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ИНОСТРАННЫЙ ЯЗЫК

ТЕХНОЛОГИЧЕСКИЕ МАШИНЫ И ОБОРУДОВАНИЕ

Методические указания для самостоятельной работы студентов бакалавриата направления подготовки 15.03.02

TECHNOLOGICAL MACHINES AND EQUIPMENT

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Методические указания предназначены для самостоятельной работы студентов бакалавриата направления 15.03.02 «Технологические машины и оборудование (Инжиниринг технологического оборудования)» и согласованы с программой по иностранному языку для студентов неязыковых вузов.

Предлагаемый материал направлен на совершенствование навыков чтения, понимания и перевода технических текстов, построения высказываний на основе полученной информации, а также на развитие навыков самостоятельной работы с аутентичным материалом в рамках профессиональной направленности. В методические указания включены оригинальные тексты, сопровождающиеся комплексом упражнений с целью овладения иноязычной профессиональной компетенцией.

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ПРЕДИСЛОВИЕ

Данные методические указания предназначены для самостоятельной работы студентов бакалавриата направления 15.03.02 «Технологические машины и оборудование (Инжиниринг технологического оборудования)», а также могут быть полезны для студентов вузов технического профиля близких специальностей. Методические указания составлены в соответствии с учебной программой по дисциплине «Иностранный язык» для формирования иноязычной профессиональной компетенции будущих специалистов.

Предложенные аутентичные материалы и разработанный к ним комплекс упражнений направлены на совершенствование навыков устной и письменной иноязычной речи в контексте профессионально-ориентированного общения. Тематика текстов затрагивает различные аспекты истории и современного состояния производства технологического оборудования. Большая часть заданий нацелена на отработку навыков перевода, а также навыков ознакомительного и поискового чтения.

Особое внимание уделяется расширению словарного запаса, который включает наиболее употребительные для специальности термины и слова общетехнического значения.

UNIT 1 ORIGINS OF MODERN MANUFACTURING

Text 1

What did Manufacturing Look like before the Industrial Revolution?

Task 1. Translate the following international words without a dictionary: aspects, innovation, period, Industrial Revolution, product, individually, manufacture, exclusive, official, system, training, religions, privileged, design, effect, political, economic, invest, expansion, potential, patent, electric, generator.

Task 2. Use a dictionary to translate the words and phrases in bold into Russian.

Task 3. Look at the title of the text and the vocabulary in bold to predict what the text is about.

Task 4. Skim through the text to check your ideas.

Task 5. Read and translate the following text.

Many aspects of our lives—including the goods we produce, the cities we live in, and the environment we **inhabit**—can **be traced back** to a period of **groundbreaking** innovation called the Industrial Revolution.

Before factories existed, highly skilled workers known as **artisans** made everything, including books, clothing, and furniture in small **workshops** across medieval Europe. The pace of production was slow, with each product individually **handcrafted**. In turn, goods were often expensive and **in short supply**. Not just anyone could manufacture and sell such goods either. Around the eleventh century, associations of artisans called **guilds** came to power. Guilds lobbied and **bribed** politicians in order to become the exclusive manufacturers of certain products. This **arrangement** meant that selling a nail, for instance, without **belonging to** the official nail guild could land someone in prison.

And how exactly did one join a guild? Well, that, too, was no small feat. **Prospective** members worked in a system in which they supplied guild artisans with **cheap labor** in exchange for training. They then had to **pay a membership fee** that could cost around nine years in wages. Many guilds refused to **admit** women, migrants, farmers, propertyless men, formerly **enslaved** people, and practitioners of **minority** religions. As a result, guild membership **belonged to** privileged members of society and often passed from father to son.

Guilds not only decided who could make their products but also what those products could look like, **enforcing** strict guidelines on price and design. Although this system was intended to ensure that guild members did not have to compete against each other, it also had the effect of largely **stifling** innovation.

What brought about the Industrial Revolution?

Guilds ruled the marketplace for a long time—but not forever. By the late seventeenth century, the British government had **repealed** many of the guilds' exclusive selling **rights**, without which artisans struggled to compete with upstart entrepreneurs who created more diverse goods at cheaper prices.

As guilds **declined**, this new class of manufacturers became increasingly wealthy, aided by various political and economic changes unfolding in England. New patent laws **encouraged** people to invest in innovation by ensuring they could protect and profit from their inventions. Reforms in banking made it easier to **borrow** money, helping businesses grow even larger. And the expansion of the British Empire meant businesses had millions of new potential customers.

Two further developments—innovations in manufacturing and the rise of the factory system—cemented the **downfall** of the guilds, marking the beginning of the Industrial Revolution in mid-eighteenth-century England.

The invention of new machines allowed entrepreneurs to **automate** parts of the manufacturing process, leading to goods that could be produced faster and cheaper than ever before. One such **entrepreneur**, Richard Arkwright, patented the water frame in 1769, which **harnessed** waterpower in the textile weaving process rather than relying on hand-spinning. When Arkwright lost his water frame patent in court in 1785, a flood of entrepreneurs **replicated** his water-powered cotton mill. In subsequent decades, manufacturers in other industries would seek to similarly **improve efficiency** through the creation of new tools. A flurry of new inventions entered the market, including the cotton gin, the internal **combustion engine**, and the electric generator.

Inventions of the Industrial Revolution

Around the same time, factories became increasingly common. Unlike guild-style workshops in which a single artisan would produce a good—say, a shoe—from start to finish, factories employed a system called **division of labor**. This system increased efficiency by dividing manufacturing into a series of tasks with each worker responsible for a single task. Rather than have one worker produce an entire shoe, each worker could spend their entire day fastening heels or threading shoelaces for hundreds of shoes. And because the majority of tasks were **menial**, factories could hire cheap, unskilled, and easily replaced laborers instead of artisans. In the early 1900s, Henry Ford further accelerated the pace of production by **implementing** the moving **assembly line**, which reduced the time it took to produce a single car from twelve hours to just over ninety minutes.

Between the **surge** in technological innovation and the rise of a new system of production, the Industrial Revolution led to manufacturing becoming highly efficient and, therefore, highly profitable.

From https://world101.cfr.org/historical-context/prelude-global-era/what-are-origins-modern-production

Task 6. Answer the following questions:

1. What period can many aspects of our lives be traced back to?
2. Who made everything before factories existed?
3.How did guilds work?
4.Why did guilds decline?
5.What did the invention of new machines allow entrepreneurs?
6.How did a system called *division of labor* increase efficiency?
7.What did Henry Ford implement to further accelerate the pace of production in the early 1900s?

Task 7. Make a plan and give a short summary of the text.

Text 2

How did the Industrial Revolution Reshape the Society?

Task 1. Pay attention to the formation of the following words and translate them into Russian: unpredictable, inability, unprecedented, industrialist, entirely, reorder, workshops, unemployed, self-employed, monotonous, notification, management, owners, informal, largely, regulations, membership, philosopher, frequently, threaten, productivity, urbanization, noticeable, deindustrialization.

Task 2. Use a dictionary to translate the words and phrases in bold into Russian.

Task 3. Look at the title of the text and the vocabulary in bold to predict what the text is about.

Task 4. Skim through the text to check your ideas.

Task 5. Read and translate the following text.

Prior to the Industrial Revolution, farming was a common profession. It was also **precarious** work. Any number of unpredictable factors, like a single drought or one bad harvest, could spell financial ruin and the inability to put food on the table. But as the Industrial Revolution produced new jobs—first in England and, **eventually**, around the world—people started leaving their farms for factories. With that transition came more **reliable and consistent incomes**. And with innovations in mass production, food and household items became cheaper and more available as well.

