the demands of a modern consumer society. Properly managing these processes is crucial for sustainable development and responsible resource utilization. Understanding the distinctions between these methods enables the community to optimize the use of materials and create goods efficiently, balancing economic growth with environmental considerations.

1.1. The Dawn of Human Civilization

Living almost two million years ago in a primitive world, devoid of schools, clothes, or settled communities, survival is a constant struggle for me and my family. With no language as we understand it today, communication is limited to basic gestures and grunts. As we forage for food and fend off dangerous animals, my father's lucky use of a stone to protect us and hunt marks a crucial turning point in our existence. That stone, the first tool, becomes the foundation of technology, enabling us to improve our physical abilities and increase our chances of survival. Over time, we learn to create more sophisticated tools, enhancing productivity and progress. The ability to think and innovate, coupled with our mastery of technology, sets us apart from other creatures, driving our evolution forward.

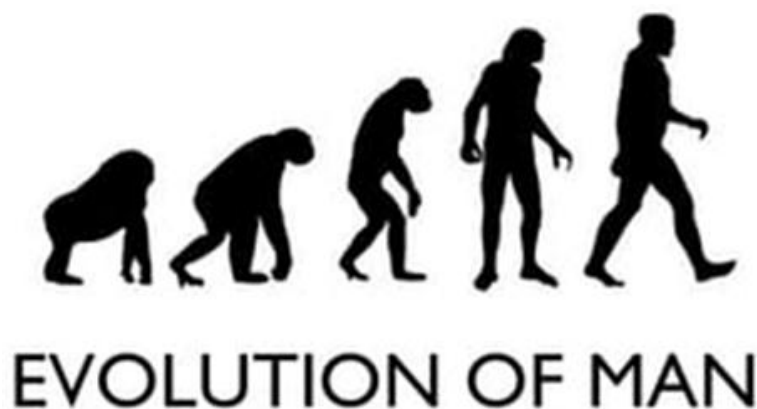


Figure 2

The Dawn of Human Civilization

1.2. Innovation sparks the birth of a new economic system

Throughout history, man's progress in technology has been marked by the discovery of new materials like metal, starting with copper in Egypt around 5,000 years ago and later bronze, followed by iron in Europe.

These metals gave humans more control over nature and led to the development of new tools and technologies. With the efficiency gained from tools, people could now specialize in various tasks beyond basic survival, such as clothing, shelter-building, governance, teaching, and entertainment. Specialization allowed for increased productivity and trade, leading to an economic system where goods and services are exchanged. Technology played a pivotal role in producing an abundance of goods, shaping the economic landscape and society as we know it today.



Figure 3

Innovation sparks the birth of a new economic system

Innovation indeed has a profound impact on economic systems, often leading to the birth of new ones. When significant innovations emerge, they disrupt existing industries, create new opportunities, and reshape the way businesses and societies operate. This transformative process can give rise to entirely new economic models.

Technological Advancements: Technological innovations, such as the invention of the internet, artificial intelligence, or renewable energy sources, can revolutionize industries, opening up new markets and changing the way products and services are produced and delivered. These breakthroughs can lead to the emergence of new economic sectors and the restructuring of traditional industries.

Efficiency and Productivity: Innovations that improve efficiency and productivity can drive economic growth. When businesses adopt more efficient processes or introduce automation, they can produce more goods and services at lower costs, leading to increased output and potential economic expansion.

Market Disruptions: Innovations often disrupt existing markets, rendering certain products or services obsolete while creating demand for new ones. This dynamic creates opportunities for entrepreneurs and startups to enter the scene and contribute to the formation of a new economic ecosystem.

Job Creation and Skill Shifts: As new technologies and industries emerge, they generate a demand for specific skills and expertise, creating new job opportunities. However, this shift may also require retraining and upskilling the workforce to adapt to the changing economic landscape.

Globalization and Connectivity: Innovations in communication and transportation have facilitated global trade and connected economies across borders. This interconnectedness has led to the integration of various markets and the development of global economic systems.

Sustainable Development: Innovations in sustainable practices and green technologies have the potential to shape new economic models focused on environmentally responsible and resource-efficient approaches. This shift towards sustainability can influence consumer behavior, market dynamics, and policy frameworks.

Economic Inclusivity: Certain innovations, such as mobile banking and digital payment systems, have the potential to increase financial inclusion and provide economic opportunities to previously underserved

populations, leading to more inclusive economic systems.

