SFEU

Scottish Further Education Unit

Skills for Work:
Engineering Skills Intermediate 2

Course Guidance and Employability Skills

Support Material

June 2008

Scotland's Colleges

Acknowledgements

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Engineering Skills (Intermediate 2)
C253 11

Introduction

These notes are provided to support teachers and lecturers presenting the Scottish Qualifications Authority Course C253 11*, Engineering Skills: (Intermediate 2)*.

Enquiries relating to this support pack or issues relating to copyright should be addressed to:

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Further information regarding this Unit including Unit Specifications, National Assessment Bank materials, Centre Approval and certification can be obtained from:

The Scottish Qualifications Authority
Optima Building
58 Robertson Street
Glasgow
G2 8DQ

Website: www.sqa.org.uk

Class Sets

Class sets of this pack may be purchased direct from the printer. Costs are dependent on the size of the pack and the number of copies. Please contact:

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Disclaimer

Whilst every effort has been made to ensure the accuracy of this support pack, teachers and lecturers should satisfy themselves that the information passed to candidates is accurate and in accordance with the current SQA arrangements documents. SFEU will accept no responsibility for any consequences deriving either directly or indirectly from the use of this pack.

Contents

How to Use this Pack

This pack is designed to help tutors to deliver the *Engineering Skills* Intermediate 2 course. It contains advice on learning, teaching and assessment approaches for lecturers/teachers, together with student support materials including interactive activities. The pack is made up of five main sections:

The **Reference Section** of the pack provides information on the rationale for, and ethos behind, the *Skills for Work* courses, the Course Rationale, and the Employability Skills Profile for Intermediate 2 Engineering.

The **Tutor Support Section** gives guidance on learning and teaching with the under 16 age group, general advice for course teams on course delivery, health and safety issues and some subject-specific hints and tips from centres that have had previous success in running engineering courses through school-college or other types of partnership agreements. Finally it gives advice on both essential and recommended resources for centre use.

The **Course Induction Section** is designed to assist with the development of an induction programme. It contains introductory activities which can help to introduce learners to *Skills for Work* courses in general, followed by suggestions for induction into the Engineering Skills Course. There is a suggested approach to the introduction of the course and the concept of employability skills. It also contains a student induction evaluation sheet which centres may wish to use or adapt.

The **Employability Support Section** gives guidance for course teams on integrating employability skills across all the units of the course. It includes delivery and assessment advice and suggested learning and teaching approaches.

The **Student Support Section** contains material that can be used or adapted to introduce students to the specific employability skills, health and safety and engineering materials that will be assessed through the activities of this course. It also contains a glossary of terms for students, guidance for students on the Review process, and a Course evaluation sheet which centres may wish to use or adapt.

The Student Notes are intended to be used in an integrated way throughout all the units in the course.

None of the material in this pack is mandatory. Rather, it is intended as a guide and an aid to delivery of the Course and integration of Employability Skills. It aims to provide centres with a flexible set of materials and activities which can be selected, adapted and used in whatever way suits individual circumstances. It may also be a useful supplement to tried and tested materials and approaches that you have developed yourself. The pack is available on the SFEU website in Word format to enable you to customise it to suit your own needs.

Activities are identified with the symbol: 

Reference Section

What are Skills for Work Courses all about?

Skills for Work Courses are designed to help candidates to develop:

- skills and knowledge in a broad vocational area
- Core Skills
- an understanding of the workplace
- positive attitudes to learning
- skills and attitudes for employability.

A key feature of these Courses is the emphasis on **experiential learning**. This means learning through practical experience and learning by reflecting on experience.

Learning through practical experience

Teaching/learning programmes should include some or all of the following:

- learning in real or simulated workplace settings
- learning through role play activities in vocational contexts
- carrying out case study work
- planning and carrying out practical tasks and assignments.

