МЕЖГОСУДАРСТВЕННОЕ ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ «БЕЛОРУССКО-РОССИЙСКИЙ УНИВЕРСИТЕТ»

Кафедра «Гуманитарные дисциплины»

АНГЛИЙСКИЙ ЯЗЫК

Методические рекомендации к практическим занятиям для студентов специальностей 1-36 01 01 «Технология машиностроения», 1-36 01 03 «Технологическое оборудование машиностроительного производства», 1-36 01 04 «Оборудование и технологии высокоэффективных процессов обработки материалов», 1-40 05 01 «Информационные системы и технологии (по направлениям)», 1-53 01 01 «Автоматизация технологических процессов и производств (по направлениям)» очной и заочной форм обучения

ЗАДАНИЯ ДЛЯ ОБУЧЕНИЯ ПРОФЕССИОНАЛЬНО-ОРИЕНТИРОВАННОМУ ЧТЕНИЮ НА АНГЛИЙСКОМ ЯЗЫКЕ

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Могилев 2020

УДК 804.0
ББК 812.АНГ
А64

Рекомендовано к изданию
учебно-методическим отделом
Белорусско-Российского университета

Одобрено кафедрой «Гуманитарные дисциплины» «18» мая 2020 г., протокол № 12

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Методические рекомендации предназначены для развития и совершенствования навыков чтения профессионально-ориентированных текстов. Задания разработаны на основе аутентичных текстовых материалов.

Учебно-методическое издание

АНГЛИЙСКИЙ ЯЗЫК

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Unit 1. Automation in Manufacturing

1. Discussion.

1. What does the word *automation* make think you of?
2. Can you name any automated systems you have at home?
3. What are advantages and disadvantages of automation?

2. Study the following words.

1	manufacturing automation	автоматизация производства
2	computer numerical control	числовое программное управление, ЧПУ
3	machine/machine tool	(металлорежущий) станок
4	flexible manufacturing	гибкое автоматизированное производство, ГАП
5	computer integrated manufacturing (CIM)	автоматизированная система управления производством, АСУП
6	computer aided manufacturing (CAM)	автоматизированное производство
7	lathe	токарный станок
8	milling	фрезерование
9	drilling	сверление; просверливание
10	boring	растачивание, рассверливание
11	grinding	шлифование
12	controls	средства управления
13	setting	установка
14	feed	подача

3. Read the text.

Automation has a variety of applications in manufacturing such as products and systems in the area of **'manufacturing automation'**. Some of these applications are as follows:
  1. **Computer numerical control (CNC) machines.**
  2. Tool monitoring systems.
  3. Advanced manufacturing systems.
      – **Flexible manufacturing** system (FMS)
      – **Computer integrated manufacturing** (CIM)
4. Industrial robots.

Computer numerical control (CNC) machines are the best and basic example of application of *Mechatronics* in manufacturing automation. Efficient operation of conventional machine tools such as **lathes**, **milling**, **drilling and boring machines** is

dependent on operator skill and training. In addition, a lot of time is consumed in **workpiece setting, tool setting** and controlling the process parameters such as **feed**, speed, depth of cut. Thus, conventional machining is slow and expensive to meet the challenges of frequently changing product/workpiece shape and size.

Computer numerical control (CNC) machines are now widely used in small to large-scale industries. CNC machine tools are an integral part of **Computer Aided Manufacturing (CAM)** or Computer Integrated Manufacturing (CIM) system. CNC means operating a machine tool by a series of coded instructions consisting of numbers, letters of the alphabets, and symbols, which the machine control unit can understand. These instructions are converted into electrical pulses of **current**, which the machine's motors and controls follow to carry out machining operations on a workpiece. Numbers, letters, and symbols are coded instructions, which refer to specific distances, positions, functions, or motions, which the machine tool can understand.

4. Find the English equivalents for the following word combinations in the text and memorize them:

передовые производственные системы, установка заготовки/инструмента, сверлильные станки, системы мониторинга состояния инструмента, операции обработки, крупные отрасли промышленности, электрические импульсы тока, глубина резания, блок управления станка.

5. Match the sentence beginnings with the correct endings.

1. The typical program	a) to turn the piece of metal to certain diameter, drill the hole of certain diameter and depth, etc.
2. The program of instructions of the NC machine is regarded	b) gives the instructions to the computer to perform certain functions.
3. These instructions can tell the machine-tool	c) who has programming knowledge as well the machining knowledge.
4. The set of instructions are coded	d) which are required to manufacture a particular product.
5. The program instructions are written by the expert,	e) as step-by-step instructions that tell the machine-tool what it has to do.
6. The expert should know various steps of the machining	f) to perform the required machining operations.
7. This specialist should be able to write these steps in the form of the program	g) in numerical or symbolic form and written on certain medium to be interpreted by the NC machine controller unit.
8. The program will direct the machine tool	h) that can be understood by the control unit of the NC machine.

6. Match the names of machining operations and other manufacturing-related notions with their description.

> turning, milling, drilling, boring, grinding, workpiece, tool setting, feed, depth of cut

1. … is a process in which a rotary multi-tooth tool called a milling cutter is rotated rapidly while the work is fed under it.

2. … … … is the measurement (normally in inches or millimeters) of how deep the tool cuts into the workpiece.

3. … … is the manner, position, or direction in which a tool is set.

4. … is a machining process used to make cylindrical parts in which the cutting tool moves in a linear fashion while the workpiece rotates.

5. … is the process of enlarging a hole that has already been drilled by means of a single-point cutting tool.

6. … is the action of making a hole in something with a drill.

7. … is an object being worked on with a tool or machine.

8. … is an abrasive machining process that uses a grinding wheel as the cutting tool to show the high surface quality and accuracy.

9. … is the rate of the cutting tool travel through the material.

7. Writing. Find some additional information about automation in manufacturing, its pros and cons, and arrange your data in a short essay.