Regulatory and Policy Impacts: The emergence of groundbreaking innovations may require new regulatory frameworks and policies to address potential challenges and ensure fair competition. Governments play a vital role in shaping the development and adoption of new technologies within the economic landscape.

In conclusion, innovation acts as a catalyst for change in economic systems, fostering growth, efficiency, and the creation of new industries. The continuous cycle of innovation drives progress, and as technology and human creativity evolve, we can expect to witness the birth of new economic systems, shaping the world's economic landscape for generations to come.

1.3. Processing economic goods involves obtaining materials through two primary methods:

1. Extraction from nature, and
2. Natural reproduction.

Indeed, before we can use many materials to fulfill our needs and desires, they undergo processing through two main methods: construction and manufacture.

Construction involves shaping and assembling raw materials to create structures, buildings, and infrastructure. It encompasses various activities such as carpentry, masonry, and welding, which transform materials like wood, bricks, and steel into functional and aesthetically pleasing constructions. Construction is essential for creating homes, offices, roads, bridges, and other vital components of our built environment.

On the other hand, manufacture involves transforming raw materials into finished products through industrial processes. This can include procedures like molding, machining, or chemical reactions, which convert materials into consumer goods, machinery, electronics, and other products. Manufacturing plays a crucial role in mass-producing items and meeting the demands of a modern consumer society.

Both construction and manufacture are integral to economic development and human progress. They enable us to shape the world around us and provide us with a vast array of products that improve our quality of life. Properly managing these processes is essential for sustainable development and ensuring the responsible use of resources to meet the needs of current and future generations.

To satisfy our needs, most materials undergo processing before they are utilized. This processing occurs through two primary methods: construction and manufacture.

1. **Construction.** Involves shaping and assembling raw materials to create structures and objects. Examples include carpentry, masonry, and welding, transforming materials like wood, bricks, and steel into buildings, infrastructure, and other functional components of our built environment.
2. **Manufacture.** Encompasses industrial processes that transform raw materials into finished products. Examples include molding, machining, and chemical reactions, converting materials into consumer goods, machinery, electronics, and various manufactured items that cater to our diverse needs.

Extraction is the method of obtaining materials directly from their natural sources.



Figure 4
Resource Extraction

Resource extraction. It is the process of removing natural resources from the earth or its surrounding environments for various purposes, such as manufacturing, energy production, construction, and consumption. It is a fundamental aspect of human civilization, enabling the production of goods and services that sustain modern societies. However, resource extraction also raises important economic, social, and environmental considerations.

Several examples illustrate this process:

1. Extracting crude oil involves drilling a hole into the ground and pumping out the oil reserves from underground reservoirs, which serves as a fundamental raw material for various industries, such as energy production and manufacturing.

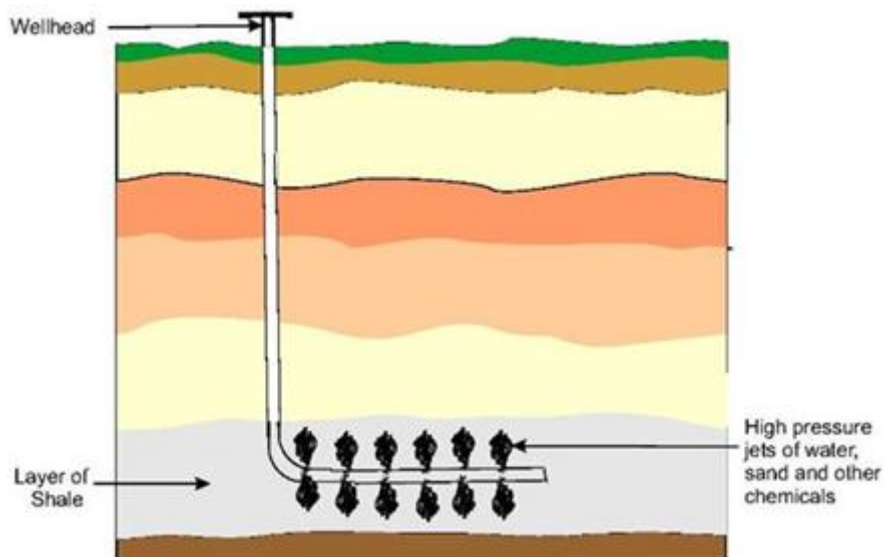


Figure 5

Hydraulic fracturing (fracking) used to release oil and natural gas from a stratum of shale

1. Panning a stream for gold involves using a shallow, wide-bottomed pan to sift through sediment and gravel to separate gold particles from other materials. This historical method has been used for gold prospecting and remains a technique used in some regions.