Learning through reflecting at all stages of the experience

Teaching/learning programmes should include some or all of the following:

- preparing and planning for the experience
- taking stock throughout the experience - reviewing and adapting as necessary
- reflecting after the activity has been completed - evaluating, self-assessing and identifying learning points.

The *Skills for Work* Courses are also designed to provide candidates with opportunities for developing **Core Skills** and enhancing skills and attitudes for **employability**.

Core Skills

The five Core Skills are:

- Communication
- Numeracy
- Information Technology
- Problem Solving
- Working with Others

Employability

The skills and attitudes for employability, including self-employment, are outlined below:

- **generic skills/attitudes valued by employers**
    - understanding of the workplace and the employee's responsibilities, for example time-keeping, appearance, customer care
    - self-evaluation skills
    - positive attitude to learning
    - flexible approaches to solving problems
    - adaptability and positive attitude to change
    - confidence to set goals, reflect and learn from experience.
- **specific vocational skills/knowledge**
    - Course Specifications highlight the links to National Occupational Standards in the vocational area and identify progression opportunities

Opportunities for developing these skills and attitudes are highlighted in each of the Course and Unit Specifications. These opportunities include giving young people direct access to workplace experiences or, through partnership arrangements, providing different learning environments and experiences which simulate aspects of the workplace. These experiences might include visits, visiting speakers, role play and other practical activities.

A Curriculum for Excellence (Scottish Executive 2004) identifies aspirations for every young person. These are that they should become:

- successful learners
- confident individuals
- responsible citizens
- effective contributors.

The learning environments, the focus on experiential learning and the opportunities to develop employability and Core Skills in these Courses contribute to meeting these aspirations.

The Course in Engineering Skills (Intermediate 2)

Course Rationale

The Intermediate 2 Engineering Skills Course has been designed to provide a basis for progression into further education or for moving directly into training in employment within an engineering sector. The overall purpose of the Course is to ensure that candidates start to develop the generic and practical skills, knowledge and understanding and employability skills needed within an engineering sector.

The engineering sector includes the following:

Mechanical	Manufacture	Maintenance
Fabrication	Welding	Electrical
Electronic	Foundry	Automotive
Control	Transport	Aeronautical
Communications	Space	Energy Generation
Conservation	Marine	Water
Desalination	Oil/Gas	Petroleum

This course focuses on the broad areas of Mechanical, Fabrication, Electrical, Electronic, Maintenance and an element of Design and Manufacture. This will allow the candidates to gain basic transferable skills which can be applied to any of the above engineering areas.

The primary target group for this Course is school candidates in S3 and above. It is anticipated that, for this group of candidates, the Course will rely on and build on existing partnerships between schools and colleges and employers (or other agencies). This may be particularly pertinent in the case of the Engineering Skills course due to the specialist expertise and facilities available in, for example, further education colleges and training providers. Nevertheless, the Engineering Skills course is designed at a level and scope such that it can be delivered in schools, if the school has suitable facilities and teaching expertise. A partnership approach would still be necessary in order to provide the contact with the workplace which is an essential part of the experience for candidates.

The Course is also suitable for adult candidates who are seeking to enhance their employability and develop introductory vocational skills in an engineering sector.

The general aims of the Engineering Skills (Intermediate 2) course are to:

- widen participation in vocationally related learning for school candidates from S3 upwards
- allow candidates to experience vocationally-related learning
- provide candidates with a broad introduction to the engineering vocational sector
- encourage candidates to develop a good work ethic, including timekeeping, a positive attitude and other relevant employability skills
- provide opportunities to develop a range of Core Skills in a vocational context
- encourage candidates to take responsibility for their own learning and development
- provide a range of teaching, learning and assessment styles to motivate candidates to achieve their full potential
- facilitate progression to further education and/or training
- encourage candidates to plan their work and review their progress
- encourage candidates to develop a positive attitude to waste minimisation and environmental issues.