On the national level, in the mid-nineteenth century, the British economy was consistently growing for the first time in its history, **buoyed** by the country's **thriving** textile, coal, and iron industries and their ability to produce goods at unprecedented rates.

The Industrial Revolution created so much growth that countries were willing to spy and steal to get their hands on the latest technology. The British government—determined to protect its economic advantage—even passed laws **prohibiting** the emigration of skilled workers and the export of industrial technology. Those laws, however, had little success. In one instance, a British industrialist named Samuel Slater emigrated to the United States in 1789 **disguised** as a farmer. He would go on to build the country's first textile factory entirely from memory, having left Britain without notes or plans that could have been confiscated by British **authorities**. In the United States, Slater is known as the Father of the American Industrial Revolution; in England, he's known as Slater the Traitor.

The Industrial Revolution would reorder not only the ways in which we produce goods but also the ways in which we work and live. Many of those changes are still felt today. Let's explore five ways in which the Industrial Revolution reshaped society for centuries to come.

Changing workforce: The origins of today's manufacturing workforce date back to the Industrial Revolution with the **transition** from artisan-led workshops to large factories employing cheap, unskilled workers.

This transition, however, often **faced resistance**. As factories grew and workshops shuttered, highly skilled—and now unemployed—artisans turned to factories for work. For many, this was the first time they were not self-employed. They had managers dictating their **schedules** and **assigning** them monotonous tasks far below their skill level. Some artisans **rebelled** against their employers, ignoring orders and moving from factory to factory without notification. Others outright **revolted**, breaking machines and attacking factories in protest. In response, factory owners—including Richard Arkwright—armed their buildings with guns and cannons.

Factory owners struggled to find new ways to manage their workers. For the first time, many workplaces began **establishing** designated management positions and strict working hours. In several instances, factory owners even tried to **ensure** that future generations of workers would be more disciplined and **obedient**, sponsoring churches, chapels, and the first Sunday schools. Many schools went through parallel changes and started implementing their own reforms, moving from small, informal schoolhouses to a "cells and bells" system with set schedules and larger class sizes.

Labor rights: Some of the first labor unions advocating for workers' rights emerged during the Industrial Revolution in response to **oppressive** factory conditions and low wages.

Factories at the time largely lacked **safety regulations**, leading many workers to suffer injuries on the job. In addition, work shifts stretched as long as eighteen hours, and many factories employed children, some as young as five years old. Although the Industrial Revolution produced **tremendous** economic growth, many of those gains were concentrated in the hands of factory owners rather than the **average** worker.

Such conditions motivated calls for change and even inspired the German philosopher Karl Marx to write *The Communist Manifesto*. Those conditions also led to a rise in union membership. Unions, however, frequently **faced pushback** from factory owners and governments that feared that labor reforms could threaten productivity and profits. In many instances, conflicts between workers and management devolved into **violence**.

Urbanization: For much of human history, the size of cities paled in comparison to today's **booming** metropolises. At the start of the Industrial Revolution in 1750, England had just two cities with a population greater than fifty thousand. By 1851, that number had risen to twenty-nine. So what **accounted for** this massive wave of urbanization?

Early in the Industrial Revolution, factories—like Arkwright's cotton mill—had to be built next to rivers in order to **harness** their energy. But in the early nineteenth century, an invention known as the Watt steam engine became **increasingly** popular. This device created energy by burning coal, which allowed entrepreneurs to move their factories away from water sources and into major cities full of people who would buy their products and work in their **mills**.

As urban factories opened, people migrated from **rural** areas into cities in search of work. However, cities were often unprepared to accommodate **the influx**. The lack of sufficient housing, clean water, and sanitation **contributed to** the spread of diseases such as cholera and typhus.

Climate change: Manufacturers set the world on a dangerous climate trajectory when they started using coal to power their factories. The burning of coal releases greenhouse gases—such as **carbon dioxide**—which warm the planet by trapping the sun's heat in the atmosphere.

Today, the world is nearly 1.8˚F (1˚C) warmer than it was before the Industrial Revolution. While 1.8˚F could seem hardly noticeable on a sunny day, countries are already seeing the **severe effects** of planetwide warming at this level. Heat waves are lasting longer, crop yields are shrinking, and rising sea levels are threatening coastal areas.

Scientists warn that without a significant **reduction in** greenhouse gas **emissions**, global temperatures could reach 2˚C (3.6˚F) above pre-Industrial Revolution temperatures by 2050. Should this happen, the results would be catastrophic and potentially **irreversible**.

Colonialism: The Industrial Revolution fueled a new wave of colonialism, the economic effects of which can still be felt hundreds of years later.

As European manufacturing expanded, suppliers needed more customers and new sources of raw materials, such as coal and cotton. These interests, in part, motivated European empires to **seize** resource-rich lands abroad. Throughout the nineteenth century, England expanded its control over India, France colonized Algeria and large parts of Southeast Asia, and Germany took over territories in Africa—to name just a few examples.

Industrialized countries frequently forced their colonies to produce **raw materials**, which would be shipped to European homelands, turned into finished products, and sold back to the colonies at **marked-up prices**. Under British rule, India's textile industry collapsed. The country went from making finished goods like fabric to instead exporting raw cotton to England and importing the same goods it once produced **domestically**. This process—known as deindustrialization—is believed to have severely **stunted** India's economic development.

What can the Industrial Revolution teach us about innovation?

The **legacy** of innovation is complicated. The Industrial Revolution produced unprecedented economic growth, led to greater food security, and provided millions of people with access to previously **unaffordable** goods. At the same time, it contributed to **deteriorating** working conditions at home, economic exploitation abroad, and a climate crisis around the world.

Scholars today claim we're in the midst of yet another Industrial Revolution. **Artificial intelligence** and new forms of automation are reshaping both low-skilled jobs like trucking and manufacturing and high-skilled professions like law and medicine.

It’s difficult to know whom this new Industrial Revolution will **benefit** and how it will reshape society. Some experts fear that innovation will lead to wide scale unemployment, with potentially half of today’s positions automated by 2055. Others believe that job creation in entirely new industries will balance out job losses, as was the case during the first Industrial Revolution.

But one thing is **certain**: the legacy of innovation is lasting. Manufacturing changes from more than two hundred years ago have directly shaped today’s workdays, cities, climate, and global economy.

From https://world101.cfr.org/historical-context/prelude-global-era/what-are-origins-modern-production

Task 6. Answer the following questions:

1. What was farming like prior to the Industrial Revolution?
2.Were laws prohibiting the emigration of skilled workers and the export of industrial technology successful?
3.How did the Industrial Revolution change workforce?
4. What new ways to manage their workers did factory owners find?
5.What emerged in response to oppressive factory conditions and low wages?
6.How did the invention of the steam engine facilitate a massive wave of urbanization ?
7. What do scientists warn about if there is no significant reduction in greenhouse gas emissions?
8. What did industrialized countries frequently force their colonies to do?
9. How can the legacy of innovation be described?

Task 7. Make a plan and give a short summary of the text.

Text 3

The Evolution of the Industrial Ages: Industry 1.0 to 4.0

Task 1. Translate the following international words without a dictionary: industrial, era, evolution, mechanical, businesses, manager, focus, electrical, energy, resource, standard, program, engineer, optimize, decades, electronics, geographical, integration, location, telecommunication, concept, information, traditional, virtual, physical, logistics, dynamic, control, ecosystem.