Figure 6

Gold Panning

Gold panning is a simple and traditional method of extracting gold from rivers, streams, and other water bodies. It has been practiced for centuries and is closely associated with the early days of gold rushes and prospecting. While modern mining methods have largely replaced gold panning as a commercial activity, it remains a popular recreational activity and a symbol of the search for gold and adventure.

2. Digging on a beach in South Africa allows for diamond mining. This precious gemstone is extracted from sedimentary deposits found near coastlines, and mining operations involve carefully removing layers to reach the diamond-bearing gravel.



Figure 7

Digging on a beach

Digging on a beach can be a popular recreational activity for people of all ages, offering a fun and enjoyable experience by the shoreline. However, it's essential to consider the environmental impact and local regulations when engaging in such activities.

2. Digging gravel out of a gravel pit is a common practice for obtaining this useful material. Gravel is widely used in construction and landscaping, and it is typically extracted from shallow open-pit mines or quarries.



Figure 8

Digging gravel out of a gravel pit

3. In all these examples, extraction is a vital step in acquiring essential resources that serve as the foundation for various industries and contribute to meeting human needs.

Reproduction, construction, and manufacture are distinct processes that contribute to obtaining useful materials and creating goods.

1. **Reproduction:** A natural process involving the propagation of living organisms. Examples include planting seeds to grow trees for landscaping, obtaining a puppy from a mother dog, or seeding a yard to grow grass. Reproduction is essential for sustaining life and ensuring the continuation of species.
2. **Construction:** Involves assembling raw materials to build structures or objects at a specific location. Examples include building houses, installing sewage systems, and constructing bridges. Construction combines various materials and components to create functional and lasting structures.
3. **Manufacture:** The process of producing goods in a factory or plant. Examples include manufacturing radios, automobiles, jet airplanes, and coloring books. In this process, raw materials are transformed through industrial procedures to create finished products for consumer use.

Each of these processes serves a crucial role in meeting human needs and advancing society. Reproduction ensures the growth and renewal of living organisms, construction creates infrastructure and buildings, while manufacture produces a wide range of products for daily use and consumption.

1.4. Industry

Industry encompasses the processes that change the form of materials to produce the things we need. Among the four ways of production (extraction, reproduction, construction, and manufacture), construction and manufacture are the primary components of industry. While reproduction and extraction use products found in nature without significant alteration, industry involves shaping materials to create goods. Industrial arts, as a field of study, focuses on the use of tools and techniques to construct, manufacture, and service goods. It is the study of construction and manufacturing technology, enabling students to understand how to create and work with various materials effectively. This year's curriculum will center on construction technology, providing valuable insights into this important aspect of industry.

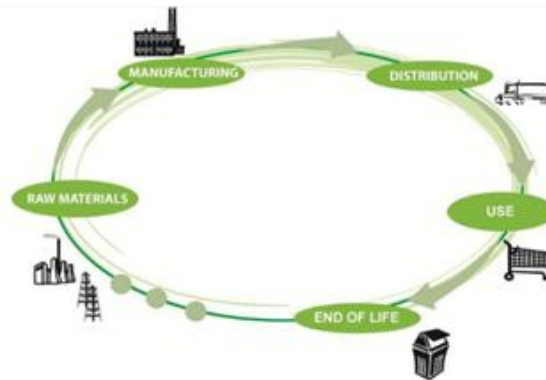


Figure 9

Ways of production

1.5. Summary

As technology advanced, human beings embraced specialization, focusing on tasks they excelled at and enjoyed. Trading and selling emerged as people exchanged their goods and services, leading to the development of an economic system. Within this system, individuals can acquire desired products, which can be categorized into material goods and services.

