МИНИСТЕРСТВО ОБРАЗОВАНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ

УЧРЕЖДЕНИЕ ОБРАЗОВАНИЯ
«БРЕСТСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»

Кафедра иностранных языков технических специальностей

ENGLISH READER IN ENGINEERING FOR STUDENTS OF MECHANICAL FACULTY

(Методические рекомендации по изучающему чтению для студентов специальности ТМ на английском языке)

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Учебно-методическое пособие предназначено для студентов технических специальностей, продолжающих изучение английского языка.

Основной целью пособия является обеспечение активного владения выпускниками неязыкового вуза иностранным языком как средством формирования и формулирования мыслей в социально-обусловленных и профессионально-ориентированных сферах обучения.

Данное пособие представляет десять уроков, структура которых содержит: аутентичный текст по специальности разнообразной проблематики, предтекстовые (1) и послетекстовые (7) задания.

Данное пособие одобрено на заседании кафедры иностранных языков технических специальностей и рекомендовано к изданию.

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Task 1: Pronounce the following words correctly. Learn them by heart.

1. to connect [kə'nekt] - соединять
2. changeover ['tʃeɪndʒ,əuvə] - перенастройка, замена
3. to perform [pə'fɔ:m] - выполнять
4. to process ['prəuses] - обрабатывать
5. stepwise ['stepwaɪz] - пошаговый
6. to proceed [prə'si:d] - поступать
7. simultaneous [,sɪməl'teɪnɪəs] - одновременный
8. to transfer ['trænsfə:] - переносить, передавать
9. sequence ['si:kwəns] - последовательность
10. properly ['prɔpəlɪ] -должным образом
11. to require [rɪ'kwaɪə] - требовать
12. to utilize ['ju:tɪlaɪz] - использовать
13. to remove [rɪ'mu:v] - удалять, снимать
14. multiple ['mʌltɪpl] - многочисленный
15. to shape [ʃeɪp] - формировать
16. to complete [kəm'pli:t] – заканчивать, завершать
17. separate ['seprɪt] -отдельный
18. to divide [dɪ'vaɪd] - делить(ся)
19. to involve [ɪn'vɔlv] - включать в себя
20. sheet [ʃi:t] - лист
21. to include [ɪn'klu:d] - содержать в себе, включать
22. partial ['pa:ʃəl] - частичный
23. to create [kri:'eɪt] - создавать

Task 2: Read the text.

Automated Production Lines

An automated production line consists of a series of workstations connected by a trans[illegible]ystem to move parts between the stations. This is an example of fixed automation, since thes[illegible]s are set up for long production runs, making a large number of product units and running for several years between changeovers. Each station is designed to perform a specific processing operation, so that the part or product is constructed stepwise as it progresses along the line. A raw work part enters at one end of the line, proceeds through each workstation and appears at the other end as a completed product. In the normal operation of the line, there is a work part being processed at each station, so that many parts are being processed simultaneously and a finished part is produced with each cycle of the line. The various operations, part transfers, and other activities taking place on an automated transfer line must all be sequenced and coordinated properly for the line to operate efficiently.

Modern automated lines are controlled by programmable logic controllers, which are special computers that can perform timing and sequencing functions required to operate such equipment. Automated production lines are utilized in many industries, mostly automobile, where they are used for processes such as machining and pressworking.

Machining is a manufacturing process in which metal is removed by a cutting or shaping tool, so that the remaining work part is the desired shape. Machinery and motor components are usually made by this process. In many cases, multiple operations are required to completely shape the part. If the part is mass-produced, an automated transfer line is often the most economical method of production. Many separate operations are divided among the workstations.

Pressworking operations involve the cutting and forming of parts from sheet metal. Examples of such parts include automobile body panels, outer shells of laundry machines and metal furniture. More than one processing step is often required to complete a complicated part. Several presses are connected together in sequence by handling mechanisms that transfer the partially completed parts from one press to the next, thus creating an automated pressworking line.

Task 3: Find in the text English equivalents to the following word-combinations.

1. ряд станков
2. линии установлены
3. единицы продукции
4. операция по обработке
5. собирается постепенно
6. заготовка поступает
7. конечный продукт
8. обрабатывается на каждом станке
9. обрабатываются одновременно
10. перемещение деталей
11. автоматический конвейер
12. все должны быть последовательны
13. функции установки времени и последовательности
14. применяются во многих отраслях
15. металл удаляется
16. необходимая форма
17. требуется много операций
18. распределены между станками
19. включают резку и формовку
20. листовой металл
21. корпусы стиральных машин
22. сложная деталь
23. передающие механизмы

Task 4: Insert the missing words in the sentences.

1. These lines are ... for long production runs.
2. Each station is ... to perform a specific processing operation.
3. Many parts are ... simultaneously.
4. The various operations must all be ... properly.
5. *Special computers can ... timing and sequencing functions.*
6. Many separate operations are ... among the workstations.

Task 5: Put the words in the correct order to make a statement or a question.

1. Automation, an example, of, this, is, fixed.
2. Enter, where, work part, does, a, raw?
3. A, being processed, is, there, at, station, each, work, part.
4. Automated, utilized, are, production, in, lines, industries, many.
5. Removed, by, metal, is, tool, or, cutting, a, shaping?
6. By, machinery, this, and, motor, usually, components, process, made, are.

Task 6: Say if the following statements are true or false according to the text.

1. An automated production line consists of one workstation.
2. Automated production lines are set up for short productions runs.
3. Each station is designed to perform various processing operations.
4. A raw work part proceeds through each workstation.
5. The various operations must all be sequenced.
6. Programmable logic controllers can perform timing and sequencing functions.

Task 7: Put the following sentences in the logical order according to the text.

1. If the part is mass-produced, an automated transfer line is often the most economical method of production.
2. Automated production lines are utilized in many industries.
3. Many parts are being processed simultaneously.
4. There is a work part being processed at each station.
5. The part or product is constructed stepwise as it progresses along the line.
6. Automated production lines are set up for long production runs.

Task 8: Speak on the following points.

1. Automated production lines are set up for long production runs.
2. In the normal operation of the line many parts are being processed simultaneously.
3. Automated production lines are utilized in many industries.
4. Many separate operations are divided among the workstations.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Does an automated production line consist of a series of workstations?
2. What are these lines set up for?
3. Are many parts being processed simultaneously or stepwise?
4. What is controlled by programmable logic controllers?
5. Automated production lines are utilized in many industries, aren't they?

Unit 2

Task 1: Pronounce the following words correctly. Learn them by heart.

1. number ['nʌmbə] - число, цифра
2. to punch [pʌntʃ] - пробивать отверстие
3. storage ['stɒ:ndʒ] -хранение
4. tape [teɪp] - лента
5. medium ['mɪ:djəm] - средство
6. initial [ɪ'nɪʃl] - начальный
7. application [,æplikeɪʃn] -применение
8. tool [tu:1] - инструмент, станок
9. relative ['relətiv] – относительный
10. set [set] - набор
11. particular [pə'tɪkjulə] - отдельный
12. to specify ['spesɪfaɪ] - устанавливать
13. to define [dɪ'faln] - определять

14. sequence ['si:kwəns] - последовательность
15. to accomplish [ə'kɔmpliʃ] - выполнять
16. feedback ['fi:dbæk] - обратная связь
17. to verify ['verifai] - проверять
18. to implement ['implimənt] -выполнять
19. to involve [in'vɔlv] - включать
20. to include [in'klu:d] - заключать, содержать
21. to insert [in'sə:t] - вставлять
22. assembly [ə'sembli] -монтаж, сборка
23. draft [dra:ft] - чертёж, проект
24. drawing ['drɔ:iŋ] - рисунок
25. accurate ['ækjurit] - точный
26. to employ [im'plɔi] - применять
27. surface ['sə:fis] - поверхность
28. lead wire [li:d] [waiə] - подводящий провод
29. hole [həul] - отверстие
30. to require [ri'kwaiə] - требовать
31. precision [pri'siʒn] - точность

Task 2: Read the text.

Numerical Control

Numerical control is a form of programmable automation in which a machine is controlled by numbers (and other symbols) that have been coded on punched paper tape or an alternative storage medium. The initial application of numerical control was in the machine tool industry to control the position of a cutting tool relative to the work part being machined. The NC part program represents the set of machining instructions for the particular part. 'The coded numbers in the program specify x-y-z coordinates in a Cartesian axis system, defining the various positions of the cutting tool in relation to the work part. By sequencing these positions in the program, the machine tool is directed to accomplish the machining of the part. A position feedback control system is used in most NC machines to verify that the coded instructions have been correctly performed. Today a small computer is used as the controller in an NC machine tool. Since this form of numerical control is implemented by computer, it is called computer numerical control, or CNC. Another variation in the implementation of numerical control involves sending part programs over telecommunication lines from a central computer to individual machine tools in the factory. This form of numerical control is called direct numerical control, or DNC.

Many applications of numerical control have been developed since its initial use to control machine tools. Other machines using numerical control include component-insertion machines used in electronics assembly, drafting machines that prepare engineering drawings, coordinate measuring machines that perform accurate inspections of parts. In these applications coded numerical data are employed to control the position of a tool or workhead relative to some object. Such machines are used to position electronic components (e.g., semiconductor chip modules) onto a printed circuit board (PCB). It is basically an x-y positioning table that moves the printed circuit board relative to the part-insertion head, which then places the individual component into position on the board. A typical printed circuit board has dozens of individual components that must be placed on its surface; in many cases, the lead wires of the components must be inserted into small holes in the board, requiring great precision by the insertion machine. The program that controls the machine indicates which components are to be placed on the board and their locations. This information is contained in the product-design database and is typically communicated directly from the computer to the insertion machine.

Task 3: Find in the text English equivalents to the following word-combinations.

1. перфорированная бумажная лента
2. первоначальное применение
3. станкостроительная промышленность
4. режущий инструмент
5. определяя разные положения
6. относительно рабочей детали
7. путём последовательного расположения
8. выполнять обработку детали
9. выполнены правильно
10. используется компьютером
11. использование цифрового контроля
12. механизм для установки деталей
13. точная проверка деталей
14. закодированные цифровые данные
15. должны быть расположены на её поверхности
16. должны быть размещены в маленькие отверстия
17. требующие большой точности
18. передаются напрямую от компьютера

Task 4: Insert the missing words in the sentences.

1. The NC part program ... the set of machining instructions.
2. By sequencing these positions in the program, the machine tool is directed ... the machining of the part.
3. Many applications of numerical control have been ... since its initial use.
4. Other machines using NC ... component-insertion machines.
5. Coded numerical data are ... to control the position of a tool.
6. Dozens of individual components must be ... on its surface.

Task 5: Put the words in the correct order to make a statement or a question.

1. Mean, does, control, what, numerical?
2. Instructions, set, of, it, machining, the, represents.
3. Tool, the, the part, accomplishes, machining, the, machine, of.
4. Employed, these, applications, in, data, numerical, coded, are.
5. Position, components, what, electronic, machines?
6. Components, has, what, dozens, of, individual?

Task 6: Say if the following statements are true or false according to the text.

1. The only application of numerical control was in the machine tool industry.
2. The NC part program represents the set of machining instructions.
3. The coded numbers define the various positions of the cutting tool.
4. A position feedback control system is used in some NC machines.
5. DNC means sending part programs from a central computer to individual machine tools.
6. Such machines are used to make electronic components.

Task 7: Put the following sentences in the logical order according to the text.

1. The initial application of numerical control was in the machine tool industry.
2. The coded numbers define the various positions of the cutting tool.
3. The control system verifies that the coded instructions have been correctly preformed.

4. Part programs are sent from the central computer to individual machine tools.
5. Many applications of NC have been developed.
6. The control program indicates which components are to be placed.

Task 8: Speak on the following points.

1. Numerical control is a form of programmable automation.
2. A position feedback control system is used in most NC machines.
3. Many applications of numerical control have been developed since its initial use.
4. A typical printed circuit board has dozens of individual components.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Does the NC part program represent a set of machining instructions?
2. Where was the initial application of numerical control?
3. Is the machine tool directed to accomplish the machining or turning of the part?
4. What is used to verify that the coded instructions have been correctly performed?
5. Today a small computer is used as the controller, isn't it?

Unit 3

Task 1: Pronounce the following words correctly. Learn them by heart.