In particular, the aims of the Engineering Skills Course are to encourage candidates to:

- consider a career in the engineering industry
- develop an awareness of what opportunities there may be within engineering in terms of the types and range of career options
- develop and apply practical, technical and communication skills as a foundation for future learning and progression
- develop an awareness of their individual strengths and weaknesses in relation to the requirements of engineering, and to reflect on how this affects their employability potential
- gain the technical knowledge, skills and understanding associated with a range of skills in engineering at this level
- apply their knowledge and understanding of engineering by using skills of evaluation and problem-solving in a vocational context
- develop an awareness that health and safety issues are integral to the world of work generally and engineering in particular
- undertake further learning, study and training opportunities for employment in engineering and related occupations.

The Engineering Skills (Intermediate 2) course has been designed with National Occupational Standards in mind. The standards set for first-year apprentices in the engineering industry, and the standards set out in the Intermediate 2 course, are broadly comparable in terms of skills and tolerances.

While no formal entrance qualifications are required for this Course, it would be expected that candidates embarking on the Course would have the following:

- basic proficiency in literacy
- basic proficiency in numeracy
- some aptitude for graphical forms of communication (the reading of basic engineering drawings is developed in the Course)
- motivation to work as part of a team

This Course supports progression into appropriate further education, training, or employment. The Course provides the basis for candidates to gain an insight into engineering occupations such as Mechanical, Fabrication, Automotive, Aeronautical, Electrical, and Electronic, Marine, Control, Maintenance, and Manufacture and to use their studies to help them decide the career they wish to follow. Candidates studying this Course in Engineering and choosing a skills option, may be aiming to progress into an apprenticeship in industry. Candidates who are uncertain which trade to follow may undertake vocational courses at further education colleges.

The Intermediate 2 Course should facilitate progression to a relevant vocational Course or an appropriate National Certificate/Qualification programme.

Summary information on the Engineering Skills Course Units

This Course comprises four 40 hour Units. The content of the Course focuses on the development of engineering hand skills across the disciplines of:

- Mechanical and Fabrication
- Electrical and Electronic
- Maintenance, and
- Design and Manufacture

Central to the content are the generic employability skills valued by employers in an engineering sector. These skills are developed in each of the four Units and are assessed during the course. These add value to the development of specific vocational skills.

Employability Skills

The development and assessment of generic Employability Skills is a key feature of this Course and is integrated with the skill specific Units. Candidates can readily gather evidence for assessment during their work in these practical skills Units. Reviewing progress with employability skills and attitudes will take place in the practical context of work in the different activities. Candidates will complete a minimum of four review sheets in the different trade activities.

Assessment of interpreting drawings and specifications and materials should also take place during the work in skill specific practical Units. An employability skills profile for the Course is shown on the next page and this gives a clear indication of where assessment evidence is gathered for generic employability skills. Further advice on integrating the development of these skills throughout the course is found in the Employability Support Section.

Within the skills specific practical Units, the candidate will produce evidence as a natural part of the learning and teaching process. Candidates will first learn and practise the correct techniques and methods for each of the skills they undertake. Assessment of the various practical tasks will take place at appropriate points throughout the Course, allowing time for candidates to make quality checks of their finished products against the prescribed tolerances, before being submitted for assessment.

Employability Skills Profile

Mechanical and Fabrication = A
Electrical and Electronic = B
Maintenance = C
Design and Manufacture = D

In addition to the specific, vocational skills developed and assessed in this Course, employability skills are addressed as detailed below:

Employability skill/attitude	Evidence
• maintaining good timekeeping and attendance	A, B
• showing health and safety awareness	A, B, C, D
• selecting and using engineering tools and materials	A, B
• interpreting engineering drawings and specifications	B, C, D
• working co-operatively with others	C, D
• planning and preparing for work	C, D
• applying time management	D
• awareness of environmental considerations	B, C
• quality checking own work	A, B, C, D
• self review and evaluation	A, B, C, D

Assessment evidence in all Units:

Assessor observation checklists of practical activities and candidate review sheets.