Task 2. Use a dictionary to translate the words and phrases in bold into Russian.

Task 3. Look at the title of the text and the vocabulary in bold to predict what the text is about.

Task 4. Skim through the text to check your ideas.

Task 5. Read and translate the following text.

The modern industry has seen great advances since its earliest **iteration** at the beginning of the industrial revolution in the 18th century. For centuries, most of the goods including weapons, tools, food, clothing and housing, were manufactured by hand or by using work animals. This changed in the end of the 18th century with the introduction of manufacturing processes. The progress from Industry 1.0 was then rapid **uphill climb** leading up to the upcoming industrial era – Industry 4.0. Here we discuss the overview of this evolution.

Industry 1.0 The late 18th century introduced mechanical **production facilities** to the world. Water and **steam powered machines** were developed to help workers in the mass production of goods. The first **weaving loom** was introduced in 1784. With the **increase in** production **efficiency** and scale, small businesses grew from serving a limited number of **customers** to large organizations with owners, manager and employees serving a larger number. Industry 1.0 can also be deemed as the beginning of the industry culture which focused equally on quality, **efficiency** and scale.

Industry 2.0 The beginning of the 20th century marked the start of the second industrial revolution – Industry 2.0. The main **contributor** to this revolution was the development of machines **running on** electrical energy. Electrical energy was already being used as a primary **source of power**. Electrical machines were more efficient to operate and **maintain**, both in terms of cost and effort unlike the water and steam based machines which were comparatively inefficient and resource hungry. The first **assembly line** was also built during this era, further streamlining the process of mass production. Mass production of goods using assembly line became a standard practice.

This era also saw the evolution of the industry culture introduced in Industry 1.0 into management program to **enhance** the efficiency of **manufacturing facilities**. Various production management techniques such as **division of labor**, **just-in-time manufacturing** and **lean manufacturing** principles refined the underlying processes leading to improved quality and output. American mechanical engineer Fredrick Taylor introduced the study of approaches to optimize worker, workplace techniques and optimal **allocation** of resources.

Industry 3.0 The next industrial revolution resulting in Industry 3.0 was brought about and **spurred** by the advances in the electronics industry in the last few decades of the 20th century. The invention and manufacturing of a **variety** of electronic devices including **transistor and integrated circuits** automated the machines substantially which resulted in reduced effort, increased speed, greater **accuracy** and even complete replacement of the human agent in some cases. **Programmable Logic Controller (PLC)**, which was first built in 1960s, was one of the landmark inventions that signified automation using electronics. The integration of electronics hardware into the manufacturing systems also created a **requirement** of software systems to enable these electronic devices, **consequentially** fueling the software development market as well. **Apart from** controlling the hardware, the software systems also enabled many management processes such as **enterprise resource planning**, **inventory management**, **shipping logistics**, **product flow scheduling** and **tracking** throughout the factory. The entire industry was further automated using electronics and IT. The automation processes and software systems have continuously evolved with the advances in the electronics and IT industry since then. The pressure to further reduce costs forced many manufacturers to move to low-cost countries. The **dispersion** of geographical location of manufacturing led to the formation of the concept of **Supply Chain Management**.

Industry 4.0 The boom in the Internet and telecommunication industry in the 1990s revolutionized the way we connected and exchanged information. It also resulted in paradigm changes in the manufacturing industry and traditional production operations **merging** the boundaries of the physical and the virtual world. **Cyber Physical Systems (CPSs)** have further blurred this boundary resulting in numerous rapid technological **disruptions** in the industry. CPSs allow the machines to communicate more intelligently with each other with almost no physical or geographical barriers.

The Industry 4.0 uses Cyber Physical Systems to share, analyze and guide intelligent actions for various processes in the industry to make the machines smarter. These smart machines can continuously monitor, detect and predict **faults** to suggest **preventive measures** and **remedial action**. This allows better preparedness and lower **downtime** for industries. The same dynamic approach can be translated to other aspects in the industry such as logistics, production scheduling, optimization of **throughput times**, quality control, **capacity utilization** and **efficiency boosting**. CPPs also allow an industry to be completely virtually visualized, monitored and managed from a remote location and thus adding a new dimension to the manufacturing process. It puts machines, people, processes and infrastructure into a **single networked loop** making the overall management highly efficient.

As the technology-cost **curve** becomes steeper every day, more and more rapid technology disruptions will emerge at even lower costs and revolutionize the industrial ecosystem. Industry 4.0 is still **at a nascent stage** and the industries are still in the transition state of adoption of the new systems. Industries must adopt the new systems as fast as possible to stay relevant and profitable. Industry 4.0 is here and it is here to stay, at least for the next decade.

From https://www.simio.com/blog/2018/09/05/evolution-industrial-ages-industry-1-0-4-0/

Task 6. Answer the following questions:

1. How were most of the goods manufactured before the 18th century?
2.What industrial eras are covered in the text?
3. What did Industry 1.0 introduce to the world?
4. What marked the start of the second industrial revolution – Industry 2.0?
5.What became a standard practice in Industry 2.0?
6.How were production quality and output improved?
7.What technological advances led to Industry 3.0?
8. When was Programmable Logic Controller (PLC) first built?
9. How was the concept of Supply Chain Management formed?

10.What revolutionized the way we connected and exchanged information in the 1990s?

11. Why are Cyber Physical Systems important in Industry 4.0?

Task 7. Make a plan and give a short summary of the text.

UNIT 2 INDUSTRY 4.0: THE GLOBAL IMPACT ON ENGINEERING SKILL DEVELOPMENT & EMPLOYMENT

Text 1

Engineering Skill Framework Set Globally for Industry 4.0

Task 1. Translate the following international words without a dictionary: massive**,** normal, sectors, modern, automation, priority, companies, systematic, analysis, problems, characteristic, transformation, mission, dynamic, interpretation, final, maximize, hierarchy, coordination, empathy, professional, personal, synchronization, identify, effective, platforms, organization, clients.

Task 2. Use a dictionary to translate the words and phrases in bold into Russian.

Task 3. Look at the title of the text and the vocabulary in bold to predict what the text is about.

Task 4. Skim through the text to check your ideas.

Task 5. Read and translate the following text.

Industry 4.0 is going to bring everyone on this earth to a reality where new technologies like IoT, Artificial Intelligence, **Machine Learning**, **Cloud Computing**, **Blockchain**, **Smart Manufacturing**, etc. will be introduced on a massive scale and it will directly impact all aspects of the humankind. We'll need to change the way we learn, the way we work, the way we communicate or even the way we live our daily life. In the normal process of coping up with the rapid technological development linked to the wide **gamut** of industry, economy, society and health, all employment sectors will look for the workforce having some **significant** skills precisely aligned to the development of modern technologies. First, the **advancement** of technologies will replace the low-skilled human workforce with automation and robotic tools. Second, a pool of skilled engineers will be required by the automation & robotic tool manufacturing & **allied industries** to support the need of different sectors. Consequently, the current engineering graduates will find it challenging to get a job if their present skills **are out of sync** with the **current** industry needs.

Combining the **outcomes** of several recent studies on the engineering skills framework set for Industry 4.0, ten **key skills** that will be in high demand after 2020 have been arranged in the order of their priority. Let's have a look.

1. **Complex Problem Solving**

Engineering companies face complex problems every day and after Industry 4.0 takes place it will tend to be more complex day by day. So, future engineers are expected to **have expertise in** the systematic analysis of complex problems.