1. assembly [ə'sembli] -монтаж, сборка
2. perform [pə'fɔ:m]-выполнять
3. workstation [,wə:k'steiʃn] - рабочее место
4. multiple ['mʌltip1] - многочисленный
5. to owe [əu] - быть обязанным
6. content ['kɔntənt] - содержание, доля
7. manual ['mænjuəl] - ручной
8. attention [ə'tenʃən] - внимание
9. recent ['ri:snt] - недавний
10. quantity ['kwɔntiti] - количество
11. lighter ['laitə] - зажигалка, осветитель
12. condition [kən'diʃən] - условие
13. to require [ri'kwaiə] - требовать
14. similar ['similə] - подобный
15. to transfer [træns'fə:] - переносить, перемещать
16. difference ['difrəns] -разница
17. instead [in'sted] - вместо
18. to consist [kən'sist] - состоять
19. to equip [i'kwip] - оборудовать
20. to deliver [di'livə] - доставлять
21. workhead ['wə:khed] - передняя бабка станка
22. actual ['æktʃuəl] - фактически существующий
23. to attach ['ətætʃ] - прикреплять
24. to include [in'klu:d] - включать
25. screwdriver ['skru:,draivə] - отвертка

26. to weld [weld] - сваривать
27. to join [dʒɔin] - соединять
28. device [di'vais] - устройство
29. to add [æd] - прибавлять, присоединять
30. partial ['pa:ʃəl] - частичный
31. to complete [kəm'pli:t] - заканчивать, завершать
32. gradual ['grædjuəl] -постепенный, последовательный
33. to proceed [prə'si:d] - продолжать, поступать
34. to consider [kən'sidə] -рассматривать, считать
35. to configure [kənfigə] - настраивать
36. particular [pə'tikjulə] - отдельный
37. volume ['vɔljum] - объём
38. to represent [repri'zent] - представлять
39. to insert [in'sə:t] - вставлять
40. to employ [im'plɔi] - применять

Task 2: Read the text.

Automated Assembly

Assembly operations have traditionally been performed manually, either at single assembly workstations or on assembly lines with multiple stations. Owing to the high labour content and high cost of manual labour, greater attention has been given in recent years to the use of automation for assembly work. Assembly operations can be automated using production line principle: if the quantities are large, the product is small, and the design is simple (e.g., mechanical pencils, pens, and cigarette lighters). For products that do not satisfy these conditions, manual assembly is generally required.

Automated assembly machines have been developed that operate in a manner similar to machining transfer lines, with the difference being that assembly operations, instead of machining, are performed at the workstation. A typical assembly machine consists of several stations each equipped with a supply of components and a mechanism for delivering the components into position for assembly. A workhead at each station performs the actual attachment of the component. Typical workheads include automatic screwdrivers, welding heads and other joining devices. A new component is added to the partially completed product at each workstation, thus building up the product gradually as it proceeds through the line. Assembly machines of this type are considered to be examples of fixed automation, because they are generally configured for a particular product made in high volume. Programmable assembly machines are represented by the component-insertion machines employed in the electronics industry.

Task 3: Find in the text English equivalents to the following word-combinations.

1. выполнялись вручную
2. сборочные линии
3. использование автоматизации
4. при условии большего количества
5. не удовлетворяют этим условиям
6. обычно требуется
7. линии конвейера
8. разница состоит в том
9. механизм подачи комплектующих
10. непосредственное присоединение детали
11. другие сборочные устройства
12. присоединяется к частично готовому продукту

13. по мере продвижения по конвейеру
14. который производят в большом объёме
15. программные сборочные механизмы
16. применяемые в электронной промышленности

Task 4: Insert the missing words in the sentences.

1. Automated assembly machines operate in a manner ... to machining transfer lines.
2. Assembly operations are ... at the workstations.
3. Each station is ... with a mechanism for delivering the components into position for assembly.
4. A workhead performs the actual ... of the components.
5. The product is being built up gradually as it... through the line.
6. Programmable assembly machines are ... by the component-insertion machines.

Task 5: Put the words in the correct order to make a statement or a question.

1. Been, how, assembly, performed, have, operations?
2. The use, to, automation, of, given, greater, been, attention, has.
3. Required, manual, assembly, when, is?
4. Operations, performed, where, assembly, are?
5. Stations, of, what, several, consists?
6. Attachment, component, the, of, the, a workhead, performs.

Task 6: Say if the following statements are true or false according to the text.

1. Greater attention has been given in recent years to the use of automation for assembly work.
2. Assembly operations can't be automated.
3. Manual assembly is never required.
4. Assembly operations are made at the workstations.
5. Each station is equipped with a supply of components.
6. Assembly machines are configured for a particular product.

Task 7: Put the following sentences in the logical order according to the text.

1. Typical workheads include automatic screwdrivers, welding heads and other joining devices.
2. Assembly operations are performed at the workstations.
3. Assembly machines of this type are considered to be examples of fixed automation.
4. Assembly operations can be automated.
5. A workhead performs the attachment of the component.
6. For some products manual assembly is generally required.

Task 8: Speak on the following points.

1. Great attention has been given to the use of automation.
2. Assembly operations are performed at the workstations.
3. The product is gradually built up.
4. Assembly machines are examples of fixed automation.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Has attention been given to the use of automation?
2. In what case can assembly operations be automated?
3. Are assembly operations or controlling performed at the workstation?
4. What is added to the product at each workstation?
5. Assembly machines are configured for a particular product, aren't they?

Task 1: Pronounce the following words correctly. Learn them by heart.

1. concept ['kɔnsept] – понятие
2. figure ['fɪgə] – цифра
3. medieval [medɪ'i:vl] – средневековый
4. church ['tʃə:tʃ] – церковь
5. to gain [geɪn] – получать
6. fame [feɪm] – слава
7. to apply [ə'plaɪ] – применять
8. handicraft ['hændɪkra:ft] – ручная работа
9. motion [məuʃn] – движение
10. creature ['krɪ:tʃə] – живое существо
11. to advertise ['ædvətaɪz] – рекламировать
12. to entertain [entə'teɪn] – развлекать
13. actually ['æktuəlɪ] – фактически
14. addition [ə'dɪʃn] – дополнение
15. remote [rɪ'məut] – дистанционный
16. to derive [dɪ'raɪv] – происходить
17. compulsory [kəm'pΛlsən] – обязательный
18. to describe [dɪs'kraɪb] – описывать
19. to lack [læk] – нехватать
20. sensibility [sensɪ'bɪlɪtɪ] – чувствительность
21. true [tru:] – правильный
22. researcher [rɪ'sə:tʃə] – исследователь
23. to arrange [ə'reɪndʒ] – располагать
24. to process ['prəusəs] – обрабатывать
25. to equip [ɪ'kwɪp] – оборудовать
26. to handle [hændl] – управлять
27. to feed [fɪ:d] - подавать
28. to surround [sə'raund] - окружать
29. environment [ɪn'vaɪrənmənt] – окружающая среда
30. to change [tʃeɪndʒ] – менять
31. feedback ['fɪ:dbæk] – обратная связь
32. to spread [spred] – распространять(ся)
33. to increase [ɪn'krɪ:s] – возрастать
34. essential [ɪ'senʃl] – существенный
35. procedure [prəu'sɪ:dʒə] - технологический процесс
36. to advance [əd'va:ns] – делать успехи
37. to explore [ɪk'splɔ:] – исследовать
38. to expand [ɪks'pænd] – расширять(ся)
39. available [ə'veɪləbl] – доступный
40. sign [saɪn] – знак, признак

Task 2: Read the text.

History of Robotics

The concept of robots dates back to ancient times, when some myths told of mechanical beings brought to life. Such automata also appeared in the clockwork figures of medieval churches, and in the 18th century some clockmakers gained fame for the clever mechanical figures that they constructed. Today the term automaton is usually applied to these handcrafted, mechanical (rather than electromechanical) devices that imitate the motions of living creatures. Some of the «robots» used in advertising and entertainment are actually automata, even with the addition of remote radio control.

The term robot itself is derived from the Czech word robota, meaning «compulsory labour». It was first used by the Czech novelist and playwright Karel Chapek, to describe a mechanical device that looks like a human but, lacking human sensibility, can perform only automatic, mechanical operations. Robots as they are known today do not only imitate human or other living forms. True robots did not become possible, however, until the invention of the computer in the 1940s and the miniaturization of computer parts. One of the first true robots was an experimental model designed by researchers at the Stanford Research Institute in the late 1960s. It was capable of arranging blocks into stacks through the use of a television camera as a visual sensor, processing this information in a small computer.

Computers today are equipped with microprocessors that can handle the data being fed to them by various sensors of the surrounding environment. Making use of the principle of feedback, robots can change their operations to some degree in response to changes in that environment. The commercial use of robots is spreading with the increasing automation of factories, and they have become essential to many laboratory procedures. Japan is the most advanced nation exploring robot technology. Nowadays robots continue to expand their applications. The home-made robots (горничная) available today may be one sign of the future.

Task 3: Find in the text English equivalents to the following word-combinations.

1. относится к древности
2. приобрели славу
3. сделанные вручную механические устройства
4. движения живых существ
5. используемые в рекламе
6. с применением дистанционного управления
7. означающее обязательную работу
8. до изобретения компьютера
9. созданная исследователями
10. мог складывать блоки
11. обрабатывая эту информацию
12. используя принцип обратной связи

Task 4: Insert the missing words in the sentences.

1. Some myths told of mechanical beings ... to life.
2. They imitate the ... of living creatures.
3. Some of the "robots" are ... automata.
4. The mechanical ... can perform only automatic, mechanical operations.
5. True robots did not become possible unit the ... of the computer.
6. It was capable of ... blocks into stacks.

Task 5: Put the words in the correct order to make a statement or a question.

1. Times, back, what, to, dates, ancient?
2. Gain, what, some, for, clockmakers, did, fame?
3. Being fed, them, can, microprocessors, to, the data, handle.
4. Their, some, to, can, degree, operations, change, to, robots?
5. Robots, why, commercial, the, spreading, use, is, of?
6. Their, continue, applications, expand, robots, to.

Task 6: Say if the following statements are true or false according to the text.

1. The concept of robots is quite modern.
2. In the 16th century some clockmakers gained fame for the clever mechanical figures.
3. This mechanical device can perform only automatic, mechanical operations.
4. True robots appeared before the invention of the computer.
5. The robot was capable of arranging blocks into stacks.
6. Microprocessors can handle the data by various sensors.

Task 7: Put the following sentences in the logical order according to the text.

1. True robots did not become possible until the invention of the computer.
2. Robots can change their operations to some degree.
3. Computers today are equipped with microprocessors.
4. Some myths told of mechanical beings brought to life.
5. The Czech word robota means "compulsory labour".
6. These mechanical devices can imitate the motions of living creatures.

Task 8: Speak on the following points.

1. The concept of robots dates back to ancient times.
2. The human-like mechanical device can perform only automatic, mechanical operations.
3. One of the first true robots was designed by researchers at the Stanford Research Institute.
4. Computers today are equipped with microprocessors.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Did some myths tell of mechanical beings brought to life?
2. What is the term automation applied to?
3. Did true robots appear before or after the invention of the computer?
4. What was capable of arranging blocks into stacks?
5. Robots can change their operations, can`t they?

Unit 5

Task 1: Pronounce the following words correctly. Learn them by heart.

1. unit ['ju:nɪt] – единица
2. length [leŋθ] – длина
3. to adopt [ə'dɔpt] – принимать
4. common ['kɔmən] – общий
5. weight [weɪt] – вес
6. measure ['meʒə] – мера
7. majority [mə'dʒɔrətɪ] – большинство
8. capacity [kə'pæsɪtɪ] – ёмкость, объем
9. palm [pa:m] – ладонь
10. breadth [bredθ] – ширина
11. elbow ['elbəu] – локоть
12. tip [tɪp] – кончик (пальца)
13. finger ['fɪŋgə] - палец
14. definite ['defənət] – определённый, точный
15. linear measures ['lɪnɪə'meʒəz] – меры длины

16. inch [ıntʃ] – дюйм
17. to define [dı'faın] – определять
18. term [tə:m] – термин
19. bar [ba:] – полоса
20. solid ['sɔlıd] – твёрдый
21. alloy ['ælɔı] – сплав
22. to maintain [meın'teın] – сохранять
23. exact [ıg'zækt] – точный
24. to refer [rı'fə:] – относится
25. supplementary [,sʌplı'mentərı] – дополнительный
26. origin ['ɔrıdʒın] – происхождение
27. agreement [ə'grı:mənt] – договор
28. to emit [ı'mıt] – испускать
29. path [pa:θ] – путь
30. to create [krı:'eıt] – создавать
31. pure [pjuə] – чистый
32. density ['densıtı] – удельный вес, плотность
33. century ['sentʃurı] – век
34. rotation [rəu'teıʃn] – вращение
35. mean [mı:n] – средний
36. solar ['səulə] – солнечный
37. complete [kəm'plı:t] – полный
38. axis ['æksıs] – ось
39. relation [rı'leıʃn] – отношение
40. frequency ['fri:kwənsı] – частота

Task 2: Read the text.

Measurements

Metric System is a decimal system of physical units, named after its unit of length, the metre, the metric system is adopted as the common system of weights and measures by the majority of countries, and by all countries as the system used in scientific work.