Unit 2. Tool Monitoring Systems

1. Discussion.

1. How do you understand the notion *tool monitoring system*?

2. Do you agree that it is important to monitor tool wear for improving product quality?

2. Study the following words.

1	uninterrupted machining	непрерывная обработка
2	wear	износ
3	tool room	инструментальный цех; участок наладки инструментов
4	measurement	измерение, размер
5	machine vision	машинное зрение
6	technique	технология; технические приёмы
7	worn-out	изношенный; сработанный
8	shop floor	цех завода
9	off-line	не подключённый к компьютеру; автономный (о режиме работы)

3. Read the text.

One of the most significant developments in the manufacturing environment is the increasing use of tool and process monitoring systems. **Uninterrupted machining** is one of the challenges facing manufacturers in order to meet the production goals in terms of product quality. Tool **wear** is a critical factor which affects the productivity of a machining operation. Complete automation of a machining process means that there is a successful prediction of tool condition during the course of machining operation.

Cutting tool condition monitoring system based on mechatronics is an integral part of automated **tool rooms** and unmanned factories. These systems predict the tool wear and give alarms to the system operator to prevent any damage to the machine tool and workpiece. Therefore it is essential to know how the mechatronics is helping in monitoring the tool wear. Tool wear can be observed in a variety of ways.

Direct methods deal with the application of various sensing and **measurement** instruments such as microscope, **machine vision** systems; radioactive **techniques** to measure the tool wear. The used or **worn-out** cutting tools will be taken to the metrology or inspection section of the tool room or **shop floor** where they will be examined by using one of direct methods. Therefore these techniques are called as **offline** tool monitoring system.

4. Find the English equivalents for the following word combinations in the text and memorize them;

система контроля состояния режущего инструмента; износ инструмента; изношенные режущие инструменты; производственная среда; влияет на производительность; сигнализировать; операция обработки; автономная система мониторинга инструмента; автоматизированное предприятие/завод; измерительные приборы.

5. Read the advertising message about Tool Monitor Adaptive Control (TMAC) systems.

Tool Monitor Adaptive Control (TMAC) system protects your CNC machine while providing valuable information about your cutting process. The system reduces the high cost of tool replacement by effectively measuring tool wear in real time. The "Adaptive" control feature of TMAC reduces cycle time and optimizes cutting conditions to improve tool life.

TMAC maximizes tool life, protects your CNC machine and tools, determines when tools are worn or broken, immediately stops a machine when a tool breaks to minimize damage, provides remote notification of machine alarms, graphically displays cutting data for analysis and is excellent for unattended operation.

6. Find the equivalents for the following word combinations in the text above and use them for writing an advertising message of your own.

защищает станок с ЧПУ; предоставляет информацию; снижает стоимость замены инструмента; измеряет износ; сокращает время цикла; оптимизирует условия резания; максимизирует срок службы инструмента; определяет, когда инструменты изношены или сломаны; минимизирует ущерб; графически отображает данные для анализа; работа в автономном режиме, не требующая внимания оператора.

Unit 3. Flexible Manufacturing Systems

1. Discussion.

1. What is a flexible manufacturing system?
2. Under what set of circumstances is the use of a flexible manufacturing system most appropriate?

2. Study the following words.

1	batch	партия (деталей); серия
2	flexibility	эксплуатационная гибкость; переналаживаемость
3	product manufacturing	промышленное производство
4	transfer	перемещение; перенос
5	tooling	инструментальная или технологическая оснастка
6	manufacturing cell	производственный модуль
7	material handling system	система транспортировки и загрузки материалов
8	auxiliary	вспомогательный, дополнительный
9	tool handling system	система перемещения инструмента
10	facility	устройство; оборудование
11	constituent	составная часть; компонент

3. Read the text.

Nowadays customers are demanding a wide variety of products. To satisfy this demand, the manufacturers' "production" concept has moved away from "mass" to small "**batch**" type of production. Batch production offers more **flexibility** in **product manufacturing**. To meet this need, Flexible Manufacturing Systems (FMS) have been evolved. FMS combines microelectronics and mechanical engineering. A central online computer controls the machine tools, other work stations, and the **transfer** of components and **tooling**. The computer also provides monitoring and

information control. This combination of flexibility and overall control makes possible the production of a wide range of products in small numbers.

Flexible Manufacturing Systems FMS is a **manufacturing cell** or system consisting of one or more CNC machines, connected by automated **material handling system**, pick-and-place robots and all operated under the control of a central computer. It also has **auxiliary** sub-systems like component load/unload station, automatic **tool handling system**, component measuring station, etc. This system is fully automatic because it has automatic tool changing (ATC) **facilities.** The central computer controls the overall operation and coordination amongst the various **constituents** of the FMS system.

4. Find the English equivalents for the following automation terms in the text and memorize them:

гибкое автоматизированное производство (ГАП); делает возможным; удовлетворить спрос; удовлетворить потребность; мелкосерийное произ-водство; промышленное производство; станция загрузки / выгрузки компо-нентов; система смены инструмента; подъёмно-транспортный робот; контролирует всю работу.

5. Learn more facts about flexible manufacturing systems. Complete the sentences with proper words.

> products, system, unloading, workstations, flexible, quality, processing, manufacturing, technicians, disadvantages, customers

A Flexible Manufacturing … consists of four or more processing … with computer terminals connected mechanically by a part handling system and electronically by an integrated computer control system. FMS is called … because it is capable of processing a variety of different parts simultaneously at the workstation. The terminals process the creation of a product, which includes loading/… , machining, assembly, … testing and data … . The system can be programmed to run one set of products and then automatically switch over to another set of … . A production process that allows … to customize their products would also be an example of flexible … .

FMS has its advantages and disadvantages. The main benefit is increased production efficiency. Production time is reduced because the production line is not shut down to set up for a new product. The … of FMS include its higher costs and the greater time required to develop the system specifications. There also is a need for specialized … to run, monitor, and maintain the FMS.

6. Answer the questions about the text above.

1. Are interconnected workstations with computer terminals included in a flexible manufacturing system?
2. What stages of the product creation are processed at the workstations?

3. Can switching from one set of products to another set be programmed using the FMS software?

4. How do you understand "to customize products"? Does it mean "to modify (something) to suit a particular individual or task"?