Careers Scotland Support

for School/College Collaboration for Scotland's Colleges in the Scottish Enterprise area

Since August 2006 Careers Scotland (SE and HI areas) has been funded by the Scottish Government to support College/School Collaboration and encourage and promote vocational educational choices for pupils in schools.

Careers Scotland (now part of Skills Development Scotland) has an important role to play in selection, recruitment and pre-entry career guidance, as well as ongoing support and pre-exit career guidance, to ensure the pupils' experience of SfW is capitalised upon in any future career planning.

Careers Scotland activity takes place locally and nationally under 4 objectives:

- Providing careers advice, guidance and employability support to pupils and their parents pre, during and post vocational education experience, focusing primarily but not exclusively on SfW pupils - demonstrating how these educational choices have implications for future career options, and support the achievement of future career goals and supporting effective transitions
- Providing targeted support to pupils at risk of becoming unemployed who would benefit from undertaking a vocational course
- Partnership working to ensure vocational study is given parity of esteem with other school and post school options, focusing on recruitment / selection and retention of pupils on vocational courses
- Capacity building through relevant shared CPD events and resource development to increase understanding of the process of uptake of vocational options and facilitate more effective support to pupils navigating these options

For further information on Careers Scotland (SE)'s involvement in school/college collaboration locally, please get in touch with your Careers Scotland Regional contact:

South East (Edinburgh & Lothians; Forth Valley; Borders)
Stephen Benwell 01786 452043 stephen.benwell@careers-scotland.org.uk

North East (Tayside; Grampian; Fife)
Val Ormiston 01592-631155 valerie.ormiston@careers-scotland.org.uk

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Tutor Support Section

Learning and Teaching with Under 16s

Scotland's Colleges have made significant progress in meeting the needs of young learners. Our knowledge of the learning process has increased significantly and provides a range of strategies and approaches which gives us a clear steer on how lecturers can add to their skill repertoire. Lecturers can, and do, provide a stable learning environment where young students develop a sense of self-respect, learn from appropriate role models and see an opportunity to progress. There are basic enabling skills for practical application which can further develop the learning process for this group of students. So what are the characteristics of effective learning and teaching which will help to engage young learners?

Ten ways to improve the learning process for under 16s
(This list is not exhaustive!)

1. **Activate prior knowledge and learning** – ascertain what the learner knows already and teach accordingly. Young people do have life experience but it is more limited than adult learners and they may not always be aware of how it will assist them in their current learning.

   Tips - Question and answer; Quick Quiz; Quick diagnostic assessment on computer; present key words from the course or unit and see how many they recognise or know something about.

2. **Tune learners into the Big Picture** – the tutor knows the curriculum inside out and why each lesson follows a sequence, however the young learner does not have this information and is re-assured by being given the Big Picture.

   Tips – Mind map or concept map; use visuals, for example wall displays of diagrams, photographs, flow charts; explain the learning outcomes in language they will understand; We Are Learning Today (WALT) targets and What I'm Looking For (WILF) targets; give clear and visible success criteria for tasks.

3. **Use Advance Organisers** – these are lists of the key concept words that are part of the course or unit.

   Tip – Highlight on any text the concept words that you will be using; make a visible list and put it on display – concept words can be struck off or referred to as they occur (NB this helps with spelling and independent learning as they do not have to keep checking meaning); highlight essential learning and action points.

4. **Vary the teaching approaches**. The two main approaches are instructing and demonstrating, however try to provide opportunities to facilitate learning.

   Tips – Ask students what they know now that they did not know before, or what they can do now they could not do before, at appropriate points in the lesson or teaching block; ensure there are problem solving activities that can

be done individually or in groups; ask students to demonstrate what they have learned; use a range of question and answer techniques that allow participation and dialogue, eg. provide hints and cues so that they can arrive at answers themselves.