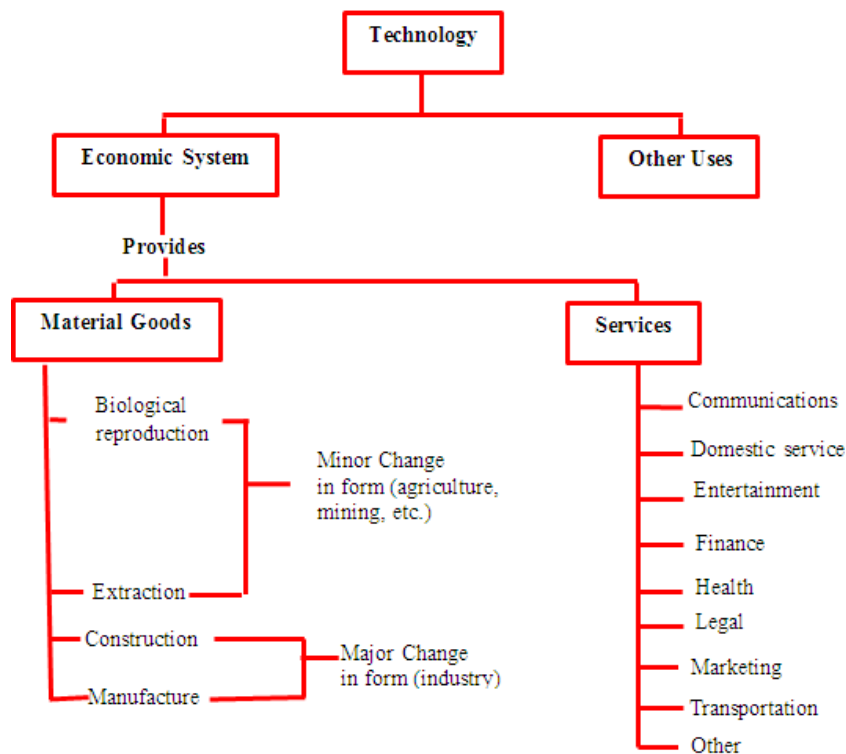


Figure 10

Material Goods and Services

Material goods can be obtained through extraction and reproduction, and they can be processed through construction and manufacturing. Among these processes, construction and manufacturing (industry) have the most significant impact on altering the shape, form, or size of materials. Industrial arts, therefore, can be defined as the study of utilizing tools and techniques to construct, manufacture, and service goods.

CONCLUSION

In conclusion, the intricate relationship between humankind and innovation has been the driving force behind the remarkable progress of human civilization. From the early use of simple stone tools to the advent of cutting-edge technologies like the internet and renewable energy, each innovation has left an indelible mark on society's trajectory. The role of specialized tools and technology in forming economic systems cannot be overstated, as they have facilitated specialization, trade, and increased productivity. As a result, complex economies have emerged, with resources efficiently allocated to fulfill the different demands of individuals and groups.

The categorization of materials into extracted, reproduced, constructed, and manufactured items highlights the diverse ways in which human ingenuity has harnessed and transformed resources. Each process represents human creativity and resourcefulness, from extracting precious metals like gold and diamonds from the earth to reproducing essential crops and livestock for sustenance and constructing towering buildings and infrastructure to manufacturing sophisticated electronics and textiles. As we move forward, we must embrace technological advancement with wisdom and forethought, considering its benefits in terms of efficiency and convenience and its potential issues, such as data privacy, cybersecurity, and environmental impact. By striking a delicate balance between progress and responsibility, we can shape a future where innovation continues to elevate human existence while preserving the planet and fostering inclusive and sustainable economic systems.

RECOMMENDATION

This guide serves as a beacon of knowledge, providing an in-depth exploration of technology's pivotal role in modern construction practices. It showcases the most recent technological developments and explains how they can be used to construct solid foundations for building projects. The comprehensive coverage of various construction techniques, materials, and tools reinforces the guide's credibility and makes it an indispensable reference for both novices and seasoned professionals.

One of the most commendable aspects of this guide is its emphasis on sustainability and environmentally friendly construction practices. As we navigate an era of heightened environmental awareness, the construction industry must embrace eco-conscious methodologies to minimize its ecological footprint. The "Technological Building Strong Foundations" guide successfully addresses this need and provides insightful strategies for implementing sustainable practices throughout construction.

Furthermore, the authors of this guide have taken a commendable approach to making the content accessible to a wide range of readers. The language is clear, concise, and free from unnecessary jargon, ensuring that even those with limited technical knowledge can benefit from its wealth of information. Moreover, including practical examples, case studies, and visual aids enhances the learning experience, making complex concepts easier to grasp.

As someone actively involved in the construction industry, the authors believe that the "Technological Building Strong Foundations" guide will become an essential companion for professionals, academics, and students seeking to stay at the forefront of construction technology. By incorporating the insights and practices presented in this guide, construction companies can streamline operations, improve efficiency, and enhance overall project outcomes.

The researchers recommended this study of "Technological Building Strong Foundations: A Guide to Construction" and strongly urge individuals and organizations involved in the construction sector to consider it a crucial addition to their libraries. Its relevance and practicality make it an enduring resource that will undoubtedly shape the future of construction practices.

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