Weights and Measures

Length, capacity, and weight can be measured using standard units. The principal early standards of length were the palm or hand breadth, the foot, and the cubit, which is the length from the elbow to the tip of the middle finger. Such standards were not accurate and definite. Unchanging standards of measurement have been adopted only in modern time.

In the English-speaking world, the everyday units of linear measurement were traditionally the inch, foot, yard and mile. In Great Britain, until recently, these units of length were defined in terms of the imperial standard yard, which was the distance between two lines on a bronze bar made in 1845.

In Britain units of weight (ounces, pounds, and tons) are now also derived from the metric standard — kilogram. This is a solid cylinder of platinum-iridium alloy maintained at constant temperature at Sevres, near Paris. Copies, as exact as possible, of this standard are maintained by national standards laboratories in many countries.

International System of Units is a system of measurement units based on the MKS (metre-kilogram-second) system. This international system is commonly referred to as SI.

At the Eleventh General Conference on Weights and Measures, held in Paris in 1960 standards were defined for six base units and two supplementary units:

Length

The metre had its origin in the metric system. By international agreement, the standard metre had been defined as the distance between two fine lines on a bar of platinum-iridium alloy. The 1960 conference redefined the metre as 1,650,763.73 wavelengths of the reddish-orange light emitted by the isotope krypton-86. The metre was again redefined in 1983 as the length of the path travelled by light in a vacuum during a time interval of l/299,792,4'58 of a second.

Mass

When the metric system was created, the kilogram was defined as the mass of 1 cubic decimetre of pure water at the temperature of its maximum density or at 4.0 °C.

Time

For centuries, time has been universally measured in terms of the rotation of the earth. The second, the basic unit of time, was defined as 1/86,400 of a mean solar day or one complete rotation of the earth on its axis in relation to the sun. Scientists discovered, however, that the rotation of the earth was not constant enough to serve as the basis of the time standard. As a result, the second was redefined in 1967 in terms of the resonant frequency of the caesium atom, that is, the frequency at which this atom absorbs energy: 9,192,631,770 Hz (hertz, or cycles per second).

Task 3: Find in the text English equivalents to the following word-combinations.

1. принята как общая система
2. система, применяемая в научной работе
3. используя стандартные единицы
4. расстояние от локтя до кончика среднего пальца
5. традиционно были дюйм, фут, ярд и миля
6. до недавнего времени
7. хранятся в национальных лабораториях стандартов
8. были определены для шести основных единиц
9. по международному договору
10. один кубический дециметр чистой воды
11. вращение земли
12. средний солнечный день

Task 4: Insert the missing words in the sentences.

1. The metric system is ... as the common system of weight and measures.
2. *Such standards were not ... and definite.*
3. This is a solid cylinder of platinum-iridium...
4. This international system is commonly ... to as SI.
5. The metre had its ... in the metric system.
6. Time has been measured in terms of the ... of the earth.

Task 5: Put the words in the correct order to make a statement or a question.

1. System, weights, the, metric, system, of, common, is, the, measures, and.
2. Definite, such, not, standards, and, were, accurate.
3. Again, the, was, redefined, metre?
4. Constant, the, of, was, the, rotation, not, earth.
5. Redefined, the, 1967, in, time, was, standard?
6. Base, were, standards, for, units, six, defined.

Task 6: Say if the following statements are true or false according to the text.

1. The metric system is adopted only by some countries.

2. This system is used in scientific work.
3. Old standards were not accurate and definite.
4. Unchanging standards have been adopted only in modern time.
5. Copies of this standard are maintained only in Paris.
6. This national system is commonly referred to as SI.

Task 7: Put the following sentences in the logical order according to the text.

1. A solid cylinder of platinum-iridium alloy is maintained near Paris.
2. Time has been measured in terms of the rotation of the earth.
3. The metric system is adopted by the majority of countries.
4. Such standards were not accurate and definite.
5. The metre was again redefined in 1983.
6. Standards were defined for six base units.

Task 8: Speak on the following points.

1. Metric System is a decimal system of physical units.
2. Unchanging standards have been adopted only in modern time.
3. The metre had its origin in metric system.
4. Time has been measured in terms of the rotation of the earth.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Is the metric system commonly adopted?
2. Why isn`t it accurate and definite?
3. Are copies of this standard maintained in many countries or in one country?
4. What was redefined in 1983?
5. The rotation of the earth is not constant, is it?

Unit 6

Task 1: Pronounce the following words correctly. Learn them by heart.

1. quick [kwɪk] – быстрый
2. to change [tʃeɪndʒ] – менять
3. initial [ɪ'nɪʃl] – начальный
4. solution [sə'lu:ʃn] – решение
5. to involve [ɪn'vɔlv] – включать в себя
6. insert ['ins ə:t] – вставка
7. drawback ['drɔ:bæk] – недостаток
8. application [,æplɪ'keɪʃn] – применение
9. to suffer ['sʌfə] – страдать
10. advent ['ædvənt] – появление
11. approach [ə'prəutʃ] – подход
12. similar ['sɪmələ] – подобный, похожий
13. current ['kʌrənt] – текущий
14. to impose [ɪm'pəuz] – налагать (обязательство)
15. restriction [rɪ'strɪkʃn] – ограничение
16. owning to ['əuɪŋ] – благодаря, по причине
17. relative ['relətɪv] – относительный
18. capacity [kə'pæsɪtɪ] – вместимость
19. rapid ['ræpɪd] – быстрый
20. to exhaust [ɪg'zɔ:st] – истощать, исчерпывать

21. to prolong [prəu'lɔŋ] – продлить
22. multitude ['mʌltitju:d] – множество
23. clamp [klæmp] – зажим
24. to cause [kɔ:z] – вызывать, быть причиной
25. demand [dı'ma:nd] – требование
26. to exacerbate [eks'æsəbeıt] – обострять
27. suitable ['su:təbl] – подходящий
28. advantage [əd'va:ntıdʒ] – преимущество
29. to overcome [,əuvə'kʌm] – преодолеть
30. worth [wə:θ] – стоящий
31. to mention ['menʃən] – упоминать
32. to offer ['ɔfə] – предлагать
33. certain ['sə:tn] – определённый
34. instance ['ınstəns] – пример
35. storage ['stɔ:ndʒ] - хранилище, запоминающее устройство
36. valid ['v ælıd] – веский
37. outlay ['autleı] – издержки, расходы
38. finite [' faınaıt] – ограниченный
39. to accommodate [ə'kɔmədeıt] – приспосабливать, устанавливать
40. to require [rı'kwaıə] – требовать
41. variety [və'raıətı] – разнообразие
42. to reduce [rı'dju:s] – уменьшать
43. considerable [kən'sıdərəbl] – значительный

Task 2: Read the text.

Modular Quick-change Cutting-tool Systems

Cutting-tool manufacturers have not been slow in developing and producing quick-change tooling systems. Their initial steps towards automatic tool changing were made a decade or so ago. One early solution involved changing the indexable insert itself; the main drawback with this was that the changer was complex in design and could only change one type of insert. Therefore its use was limited to long-run turning applications, and even here it suffered with the advent of CNC.

Other approaches involved changing both the tool and the tool-holder, in a similar manner to current practice with CNC machining centres. This system also imposed restrictions owing to the relatively high weight and size of the tool-changer, which meant that its load-carrying capacity was limited. Even where a tool magazine is present (i.e. in the case of machining and turning centres) its capacity is rapidly exhausted, so that fully-automatic operation over a prolonged period is not possible. Further, the multitude of geometries and clamping systems necessary causes impossible demands on an automatic tool-changer, and the problem is exacerbated further by the fact that indexable inserts may not be suitable for all machining operations. A completely different approach is necessary for automatic tool-changing systems if these disadvantages are to be overcome.

Before we discuss some of the quick-change systems found today, it is worth mentioning that many machine-tool manufacturers can offer extra-capacity tool magazines holding more than 300 tools in certain instances. So one might rightly ask 'Who needs quick-change tooling when such machines have their own built-in storage and quick-change mechanisms?' This is a valid-point, but a high financial outlay is required for these extra-large magazines, and even then only a finite amount of tooling can be accommodated whose variety is reduced considerably when the 'sister-tooling' approach* is adopted.

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*With the sister-tooling approach, there is at least a duplication of the most heavily-utilised tools within the magazine. Once the first of the pair of tools is near the end of its active cutting life, it is exchanged for its 'sister' and will not be called upon again during the production cycle.

Task 3: Find in the text English equivalents to the following word-combinations.

1. автоматическая замена инструмента
2. главный недостаток
3. механизм для замены
4. другие подходы
5. вводить ограничения
6. относительно большой вес
7. полностью автоматизированная работа
8. долгий период
9. системы зажима
10. производитель станков
11. большие финансовые затраты
12. значительно сокращено

Task 4: Insert the missing words in the sentences.

1. Their initial steps towards ... tool changing were made a decade or so ago.
2. One early solution ... changing the indexable insert itself.
3. This systems also ... restrictions.
4. Fully-automatic operation over a ... period is not possible.
5. Indexable inserts may not be ... for all machining operations.
6. A high financial ... is required for these extra-large magazines.

Task 5: Put the words in the correct order to make a statement or a question.

1. Involve, did, solution, what, one, early?
2. Design, in, the, was, changer, complex?
3. Turning, applications, limited, what, was, long-run, to?
4. Impose, this, restrictions, did, system?
5. Suitable, indexable, may, be, not, inserts, all, for, operations, machining.
6. Hold, more, can, tool, than, magazines, tools, 300.

Task 6: Say if the following statements are true or false according to the text.

1. Cutting-tool manufacturers have been slow in developing quick-change tooling systems.
2. The main advantage with this was that the changer was complex in design.
3. Other approaches involved changing either the tool or the tool-holder.
4. The multitude of geometries and clamping systems are the reasons of impossible demands on an automatic tool-changer.
5. To overcome these drawbacks a different approach is necessary for automatic tool-changing systems.
6. Many machine-tool producers can offer extra-capacity tool magazines.

Task 7: Put the following sentences in the logical order according to the text.

1. The multitude of geometries and clamping systems causes impossible demands on an automatic tool-changer.
2. Machine-tool manufacturers can offer extra-capacity tool magazines.
3. Other approaches involved changing both the tool and the tool-holder.
4. One early solution involved changing the indexable insert itself.
5. A high financial outlay is required for these extra-large magazines.
6. A completely different approach is necessary for automatic tool-changing systems.

Task 8: Speak on the following points.

1. The development and production of quick-change tooling systems.
2. The system imposes some restrictions.
3. The multitude of geometries and clamping systems causes impossible demands.
4. Many machine-tool manufacturers can offer extra-capacity tool magazines.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Did one early solution involve changing the indexable insert itself?
2. What was the system`s main drawback?
3. May indexable inserts be suitable for all or some machining operations?
4. What is necessary for automatic tool-changing systems?
5. A high financial outlay is required for these extra-large magazines, isn`t it?

Unit 7

Task 1: Pronounce the following words correctly. Learn them by heart.

1. effort – ['efət]- усилие
2. reduction – [rı'dʌkʃn]- снижение
3. conventional – [kən'venʃənl]- обычный
4. benefit – ['benıfıt]- выгода, польза
5. to gain – [geın]- получать, достигать
6. initial – [ı'nıʃl]- начальный
7. maintenance – ['meıntənəns] - содержание и тех. обслуживание
8. management – ['mænidʒmənt] - умение владеть (инструментом)
9. to deal(with) – [dı:l] – рассматривать вопрос
10. approach – [ə'prəutʃ] - подход
11. to overcome – [,əuvə'kʌm] - преодолеть
12. inventory – ['ınvəntrı]- инвентарь
13. flexible – ['fleksəbl]- гибкий
14. requirement – [ri'kwaiəmənt] - требование
15. to occur – [ə'kə:] - встречаться
16. similar – ['sımələ] – подобный, похожий
17. survey – [sə'veı] – осмотр, обследование
18. to commission – [kə'mıʃn] - выполнять
19. to load – [ləud] – грузить, нагружать
20. set-up – ['setʌp] – установка
21. to gauge - [geıd3] - измерять
22. failure – ['feılјə] – отказ в работе
23. complete - [kəm'plı:t]- полный
24. shift – [ʃıft] – смена, чередование
25. to relate – [rı'leıt] - относиться
26. to amount – [ə'maunt] – составлять (сумму), равняться
27. to advise – [əd'vaız] - советовать
28. significant – [sıg'nıfıkənt] - важный
29. to improve – [ım'pru:v] – улучшать(ся)
30. to eliminate – [ı'lımıneıt] - устранят
31. to incorporate – [ın'kɔ : pəreıt] - использовать
32. to accrue – [ə'kru:] - появляться
33. application –[,æplı'keıʃn] - применение
34. pay-back – ['peıbæk]- окупаемость

Task 2: Read the text.