5. **Preview and review of learning**. This helps to embed previous learning and listening skills and provides another opportunity to elicit learner understanding. Consolidates and reinforces learning.

   Tips – At the beginning of each lesson, or session, review previous learning and preview what is coming up; at the end of each lesson or session, review what has taken place and what will be focussed on next time – these can both be done through question and answer, quizzes and mind mapping activities.

6. **Language in the learning environment**. Do not assume that the language which is used in the learning environment is always understood by young learners, some words may be familiar but do not have the same meaning when used vocationally.

   Tips - At appropriate points ask students what words mean; explore the various meanings of words to find out if they may have come across this language in another context; by looking at the structure and meaning of words there is an opportunity for dialogue about learning and to build vocabulary.

7. **Giving instructions in the learning environment**. This is one of the most difficult tasks a tutor has to do whatever the curriculum area. With young learners this may have to be repeated several times.

   Tips – Ask a student to repeat back what you have asked them to do before beginning a task; ask them to explain the task to one of their peers; use the KISS principle – Keep It Short and Simple so that they can absorb and process the information.

8. **Effective feedback**. Feedback is very important for the learner to assess their progress and to see how and what they can improve. Provide opportunities to engage in dialogue about the learning function of assessment – provide details of the learner's strengths and development needs either in written or spoken form. With younger learners identifying one or two areas for development is sufficient along with acknowledgement of what has been done well.

   Essentially, learners are helped by being given a **specific** explanation of how work can be improved. You can also use summative assessment formatively, ie. as an opportunity to identify strengths, development needs and how to improve.

   Tips – Ask students themselves to identify their own strengths and development needs – self evaluation; peer evaluation of work can be successful once they have been taught how to do it; the tutor can produce a piece of work and ask students to assess it anonymously; have a discussion about the success criteria for the task and ensure the students are clear about

them; allow learners to set criteria for success and then measure their achievements against these.

9. **Managing the learning behaviour**. Under 16s are coming into Scotland's Colleges and training establishments from largely structured and routine-driven environments in schools and early feedback from those undertaking *Skills for Work* courses indicates that they very much enjoy the different learning environment that colleges and other training providers offer. Remember though that these are still young learners. They will still expect tutors to provide structure and routine, and will perform best in a calm, orderly learning environment. Young students will respond to firm, fair, and consistent management. Such routines have to be established quickly and constantly reinforced.

   Tips - Health and safety is non-negotiable and consequences of non-compliance with the regulations should be made clear and adhered to at all times; set out your expectations from day one and provide a consistent message; have clear beginnings, middles and endings for each session; be a positive role model for your students, ie. be there before they are and manage the learners with respect; always deliver what you promise; build up good relationships and get to know the learners, make the curriculum interesting and stress the relevance of the learning; set up a positive behaviour management system. By following these guidelines you will build up two-way respect, which, while sometimes challenging to achieve, can be very powerful and work to everyone's benefit.

10. **Care and welfare issues**. School/college partnerships mean increasing numbers of young learners in college. Tutors have to be aware of their professional responsibilities and mindful of young people's rights. However tutors have rights too, in terms of feeling safe and secure in working with young people and there are basic steps staff can take to minimise risks. It is essential that colleges ensure that tutors have a working knowledge of the Child Protection policies (local authority and college documentation) and follow procedures and policies diligently. School/College Liaison Officers will be familiar with these documents and can provide support and advice. There are also training sessions on Child Protection available from SFEU (see the following page).

    Tips - Avoid one-to-one situations with young students in a closed area; do not do or say anything that could be misinterpreted; if the opportunity arises, do some observation in schools to see and discuss how teachers use the guidelines for their own protection as well as the young person's.

Most young people are a delight to work with and they will positively enjoy the experience of learning in college. However, there will inevitably be some who are disengaged, disaffected and who have not yet had an opportunity to experience success. '*Skills for Work*' is a unique educational initiative that young people can be motivated to buy into – you as the tutor are key to the success of these programmes.