5. What advantages do flexible manufacturing systems have?

6. Why is production time reduced?

7. What are the disadvantages of FMS?

8. Why do you think specialized technicians are needed to run and monitor the FMS?

7. Writing. Find more information about the FMS benefits and write it down in the form of a report to your boss in which you would recommend introducing them in your company to increase efficiency.

Unit 4. Computer Integrated Manufacturing (CIM)

1. Discussion.

1. Do you know what *Computer Integrated Manufacturing* means?

2. What can you say about the advantages of Computer Integrated Manufacturing?

2. Study the following words.

1	application	применение, употребление
2	to enhance	усиливать; улучшать
3	overall	общий; полный
4	computer-aided design	автоматизированное проектирование
5	manufacturing enterprise	производственное предприятие
6	response	реакция; отклик
7	customer	потребитель; заказчик

3. Read the text.

A number of activities and operations, such as designing, analyzing, testing, manufacturing, packaging, quality control, etc. are involved in the life cycle of a product or a system. **Application** of principles of automation to each of these activities **enhances** the productivity only at the individual level. These are termed as 'islands of automation'. Integrating all these islands of automation into a single system enhances the **overall** productivity. Such a system is called as "Computer Integrated Manufacturing (CIM)".

The Society of Manufacturing Engineers (SME) defined CIM as 'the integration of the total **manufacturing enterprise** through the use of integrated systems and data communications coupled with new managerial philosophies that improve

organizational and personal efficiency'. CIM basically involves the integration of advanced technologies such as **computer aided design (CAD),** computer aided manufacturing (CAM), computer numerical control (CNC), robots, automated material handling systems, etc.

The use of computers and automation technologies made the manufacturing industry capable to provide rapid **response** to the changing needs of **customers.**

4. Find the English equivalents for the following word combinations in the text and memorize them:

повысить общую производительность; передовые технологии; система транспортировки и загрузки материалов; передача данных; организационная эффективность; жизненный цикл продукта.

5. Complete the following sentences by choosing the right ending.

1. Computer Integrated Manufacturing (CIM)
    a) is a technology that has been used for centuries;
    b) is a relatively new technology.

2. This technology means, that
    a) all aspects of manufacturing are not interrelated and can function independently.
    b) all aspects of manufacturing should be computerized and linked together into an integrated whole.

3. CIM ensures that
    a) design specifications and manufacturing instructions developed by the design engineer are sent automatically to the shop floor;
    b) the design engineer's workstation is not linked into the overall system.

4. Computer Integrated Manufacturing (CIM)
    a) enables manufactures to make cheaper and higher-quality products;
    b) does not influence the quality and cost of products.

6. Writing. According to the text, are the following sentences TRUE or FALSE? If they are false, explain why.

1. The impact of computer technology on the manufacture and development of products has been small.
2. CIM has a very limited range of application.
3. Computer Integrated Manufacturing helps to eliminate human errors and reduce costs.
4. Integrated CAM/CAD systems work independently from manufacturing equipment.
5. New managerial philosophies cannot improve organizational and personal efficiency.

6. CIM involves the integration of advanced technologies such as computer aided design (CAD), computer aided manufacturing (CAM), computer numerical control (CNC), robots, automated material handling systems, etc.

7. New technologies provide rapid response to changing needs of customers.

7. Write a list of as many industrial uses of the computer as you can think of using the previous texts and additional information.

Unit 5. What Is CAD and CAM?

1. Discussion.

1. Do you know what stands for CAD and CAM?
2. How are computer-aided design and computer-aided manufacturing used for?

2. Study the following words.

1	computer integrated factory	компьютерно-интегрированный завод
2	hardware	аппаратные средства, «железо»
3	to facilitate	облегчать; способствовать
4	stress-strain analysis	анализ напряженно-деформированного состояния
5	heat transfer	теплопередача
6	numerical control	числовое программное управление
7	interface	взаимодействие, интерфейс
8	to perform	выполнять

3. Read the text.

CAD/CAM is a term which means computer-aided design and computer-aided manufacturing. It is the technology concerned with the use of digital computers to **perform** certain functions in design and production. This technology is moving in the direction of greater integration of design and manufacturing, which have traditionally been treated as separate functions in a production firm. Ultimately, CAD/CAM will provide the technology base for the **computer integrated factory** of the future.

Computer-aided design (CAD) can be defined as the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. The computer systems consist of the **hardware** and software to perform the specialized design functions. The CAD hardware typically includes the computer, one or more graphics display terminals, keyboards, and other peripheral equipment. The CAD software consists of the computer programs to implement computer graphics on the system plus application programs **to facilitate** the engineering functions of the user company. Examples of these application programs include **stress-strain analysis** of

components, dynamic **response** of mechanisms, **heat-transfer** calculations, and **numerical control** programming.

Computer-aided manufacturing (CAM) can be defined as the use of computer systems to plan, manage, and control the operations of a manufacturing plant through either direct or indirect computer **interface** with the plant's production resources.

4. Find the English equivalents for the following word combinations in the text and memorize them:

автоматизированный; интеграция проектирования и производства; клавиатура; терминал графического дисплея; программное обеспечение; реализовать компьютерную графику; прикладная программа; динамический отклик механизмов; расчеты теплопередачи; планировать; управлять и контролировать работу производственного предприятия.

5. Complete the sentences with a proper word/word combination.

design, manufacturing, hardware, software, facilitates, response, numerical control, interface, perform

1. The machines, wiring, and other physical components of a computer or other electronic system are called … .
2. It was necessary to measure the dynamic … of both models.
3. … refers to the programs and other operating information used by a computer.
4. A device or program enabling a user to communicate with a computer is what we call an … .
5. This invention considerably … efficient work.
6. What tasks can a computer … ?
7. The form of programmable automation, in which the process is controlled by the number, letters, and symbols is called a … … .
8. CAD facilitates the … process by transferring detailed information about a product in an automated form.
9. Companies are introducing computerized systems that support computer-aided … and manufacturing.

5. In each line of words (1–4) find the odd one out. Explain your choice.

1. hardware, stress-strain analysis, software, peripheral equipment;
2. numerical control, programming process, response, design method;
3. consist of, includes, assists, comprises;
4. design, production, manufacturing, computer graphics.