The machine-tool builders have spent much effort on reductions in the non-productive cutting time with conventional quick-change tools situated in magazines or carousels, by reducing their 'cut-to-cut' tool-change times. Another area where much benefit has been gained is in the initial tool set-up and maintenance of cutting tools.

So far, this chapter has dealt with early methods of quick-change tooling and the machine-tool builders' approaches in overcoming the problem. So why does one need modular quick-change tooling? The reason for using modular quick-change tooling systems on machining centres has been to standardise and thereby reduce tooling inventories, whilst at the same time making them more flexible to the cutting requirements that occur during a production run. Now that turning centres are used with a driven tooling facility more often than not, their requirements for modular tooling are similar to those of machining centres.

The well-documented survey commissioned in the early 1980s by the US Government, the Machine Tool Task Force Study, found that medium-volume manufacturing companies that used typical machine tools were doing productive cutting for only about 11% of the time. The non-productive time was taken up by such activities as loading and unloading (6% of the total time), changing tools (10%), set-up and gauging (10%), equipment failure (8%) and last, but by no means least, the incomplete use of shifts (55%). Thus the study illustrated that the times for activities related to cutting tools, namely the tool-changing and set-up and gauging times, amounted to at least 20% of the machine tool's available time. Therefore the cutting-tool companies advise users to focus their attention on reducing the times for these non-productive operations, as this will significantly improve the efficient utilisation of the machine tool over the working day.

It can now be seen that significant reductions in the machine tool's non-productive time can be made by eliminating, or at the very least minimising, the down-time associated with using cutting tools. If a company incorporates quick-change tooling systems on its machining and turning centres, great productivity benefits will accrue with relatively short pay-back periods. This is the basis for the discussions in the next sections, which will first consider the tooling requirements of turning centres, and then the applications of modular quick-change tooling on machining centres.

Task 3: Find in the text English equivalents to the following word-combinations.

1. приложили много усилий
2. обычные инструменты быстрой замены
3. установка и техническое обслуживание
4. рассматривает первоначальные способы
5. пути решения этой проблемы
6. сделать их более гибкими
7. возникают в процессе производства
8. непродуктивное время
9. установка и измерение
10. отказ в работе оборудования
11. составляло, по крайней мере
12. значительно улучшит

Task 4: Insert the missing words in the sentences.

1. The machine-tool builders have spent much effort on ... in the non-productive cutting time.
2. Another area where much ... has been gained is in the initial tool set-up.
3. This chapter has dealt with the machine-tool builders' ... in overcoming the problem.

4. The cutting-tool companies ... users to focus their attention on reducing non-productive operations.
5. This will improve the efficient ... of the machine tool over the working day.
6. Great productivity ... will accrue with relatively short pay-back periods.

Task 5: Put the words in the correct order to make a statement or a question.

1. Are, quick-change, used, systems, tooling, tooling inventories, to reduce?
2. Used, are, tooling, turning centres, facility, a, driven, with?
3. Requirements, similar, modular tooling, are, their, those, machining centres, of, to, for.
4. Turning centres, now, used, are, a, driven, with, facility, tooling.
5. Non-productive, the, taken up, time, was, by, and, unloading, loading.
6. Periods, will accrue, productivity, great, benefits, pay-back, with, short.

Task 6: Say if the following statements are true or false according to the text.

1. Much benefit has been gained in the initial tool set-up and maintenance of cutting tools.
2. Modular quick-change tooling systems are used to reduce tooling inventories.
3. Turning centres are seldom used with a driven tooling facility.
4. Manufacturing companies that used typical machine tools were doing productive cutting for 20% of the time.
5. The times for activities related to cutting tools amounted to 30%.
6. Quick-change tooling systems on machining and turning centres will give great productivity benefits.

Task 7: Put the following sentences in the logical order according to the text.

1. If a company incorporates quick-change tooling systems great productivity benefits will accrue.
2. Modular quick-change tooling systems are used to reduce tooling inventories.
3. The companies that used typical machine tools were doing productive cutting for about 11% of the time.
4. The machine-tool builders have spent much effort on reductions in the non-productive cutting time.
5. Much benefit has been gained in the initial tool set-up and maintenance of cutting tools.
6. Now turning centres are often used with a driven tooling facility.

Task 8: Speak on the following points.

1. The machine-tool builders have spent much effort on reduction in the non-productive cutting time.
2. The reason for using modular quick-change tooling systems.
3. The cutting-tool companies advise users to reduce the times for non-productive operations.
4. The efficient utilization of the machine tool over the working day.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Have they spent much effort on reductions in the non-productive cutting time?
2. What has this chapter dealt with?
3. Does one need modular or conventional quick-change tooling?
4. What is used with a driven tooling facility?
5. The requirements for modular tooling are similar to those of machining centres, aren't they?

Task 1: Pronounce the following words correctly. Learn them by heart.

1. cutter –['kʌtə] – режущий инструмент
2. range - [reɪnd3] - сфера
3. to extend – [iks'tend] - вытягивать
4. shank – [ʃæŋk] – ручка, рукоятка
5. lathe – []leɪδ] – токарный станок
6. to bore – [bɔ:] - сверлить
7. to load – [ləud] - нагружать
8. manual – ['mænjuəl] - ручной
9. to probe – [prəub] - исследовать
10. to sense – [sens] - чувствовать
11. condition – [kən'dɪʃn] - условие
12. to recoup – [rɪ'ku:p] - вернуть
13. simultaneous – [sɪml'teɪnɪəs] - одновременный
14. overall – ['əuvərɔ:l] – полный, общий
15. to rotate – [rəu'teɪt] - вращаться
16. to mill – [mɪl] – обрабатывать на станке, фрезеровать
17. to tap – [tæp] – нарезать внутреннюю резьбу
18. to drill – [drɪl] - сверлить
19. to eliminate – [ɪ'lɪmɪneɪt] - устранять
20. to save – [seɪv] - экономить
21. to purchase – ['pə:tʃəs] - покупать
22. to justify – ['d3ʌstɪfaɪ] - подтверждать
23. to vary – ['veərɪ] – разниться, расходиться
24. to provide – [prə'vaɪd] - обеспечивать
25. to repeat - [rɪ'pɪ:t] - повторять
26. to ensure – [ɪn'ʃɔ:] - обеспечивать
27. respective - [rɪ'spektɪv] - соответственный
28. to mount – [maunt] - устанавливать
29. carriage – ['kærɪd3] – каретка, суппорт
30. turret – ['tʌrət] - башня
31. release – [rɪ'lɪ:s] - разъединение

Task 2: Read the text.

Tooling Requirements of Turning Centres

Of all the machine tools that use single or multi-point cutters, the turning centre has undergone the greatest changes. The range extends from the earlier basic CNC lathes, with conventional square-shanked tool-holders and round-shanked boring-bars that are loaded manually by the operator, to the very latest turning centres, with features such as robot part loaders, flexible work holding, quick-change tooling, tool-wear probing, work-gauging systems and equipment to sense tool condition.The latest machines, where some or all of these features are fitted, cost a considerable amount of money. In order to recoup the financial outlay as fast as possible, they must increase the productive cutting time, whilst simultaneously reducing the direct labour costs. It is often this latter aspect, of labour-cost reduction, which becomes the most attractive cost-saving item, as this is always a large component of the overall manufacturing costs in any factory.

If a company specifies a turning centre with a rotating tooling facility (sometimes called 'driven tooling'), which is held in the turret along with the usual tooling, the programmer will be able to program secondary operations such as light milling, tapping, drilling etc. to be carried out in a single set-up; this is known as 'one-hit machining'. These secondary machining operations may even eliminate the need for work to be carried out after turning-by a machining centre, for example; this gives a further saving in production time which is related to cost by reducing the work-in-progress and minimising the need to purchase or utilise a second machine tool.

The previous paragraphs have justified the need to use quick-change tooling and turning centres. There now follows a review of popular systems used extensively throughout the world, some of which can be categorised into two types: cutting-unit systems and tool-adaptor systems. The two systems vary in their basic approach to quick-change tooling and whether they are designed to be used on machining or turning centres separately, or for a more universal approach. The cutting-unit system is commonly known as the 'Block tool' system (Fig 2.1); it was the first to be developed by a leading cutting-tool manufacturer. This system is based on a replaceable clubhead for a square-shanked tool-holder; the coupling provides radial repeatability to within ±0.002mm. This high level of repeatability is necessary in order to minimise the coupling's effect on the diameter to be turned. To ensure that the forces generated whilst cutting do not deflect a Block tool, a clamping force of 25kN is used. The clamping may be done in a number of ways; manually, semi-automatically or automatically, as shown in Fig. 2.1b, c and d respectively. The clamping force is most commonly provided using a certain number of spring washers, which are preloaded to provide a reliable clamping force; the cutting units are released by compressing the washers so that the draw-bar can move forward. In the automatic clamping system, a small hydraulic cylinder mounted on the carriage behind the turret causes the draw-bar release, activated by the CNC.

Task 3: Find in the text English equivalents to the following word-combinations.

1. подвергся большим изменениям
2. заправляется вручную оператором
3. оборудование для определения состояния резца
4. стоят дорого
5. как можно быстрее
6. продуктивное время резки
7. операции вторичной обработки
8. интенсивно используемые во всём мире
9. для более общего использования
10. высокий уровень повторяемости
11. несколькими способами
12. чтобы обеспечить надёжное закрепление

Task 4: Insert the missing words in the sentences.

1. The turning centres has ... the greatest changes.
2. The latest machines cost a ... amount of money.
3. The paragraphs have ... the need to use quick – change tooling and turning centres.
4. The two systems ... in their basic approach to quick – change tooling.
5. The coupling ... radial repeatability to within ±0.002 mm.
6. The ... may be done in a number of ways.

Task 5: Put the words in the correct order to make a statement or a question.

1. Extends, earlier, from, the, CNC, basic, lathes, range, the.
2. Amount, what, money, a, costs, of, considerable?
3. Productive, they, increase, the, time, must, cutting.

4. Secondary, to program, will, the, be able, operations, programmer.
5. Saving, a, time, in, this, further, gives, production.
6. Cutting, the, units, washers, the, released, are, compressing, by.

Task 6: Say if the following statements are true or false according to the text.

1. The latest machines are cheap.
2. They can't increase the productive cutting time.
3. These secondary machining operations may eliminate the need for work after turning.
4. The popular systems used extensively throughout the world are of five types.
5. This system is based on a replaceable club head.
6. The cutting units are released by compressing the washers.

Task 7: Put the following sentences in the logical order according to the text.

1. The programmer will be able to program secondary operations.
2. The cutting – unit system was the first to be developed by a leading cutting – tool manufacturer.
3. The clamping may be done in a number of ways.
4. The range extends from the earlier basic CNC lathes to the very latest turning centres.
5. Now follows a revive of popular systems used extensively throughout the world.
6. The latest machines cost a considerable amount of money.

Task 8: Speak on the following points.

1. The turning centre has undergone the greatest changes.
2. The programmer will be able to program secondary operations.
3. The popular systems used throughout the world.
4. The clamping may be done in a number of ways.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Has the turning centre undergone the greatest changes?
2. How are boring-bars loaded by the operator?
3. Do they cost much or little money?
4. What is a large component of the overall manufacturing costs?
5. This gives a further saving in production time, doesn't it?

Unit 9

Task 1: Pronounce the following words correctly. Learn them by heart.