2. **Critical Thinking**

Industry 4.0 focuses more on the innovative **approach** to bring the new era of digital transformation. All companies need to update their mission & vision adaptively with the dynamic need of the hour. So, their engineering workforce should have expertise in the interpretation of different data leading to final **decision-making**.

3. **Creativity**

This is one of the top skills that are driving Industry 4.0. The companies want their engineering workforce to always **think out of the box** and uniquely create new products to maximize the customized market reach.

4. **People Management**

Industry 4.0 leaders need to disperse leadership and managerial **responsibilities** throughout the organizational network to **sustain** the rapid characteristic transformation of the companies. So, all **budding** engineers need to **build their mindset** to act as decision-makers irrespective of the hierarchy.

5. **Coordinating with Others**

Not only management, but it is also required by the engineers to have good coordination skills as well to **achieve** common **goals** of different teams together to save time and resource of the companies under Industry 4.0.

6. **Emotional Intelligence**

Along with the technical expertise, Industry 4.0 engineers need to be emotionally intelligent as well to feel sympathy and empathy for each other so that the working environment becomes helpful for everyone's professional and personal growth in synchronization with the rapid change of new technology.

7. **Judgement and Decision-Making**

Industry 4.0 engineers should also have the ability to identify an issue, gather data corresponding to it, analyze the collected data, make **meaningful** representations and **draw conclusions** effective for driving decisions.

8. **Service Orientation**

Along with analytical skills, Industry 4.0 engineers need to be inclined towards **providing** the best engineering solutions to their clients. This requires them to have the ability to connect to their customers for a more effective and efficient **resolution** of customer issues and concerns.

9. **Negotiation Skill**

Industry 4.0 engineers should also have good negotiating capabilities over multiple digital platforms to **establish** a **mutually beneficial relationship** between the organization and its clients.

10. **Cognitive Flexibility**

An Industry 4.0 engineer needs to have the ability to adapt easily to any working environment changes, operating role switching, changes in **consumer demands**, and technological advancements.

Need for the Change

An immediate change in engineering education policy has to take place worldwide that would sustain the professional development of a budding engineer following these 10 **skillsets**. The engineering students must be **facilitated** with proper **upskilling & reskilling training** by the higher educational institutions, governments & industries to ensure their **employability** in the advent of much-awaited Industry 4.0.

Task 6. Answer the following questions:

1.What new technologies characterize Industry 4.0?
2.What will everyone need to change in the Industry 4.0 reality?
3. What will be replaced with automation and robotic tools?
4.Why will the current engineering graduates find it challenging to get a job?
5. How many key skills will be in high demand in Industry 4.0? What are they?
6. What must engineering students be facilitated with to ensure their employability in Industry 4.0?

Task 7. Make a plan and give a short summary of the text.

Text 2

Industry 4.0: The Next Gen Manufacturing Workforce

Task 1. Translate the following international words without a dictionary: machines, distribution, productive, communication, results, talents, roles, mobile, interactive, partners, incidents, monitoring, vibrations, sensors, function, risk, traditional.

Task 2. Use a dictionary to translate the words and phrases in bold into Russian.

Task 3. Look at the title of the text and the vocabulary in bold to predict what the text is about.

Task 4. Skim through the text to check your ideas.

Task 5. Read and translate the following text.

Industry 4.0, or the Industrial Internet of Things (IIoT), is taking the manufacturing world by storm. Machines, systems, and devices are **interconnected** and communicating with one another for a 360-degree view of the entire manufacturing process, from production to distribution. The factory of the future is here, and it’s creating a next generation workforce that is engaged on a whole new level.

By 2025 there will be over 75 billion devices communicating with one another. **By one estimate**, IIoT will make manufacturing seven times more productive. But this factory of the future will still depend on production workers to **supervise** operations, monitor communication, analyze results, and make the **data-driven decisions** that only humans can.

Below, we break down how the manufacturing workforce will evolve in the Industry 4.0 era.

The New Face of the Industry 4.0 Workforce

Manufacturing has **a declining workforce** and has had trouble competing for new talents. But Industry 4.0 is rebranding the industry. Technologies are creating more job **opportunities** and attracting more **job seekers**, resulting in a revitalized, more **sustainable** industry. Here are ways the IIoT will spur workforce growth in manufacturing.

Next Generation Workers

With an **aging** workforce comprised mainly of baby boomers and Gen X, the manufacturing industry is losing millions of employees to **retirement**. To stay competitive, companies need to **leverage** IIoT as a recruiting tool and target the millennial generation, **a tech-fluent generation** who will be attracted to the **capabilities** of smart factories.

New Roles Created by IIoT

As Artificial Intelligence takes over more of the **routine tasks**, new career opportunities will emerge. Smart factories will need more supervisors, data analysts, software engineers, and IT support roles. As factories become more efficient and increase **production output**, there will be a greater need for customer-facing jobs such as sales and marketing.

IIoT Creates More Engaged Production Workers

As manufacturing companies upgrade to the industrial IoT, production workers are best positioned to manage communication by their **proximity** to the systems, and their **hands-on experience** in the process. All they need is an IoT-compatible employee app to receive data and track operations from anywhere on their mobile devices. IIoT enables previously independent **data silos** to share information, building a fully-interactive information ecosystem for production workers who become more active **collaborators** in the operation. With the ability to receive and manage data, production workers are **valuable** communication partners in the IIoT environment, establishing an inclusive culture that increases **engagement**.

How IIoT Creates a Safer Environment for Production Workers

The benefits of the industrial IoT that get the most attention are production, efficiency, and **cost savings**. However, manufacturing has one of the highest **accident rates** of any industry, with most incidents involving equipment failure or use error. The IIoT is creating safer manufacturing companies with automated condition monitoring. Through sound frequency and vibrations, sensors track and report real-time equipment function. Production workers can receive the data and check on the health of a machine through the employee app on their mobile device. This catches **signs of failure** before it happens, reducing the risk of equipment-caused accidents to build a safer work environment.

Transitioning to a smart factory is an investment, but one that will revitalize production, and create a more efficient, safer environment with an engaged workforce. This **ultimately** gives companies a **competitive advantage**. Traditional manufacturing plants will begin to lose out and lose talent to smart factories making IoT well-worth the investment.

From https://www.simio.com/blog/2018/09/05/evolution-industrial-ages-industry-1-0-4-0/

Task 6. Answer the following questions:

1.Why are machines, systems, and devices interconnected in Industry 4.0?

2. How many devices communicating with one another will be there by 2025?

3. Will IIoT make manufacturing more productive?

4. Will factories of the future depend on production workers?

5.How can Industry 4.0 rebrand the industry?

6. What are IoT-compatible employee apps used for?

7. What are the benefits of transitioning to a smart factory?

Task 7. Make a plan and give a short summary of the text.

UNIT 3 DIGITAL MANUFACTURING

Text 1

Task 1. Express your opinion: What are the main pros and cons of manufacturing digitalization?

Task 2. Translate the words into Russian and check their pronunciation: *watershed, the troves of data, data capture, workflow, to enhance, contribution, to compete, installment, chips (in the machine shops), breakdown, maintenance.*

Task 3. Read and translate the following text.

Industrial production is at the cusp of a watershed that has already disrupted the market for equipment and machinery. Digitalization has forced equipment manufacturers to shift their value proposition into service areas such as data capture and analytics, life-cycle monitoring and production optimization, transforming standalone hardware into interconnected systems that orchestrate workflows.