6. Work in pairs: take turns asking and answering the questions. Keep in mind that some questions may need a negative answer.

Model: Ask if a term CAD/CAM means computer-aided design and computer-aided manufacturing.

Student A: *Does this term mean computer-aided design and computer- aided manufacturing?*

Student B: *Yes, it does. It means … . (No, it doesn't. It doesn't mean …).*

	Student A	Student B
1	Ask if this technology uses analogue computers to perform certain functions in design and production.	Answer the question
2	Ask if CAD/CAM moves in the direction of integration of design and manufacturing.	Answer the question
3	Ask whether CAD assists in the creation, modification, analysis, or optimization of a design.	Answer the question
4	Ask if the computer system consists of the hardware and software.	Answer the question
5	Ask whether the CAD hardware consists of computer programs and application programs.	Answer the question
6	Ask if the CAD software includes the computer, graphics display terminals and keyboards.	Answer the question
7	Ask if application programs facilitate the engineering functions of the user company.	Answer the question
8	Ask if CAM uses computer systems to plan, manage and control operations of a manufacturing plant.	Answer the question

7. Writing. Give a written explanation of the following:

a) what the term CAD/CAM means;
b) what this technology uses and in what direction it is moving;
c) what CAD consists of and what, in their turn, hardware and software include;
d) how the CAM function can be described.

Unit 6. The History of Computer-Aided Design (CAD)

1. Discussion.
1. We all use CAD nowadays, but do you know its history?
2. What early applications of this technology do you know?

2. Study the following words and terms.

1	engineering design	проектирование; конструирование
2	precision	точность
3	versatility	универсальность, многосторонность
4	to underestimate	недооценивать
5	point plotter	точечный графопостроитель
6	instance	экземпляр класса (объекта)
7	designer	конструктор; проектировщик
8	to constrain	ограничить
9	drafting	черчение; изготовление чертежей
10	to intend	намереваться; планировать

3. Read the text.

During World War II considerable work was done in the development of real-time computing and by the 1950s there were dozens of people working on numerical control of machine tools and automating **engineering design**. But it was the work of two people—Patrick Hanratty and Ivan Sutherland—who may be considered the Fathers of what we know today as CAD.

More than sixty years ago, in 1957, Dr. Patrick Hanratty created the first numerical control system, named PRONTO, which later became Computer Aided Design (CAD). The **precision**, **versatility** and the possibility of CAD projects have revolutionized the entire production environment, so the importance of CAD cannot be **underestimated** in the industrial production.

A very innovative system (although of course primitive compared to today's CAD software) called "**Sketchpad**" was developed by Ivan Sutherland as part of his PhD thesis at Massachusetts Institute of Technology (MIT) in 1960. Sketchpad was especially innovative because the **designer** interacted with the computer graphically by using an optical pen to draw on a **point plotter** display. It was the first software that let users to **constrain** properties in a drawing, creating the concept of "objects" and "**instances**".

Due to the very high cost of early computers, large aerospace and automotive companies were the earliest users of CAD software. First-generation CAD software systems were typically 2D **drafting** applications **intended** to automate repetitive drafting routine.

4. Find the English equivalents for the following word combinations in the text and memorize them:

производственная среда, система ЧПУ, промышленное производство, диссертация на соискание степени кандидата наук, взаимодействовать с компьютером графически, чертить, создание понятия «объекты» и «экземпляры класса», автомобильные компании, программное обеспечение САПР первого поколения.

5. Match the sentence beginnings with the correct endings.

1. The beginnings of CAD can be traced to 1957, when Dr. Patrick Hanratty developed PRONTO,	a) which demonstrated the basic principles of computer technical drawing.
2. In 1960, Ivan Sutherland created SKETCHPAD	b) because design engineers had to learn how to use computers and CAD.
3. The first CAD systems served	c)) functionality and user friendliness.
4. Though productivity of design increased, but it was still time-consuming	d) which was the first commercial numerical-control programming system.
5. Nevertheless modifications and revisions were easier,	e) as mere replacements of drawing boards.
6. CAD programs grew in	f) developed for PCs.
7. AutoCAD appeared in 1982 making it the first CAD system	g) as the first major 3D CAD software but it ran on UNIX workstations because PCs in the 1980s were not powerful enough.
8. Pro/Engineer was released in 1987	h) moved CAD to the cloud.
9. Autodesk 360 (2012)	i) and over time CAD software and hardware became cheaper and affordable for midsize companies.

6. Work in pairs: take turns asking and answering the questions. Keep in mind that some questions may need a negative answer.

Model: *Ask if lots of work was done in the development of real-time computing during World War II.*

Student A: *Was lots of work done in the development of real-time computing during WWII?*

Student B: *Yes, it was. Considerable work was … .* (*No, it wasn't. Much work wasn't … .*)

	Student A	Student B
1	Ask if the beginning of CAD was the merit of dozens of people.	Answer the question
2	Ask if the first numerical control system was named PRONTO.	Answer the question

3	Ask whether "Sketchpad" was created by Patrick Hanratty.	Answer the question
4	Ask if "Sketchpad" was very innovative because the designer interacted with the computer graphically.	Answer the question
5	Ask whether it was the first software that created the concept of "objects" and "instances".	Answer the question
6	Ask if the importance of CAD is underestimated in the industrial production now.	Answer the question
7	Ask if large aerospace and automotive companies were the earliest users of CAD software.	Answer the question
8	Ask if first-generation CAD software systems were typically 3D drafting applications.	Answer the question

7. Answer the following questions in writing and speak about the CAD/CAM history using your answers as a plan.

1. Who may be considered the Fathers of CAD?
2. When was the first numerical control system created?
3. Name CAD features that have revolutionized the production environment.
4. Who was "Sketchpad" developed by?
5. How did the designer interact with the computer while using "Sketchpad"?
6. Was it the first software that created the concept of "objects" and "instances"?
7. What companies were the earliest users of CAD software?
8. Where the first-generation CAD software systems 2D or 3D drafting applications?

Unit 7. What's Next for CAD/CAM Technology?