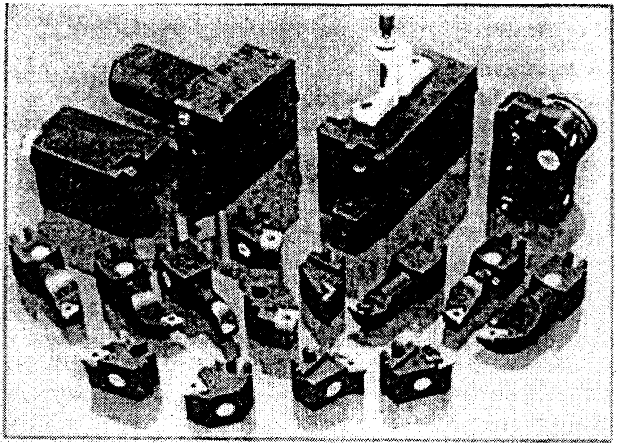
1. to mention [menʃn] – упоминать
2. accuracy ['ækjurəsı] – точность
3. mode [məud] – способ
4. to consider [kən'sıdə] – рассматривать
5. precise [prı'saız] – точный
6. holder ['həuldə] – держатель
7. to achieve [ə'tʃı:v] – достигать
8. to slip [slıp] – скользить
9. above [ə'bʌv] - наверх

10. coupling [kʌplɪng] - сцепление
11. firm [fə:m] крепкий, устойчивый
12. to support [sə'pɔ:t] – поддерживать
13. tangential [tæn'dʒenʃəl] – тангенциальный
14. to seat [sɪ:t] располагать
15. to pull [pul] – тянуть
16. rigid ['rɪdʒɪd] – жесткий, негнущийся
17. load [ləud] – нагрузка
18. to offer ['ɔfə] - предлагать
19. bonus ['bəunəs] – премия
20. to reduce [rɪ'dju:s] – уменьшать
21. fatigue [fə'tɪ:g] – усталость
22. to store [stɔ:] – хранить, вмещать
23. to allow [ə'lau] – позволять
24. to retrieve [rɪ'trɪ:v] – вернуть, взять обратно
25. to appreciate [ə'prɪ:ʃɪeɪt] – оценивать
26. value ['vælju:] – ценность
27. comparison [kəm'pærɪsən] – сравнение
28. involvement [ɪn'vɔlvmənt] – включение
29. to change [tʃeɪndʒ] – менять
30. to secure [sɪ'kjuə] – закреплять
31. maintenance ['meɪntənəns] – эксплуатация
32. data [deɪtə] – данные
33. mix [mɪks] – смешивать
34. batch [bætʃ] – партия
35. actual ['æktjuəl] – действительный
36. to assume [ə'sju:m] – предполагать
37. average ['ævərɪdʒ] – средний
38. quantitive ['kwɔntətɪv] - количественный

Task 2: Read the text.

So far we have mentioned accuracy, the clamping force and modes of releasing the Block tool; we now consider how the tool's precise location in its holder is achieved. The Block tool is located by the following process: the cutter unit slips in from above the coupling to rest firmly on a supporting face on the bottom of the clamping device; this supports the cutting unit tangentially during the cutting operation. Once the cutting unit is seated on the bottom face, the draw-bar is activated - either manually, using a key, or automatically by the hydraulic unit- to pull the cutting unit against a face; this makes a rigid and stable coupling that is easily able to support the loads produced during cutting. Both internal and external cutting units can be supported in this manner, as shown in Fig. 2.1 and f respectively.

A major advantage of all modular quick-change systems is the easier and quicker tool changing they offer, producing shorter cut-to-cut times. There is the added bonus of reduced operator fatigue, since tool handling - particularly of the heavy tools - is now a thing of the past with the manual and semi-automatic tool-changing methods. As a result of the smaller size of the modular tools, they can more readily be stored in a systematic manner, which allows them to be more efficiently located and retrieved from stores, as well as minimising the tool-stock space.



(a) A range of tools and holders for use on turning centres, etc

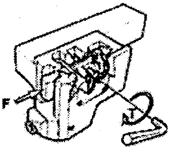
Fig. 2.1 The Block tool system (Courtesy of Sandvik (UK) Ltd.)

The advantages of the manual Block tool system over conventional tool-holders and their tool blocks, can be more fully appreciated through the following example. The numerical values in the table form the basis of the comparisons. The ones in the lefthand column are typical of any turning centre where there is manual involvement in tool changing, securing and maintenance.

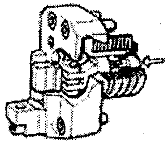
Operation	*Conventional tool-holder*	*Block tool system*
Setting-uptime (minutes)	30	15
Tool-changing time (minutes)	3	1
Measuring-cut time (minutes)	5	0

This data can now be applied to the practical situation of a mixed production of small batches of turned components, where the actual cutting time is 15 % of the total machine-shop time. Assume that an average of 30% of the tools needed measuring cuts (e.g. diameters measured, etc.), that 200 set-ups were required per year on the machine, and that some 1580 tool changes were needed during the year. So for these production parameters, the quantitive benefits of using the modular quick-change tooling system are as follows:

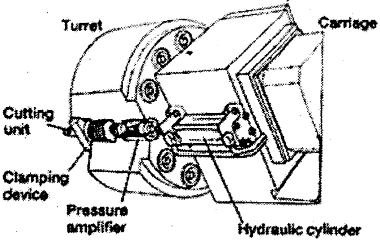
- The difference in the setting-up times is
  $15 \times 200 = 3000$ minutes per year
- The difference in the tool-changing times is
  $2 \times 1580 = 3160$ minutes per year
- The difference in the measuring-cut times is
  $\frac{1580}{3} \times 5 = 2630$ minutes per year



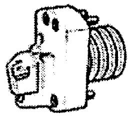
(b) *Manual operation*



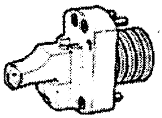
(c) *Semi-automatic operation*



(d) *Automatic cutter-release mechanism*



(e) *External*



(f) *Internal*

Task 3: Find in the text English equivalents to the following word-combinations

1. упомянуть о точности
2. точное расположение инструмента
3. внизу зажимного устройства
4. в процессе резки
5. жёсткое и прочное соединение
6. удерживать нагрузки
7. внутренние и внешние режущие блоки
8. меньшей утомляемости оператора
9. полуавтоматические способы замены инструмента
10. более полно оценено
11. цифровые данные в таблице
12. замена инструмента вручную

Task 4: Insert the missing words in the sentences.

1. The block tool is ... by the following process.
2. The draw – bar is ... either manually or automatically.
3. This makes a rigid and ... coupling.
4. Both internal and external cutting units can be ... in this manner.
5. There is the added bonus of ... operator fatigue.
6. They can more readily be ... in a systematic manner

Task 5: Put the words in the correct order to make a statement or a question.

1. Cutter, slips in, above, from, coupling, the, unit, the.
2. Supports, unit, the, what, cutting?
3. Activated, is, the, or, the, cutting unit, draw-bar?
4. Rigid, does, make, it, a, and, coupling, stable?
5. External, be supported, cutting, can, both, internal, units, and.
6. Stored, they, readily, more, be, can.

Task 6: Say if the following statements are true or false according to the text.

1. The cutting unit is seated on the top face.
2. The coupling is able to support the loads produced during cutting.
3. Only internal cutting units can be supported in this manner.
4. The draw-bar is always activated manually.
5. A major advantage of all modular quick-change systems is the easier and quicker tool changing
6. Modular tools can't be stored in a systematic manner.

Task 7: Put the following sentences in the logical order according to the text.

1. Small modular tools are more efficiently located and retrieved from stores.
2. All modular quick-change systems offer easier and quicker tool changing.
3. The draw-bar is activated to pull the cutting unit against a face.
4. The manual and semi-automatic tool-changing methods are things of the past.
5. The cutter unit slips in from above the coupling.
6. We now consider how the tool`s precise location in its holder is achieved.

Task 8: Speak on the following points.

1. The precise location of the Block tool.
2. A major advantage of all modular quick-changing systems.
3. Manual tool handling is a thing of the past.
4. The advantages of the manual Block tool system over conventional tool-holders are obvious.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Is the tool`s precise location in its holder achieved?
2. How is the Block tool located?
3. Is the coupling able to support the loads or other units?
4. What is now a thing of the past?
5. The modular tools can be stored in a systematic manner, can`t they?

Unit 10

Task 1: Pronounce the following words correctly. Learn them by heart.

1. to increase [ɪn'kri:s] – увеличивать
2. to link [lɪŋk] – соединять
3. workpiece ['wə:k,pi:s] – рабочая деталь
4. to handle [hændl] – управлять
5. supervision [su:pə'vɪ n] – надзор, контроль
6. aim [eɪm] – цель
7. stoppage ['stɔpɪd] – засорение
8. to set [set] – устанавливать

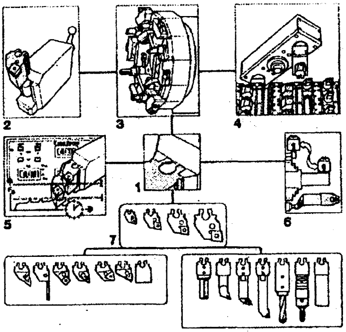
9. to occur [ə'kə:] – встречаться
10. according to [ə'kɔ:dɪŋ tu:] – согласно
11. pattern ['pætn] – образец
12. shift [ʃɪft] – смена
13. to preset [prɪ'set] – устанавливать
14. schedule ['ʃedju:l] – режим
15. environment [ɪn'vaɪrənmənt] – окружающая среда
16. to assure [ə'ʃuə] – обеспечивать
17. to utilise ['ju:tɪlaɪz] – использовать
18. to confirm [kən'fə:m] – поддерживать
19. trigger ['trɪgə] – защёлка
20. to probe [prəub] – исследовать
21. further ['fə:ðə] – дальнейший
22. aid [eɪd] – помощь
23. to ensure [ɪn'ʃɔ:] – обеспечивать
24. to perform [pə'fɔ:m] – выполнять
25. to eliminate [ɪ'lɪmɪneɪt] – устранять
26. critical ['krɪtɪkl] – изношенный
27. wear [weə] – износ
28. to expect [ɪk'spekt] – ожидать
29. to raise [reɪz] – повышать
30. to lead [li:d] – приводить
31. obvious ['ɔbvɪəs] – очевидный
32. to gain [geɪn] – получать
33. to justify ['dʒʌstɪfaɪ] – объяснять
34. expenditure [ɪks'pendɪtʃə] - расход
35. degree [dɪ'gri:] – степень
36. particular [pə'tɪkjulə] – особенный
37. true [tru:] верный
38. to complicate ['kɔmplɪkeɪt] – усложнять
39. to require [rɪ'kwaɪə] – требовать

<u>Task 2: Read the text.</u>

Today, large batches, and even mass production, are increasingly performed in 'linked' turning centres with automated workpiece handling and process supervision. The aim is to limit operator involvement and for stoppages for tool changing and setting to occur according to an organised pattern, so that they usually happen in between shifts, or at the scheduled stops.

Using the Block tool system, say, tool changes can be organised and made very efficient, especially so when the tool changes are semi-automatic. The cutting units are small, light and easily organised for tool changing. They can be preset outside the machine environment, and their accuracy is assured by the precise coupling to the holder. Also, 'intelligent' tooling can be utilised using coded or numbered cutting units, which allows the operator to change some or all of the tools in a turret in a very short time. The settings of these new preset tools can quickly be confirmed if touch-trigger probes are present, so they further reduce tool-changing down-time. These tooling aids also minimise the operator's activity and ensure that it is performed correctly, so eliminating the risk of mistakes being made during hectic machine stoppages. Another benefit of using quick-change tooling is that, as the time to change tools is very short, it may be possible to make unscheduled changes of critical tools if, for example, their wear-rate is unexpectedly high. This will raise the cutting performance, which in turn will lead to a more economical utilisation of each machine during large-batch production.

Where a company is involved in large-batch or mass-production runs, it is obvious that considerable savings can be gained by reducing the non-productive cutting times, and it might seem that this is the only production environment that can justify the extra expenditure for these tooling systems. This is not the case; companies producing small batches or one-offs can also gain, to a lesser degree, from an efficient quick-change tooling system. This is particularly true when machining families of similar components, or where there is a complicated machining requirement on one-offs.



1 An accurate and stable coupling
2 Small light cutting units
3 Manually or automatically-operated clamping devices
4 A tool-changer and tool magazine
5 Feed-force monitoring
6 Measuring probes for automatic gauging of tool and workpiece
7 External and internal tools

Fig. 2.2 Features of the Block tool system for turning centres (Courtesy of Sandvik (UK) Ltd.)

Task 3: Find in the text English equivalents to the following word-combinations

1. всё больше производят
2. автоматическая обработка детали
3. обычно происходят в "пересменке"
4. полуавтоматическая замена инструмента
5. можно установить вне станка
6. точное присоединение к держателю
7. пронумерованные резцы
8. сокращают время замены инструмента
9. обеспечивают правильность выполнения
10. внеплановая замена изношенных инструментов
11. степень износа очень большая
12. более экономичное использование каждого станка

Task 4: Insert the missing words in the sentences.

1. Large batches are ... in "linked" turning centres.
2. They usually happen in between shifts or at the ... stops.
3. Tool changes can be ... and made very efficient.
4. The ... units are small, light and easily organised.
5. They can be ... outside the machine environment.
6. They further ... tool – changing down-time.

Task 5: Put the words in the correct order to make a statement or a question.

1. Involvement, aim, to limit, the, operator, is.
2. Do, happen, usually, when, they?
3. Efficient, what, very, be made, can?

4. Precise, what, the, coupling, is assured, by?
5. Utilised, tooling, be, "intelligent", can.
6. Batches, producing, can, gain, also, companies, small.

Task 6: Say if the following statements are true or false according to the text.

1. Large batches are performed in "linked" turning centres.
2. The aim is to expand operator involvement.
3. Tool changes can`t be made very efficient.
4. Their accuracy is assured by the precise coupling.
5. The operator changes the tools in a turret in a very short time.
6. They further shorten tool – changing down – time.