The deployment and use of digital manufacturing tools and practices on factory floors are no longer optional. Thankfully, today these tools are widely available and easier than ever to implement. Of all of the transformations that have taken place in manufacturing over the last decade, the rise of digital technologies has been the most sweeping and impactful. From machine monitoring to machine tool dynamics to out-of-the-box digital tools, digital manufacturing technologies are a requirement for competing in the marketplace as well as simplifying and improving businesses.

There are five components of digital infrastructure:

1. As the practice of monitoring machine uptime becomes more and more common, manufacturers are finding new ways to utilize the troves of data being compiled at shops across the country and around the world. Keeping track of this data can not only help managers make more informed decisions, it also drives innovation and new ways of tackling production challenges. If, for example, a high-volume job is showing frequent downtime because of part changes, the facility manager has exactly the information needed to justify investing in

automated solutions for changing out parts. More importantly, machine monitoring systems can enhance the contributions of manufacturing workers. These systems can identify bottlenecks that slow down jobs, helping the production team to gain a clearer picture of what processes need their attention. If the data shows that one process is slowing production, it provides a focal point for shopfloor personnel to develop improvements that can drastically cut down the amount of time a part spends in the shop. Of course, machine monitoring is not a solution in and of itself. Rather, it is a guide that can illuminate problems in a process, enabling users to fix those problems on their own. Whether the solution is to retrain an employee, develop a new process or invest in more advanced machinery will depend on the problem. However, solving that problem is impossible until you manage to identify it. That’s where this technology can help. Machine monitoring systems can enhance the contributions of manufacturing workers.

2. Cutting tool management is a vital part of the daily functioning of every machine shop, as no chips are flying without the right tools in stock. Some companies have recognized this and developed digital tools to help manufacturers keep accurate digital records of their cutting tool needs. Some manufacturers create a “digital twin” that represents the tool’s current state of wear, temperature, positioning and vibration. In addition to helping optimize the cutting process and predict tool life, software can keep track of stock and even the location of cutting tools to improve the users’ ability to prepare for upcoming jobs. The software fundamentally does the work of keeping track of the tools so that the user can make informed decisions. In addition, maintaining control of each tool crib’s inventory is an essential aspect of process consistency. Ensuring that tools are replaced with identical tools, keeping tool changes to a minimum and staying on top of problems as they arise are vital methods of controlling consumable costs and process variations that, when left unchecked, can lead to scrapping expensive cutting tools. In addition to helping optimize the cutting process and predict tool life, software can keep track of stock and even the location of cutting tools to improve the users’ ability to prepare for upcoming jobs.

3. One of the most common concerns with adopting any new technology is the time, training and resources needed to introduce it into

the mix. The truth is, today's digital tools present solutions that are easier to implement than ever before. This includes more modular options that are accomplishing more tasks in a single installment, offering more interoperability with minimal training required. Rather than needing 2-3 pieces of equipment each built with its own interface, and then struggling to connect them all to each other, users can introduce fewer components with more simplified means of integration with other pieces of equipment on the factory floor. This degree of consolidation, and sophistication, brings multi-tasking to a whole new level, and alleviates concerns with getting new technology up and running as soon as possible.

4. Unanticipated machine tool maintenance is one of the fastest ways for a machine shop to lose money. Unscheduled machine down time has a cascade of negative effects that reach every corner of the business, from inventory costs to lead times to overall throughput. Unfortunately, few things are more expensive than repairing a large machine, as the loss in productivity magnifies the drain the busted equipment has on a manufacturing firm. Fortunately, newer digital tools can avoid unplanned repairs by scheduling preventative measures that are less expensive and more effective than making repairs after a breakdown occurs. In many ways, this technology is an outgrowth of standard machine monitoring. However, it takes advanced software to analyze the fail-states of machines, identify patterns in machine data that precipitates these breakdowns, and identify maintenance needs before anything goes wrong. While it often takes months for software to recognize the problems that can shut down a machine, once a preventative maintenance system familiarizes itself with your machines, it can drastically reduce the number of breakdowns you experience, paying for itself many times over. It takes advanced software to analyze the fail-states of machines, identify patterns in machine data that precipitates these breakdowns, and identify maintenance needs before anything goes wrong.

5. Many of these technologies have been developing for a while, what's emerging now is the practicality of making these disparate components of manufacturing technology work together. Another component of the evolving digital landscape is standardization — especially open-source interoperability standards that establish a

common language for equipment and devices to interact on the factory floor. The benefits of data-driven systems include increased productivity, detailed system monitoring, and real-time data to make informed decisions.

From https://www.mmsonline.com/kc/digital-manufacturing

Task 4. Answer the questions:

1. What can machine monitoring systems improve?
2. What is the use of a "digital twin"?
3. Why are digital tools solutions easier to implement today?
4. What are the consequences of an unscheduled machine down time?
5. What is the prospective of the future development of digital manufacturing?

Task 5. Make up your own sentences from the underlined words in the text.

Text 2

Additive Manufacturing

Task 1. Express your opinion: What can smart manufacturing improve? What are the differences between additive and subtractive manufacturing?

Task 2. Match the words from column A to their synonyms from column B. Translate them.

A	B
supportable	variability
unavoidable	bonding
changeability	sustainable
spread	accuracy
joining	inevitable
precision	distributed

Task 3. Read and translate Part 1 of the text.

Nowadays, the business markets look for up-to-date manufacturing technologies to find a quick response for high demands of variability, e-client supply chain, and optimized energy consumption. As a solution, industry uses the benefits of the integration of modern manufacturing technologies and information systems to promote production capabilities. In this context, smart manufacturing improves long-term competitiveness by optimizing labor, energy, and material to produce a high-quality product, and find a rapid response for variation in market demands and delivery time. Smart factories represent a new generation of the production system in the concepts of smart manufacturing and support advanced technologies such as computerization manufacturing, cyber-physical systems (CPS), big data, internet of things (IoT) and cloud computing. In a general view, IoT provides information, including machines, products, or production lines, from all physical objects through a wireless or network connection. Also, the other data sources gather all information about the suppliers, customers, and logistics, then this large quantity of data, which is called big data, is analyzed and investigated by cloud computing. In fact, a cyber-physical system (CPS) shares information regarding all machines, utilities, and storage systems and controls them autonomously. CPS technology can help to improve the manufacturing process in the concept of smart manufacturing.

The additive manufacturing (AM) technique is applied for the fabrication of various structures and complex components. This technology was first employed by Charles Hull for the stereolithography (SLA) process in 1986. The other printing methods were discovered over the years and the application of AM technology was extended extraordinarily in only three decades and consequently transformed the manufacturing and logistics processes. AM benefits attract many attentions in the field of manufacturing such as mass-customized production, prototyping, sustainable production, and minimized lead time and cost. Recently, new developments in the AM process has made them more attractive, such as bioprinting, four-dimensional (4D) printing, nano-scale, and metamaterials printing. Also, the other advantage of the AM processes is to help effectively smaller companies and end-users to develop their innovative designs and products themselves as a self-designer and manufacturer. Obviously, AM can be a vital component of industry or smart manufacturing due to its high capability as a non-traditional manufacturing approach for mass customization. Among many advantages, the environmental impact of AM is very impressive in the improvement of sustainability in production systems compared to traditional manufacturing methods. The sustainability benefits of AM can be summarized into high resource efficiency, production life, and reconfigured value chain. However, the evolution of AM has not been explored sufficiently and is limited to many types of research on individual production technologies, not comprehensively on the components of the manufacturing system. Although AM offers numerous unique capabilities in the manufacturing process, it should be considered in simplifying industrial production such as "design and manufacture".