1. Discussion.

1. How do you see the future of CAD/CAM systems? Will it be bright?
2. Why are you interested in working in this field?

2. Study the following words and terms.

1	design software	программное обеспечение САПР
2	to enhance	увеличивать, усиливать, улучшать
3	to anticipate	предвидеть
4	machine learning	машинное самообучение
5	input	вложение, инвестиции, ввод
6	access	доступ
7	sharing	совместное использование
8	SaaS (Software as a Service) model	ПО "как услуга (как сервис)"

9	sophisticated	сложный, современный, передовой
10	customization	изготовление продукта по требованиям (условиям) заказчика
11	one-size-fits-all	на все случаи жизни
12	affordability	доступность
13	feature	[функциональная] возможность, свойство
14	drafter	чертёжник; конструктор

3. Read the text.

The following trends may show us where the next great leap in CAD/CAM technology will emerge:

Artificial Intelligence**:** Incorporating AI into **design software** allows the automation of design tasks, **enhances** quality control by **anticipating** design errors and (with **machine learning**) paves the way for the creation of unique designs without human **input**.

Cloud collaboration**:** Cloud technology allows CAD/CAM to move beyond a single computer at a workplace to universal access through a Saas (Software-as-a-Service) model. Several people can work on the same project at once because **sharing** across organizations and geographies has become much easier.

Virtual reality: VR helmets and VR glasses can be used to take advantage of the life-like visualization offered by **sophisticated** CAD software.

Customization: Software providers are moving away from a **one-size-fits-all solution** to provide the option of configuring CAD/CAM to suit your work environment, and choose only the tools required for a particular job. This may be a way to offer **affordability** by cutting out dozens of **features** that the average user may never need.

The latest software will make lots of jobs obsolete, the technological evolution of the **drafter**'s craft shows how smart software can enhance or even replace a profession.

4. Find the English equivalents for the following words and word combinations:

скачок в технологии CAD/CAM, автоматизация проектных задач, улучшать/усиливать контроль качества, предвидеть ошибки проектирования, прокладывать путь, без участия человека, облачное сотрудничество, реалистичная визуализация, предоставить возможность конфигурировать CAD/CAM, исключая десятки функций, профессия чертёжника, устарелый.

5. Match these notions with their definitions.

CAD software, Artificial Intelligence, machine learning, VR helmets, cloud collaboration, virtual reality, SaaS (Software-as-a-Service), customization

1. … is an application of artificial intelligence (AI) that provides systems the ability to automatically learn without being explicitly programmed.

2. … is a simulated experience that can be similar to or completely different from the real world.

3. … refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions.

4. … is to modify or build according to individual or personal specifications or preference.

5. … is used by designers and engineers to create two-dimensional and three-dimensional models of physical components.

6. … is a system of communication that enables employees to work together on a project that is hosted in the cloud.

7. A … is a head-mounted device that provides virtual reality for the wearer.

8. … is a model in which a service provider hosts applications for customers and makes them available to these customers via the internet.

6. Work in pairs: take turns asking and answering the questions.

Model: *Ask what incorporating AI into design software allows.*
Student A: *What does incorporating AI into design software allow?*
Student B: *It allows the automation of design tasks and enhances quality control.*

	Student A	Student B
1	Ask, what possibilities cloud collaboration create.	Answer the question
2	Ask, how several people can work on the same project at once.	Answer the question
3	Ask, how several people can work on the same project at once.	Answer the question
4	Ask, what your partner needs to take advantage of the life-like visualization.	Answer the question
5	Ask, how we call the process if we build something according to individual specifications or preference.	Answer the question
6	Ask, how software providers are moving away from a one-size-fits-all solution.	Answer the question
7	Ask, what the technological evolution of the drafter's craft shows.	Answer the question

7. Writing. What do you think about the future of CAD/CAM systems? Support your opinion with reasons.

Unit 8. Fundamentals of CAD

1. Discussion.

1. What do you know about interactive computer graphics?
2. What elements does it include?

2. Match terms in Column A with their definitions in Column B.

A	B
1. hardware	a. a set of instructions designed to perform a frequently used operation within a program.
2. software	b. information, especially facts or numbers, collected to be examined and considered
3. subroutine	c. physical and electronic parts of a computer, rather than the instructions it follows.
4. interactive computer graphics	d. the programs and other operating information used by a computer.
5. central processing unit	e. instruction.
6. data	f. allows the user to interact with the graphical information presented on the display using one or more of a number of input devices.
7. designer	g. the part of a computer in which operations are controlled and executed.
8. workstation	h. the surface of an electronic device, on which images and data are displayed.
9. command	i. plans the look or operation of something prior to it being made, by preparing drawings or plans.
10. screen	j. visible impression displayed on a computer or video screen.
11. image	k. devices used to put information into and get information out of the computer.
12. peripheral devices	l. a desktop computer terminal, typically networked and more powerful than a personal computer.

3. Read the text.

The computer has become essential in the operations of business, government, engineering, and research. It has also demonstrated itself to be a very powerful tool in design and manufacturing.

The computer-aided design makes use of the computer to develop, analyze, or modify an engineering design. Modern CAD/CAM systems are based on **interactive computer graphics** (ICG). ICG denotes a user-oriented system in which the computer is employed to create, transform, and display **data** in the form of pictures or symbols. The user in the computer graphics design system is the designer, who communicates data and **commands** to the computer through any of several input

devices. The **designer** creates an image on the screen by entering commands to call the desired software **subroutine**s stored in the computer. The **image** can be modified according to the commands of the designer — enlarged, reduced in size, moved to another location on the **screen**, rotated, and other transformations. Through these various manipulations, the required details of the image are formulated.

The typical ICG system is a combination of **hardware** and **software.** The hardware includes a **central processing unit**, one or more **workstation**s and **peripheral devices** such as printers, plotters, and drafting equipment. The software consists of the computer programs needed to implement graphics processing. The software would also include additional specialized application programs to accomplish the engineering functions required by the user company.

4. Find the English equivalents for the following words and word combinations:

разработчик; интерактивная компьютерная графика; техническое проектирование; подпрограмма; ввод команд, чтобы вызвать нужные подпрограммы; создает изображение на экране; прикладная программа; увеличенный или уменьшенный в размере; устройства ввода; чертежное оборудование.