Skills for Work Workshops

To take this 10 point plan forward and to add to it, you can attend one of SFEU's *'Get Skilled Up'* half day workshops for tutors delivering *Skills for Work* Courses, when we explore further the learning process and look at a range of specific teaching and learning techniques to use with the under 16 age group. To find out when the next event is visit our website www.sfeu.ac.uk or contact the Learning Process team at SFEU on 01786 892000.

Child Protection Workshops

These are run on a regular basis by staff at SFEU in Stirling and also in colleges. For more information on these workshops please contact members of the Access and Inclusion team at www.sfeu.ac.uk or contact the team at SFEU on 01786 892000.

Guidance on Course Delivery

The Course has four mandatory Units which offer a broad range of different engineering experiences:

- Mechanical and Fabrication
- Electrical and Electronic
- Maintenance
- Design and Manufacture.

Firstly, it is important that a well planned induction to the Course is delivered, emphasising its integrated nature and stressing the importance of generic employability skills throughout. Employability skills should span the Course, allowing students ample opportunity to develop and review employability skills and attitudes over a range of engineering skills and over a reasonable period of time.

Students who have completed the *Engineering Skills: Intermediate 1* course will have developed employability skills appropriate to that level of course. The *Engineering Skills: Intermediate 2* course will further enhance and develop employability skills at this level.

Sequence of Delivery

It is recommended that the Mechanical and Fabrication Unit is completed initially as some aspects of the content of this Unit are incorporated in all of the other Course Units. Conversely, the Design and Manufacture Unit should only be attempted after successful completion of the other three Units.

Integrated Course Delivery

Alternatively, centres may wish to combine the four mandatory units into an integrated course where the engineering skills and the manufacture of the artefacts are not delivered discretely but in an integrated way similar to a real apprentice training course. If centres decide on this integrated approach the artefacts manufactured in the practical assignments that lead towards the Design and Manufacture Unit can be used as evidence of the development of skills for the other Units.

General advice on learning and teaching and assessment approaches

It is very important that the teaching team involved in delivery of this course have a common understanding of the approach. Delivery should be based on a hands-on, experiential model with an emphasis on embedding the employability skills throughout. More extensive advice on teaching and learning is given in the support notes for each individual unit. Support packs for each of the Units are available to download from the *Skills for Work* pages of the SFEU website www.sfeu.ac.uk

Health and Safety

General advice on Health and Safety

The majority of this Course must be delivered in a real or realistic work setting that may be provided by a College, an employer or a training provider. Risk assessment and compliance with health and safety legislation is of paramount importance in these environments.

Centres will need to adhere to all current, relevant health and safety legislation and carry out appropriate risk assessments before learning and teaching begins.

A person, (or persons), who has had both appropriate risk assessment training and a current experiential knowledge of the particular working environment into which the students are entering, should carry out risk assessment well in advance of the learning activities.

The format of risk assessment is at the discretion of the Centre. Specific guidance for carrying out **risk assessments** can be obtained from this guide available on the **Health and Safety Executive** website at the following link: http://www.hse.gov.uk/pubns/indg163.pdf

Each of the support packs for the Units of this course will have more specific guidance on health and safety for particular aspects of this course.

In terms of course delivery it is important for centres to note that:

- Appropriate Personal Protective Equipment (PPE) must be provided which is suitable for the context of delivery.
- Particular attention should be given to group sizes and supervisor numbers, considering the likely age and inexperience of students.
- Particular consideration should be given to the specific health risks that may exist in an engineering workplace.
- Students should not enter any of the working environments before receiving a full health and safety induction including the correct fitting of any PPE and appropriate safety considerations for the workplace.

General Safety in the Workplace

This deals with the issues of:

- General Health and Safety
- Personal Protective Equipment (PPE)
- Safe working techniques (including tool-handling)
- First Aid
- Fire Alarm
- COSHH
- Good housekeeping in the working environment.