AM processes are basically the processes that add some materials to the previous surface via different deposition techniques that lead to different part quality, density, and geometrical accuracy. The conventional processes are usually subtractive or a combination of several processes in case of complicated parts. The major drawback of conventional processes is the high amount of material waste and lack of control systems to continuously modify the processes based on the current conditions. With the rise of computer-controlled machines, the latter problem is solved to some extent, but the material waste is still a challenge. In the current era, which is also known as the fourth revolution of industry, it was decided to utilize the physical facilities with modern information technology. The goal of this integration is that the control over different manufacturing processes will reduce while it is possible to make the fabrication in fewer steps with less time and material waste leading to a higher benefit–cost ratio.

All the AM processes are computer-controlled and it is possible to control an unlimited number of machines from a computer at once. The general procedure of all AM processes is that a layer of material is deposited, and this cycle continues to the point that the final 3D object is completed. Some of these processes need post-processing and some of them make parts in net shape with the minimal processes needed to be done. Based on the materials used in a specific process, the source of deposition varies. The most common materials used in AM processes are polymers, engineering plastics, ceramics, metals, metallic oxides, and metallic alloys. The feedstock is also available in different forms of solids and liquids, such as liquid polymers/resins, rods, wires, sheets, powders, etc.

AM machines of different types are such devices controlled by computers and the processes can be modified online with a single control unit. As a result, this technology gives the opportunity to integrate many machines in a factory and control them online. The outcome of this combination is that a user-specific product can be produced within each machine. This flexibility in the manufacturing of different products at the same time with the almost unlimited level of complexity provides the opportunity to utilize AM machines as an inevitable part of the modern manufacturing era. There are some terms used in this category of which rapid prototyping, rapid manufacturing, three-dimensional (3D) printing, smart manufacturing, and cloud manufacturing are the most used. Cloud manufacturing refers to the processes that are highly service-oriented and can be modified online. In order to clarify this process, a customer orders the desired geometry to be purchased. After accessing the design tools provided by a factory, they can change the materials, colors, and other aesthetic features of their desired product and at the same time, they can check the availability of the materials, machines, and the transportation systems. By checking all the items, the customers can easily upload their designs and receive their specific and unique product.

In material jetting, polymers are usually melted and deposited in the shape of droplets to form the needed geometry. The molten polymers then undergo a curing process by heat, light, or chemical reactions to increase the bonding strength. In binder jetting, there is a prepared bed of metallic powder laying under a jetting nozzle that disperses bonding polymers selectively on the surface of the metallic powder. After applying the polymer glue on the surface, a new layer of metallic powder is deposited, and the glue dispersion takes place. This cycle continues until the final shape is achieved. After that, the parts are sintered in furnaces with controlled atmosphere and different temperatures based on the metallic powders and the glue utilized to bond them together. Usually, these two processes are considered fast, but the final product has some porosities. The best application of these processes is making selectively porous mechanical objects.

Powder bed fusion appears in different shapes and selective laser melting (SLM) is one of the most popular ones. In SLM, metallic particles are fed in different layer thicknesses and a laser beam melts the desired regions of the surface. In the next step, a new layer of powder is distributed on the build plate and the laser source melts the powder until the deposition finishes and the final shape is achieved. The sources of melting beams can vary based on conditions and price of the utilized machines. The most common sources are the laser, electron, and ion beams.

The other widely used AM process is known as direct energy deposition (DED). In this process, a laser head is utilized as the source of energy and the metallic particles are injected into the building region via a couple of powder nozzles just next to the laser head. DED is significantly faster than SLM, but it suffers from lower geometrical accuracy of the final product. Thanks to its high deposition rate, it is possible to produce parts with a high aspect ratio (height to thickness). DED processes can be conducted in a controlled atmosphere or in the air.

Task 4. Answer the questions:

1. What does IoT provide?
2. How can CPS technology help?
3. When was AM technology first employed?
4. What are the benefits of AM?
5. What is still a challenge about AM that should be solved?
6. Which materials are commonly used for AM?

Task 5. Read Part 2 of the text and translate phrases in bold:

Each process has its own advantages/disadvantages and the choice of which to employ is application-dependent. To review the advantages of AM processes, characterizing their **key features** is required. There are three important key features, i.e., **time, cost and flexibility**, based on which the advantages of AM can be evaluated. One of the main purposes of using AM is to save manufacturing time and increase production speed. This will **accelerate prototyping** and reduces the time of production of spare parts and replacement parts. Moreover, AM does not require additional resources such as fixtures, cutting tools, jigs, and coolants. However, it is unlikely that AM technology will knock out traditional methods. Instead, they may be combined, and an integrated process could be developed **to achieve the efficient production of complex products**.

Production of complicated shapes at high volume and speed with lower cost is a dream of every industrial unit. 3D printing will grow through increasing the applications in existing markets, finding new opportunities in non-industrial markets such as food, fashion products, eyewear, and textiles. Future work will concentrate on the development of multifunctional structures, ceramics, a combination of metals and ceramics which can produce materials with lower brittleness, reducing inventory by on-demand production, reducing time-to-market, automated repair processes, and designing new complicated parts. Although 3D printing is growing and **benefiting the use of AM technology in many industrial sectors**, it still has some limitations:

- The high cost (such as operation, purchase, depreciation, and maintenance) of AM materials and machines;
- The requirement for high-speed 3D-printing technology (such as novel AM technology with higher speed, accuracy and resolution, and bigger build volumes);
- **The lack of reliability in quality assurance practices** across the sector;
- Design tools (such as software) **need to be more investigated** to present the full potential of the AM process;
- An overall shortage of **appropriately trained workers** in AM, and limited opportunities for collaboration and exploit of ideas.

The future of AM in some important aspects of the industry, e.g., applications, technology, and materials, are considered briefly in the next section. The most applications of AM processes occur in aerospace and automotive, art industry, medical and even architectural industry. The aerospace industry has shown interest in these technologies because it enables them to directly manufacture metallic parts such as from titanium (for aircraft) and the ability to easily manufacture complex and high-performance products **with significantly less tooling considerations**. Selective Laser Sintering (SLS) and Electron Beam Melting (EBM) are now used in the aircraft and aerospace industry. The principle goal of the automotive and aerospace industries is to manufacture **lightweight vehicles or aircrafts**. These AM-based technologies are capable of manufacturing lightweight components. The AM has many applications in medical fields.

AM technology has excessive potential for the production of complex geometries of the implant. It should not be forgotten that AM technology helps in reducing costs and producing a medical model in a shorter time. The most complex and complicated designs in the jewelry and art industries could be fabricated using AM technology. AM technology can provide effective tools for the work of jewelers and artists, enabling them to create unique shapes in hours instead of days or weeks. The methods of production will not change by additive manufacturing. However, **improving most areas of the industry is inevitable**.

From "The Potential of Additive Manufacturing in the Smart Factory Industrial"

Task 6. Translate the following words and expressions from Russian into English: *большие объемы строительства, пониженная хрупкость, увеличение использования, замена деталей, оценить преимущества, неизбежная модернизация производства, легкое транспортное средство.*

Task 7. Use the Internet and prepare a report about any widely used AM processes.

Text 3

AM for Metallic Materials

Task 1. Match the words and phrases with their Russian equivalents. Find them in the text below:

1. relatively	a. форма
2. to remedy	b. проводимость
3. framework	c. относительно
4. deposition	d. износ инструмента
5. conventional	e. исправить
6. fine	f. осаждение
7. maraging	g. традиционный

8. conductivity	h. неблагоприятный
9. adverse	i. точный
10. tool wear	j. мартенситная (сталь)

Task 2. Decode the following abbreviations before reading the text can: SLM, SLS, FDM, LENS, DLF, EBM.