Task 7: Put the following sentences in the logical order according to the text.

1. It may be possible to make unscheduled changes of critical tools.
2. Tool changes can be made very efficient.
3. The aim is to limit operator involvement.
4. Considerable savings can be gained by reducing the non-productive cutting times.
5. They usually happen in between shifts.
6. The cutting units can be preset outside the machine environment.

Task 8: Speak on the following points.

1. Turning centres have automated workpiece handling and process supervision.
2. Tool changes can be organised and made very efficient.
3. The time to change tools is very short.
4. Companies can gain from an efficient quick-change tooling system.

Task 9: Discuss the content of the text in the form of a dialogue. Use all types of questions.

1. Do they happen between shifts?
2. How can tool changes be made very efficient?
3. Can they be preset outside or inside the machine environment?
4. What allows the operator to change tools in a turret in a very short time?
5. These tooling aids minimize the operator's activity, don`t they?

Supplementary Reading

Text 1.

A frequent problem is that of insufficient tool storage on the machine tool, particularly on single-turret turning centres, and quick-change tooling is often the answer in these circumstances. Using the semi-automatic Block tool system, say, extends the turret capacity with minimal loss of productive cutting. Replacing a new cutting unit simply requires the operator to lift out the old unit and push in another; optional stops can be programmed into the CNC. Presetting the tooling, in conjunction with the repeatability of the coupling between the cutting unit and the holder, ensures that the cutting edge is correctly positioned in relation to the workpiece. Therefore, the operator no longer needs to adjust the machine when changing the workpiece for different configurations.

Some figures to reaffirm the company's decision to use quick-change tooling on conventional machines, for the particular case where heavy or large tooling was previously used (e.g. on turret or capstan lathes), are that the average time to change the old-style tools would have been about five minutes using square or round-shanked tooling, whereas with quick-change manual-clamping tooling it is less than 50 seconds. One company that used this method saved up to 84 minutes a day in reduced down-time, and this cost, when related to the machine's running cost, worked out at a saving of £38 per day. The total savings per year more than paid for the investment required in purchasing the quick-change tooling system, which could be used on other work without extra cost, ensuring even greater profits later!

In spite of all this convincing evidence in favour of quick-change modular tooling, some pessimistic production engineers may still remain sceptical as to the advantages to be gained from such expenditure. Another factor, which might be of even greater importance, could be that the company simply cannot afford the luxury of purchasing a complete tooling system. In either of these cases some caution may be advisable before a company becomes fully" committed to purchasing such a system. In such cases, the solution might be to purchase just a few quick-change units, for a specific medium-sized batch, and later appraise the situation in terms of the likely productivity increases and the operators' experiences. In this manner only a relatively small financial outlay will be necessary and the company will not become too disenchanted if the results are unfavourable owing to some extraneous circumstances beyond its control.

The discussion so far has basically concerned just one system - the cutting-unit method, typified by the Block tool system. The tool-adaptor systems tend to be more diverse in their approaches to modular quick-change tooling. Typical of this design philosophy is the KM system, which was developed out of the experience gained using the original KV system. The system is diagrammatically represented in Fig. 2.3. The next section discusses how this system was designed and how it operates, highlighting the benefits of its application in the metal-cutting industry.

Text 2.

Prior to designing a new quick-change tooling system, a number of key decisions had to be made. The basic criterion of the system's configuration for use with turning, boring and rotating tooling required that it be round and on the centre-line. Also, for ease of tool changing and accuracy in the radial direction (X-axis), a tapered shank was necessary. So that an equal accuracy occurred in the axial direction (Z-axis), there was a face contact requirement (Figs. 2.3b and 2.4c). The cutting-edge height was deemed to be a less critical dimension and a reasonable tolerance was allowed here, which would give good results for the great majority of metal cutting operations using modular quick-change tooling. Together, these design criteria gave the following requirements for repeatability:

- Axial tolerance = ±0.0025mm.
- Radial tolerance = ±0.0025mm.
- Cutting-edge height = ±0.025mm.

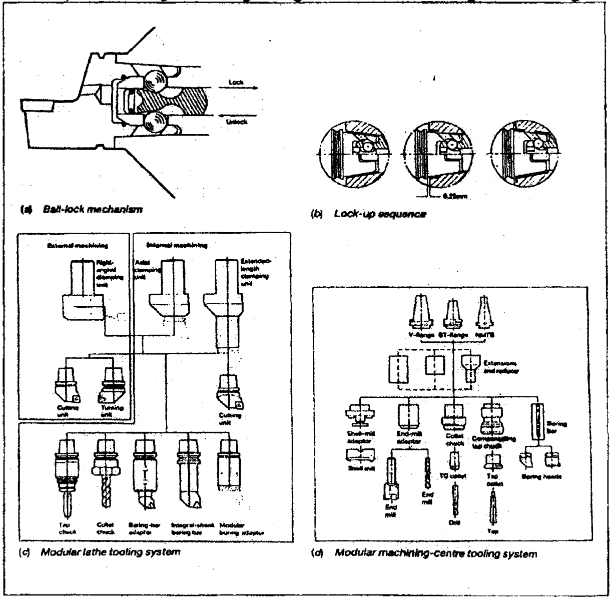


Fig. 2.3 The KM tooling system (Courtesy of Kennametal (UK) Ltd.)

Quick-change turning-centre tooling installations are in the 'intermediate' size range, and are capable of handling tangential cutting loads of 12 000N. With this load requirement, the cutting unit closely approximates to a 32mm square-shanked tool-holder, and this is the KM's smallest size, as shown in Fig. 2.4d. However, when a review of the dimensional envelope of machines of this size was made, it was found that a 40mm round-shanked system was the maximum that could be accommodated. This size was chosen for the coupling, with adaptors for sizes from 25mm to 80mm for use on turning as well as machining centres.

Once the basic configuration to meet the dimensional and repeatability criteria had been established, the'coupling shape could be considered. It was quickly decided to use the male part of the joint on the cutting-tool unit, as its overhang was the smallest and it was less influenced by deflections produced by high tangential loads. Another advantage of using a male cutting unit, is that it provides more protection for the taper and the locking mechanism once the cutting tool is removed.

With the taper's configuration determined, it was then necessary to decide on the method of achieving contact between the taper and the face. There are two methods of providing this contact: by providing metal-to-metal contact by holding very close tolerances on both halves of the coupling, or by designing a small amount of elastic deformation into the assembly. As the male half of the joint was located on the cutting tool, any such deformation would take the form of an expansion of the female taper in the clamping unit. In testing, an optimum performance occurred with a combination of the pull-back force coupled with the elastic deformation. This resulted in better static and dynamic stiffness, and was less costly to manufacture than a metal-to-metal configuration.

Text 3.

Once the coupling shape had been established, the locking mechanism could be considered. This was fully investigated using the latest computer-aided design (CAD) techniques, which allows information to be quickly transmitted to the manufacturing process without errors. Techniques such as finite element analysis were used on the key components to ensure the correct strength and durability levels (Fig. 2.4a and b). Extensive life testing was also conducted, to avoid unexpected failures of the tools in use, which would have been costly.

The locking mechanism used precision-hardened balls to produce a system which has high mechanical advantage coupled to low frictional losses and is of low cost. The newly-designed coupling required a mechanism that produced up to 31 000 N locking force, which would fit inside a taper with a gauge-line of only 30mm. The ball-lock mechanism used two balls that locked into holes machined through the tapered shank of the cutting unit, as illustrated in Fig. 2.3a. This configuration allows a 9mm draw-rod to be used to apply the pull-back force. The holes in the tapered shank, which the balls are seated in, have a machined 55° angle, resulting in a mechanical advantage of 3.5 : 1.

The resulting coupling allows a high clamping force of 31 000 N to be produced by a draw-rod pulling force of 8 900N. As the draw-rod is pulled back it forces the two balls radially outwards, until they lock into the tapered machined holes, as shown in the lock-up sequence in Fig. 2.3b. Applying a force and pushing the draw-rod releases the balls and at the same time 'bumps' the cutting tool to release it from the self-holding taper.

Referring to the lock-up sequence illustrated in Fig. 2.3b again, once the cutting unit is inserted in thfemale taper it makes contact at a stand-off distance of 0.25mm from the face. As the locking force is applied, a small amount of elastic deformation occurs at the front of the female taper. Once the cutting tool is locked, there is a three-point contact, at the face, the gauge-line and the rear of the taper, as shown in Fig. 2.4c.

If one compares the coupling's stiffness with that of a solid-piece unit which has been machined to similar external dimensions (for example, cutting unit and clamping assembly), then when a 12 000N load is applied to simulate tangential cutting loads to the tool point, the difference in deflection between them would be of the order of only 0.005mm. Hence, this new modular coupling and its assembly closely approximate to the ultimate rigidity of a solid-piece cutting tool.

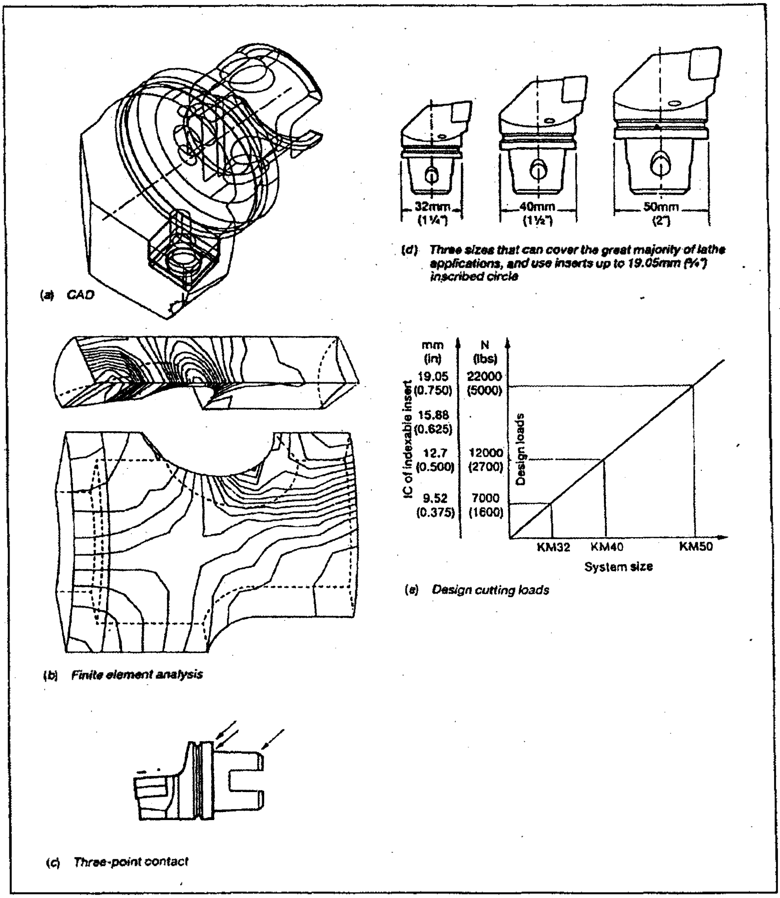


Fig. 2.4 The design of the KM modular quick-change tooling system (Courtesy of Kennametal (UK) Ltd.)

Text 4.

The holders for this new modular tooling system, easily fit into the VDI (DIN) and VDMA standard envelopes as shown in Fig. 2.5b. This torque-nut clamping method has a threaded draw-rod which is engaged by the drive nut. Rotating the drive nut in a clockwise direction will lock the tool; similarly, counterclockwise rotation will release it. Five turns of the drive nut are required to lock or unlock the tool, with a torque of 20Nm. The torque-nut designed holders, or 'axial units' as they are often known, are primarily used for internal machining; right-angled units are used for external machining, with a wedge mechanism to redirect the lock-and unlock force. These right-angled units are carefully designed so that the mechanical advantage needed for 'torquing' the nuts remains the same as for the axial-clamping types. The torque-nut design (i.e. the axial-clamping unit) can be utilised in a semi-automatic or a fully-automatic installation.

The disc-spring designed clamping method illustrated in Fig. 2.5c also allows for either semi or fully-automatic application. In this design the disc springs apply the clamping force through an end-cap which is threaded onto the back of the draw-rod. Pushing on the end-cap releases the cutting tool. A hydraulic cylinder mounted on the machine-tool carriage, behind the turret, provides the release force. A force of the order of 20 000N with a stroke length of 6.5mm is sufficient to release the cutting unit. The disc-spring clamping unit is designed to fit into the same dimensional envelope as the torque-nut type discussed earlier. Designing clamping systems in this manner allows the machine-tool builders, who also design turrets, to offer these new modular tooling systems with only minor modifications to the turret top-plate and the release cylinder.