Each student will require the minimum **PPE** of safety boots and overalls for most workshop activities. In some cases students may require additional equipment such as goggles, gloves, safety spectacles or ear defenders.

Safe working techniques will include general workshop behaviour and protocol. This will include the correct handling and transportation of tools, tool safety, workshop layout, procedures for starting and finishing practical activities.

First Aid considerations should include awareness of the nearest first aid station, first aider, first aid procedures, accident reporting and avoidance of potential accidents.

Fire Alarm evacuation procedures should be practised and students made familiar with the audible warning sound, alarm points, location of fire fighting equipment, fire exits, assembly areas and correct conduct under alarm conditions.

The **Control of Substances Hazardous to Health** (COSHH) must be stressed if students are subjected or exposed to any chemicals, fumes, dust or irritants.

Good housekeeping means taking due consideration of the welfare of all participants and the general working conditions in the workplace. This will include safety, PPE, behaviour, conduct, storage and condition of tools and equipment, walkways and handling and disposal of waste/scrap materials.

Whilst the tasks may not always require the movement or handling of heavy objects, the use of safety footwear and manual handling techniques should be discussed and encouraged as a matter of good safety practice.

Some tasks may involve using heat or a heat source and students should be made aware of the dangers of both hot and previously heated materials and workbenches.

Personal Safety

The students must appreciate that they are responsible for their own safety and the safety of others. This will include their conduct and behaviour in all activities. Safe working practices in workshops and the safe use of tools and equipment should be emphasised.

In all the activities students are asked to perform they should be encouraged to make sound judgements on issues such as:

- the effect of their actions on fellow students
- are the tools and equipment in good usable condition
- are they being asked to carry out an action they are unfamiliar with, and
- should they seek advice from an appropriate person.

Students' personal dress should be hardwearing and give protection against grease/oil/heat etc. This clothing should not have any loose sleeves.

No jewellery of any form should be worn; nor should any piercing jewellery be worn.

Good Practice Hints and Tips

Centres embarking on delivery of this course should consider the following issues:

- **Partnership Working**

Centres should establish partners for delivery well in advance and agreement should be made on all roles and responsibilities of each partner.

- **Student Selection**

The success of the course for each student will largely depend on the selection process. Evidence suggests that one appropriate selection method is where students complete a course application form and participate in a formal interview. This process will, in addition to ensuring that students are suitably motivated, impact on employability skills. It also gives a 'feel good' factor to each selected student.

- **Portfolios**

Portfolios have been identified as an excellent vehicle for the recording of formative and summative assessment material. This promotes ownership and introduces the student to a form of assessment that is used extensively in the engineering industry – both in education and workplace training. The portfolio belongs to the students and is a unique 'record of work' that can be used at interviews.

- **Access to Apprentices**

Many benefits can be gained both in a practical sense and in terms of employability skills of allowing the students to interact with employed apprentices.

- **Timetable Issues**

Many centres will deliver this Course over a two-year period. Where Centres plan to deliver the course over a shorter time period, they should be particularly careful to consider the effect this may have in terms of issues such as exam timetables and study leave.

Centres should never under-estimate the time that it takes for young people to be correctly fitted in PPE and prepared for the work environment: a three hour session can easily become a reality of two hours where practical activity is to be incorporated and planners should consider this carefully when preparing timetables. Centres should also consider the time that it takes to transport young people to and from the workplace.

Resources

Detailed specific advice is given in each of the Unit support packs. This identifies both physical and learning resource recommendations for the unit in the given context. There are several 'live' hyperlinks to websites where appropriate learning material and guidance documents can be downloaded.

The course requires the use of an appropriate workshop, suitably resourced with materials, tools, equipment and machinery as required by the course units.

More importantly the course requires suitably qualified and motivated staff who can enthuse, relate and promote engineering to the student group.