Task 3. Read and translate the text.

Additive Manufacturing (AM) offers great advantages of building parts with geometric and material complexities. For metallic materials, the AM methods include selective laser melting (SLM), selective laser sintering (SLS), fused deposition modelling (FDM), laser-engineered net shaping (LENS), directed light fabrication (DLF) and electron beam melting (EBM). However, the AM methods provide a relatively poor surface finish and quality, as well as dimensional and geometric accuracies.

For example, powder material was sprayed through a nozzle into the spot of a laser beam focused on the workpiece, and the relative inaccuracy of the powder jet deposition was remedied by applying a CNC milling operation that milled the contour and the upper surface of each layer before applying the next one. These methods propose frameworks for applying the concept of additive/subtractive hybrid manufacturing. Other research work on hybrid processes has been done such as 3D welding and milling for fabrication of metallic prototypes and the hybrid plasma deposition and milling for aero-engine components. Additionally, selective laser cladding (SLC) and milling was combined for mold fabrication and modification. Similarly, CO2 laser welding were combined with conventional milling for rapid prototyping and tooling. Recently, a CNC milling machine was integrated with an arc welding unit.

Distinctive advantages can be provided by combining the SLM as an additive and milling as a subtractive process over the conventional machining and simplex AM. Firstly, if a large volume must be removed, a competitive approach can be offered in terms of fabrication time by using the additive method and subsequent surface finishing during the fabrication of a near-net-shaped part. In addition, if the material is a rare metal or difficult-to-machine material, the near-net-shaped part offers an economic way for the subtractive process because of less machining chip waste and tool wear. Secondly, some special features that are either impossible or difficult to machine can be manufactured using the hybrid method, such as a hollow structure or internally conformal cooling channel. Thirdly, the combined process permits fabricating accurate parts with various materials, depending on the functional requirements. Fourthly, it is believed that the part produced by A/SM presents higher fatigue strength than that produced by the simplex AM process because of the difference in surface quality.

Maraging steels with a low carbon content combine good mechanical properties, e.g. yield and tensile strengths with toughness and weldability. This combination of properties is attributed to the microstructure consisting of the fine intermetallic structure in the cubic martensitic matrix compounds obtained by heat treatment. Maraging steels are well suited for the A/SM process for three reasons. Firstly, the material with the martensitic matrix needs to be quenched rapidly to a temperature that converts austenite to martensite. Because of the relatively small size of the melt pool in the A/SM process, cooling time is typically short so as to easily obtain the martensitic structure. Secondly, while the steel is still in the condition after the additive laser process and before age-hardening, machinability is excellent because of the low hardness of the materials. After the whole A/SM hybrid process, a proper heat treatment can be conducted with little dimensional variations. Thirdly, maraging steels are mainly used in the aerospace industry and tooling applications due to their substantially high cost. These industries often require geometrically complex components with excellent external and internal surface quality in a small batch, which can be achieved by the A/SM process.

Hybrid process parameters. The microstructure evolution of an A/SM part mainly depended on the local heat transfer condition which was influenced by laser energy, scanning speed, heat conductivity of the powder bed, etc. The additive process parameters were determined based on the considerations of the mold sample quality. Before being clamped onto the worktable, the substrate was blasted with alumina. The ‘Island’ scanning strategy was applied in order to decrease residual stresses of the mold sample: each layer of the powders was divided into small islands that were raster scanned with short scan tracks in a random order. The island scanning strategy can effectively decrease the distortion and cracking problem.

The milling tool intervened every ten constructed layers to finish the contour of the new layers and the surface of the sample. During the subtractive process two milling cutters were used according to the different needs for machining, one with a diameter of 2.0 mm, and the other with a diameter of 1.0 mm. The cutting tool was not interfered by the powders due to good flowability. Due to the molten pool in the SLM process, the workpiece temperature is relatively high for high speed milling. However, different from the traditional cutting processes, liquid coolant is prohibited in the A/SM process since it may have an adverse effect on the powder bed. In A/SM due to the tool changing process, there is a time interval between the SLM and milling processes, heat transfer takes place in the time interval, leading to a temperature drop in the workpiece. Nevertheless, the workpiece temperature is still higher than that in the traditional cutting, which may cause rapid tool wear in A/SM. How to optimize this time interval to suppress tool wear needs further investigation.

Maraging steel has a relatively low thermal expansion coefficient, and thus its geometric accuracy is temperature-insensitive under the condition of an elevated temperature in A/SM. Since AM is a near-net-shaped process, only a minimal amount of material removal is required for the A/SM workpiece. Therefore, the cutting chips are relatively small in size compared to that in the traditional cutting processes, and should not have a significant effect on the next powders layer. After the A/SM hybrid process, the sample was heat treated. The heat treatment process was arranged for three hours at 500 °C in a vertical tube furnace and cooled down naturally in the furnace.

From "A Novel Method for Additive/Subtractive Hybrid Manufacturing of Metallic Parts"

Task 5. ► You are going to watch video "How it works: Direct metal laser sintering (DMLS)". After watching describe the process in your own words: https://www.youtube.com/watch?v=yiUUZxp7bLQ.

UNIT 4 PROJECT METHODOLOGY

Text 1

Engineering Method

Task 1. Say these words correctly. Use the proper word stress:, *engineering, solution, development, launch, definition, specified, specification, requirement, completion, feasibility, viability, available, identifying, schematic, verification.*

Task 2. Read the text and then put A-F paragraphs in the logical order according to the six steps of the engineering method:

The engineering method (also known as engineering design) is a systematic approach used to reach the desired solution to a problem. There are six steps (or phases): idea, concept, planning, design, development, and launch from problem definition to desired result.

The engineering method has six steps (or phases):

1) Idea; 2) Concept; 3) Planning; 4) Design;5) Development; 6) Launch

A. The (…) phase is where “the rubber meets the road.” Details are specified; specifications are established. Some call this phase “design planning” and the development phase “detailed design.” But no matter what it is called, the purpose of this phase is to translate the customer requirements and systems engineering model into engineering specifications that an engineer (designer) can work with to design and build a working prototype. Specifications are detailed using a number with associated units, e.g., 4 volts, or 3.82 inches, or 58 Hz, or a completion time of 22 days.

B. The (…) phase usually begins with a problem. The problem statement is typically only vaguely defined and requires research into its viability and its feasibility. Viability suggests that there is significant value (or demand in the case of product development) in pursing the solution. Feasibility serves as a check on whether the idea can be realized. Feasibility may be high, medium, or low: where high feasibility means that people, technology, and time resources are readily available or known; medium is that resources may not be available directly, but can be found; and low means the resources may be rare or do not exist. The most critical part of the idea phase is to define the problem, validate its value, and identify the customer who desires its solution.

C. (…) includes the release of the engineering design and documentation package to manufacturing facilities for production. At this point, all qualification testing is complete, and the working prototype has demonstrated functionality.

D. The (…) phase is about defining the implementation plan: identifying the people, tasks, task durations, task dependencies, task interconnections, and budget required to get the project done. Many tools are used to convey this information to team members and other stakeholders including Gantt and Pert charts, resource loading spreadsheets, sketches, drawings, proof-of-concept models to validate that the project can be successfully completed. One critical tool of the planning phase is the system engineering diagram. This diagram shows the solution as an interconnection of smaller and less complicated sub-systems. A system engineering diagram establishes all the inputs and outputs for each module, as well as the way in which the module transforms the inputs into outputs.