The last clamping method to be considered is the cheapest to buy and install on turning centres. This is the manual clamping unit, which can be easily retrofitted to current CNC machines. On most existing machines, there is no access to the turret's rear, and in such cases a front-activating mechanism is necessary. This manual right-angled clamping unit is shown in Fig. 2.5a. It is applicable on either turning or machining centres, and is activated by a key at a right angle to the holder centre-line. Rather than orienting the draw-rod axially, as in the other

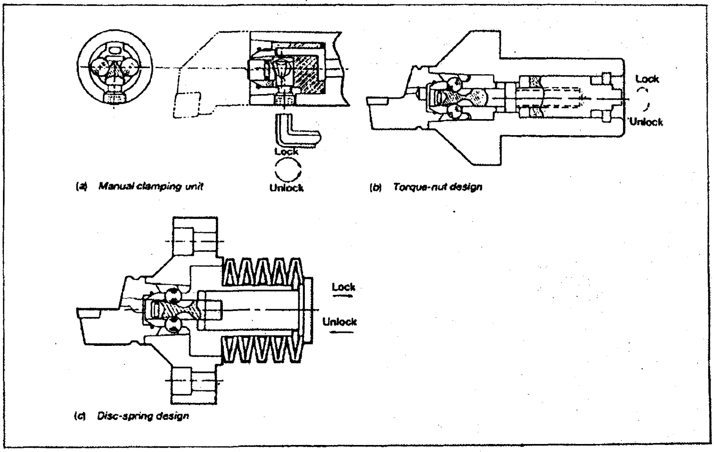


Fig. 2.5 Clamping methods for KM tooling (Courtesy of Kennametal (UK) Ltd.)

two designs, in this design the draw-rod is turned through 90° to the centre-line of the coupling. It is pushed, not pulled, to lock the coupling, using a differential screw connected to a threaded draw-rod. As this draw-rod cannot 'bump' the cutting tool to release it from its taper, a wedge, which is activated when the draw-rod's differential screw is reversed, performs this function. Four turns are needed for the differential screw to lock and unlock the tool, with a torque of 15Nm.

Text 5.

The problems a cutting-tool company has to overcome in designing, testing and developing a new modular quick-change tooling system have been discussed. Before considering the requirements of machining centres, it is worth looking briefly at the finished product as designed for a turning centre, which is illustrated in Fig 2.6. The photograph shows the compact nature of the cutting units for external and internal machining. The short self-holding taper and the ball-locking holes can also be seen, the function of which was discussed earlier in this section.

Fig. 2.6 KM modular quick-change tooling (Courtesy of Kennametal (UK) Ltd.)

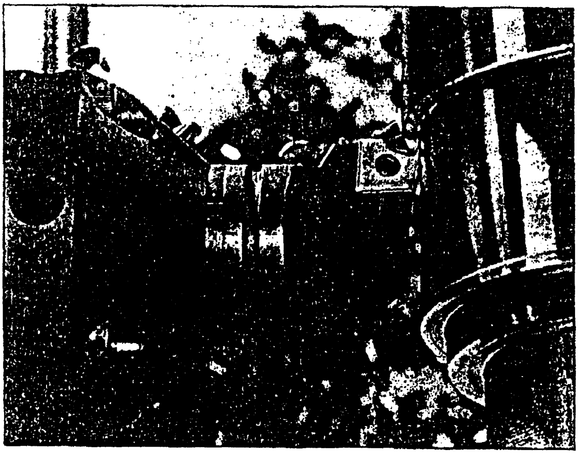


Fig. 2.7 KM modular tooling in action (Courtesy of Kennametal (UK) Ltd.)

Fig. 2.7 shows the actual cutting unit during a cutting cycle; it can be appreciated how sturdy the assembly is and that the cantilever effect (i.e. overhang) is reduced to a minimum to give greater rigidity and improve the dynamic cutting stability.

Fig. 2.8 shows the earlier KV modular quick-change tooling system held in the turret of a turning centre. The picture highlights how compact tooling is; this is even more true on the latest KM system, and enables a high density of tooling to be situated on a turret. Fig. 2.8 also shows the diversity of the cutting tools that may be accommodated without fouling each other. This is often a problem with solid tooling: sometimes tool pockets either side of a large tool have to be left empty, which clearly limits the turret's tooling capacity.

Yet another tool-adaptor system - the 'FTS' - uses a Hirth gear-tooth coupling, as shown in Fig. 2.9b. The coupling between the tool cutting unit and the clamping/adaptor unit is by means of a Hirth gear-tooth system with a collet, which guarantees a high positioning accuracy with a near-perfect transmission of torque produced whilst cutting. The clamping method consists of a collet with several clamping elements which open wide, so that the tool cutting unit does not require precise positioning to be inserted. Once the cutting unit is inserted, the clamping is carried out by axial movement of the draw-bar, either by manual means or using a torque motor. The same type of clamping arrangement can be used for cutting units with internal or external, right or lefthand tooling, as well as tools held at 90° to the axis. Just some of the range of tooling that makes up the FTS system are illustrated in Fig. 2.9a.

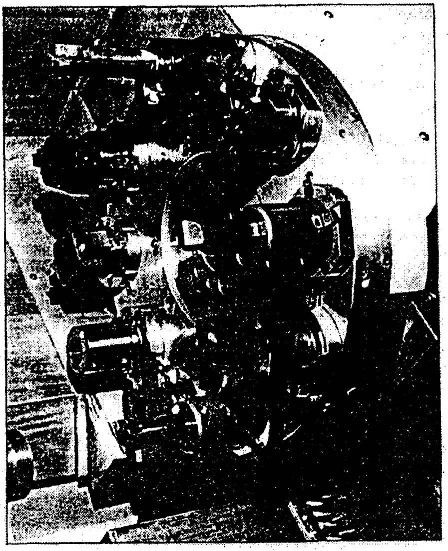
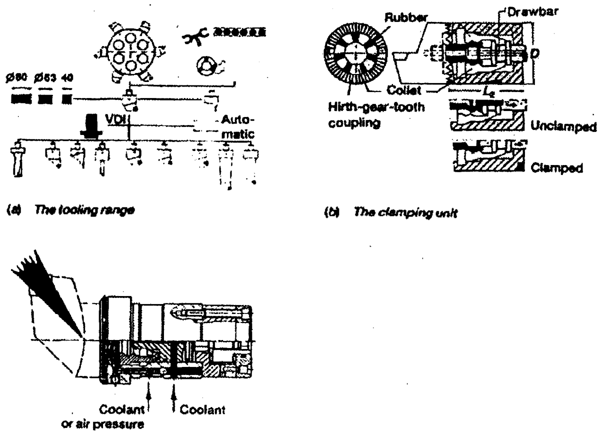


Fig. 2.8 A turning centre with KV quick-change tooling and automatic clamping units (Courtesy of Kennametal (UK) Ltd.)



(a) The tooling range

(b) The clamping unit

(c) The coolant supply

Fig. 2.9 The FTS system (Courtesy of Hertel International)

Text 6.

Since machining centres were developed, their tooling requirements have undergone relatively few changes, compared with those of turning centres, in the search for more productive cutting time. Their development is typified by the basic configuration of a machining centre with an automatic tool-changer and a tool-storage magazine, or carousel. In recent times some manufacturers have reduced tool-changing times by including a load-and-unload facility on the tool-change arm. That is, whilst the 'old' tool is still' in-cut, the 'new' one is selected from the carousel by the CNC; then the 'old' cutter is removed from the spindle and replaced by the 'new' one, in a double tool-holder design. This allows for a faster response to the next cutting requirements of the CNC program.

When one looks at the tool-storage capacity of machining centres, it can be seen that for several reasons most of them have a less-than-total capacity. This may be due to one or more of the following reasons:

- Heavy tooling may be required in the tool-storage system, and because of the system's configuration (such as with the chain type of carousel), tools must be widely spaced to keep the magazine correctly balanced.
- Large tools might require the pockets adjacent to them to be left empty to avoid the likelihood of them fouling each other.
- 'Sister-tooling' requirements might be necessary, i.e. a duplication of all, or most, of the most commonly-used tools, or those that might be susceptible to breakage or wear.

In order to increase the capacity of a tool-storage system whilst simultaneously expanding the range of tools that can be called upon during a production run, modular tooling has been developed which further extends the machine's capability and versatility.

With some of the advanced systems of modular tooling, the tools can be automatically loaded from a centralised preparation and storage facility. This requires a complex tool-presetting and tool-management ability for the retrieval of old tools and their replacement by new ones whilst the cutting cycle continues unhindered. More will be said about this in Chapter 4, and some of the in-cycle tool-monitoring systems necessary to protect the tools, and more importantly the workpiece, will be discussed in Chapter 3.

The use of modular tooling systems on machining centres is further justified by the other predictable advantages of their use. For example, they provide lighter units for the operator to load and unload, thus reducing fatigue. The tools are smaller (although in a machining centre's case, not drastically so), which decreases the tool-storage space required and the inventory. Lastly, but possibly most importantly, tool-changing times and the initial set-up times are reduced considerably. The arguments that were pursued in the discussions of the advantages of quick-change modular tooling on turning centres are equally true for machining centres; they are also valid for CNC milling machines that do not have the benefit of an automatic tool-changing facility.

Text 7.

So far the merits of using modular tooling on machining centres have been praised, but what does a typical system look like, and how adaptable is it to most shop-floor production requirements? The diagram in Fig. 2.3d answers the first of these questions, showing a typical modular tooling system for a machining centre. All such systems have been based upon popular rotating adaptors, such as the V-flange, BT-flange, NMTB and others not specified here. They are available as modular tooling in six sizes from 25mm to 80mm in diameter in this tool manufacturer's range, and have a manual right-angled coupling device.

The rotating modular quick-change tool-holders and cutting units illustrated in Fig. 2.3d will fit any of the rotating adaptors with the same coupling size. To further expand their versatility , a range of extensions and reducers can be used; these have the same manual right-angled coupling as the adaptors and a tapered shank to accommodate a rotating adaptor. These 'mechanical interfaces' (i.e. reducers and extensions) can be used to assemble cutting tools of extended length or to attach a small rotating tool-holder to larger-sized adaptors. These extensions and reducers have also been used in turning-centre applications with modular tooling, specifically where there is a need for internal machining or rotating tooling applications. So by using them'in a modular machining-centre tooling system, a wide variety of cutting configurations can be assembled from a limited tooling inventory.

Recently, two cutting-tool companies pooled their resources to develop the quick-change modular tooling concept a stage further, whilst at the same time expanding modular tooling's versatility. The system they developed could be termed a 'universal' tooling system; it is schematically represented in Fig. 2.10. This system of modular tooling allows cutting tools to be shared equally between machining and turning centres, such that turning, boring, drilling, reaming, spot-facing, fly-cutting, face milling, etc. can be done on either machine, provided that the machine tool is configured accordingly. This has the extra advantage of reducing the tooling inventory still further on top of all the other benefits that accrue from this type of tooling in terms of enhancements in productive cycle-time. The system is designed around the KM system mentioned previously. It may be mounted in the machine spindle of a machining centre, or in the turret of a turning centre or its derivatives, by using the well-known VDI or ISO, taper-shanked tool-holders, or it may be mounted directly into adaptors in the spindle or turret.

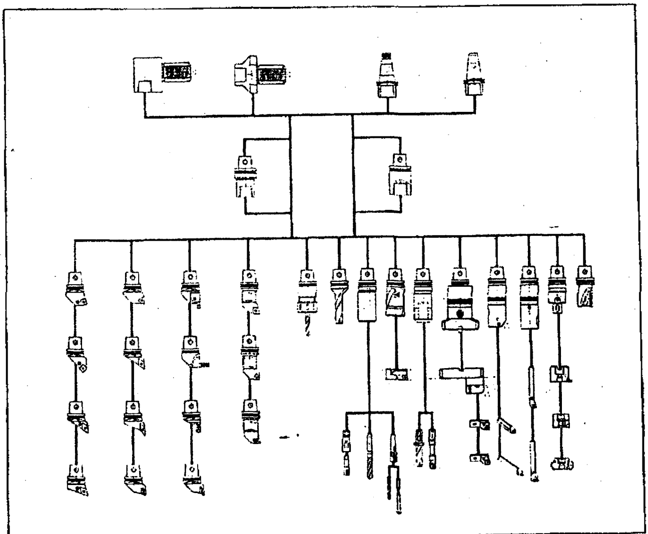


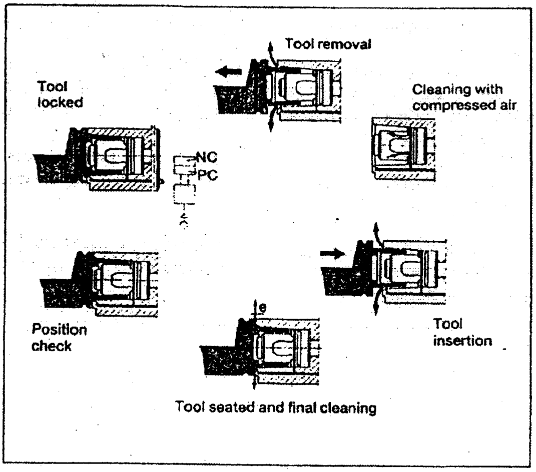
Fig. 2.10 The Widaflex universal tooling system for turning, drilling, boring and milling (Courtesy of Krupp Widia)

To enhance the universal tooling system even further and ensure that the tool is positively located in its mating taper, an electronically-activated back-pressure device coupled to the CNC can be used. The tool-locking cycle is shown in Fig. 2.11; its operation is as follows:

- The 'old' tool is removed by either the tool-change arm (on a machining centre), or a tool-transfer mechanism (on a turning centre).
- Compressed air purges the female taper, cleaning out debris from the previous tool's cutting operation.
- A 'new' tool is inserted into the holder. Its male taper is cleaned, and it begins to seat itself in the female taper.
- As it is pushed firmly home to register with its opposing taper, the back pressure is monitored electronically, and a signal to indicate that the seating has occurred is sent to the CNC, confirming that the coupling is firmly locked.
- The tool is then ready to begin the next turning or machining operation.