5. Fill in the following word and word-combinations into the sentences.

> hardware, instructions, motherboard, brain, keyboard, software. data, computing, card, flash memory, expansion slots

Computer … is the physical parts or components of a computer, such as the monitor, …, computer … storage, graphic card, sound … and motherboard. By contrast, software is … that can be stored and ran by hardware. Hardware is directed by the … to execute any command or instruction. A combination of hardware and software forms a usable … system.

The … is the main component of a computer. It is a board with integrated circuitry that connects the other parts of the computer including the CPU, the RAM, the disk drives as well as any peripherals via the ports or the … … . The CPU (Central Processing Unit) performs most of the calculations which enable a computer to function, and it is sometimes referred to as the… of the computer. Most newer CPUs include a built-in Graphics Processing Unit (GPU).

Computer memory is a generic term for all of the different types of data storage technology that a computer may use, including RAM, ROM, and … .

6. In each line of words (1–4) find the odd one out. Explain your choice:

1. hardware, keyboard, data, motherboard.
2. expansion slot, data storage, memory, subroutine.
3. design, manufacturing, production, learning.
4. develop, analyze, modify, include.

5. component, unit, function, part.
6. workstation, command, computer, processing unit.

7. Writing. Analyze the possibilities which interactive computer graphics offers (write at least 100 words).

Unit 9. The Benefits of the CAD System

1. Discussion.

1. List as many advantages of CAD as you can think of.
2. Does CAD combine the capabilities of a designer and a computer?

2. Study the following words and terms.

1	to magnify	увеличивать
2	synergistic effect	синергетический эффект
3	to perform	выполнять; совершать
4	capability	возможность; способность
5	storage	память; хранение (информации)
6	to investigate	исследовать
7	legibility	удобочитаемость; четкость
8	dimensions	размеры
9	bill of materials	опись, спецификации материалов

3. Read the text.

The CAD system comprises two components — the human designer and ICG system. Interactive computer graphics is a tool used by the designer to solve a design problem. In effect, the ICG system **magnifie**s the powers of the designer. This is called the **synergistic effect**. The designer performs the portion of the design process that is most suitable to human intellectual skills (conceptualization, independent thinking); the computer **performs** the task best suited to its **capabilities** (speed of calculations, visual display, **storage** of large amounts of data).

There are several fundamental reasons for implementing a computer-aided design system.

1. To increase the productivity of the designer. This is accomplished by reducing the time required for synthesizing, analyzing, and documenting the design and decreasing design costs.

2. To improve the quality of design. A CAD system permits a more thorough engineering analysis and a larger number of design alternatives can be **investigated**. Design errors are also reduced through the greater accuracy provided by the system. These factors lead to a better design.

3. To improve communications. Use of a CAD system provides better engineering drawings, more standardization in them, better documentation of the design, fewer drawing errors and greater **legibility**.

4. To create a database for manufacturing. In the process of creating the documentation for the product design (geometries and **dimensions** of the product and its components, material specifications for components, **bill of materials**, etc.), much of the required database to manufacture the product is also created.

4. Match the notions from the text above (A) with their definitions (B).

A	B
1. **An interactive computer graphics** system allows	a. if you have courage to go against the flow and think logically, it will help you succeed in your career.
2. **The synergistic effect** is	b. as the ability to invent or formulate an idea or concept.
3. **Independent thinking** is an advantage in any job because	c. the user to interact with the graphical information presented on the display.
4. **Conceptualization** can be defined	d. which enables searching **large amounts of data** in a fast and efficient way.
5. Computer scientists have developed an approach,	e. an effect arising between two or more agents or factors, that produces an effect greater than the sum of their individual effects.
6. **Legibility** means	f. the process of making something conform to a standard.
7. Science is a process of discovering, collecting	g. to examine (something) in detail in order to explain and interpret it.
8. **Standardization** refers to	i. and **synthesizing** facts and developing models of the world.
9. **Analyzing** means	j. the quality of being clear enough to read.

5. Work in pairs: take turns asking and answering the questions.

	Student A	Student B
1	Ask what components the CAD system comprises	Answer the question
2	Ask if Interactive Computer Graphics is used by the designer to solve a design problem.	Answer the question
3	Ask how we call the effect which magnifies the powers of the designer.	Answer the question
4	Ask what human intellectual skills are important for the design process.	Answer the question
5	Ask how a computer-aided design system increases the productivity of the designer.	Answer the question

6	Ask if CAD systems improve the quality of design and reduce design errors.	Answer the question
7	Ask what a computer-aided design system provides to improve communications.	Answer the question
8	Ask what a computer-aided design system can create.	Answer the question

6. Write these questions down.

Unit 10. Creating the Manufacturing Database

1. Discussion.

1. How was a design process organized in previous times?
2. Is designing and maintaining a manufacturing database a complex task?

2. Study the following words and terms.

1	conventional	традиционный; общепринятый
2	route sheet	маршрутная карта (технологического процесса)
3	to involve	вовлекать; включать в себя; содержать
4	time consuming	длительный, требующий много времени
5	duplication	удвоение; увеличение вдвое
6	link	связь
7	transition	переход; преобразование; превращение
8	product design	конструкция изделия; проектирование изделия

3. Read the text.

Another important reason for using a CAD system is that it offers the opportunity to develop the database needed to manufacture the product. In the **conventional** manufacturing cycle practiced for so many years in industry, engineering drawings were prepared by design draftsmen and then used by manufacturing engineers to develop the process plan (i.e., the "**route sheets**"). The activities **involved** in designing the product were separated from the activities associated with process planning. Essentially, a two-step procedure was employed. This was both **time consuming** and involved **duplication** of effort by design and manufacturing personnel.

In an integrated CAD/CAM system, a direct **link** is established between product design and manufacturing: It is the goal of CAD/CAM not only to automate certain phases of design and certain phases of manufacturing, but also to automate the **transition** from design to manufacturing. Computer-based systems have been developed which create much of the data and documentation required to plan and manage the manufacturing operations for the product.