E. The purpose of (…) is to generate the engineering documentation: schematics, drawings, source code, and other design information into a working prototype that demonstrates the solution to the problem. The solution may be a tangible working prototype or an intangible working simulation. Of course, nothing works the first time, so this part of the process tends to be more iterative than the other phases. Specifically, it consists of the iterative cycle: design, test, debug, and redesign. If the project had earlier delays or is not on the planned schedule for other reasons, then this time may be the most frantic since the customer deadline may be closely looming. While testing and debug are often consider a separate phase, most times they occur side-by-side with development as a design morphs from a concept to an artifact. The latter is recommended, reserving time at the end of development for a final test to confirm the desired result meets customer expectation and designer's intent. Testing is the verification and validation phase where the concept meets both the anticipated design specifications and the customer's requirements of the solution. Testing is achieved through experiments—an information-gathering method where dissimilarity and difference are assessed with respect to the design's present and compared to desired state for the design. The purpose of an experiment is to determine whether test results agree or conflict with the a priori stated behavior. A sufficient numbers of successful testing verifications and validations are necessary to generate acceptable results and to reduce any risk that the desired behavior is present and functions as expected. If the test observations and results do not agree, then a debug process is necessary to identify the root causes and begin corrective action to resolve the discrepancies.

F. The (…) phase is about generating numerous models (mathematical, physical, simulation, simple drawings or sketches), all of which should convey that the solution meets the customer's expectations or requirements. The numerous concepts are generated using brainstorming techniques, which are review sessions in which elements of one concept are recombined with elements from other in an effort to find a single concept that fits best. Typical design judgment and compromise are required to merge concepts. The concept phase ends with a selection of a single concept.

From https://sites.tufts.edu/eeseniordesignhandbook/2013/engineering-method/

Task 3. Give more than one synonym to the following verbs: *to specify, to develop, to translate (the requirements), to design, to define, to demonstrate, to implement, to validate, to complete, to test, to verify.*

Task 4. Use the Internet and prepare a report about a certain example of engineering method application.

Text 2

Task 1. Look at the table and describe the algorithm of the design method.

1. Pre Design Phase	a) System audit
	b) Project Proposal Development
2. Detailed Design Phase	a) Functional Specification
	b) Design Review and

	Approval
	c) Detailed Engineering
3. Manufacturing and Testing	a) Manufacturing
	b) Integrated Testing
	c) Factory Acceptance Test
4. Commissioning and Development	a) On-Site Commissioning
	b) Site Acceptance Test
	c) Training
5. Post Implementation	a) Support
	b) Continuous Improvement

Task 2. Now read the text to find additional information.

Pre Design Phase

System Audit A detailed review of the existing conditions of your facility and/or operation. For automated facilities looking to upgrade, retrofit or improve their equipment, this will involve a review of the inter dependencies of the controls and software hardware employed, as well as the engineering processes in place which will be impacted or interfaced with.

Project Proposal Development Working with the end customer, a detailed plan for the proposed work will be developed. This will focus both on the functionality of the final product, as well as the risk mitigation to be put in place to reduce impact to any existing software, hardware or engineered processes.

Detailed Design Phase

Functional Specification The first step in the detailed design process is to produce a functional specification document which outlines to the end customer the technical details for exactly what will be provided as an end product. This will include specifying hardware to be utilized and how the hardware will be configured; specifying software and database solutions to be implemented as well as a detailed description of the database schema and software functionality; specifying controls solutions to be implemented as well as a detailed description of control algorithms and device functionality.

Design Review & Approval At key steps along the way, the end customer will be involved in reviewing the progress of the produced engineering documents such as the Functional Specification, Electrical

Drawings, Control Panel Drawings, Software Application Screen Shots and System Functional & Acceptance Test Plans.

Detailed Engineering Whether it is a software, hardware, electrical or controls solution, it will be an engineered solution. The engineering teams will develop the required technical components of the project.

Manufacturing & Testing

Manufacturing Our Control Panels are manufactured to comply with both CSA and UL regulatory bodies. All our panels are tested under full load conditions prior to leaving the shop floor.

Integrated Testing Very few engineered solutions operate on an island, completely isolated from external or complimentary software & control systems. Engineering teams execute integrated tests which involve all available system components working together. When real world applications or devices are not available, industry leading emulation software is employed to replicate the real world conditions right in the office. Engineering teams test our PLC code on the physical PLC processors which will be deployed in customer's facility, and software solutions are tested on the physical machines if they are being provided new, or on a virtual machine taken of the existing on-site machine.

Factory Acceptance Test The final step in the manufacturing and testing phase is an owner witnessed Factory Acceptance Test (FAT). Whether you physically visit our facilities in-person, or remote view our product demonstrations through a web connection, we ensure that our end customer witnesses a complete demonstration of their fully functioning system running in our offices using our emulation software. The Factory Acceptance Test will allow us to execute the same tests as will be done in the field, before we ever leave the confines of our four office walls. This approach allows us to correct 99% of software bugs before touching the ground in customer's facility, leading to shorter commissioning times and greatly reducing risk to any on-going operations.

Commissioning & Deployment

On-Site Commissioning Working with electrical and mechanical installers, engineering teams oversee every aspect of project deployment to ensure the system being installed and delivered meets the highest quality expected of ISN. Engineering teams execute electrical static and system functional tests on the installed system to ensure everything functions and operates as it should.

Site Acceptance Test The final step of the commissioning & deployment process is an owner executed or witnessed Site Acceptance Test (SAT). This is where engineers execute a test plan demonstrating the system functioning in all the possible conditions it will face during everyday operation. Engineering teams test not only the functionality of the provided system, but interfaces with external or supporting systems such as HMI, SCADA, MES and ERP systems.

Training No new system would be complete without the system operators feeling comfortable operating and maintaining the equipment. Training material is developed and presented by the same engineers responsible for developing and deploying the technical solution to ensure that nothing is lost in translation.

Post Implementation

Support After placing new equipment into live operations, our qualified engineering staff will remain close by to ensure that the equipment continues to operate as designed, and that your management & staff are confident, comfortable and capable to continue to successfully operate your system when we are long gone.

Continuous Improvement Our relationship with you doesn’t stop once your new system is accepted and goes into operation. Our engineers are continually striving to push the boundaries of what is possible within the industries we all operate in. As new technologies become available and your business demands continue to grow, our team will be there growing with you every step of the way. Ultimately, our success is measured through your success. At ISN we firmly believe that Everything is Possible.

From http://www.isntech.com/skills/project-methodology/

Task 3. Do the statements correspond to the content of the text?

1. While project proposal a rough plan is suggested to an end customer and only later a detailed one.
2. The first step is to produce a functional specification document that specifies how hardware will be configured.

3. Both the customer and the engineering team will develop the required technical components of the project.
4. When real world applications or devices are not available, simulation software is used.
5. The final step in the manufacturing and testing phase is an engineering team witnessing.
6. Engineering teams use only electrical static tests on the installed system to ensure everything functions well.
7. A test plan demonstrating the system functioning is shown in all the possible conditions it will face during everyday operation.
8. Training material is developed and presented by other engineer teams responsible for developing of the technical solution.
9. The final step of the commissioning is placing new equipment into live operations with further customer’s responsibility for its maintenance.

Task 4. Give your definitions to the following terms from the text: *facilities, an end customer, risk mitigation, to utilize, database schema, emulation software, commissioning time.*

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