Quick-change modular tooling of this level of sophistication needs to be coupled to some form of tool-transfer mechanism to gain the full benefits of its range of machining applications and speed of operation, and to minimise the pay-back period on its purchase. This will be the next topic to be considered.

Fig. 2.11 The tool-locking cycle for the Widaflex quick-change modular tooling using contract-pressure monitoring of the position of the tool head (Courtesy of Krupp Widia)



Text 8.

To improve the tool-carrying capacity of conventional CNC machine tools still further, automated tool-storage devices with tool-handling equipment can be supplied. These units provide the following benefits:

- They increase the machine tool's productivity times.
- They significantly reduce the times for changing worn tools.
- New cutting units are automatically delivered to the machine by the tool-changing system.
- The rotating magazine holder can provide tool-storage capacities ranging from 60 to 240 cutting units, with up to 24 different types of tool geometries.
- They provide storage of the cutting units, which are returned automatically from the machine tool.
- The integration of these mechanisms onto machine tools can be easily accomplished.
- These systems can cover a wide range of sizes and options to suit most machining applications.

So these are the advantages of installing such systems, but how do they achieve such attractive production advantages, and how do they operate? This will be the subject of the next section.

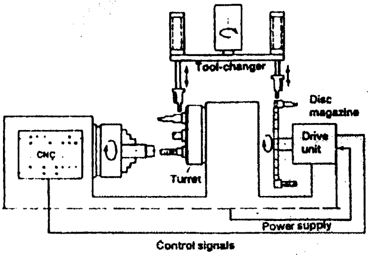
Text 9.

Automatic tool-changing mechanisms on turning centres

Cutter units can be stored in either a drum or a disc type of storage device. A typical example of the storage facilities and their automatic tool-changers is shown in Fig. 2.12. If one looks at the schematic representation of an installation (Fig. 2.12a) in conjunction with Fig. 2.12c, the method of operation can be simply discerned:

- The rotary tool-changer swivels between the tool magazine and the machine's turret. Each gripper can rotate through 90°, to deliver tools to the front face of the turret (Fig. 2.12a).
- The tool-changer simultaneously removes the cutting units from the disc magazine and the turret, then it rotates through 180° (Fig. 2.12c left).
- The new tool is delivered to the turret and accurately positioned in the correct orientation, whilst the used tool is replaced in its correct turret position, for either re-use or replacement (Fig. 2.12d right).

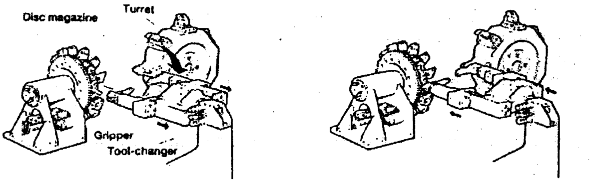
• The tool-change arm is withdrawn from the working area of the machine, and the cutting cycle commences.



(a) *Schematic of CNC turning machine with integrated disc magazine for automatic tool changing*

The disc magazine requires three connections to the turning machine:
- A mechanical tool-changer or delivery unit
- A hydraulic supply for the disc magazine drive unit
- Control (CNC/PC) to provide programmed movement of the disc to ensure that the correct tool is moved to the tool-change position

(b) *Integration into a turning centre*



The tool-changer removes tool from disc magazine and turret and rotates through 180°. . .

. . . simultaneously replacing new tool in turret and used tool in disc magazine

(c) *Operation of the tool-changer*

Fig. 2.12 The random-access automatic tool-changer for Block tools (Courtesy of Sandvik (UK) Ltd.)

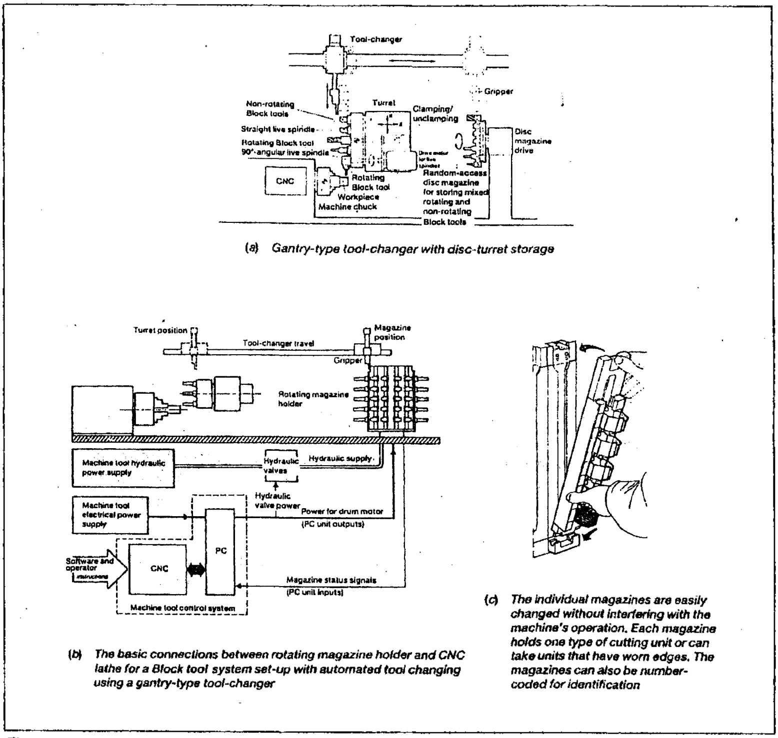
Where space in the vicinity of the machine is limited, a gantry-type of tool-changer using a twin-gripper assembly can be used for high-speed tool-changing. In this design, the gripper assembly also rotates through 90° to deliver tools to the turret's periphery, as shown in Fig. 2.13a. The major advantages of using this type of tool-changer are that it can be fitted to a machine tool with very little modification, and that it keeps the working area free and unencumbered from any mechanisms that might get fouled by swarf, or hit by the machine tool's moving parts.

The disc-type turret magazines mentioned above have 'random-access' capability. This means that the tool-changer has completely free access to any tool in the store, providing an almost instant delivery to the turret of any tool required. If a company requires even more versatility from the automation of a Block tooling system, it is also possible to change the disc turrets automatically; by doing this the tool-storage capacity approaches the infinite!

The advantage of using any of these universal tool-changing mechanisms is that they are designed on the modular principle and can be fitted to whatever configuration a company requires, allowing for a degree of customisation.

Text 10.

Consider the drum-type tool-storage facility shown in Fig. 2.14, which is being used in conjunction with a gantry-type loading configuration. The rotary drum-type holder permits a continuous supply of cutting units over long periods of untended machining, in the same manner as with the disc turret. When first setting up the machine for a new family of workpieces, the magazine racks can easily be substituted with new ones (Fig. 2.13c) holding other types of tools. The cast iron drum (Fig 2.14a) consists, for the most part, of the rotating magazine holder assembly, and it encloses the interior working parts. This drum is mounted centrally on a column and runs freely on two bearings. A locking mechanism is attached to the drum and hinge plates for mounting of either five or ten cutting-unit magazines, depending on the magazine holder's capacity.



(a) Gantry-type tool-changer with disc-turret storage

(b) The basic connections between rotating magazine holder and CNC lathe for a Block tool system set-up with automated tool changing using a gantry-type tool-changer

(c) The individual magazines are easily changed without interfering with the machine's operation. Each magazine holds one type of cutting unit or can take units that have worn edges. The magazines can also be number-coded for identification

Fig. 2.13 The automated Block tool-handling system with a gantry-type tool-changer and tool-storage drum (Courtesy of Sandvik (UK) Ltd.)

The drum can be removed easily (Fig. 2.14b) allowing for access to the interior working parts. The tool-actuator mechanism is stationary inside the rotating magazine holder; this transports the cutting units out of, and back into, the magazines and is the main interior working part of the drum assembly. When a particular tool cutting unit is called for, the drum magazine is indexed into position before the tool actuator is energised. Then the actuator will load, or unload, the gripper, as shown in Fig. 2.14c. The gripper is attached to a transportation mechanism - typically a gantry robot - and is taken to the machine-tool magazine, as shown in Fig. 2.14d to f. Gantry systems such as the one in Fig. 2.14d can cater for a whole range of machining conditions on many complex parts. 'Sister tooling' can be used for heavily utilised cutting units, so that the systems have a large and versatile cutting capacity on the shop floor, particularly if powered (driven) tooling is also incorporated into the system as mentioned earlier. Their versatility can be further enhanced if the gantry robot is designed to include such features as touch-trigger probing, of which more will be said in Chapter 3, and the capacity to load and unload the workpieces as shown in Fig. 2.14f. This level of sophistication, with tool and work loading coupled to a 'probing' ability, is almost the 'state of the art', but not quite so: completely automated machine tools, in which chuck-'jaws for different work-holding needs can be offered, or a complete chuck-changing facility using a gantry robot is possible, are listed by some machine-tool builders. When machines of this high level of specification are used, either as 'stand-alone' machines or as part of a flexible manufacturing system, the throughput of work and the variety of applications are considerable. When coupled to a high utilisation, with many shifts, the pay-back period, namely the time for the return on the investment, is much shorter.

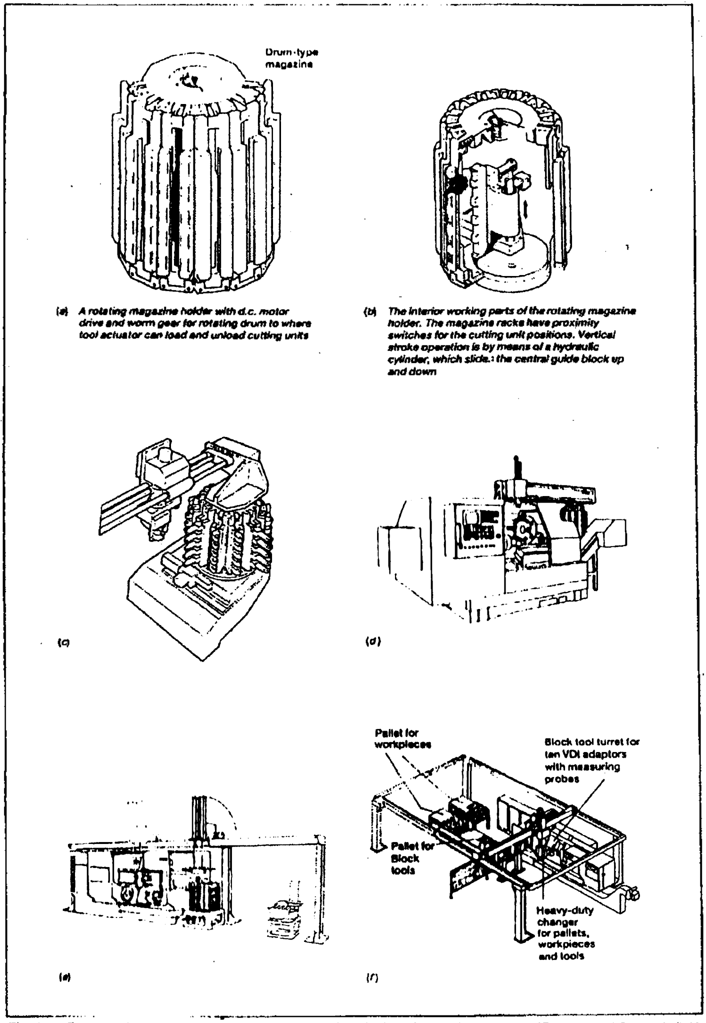


Fig. 2.14 Block tooling mechanisms and transportation devices for turning centres (Courtesy of Sandvik (UK) Ltd.)

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