The manufacturing database is an integrated CAD/CAM database. It includes all the data on the product generated during design (geometry data, bill of materials and parts lists, material specifications, etc.) as well as additional data required for manufacturing much of which is based on the **product design**.

4. Here are more facts about product design. Memorize the following words and word combinations and put them into the sentences.

1	process planning	технологическое проектирование; технологи-ческая подготовка производства
2	subassembly	сборочная единица; узел
3	tolerances	допуски
4	assembly	сборка, монтаж
5	link	связь; соединение
6	sequence	последовательность
7	raw material	сырьё
8	technological capabilities	научно-технический персонал или потенциал
9	dimensions	размеры
10	manufacturers	производители

The product design is the plan for the product and its components and … . The activity of developing such a plan is called … … . It is the … between product design and manufacturing. Process planning determines the … of processing and … steps that must be accomplished to make a product. It determines the detailed methods by which workpieces or components can be manufactured economically and competitively from initial stages (…) to finished stages (desired form). Geometrical features, … , materials, … and surface finish are analyzed to determine a sequence of processing operations. The scope and variety of processes that can be planned are generally limited by the available processing equipment and … … of the company or plant. Parts that cannot be made internally must be bought from outside … .

5. Work in pairs: take turns asking and answering the questions.

	Student A	Student B
1	Ask if the design stage was separated from the manufacturing stage in the past	Answer the question
2	Ask if it involved duplication of effort by design and manufacturing personnel.	Answer the question
3	Ask what two goals CAD/CAM systems have.	Answer the question
4	Ask what modern computer-based systems can create.	Answer the question
5	Ask what the manufacturing database includes.	Answer the question
6	Ask how we call the process of developing the product	Answer the question

	design.	
7	Ask what process planning determines.	Answer the question
8	Ask if it analyzes geometrical features, dimensions, materials, tolerances and surface finish.	Answer the question
9	Ask whether the scope and variety of processes are limited by the technological capabilities of the company.	Answer the question

6. Analyze in writing the advantages of using a manufacturing database compared to a conventional manufacturing cycle practiced for many years (write at least 100 words).

Unit 11. Hardware in Computer-Aided Design

1. Discussion.

1. What hardware components of a CAD system do you know?
2. What are the main functions of computer hardware?

2. Study the following words and word combinations.

1	stand-alone	автономный
2	secondary storage	внешние запоминающие устройства
3	to determine	определять; устанавливать
4	to accomplish	совершать; выполнять
5	to interface	соединять; связывать с компьютером
6	to generate	производить; делать
7	description	описание
8	to facilitate	облегчать; способствовать
9	conventional	традиционный; общепринятый

3. Read the text.

Typically, a **stand-alone** CAD system would include one or more design *workstations* which would consist of a digital computer, operator *input devices*, one or more *plotters* and other *output devices*, *central processing unit* (CPU), **secondary storage devices**.

The CAD workstation is the system interface with the outside world. It represents a significant factor in **determining** how convenient and efficient it is for a *designer* to use the CAD system. The workstation must **accomplish** five functions:

1. It must **interface** with the central processing unit (CPU).
2. It must **generate** a steady graphic image for the *user*.
3. It must provide digital **descriptions** of the graphic image.

4. It must translate computer commands into operating functions.

5. It must **facilitate** communication between the user and the system.

CAD applications require a digital computer with a high-speed central processing unit (CPU), *math coprocessor* to perform compute-intensive operations, and large internal memory. Today's commercial systems have 64-bit processors, which permit high-speed execution of CAD graphics and engineering analysis applications.

A plotter produces vector graphics drawings. Plotters draw lines on paper using a pen. In the past, plotters were able to produce line drawings much faster and of a higher quality than conventional printers, but now they have largely been replaced by wide-format conventional printers.

Storage peripherals are used in CAD systems to store programs and data files. The storage medium is usually magnetic.

4. Find the word or word combination in the text printed *in italics* which means the following:

1. a piece of equipment used to provide data to an information processing system such as a computer or information appliance;

2. a computer that is faster and more capable than a personal computer intended for business or professional use;

3. a principal part of any digital computer system which processes instructions, manipulates data, and transfers information to and from other components, such as the working memory, disk drive, and monitor;

4. any piece of computer hardware equipment which converts information into human-readable form;

5. a person who utilizes a computer or network service;

6. a printer that interprets commands from a computer to make line drawings on paper with multiple pens;

7. a person who plans the look or workings of something prior to it being made, by preparing drawings or plans;

8. an add-on for the processors that allows computers to perform faster mathematical calculations, increasing its overall performance.

5. Fill in the following word and word-combinations into the sentences.

CAD/CAM system, design, materials & auxiliary equipment, computer programs, productivity, display screen, time, mechanical part, computer-aided design

The introduction of CAD/CAM, which stand for … and computer-aided manufacturing, has significantly increased … and reduced the … required to develop new products. When using a … , an engineer sketches the design of some … , such as an automobile part or aircraft component, directly on the … of a computer terminal with a specific pen. The … that are provided with the system can be used to manipulate this first draft so as to improve it. After the … has been revised as

needed, the system prepares instructions for numerically controlled machine tools and places orders for … .

6. Write a short essay on the following topic: "An introduction to the realm of hardware" (at least 150 words).

Unit 12. Computer Graphics Software

1. Discussion.

1. Which software is used for computer graphics?
2. Do you know which software is best for graphic design?

2. Study the following words and terms.

1	interaction	взаимодействие
2	finite element analysis	анализ методом конечных элементов
3	numerical control part programming	программирование деталей с ЧПУ
4	simplicity	простота
5	consistency	последовательность, логичность
6	completeness	завершённость, законченность
7	robustness	робастность, устойчивость к нарушениям исходных предпосылок
8	performance	быстродействие, эффективность
9	omission	опускание, пропуск (данных)

3. Read the text.

The graphics software is the collection of programs written to make it convenient for a user to operate the computer graphics system. It includes programs to generate images on the screen, to manipulate the images, and to accomplish various types of **interaction** between the user and the system. In addition to the graphics software, there may be additional programs for implementing certain specialized functions related to CAD/CAM. These include design analysis programs (e.g., **finite element analysis** and kinematic simulation) and manufacturing planning programs (e.g., automated process planning and **numerical control part programming**).

The graphics software for a particular computer graphics system is very much a function of the type of hardware used in the system. The software must be written specifically for the types of input devices used in the system.

Newman and Spoull list six ground rules that should be considered in designing graphics software:

l. **Simplicity**. The graphics software should be easy to use.

2. **Consistency**. The package should operate in a consistent and predictable way to the user.

3. **Completeness**. There should be no inconvenient **omissions** in the set of graphics functions.

4. **Robustness**. The graphics system should be tolerant of minor instances of misuse by the operator.

5. **Performance**. Within limitations imposed by the system hardware, graphics programs should be efficient and speed of response should be fast.

6. Economy. Graphics programs should not be too large or expensive.

4. Find the English equivalents for the following words and word combinations:

осуществлять взаимодействие между пользователем и системой; реализовывать специализированные функции; программы планирования производства; легкий в использовании; работать предсказуемо для пользователя; следует учитывать; неправильное использование; скорость реакции; в пределах налагаемых ограничений; набор графических функций.

5. Say if the following is true or false. Correct the false sentences.

1. The graphics software makes it convenient for a user to operate the computer graphics system.

2. It cannot accomplish interaction between the user and the system.

3. The graphics software for a particular computer graphics system does not depend on the type of input devices used in the system.

4. The graphics software should be easy to use.

5. Predictability of the software package to the user is not important.

6. The graphics system should not be tolerant of misuse by the operator.

7. The graphics programs should be efficient and their speed of response should be fast.

8. Adobe Photoshop is the most popular software for graphic design and is used by millions of people around the world.

6. Answer the following questions.

1. What is the graphics software?

2. What does it comprise?

3. What do additional programs for implementing certain specialized functions related to CAD/CAM include?

4. Must the software be written specifically for the types of input devices used in the system?

5. List six ground rules formulated by Newman and Spoull that should be considered in designing graphics software.

6. What does each rule mean?

7. Writing. Give your arguments about the best graphic design software. What are its strong sides? Write at least 100 words.

Unit 13. The Software Configuration of a Graphics System

1. Discussion.

1. Do you know what elements the graphics software consists of?
2. Is the application program regarded as a set of operations that runs the application for the user?

2. Study the following words and terms.

1	inputting	процесс ввода, ввод
2	equentially	последовательно, логически
3	retrieve	выбирать; извлекать (данные)
4	physical entity	физический объект
5	two-dimensional	дву(х)мерный;
6	definition	определение; дефиниция
7	electronic circuits	электронные схемы
8	application program	прикладная программа
9	input subroutine	подпрограмма ввода
10	output subroutine	подпрограмма вывода

3. Read the text.

In the operation of the graphics system by the user, a variety of activities take place, which can be divided into three categories:
l. Interacting with the graphics terminal to create and alter images on the screen.
2. Constructing a model of something physical out of the images on the screen.
3. **Inputting** the model into computer memory and/or secondary storage.

In working with the graphics system the user performs these various activities in combination rather than **sequentially**. The user constructs a physical model and inputs it to memory by interactively describing images to the system.

The reason for separating these activities is that they correspond to the general configuration of the software package used with the interactive computer graphics (ICG) system.

The graphics software can be divided into three modules according to a conceptual model suggested by Foley and Van Dam:
l. The graphics package.
2. The application program.
3. The application database.

The central module is the application program. It controls the storage of data into and **retrieves** data out of the application database. The application program is

implemented by the user to construct the model of a **physical entity** whose image is to be viewed on the graphics screen.

The graphics package is the software support between the user and the graphics terminal. It manages the graphical interaction between the user and the system. The graphics package consists of **input subroutines** and **output subroutines**. The input routines accept input commands and data from the user and forward them to the application program. The output subroutines control the display terminal and convert the application models into **two-dimensional** or three-dimensional graphical pictures.

The third module in the ICG software is the database. The database contains mathematical, numerical, and logical **definitions** of the application models, such as **electronic circuits**, mechanical components, automobile bodies, and other data.

4. Find the English equivalents for the following words and word combinations:

взаимодействие между пользователем и системой, поддержка программного обеспечения, база данных приложения, изменить изображения на экране, интерфейс между пользователем и прикладным программным обеспечением, преобразует в двухмерные или трехмерные графические изображения.

5. Fill the missing words into the sentences.

images, interaction, programs, user, input devices, display, software

The graphics software is the set of … written to make it convenient for a … to operate the computer graphics system. It accomplishes various types of … between the user and the system. It includes programs to generate … on the screen. The graphics … for a particular computer graphics system depends on the type of hardware used in the system. The software must be written regarding the type of the computer … and the types of … … used in the system.

6. Work in pairs. Student A works for CIM Info Tech, a company that provides integrated manufacturing software. He wants to convince Student B, a manager of a plant, to buy it. Write down a dialogue using the hints below and act it out.

	Student A	**Student B**
1	Greet the customer and introduce yourself.	Answer.
2	Ask whether he/she knows about computer integrated manufacturing.	Say that you know something about it and that you are not interested in it.
3	Talk about the advantages of CIM.	Ask what this technology can do.
4	Answer.	Ask if it is expensive.
5	Say that you offer a software package at a reasonable cost.	Ask about maintenance and guarantees.

6	Say that your company offers a three-year guarantee plus one year of free maintenance.	Say that you will think about it and ask for a brochure.
7	Answer and say goodbye.	End the conversation in an appropriate manner

7. Here are some prompts that may be useful for making a dialogue:

1. The programmer has to do only the following things**:**
    a**) to define** the work part geometry;
    b) **to define** the repetition work;
    c) **to specify** the operation sequence.

2. As interactive graphic system is integrated with the NC part programming, the part programmer can
    a) **create** the geometrical model in the CAM package;
    b) **extract** it from the CAD/CAM database.

3. Built in tool motion commands assist the part programmer
    a) **to calculate** the tool paths automatically;
    b) **to verify** the tool paths through the graphic display using the animation function of the CAM system.

Список литературы

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