Websites

The following websites may be useful for students when gathering information to complete activities. Tutors should check for suitable content and identify particular areas of the sites for relevant information which is presented in a way which is accessible to students at this level.

Health and Safety

http://www.hse.gov.uk/

http://healthandsafety.co.uk/

http://www.teachernet.gov.uk/wholeschool/healthandsafety/

COSHH (Control of Substances Hazardous to Health)

http://www.hse.gov.uk/coshh/

http://www.coshh-essentials.org.uk/

Workshop Safety

Workshop Safety Rules: http://wwwtechnologystudent.com/health1/safetyr1.htm

Safety in Mechanical Workshops – University of Sheffield
http://www.shef.ac.uk/safety/mech/mech1.html

Workshop Safety – common faults – Borough of Kensington and Chelsea
http://www.rbkc.gov.uk/environmentalServices/HealthAndSfety/hs_workshopsafety.asp

Fire Safety

Hanford US – All you ever wanted to know about fire extinguishers
http://www.hanford.gov/fire/safety/extingrs.htm

How Stuff Works – Fire Extinguishers
http://home.howstuffworks.com/fire-extinguisher.htm

The ABCs of Portable Fire Extinguishers: Selection, Use and Maintenance
http://www.fireextinguisher.com/

Stainless Steel

http://www.worldstainless.org/

Grades and uses of stainless steel

Recycle materials

http://www.recycling-guide.org.uk/rrr.html

Ways of recycling different materials

Course Induction Section

Possible Induction Activities for Skills for Work Courses

Most of the young people arriving in colleges or school workshops to take part in Skills for Work know about the programme, have made an informed choice to be there and are looking forward enthusiastically to trying something new. Some young learners may not be off to such a positive start but as school/college partnerships develop and improve there will be fewer in this category.

However, despite their interest and excitement, many of the students will also be anxious, unclear about what is going to happen and concerned about their ability to carry out the tasks that they will be set. Inevitably some will come with unrealistic expectations of what they will be able to do right away – cut someone's hair, build a wall, bath a baby etc. In order to manage their expectations, the induction process has to address their concerns, make clear to them what is about to happen and build very quickly on their interest and enthusiasm to engage them and develop their appetite for learning. The learning environment of a college will be very different from school but the young learner's need for a feeling of security, a sense of purpose and clear instructions about what is and is not appropriate has to be acknowledged right from the outset to ensure they can make the transition safely.

All of this is a tall order, especially in the relatively short periods of time they will spend in college so the first impressions that we create have to be strong, build communications quickly and relieve any sense of stress by involving fun and stimulating 'things to do'. The following activities are ones that have been tried and tested – and though they may not work with every individual or every group they should quickly engage, help to 'break the ice' and encourage participation and communication. For clarification the term 'ice-breaker' is used here for activities which help to introduce people who do not know each other, develop communication and create a relaxed environment. 'Warm-ups' are activities to introduce learners to the topic they are about to learn in a fun, stimulating and engaging way.

- **Ice-breakers** - Any game which involves people saying their name and other people's names, eg. ask the class to arrange themselves in a line alphabetically by their first name and find out the names of the person on either side of them. They then, in order left to right, have to call out the name of the person to their left; the last person has to remember the first person's name. Then do it again calling out the name of the person to their right.

- **Paper Aeroplanes** – each student has a piece of paper on which they write their favourite colour/food/band, something they are good at and what they would like to be able to do by the end of the course. They then make the paper into an aeroplane and come and stand in a circle, throw the aeroplanes into the centre. Each person has to pick one out, (not their own), and either they, or the teacher reads it out and the owner has to identify themselves. This is a quick way to find out quite a lot about the group.

NB: Note however that any game which involves reading or writing may embarrass people who do not have good literacy skills so drawing pictures may sometimes be more appropriate.

- **Word Games/Quizzes/Jigsaws/ Mind Mapping** activities which can be done as a group. Each person in the group should have a role to ensure all participate, eg. time keeper, resource manager, quality manager, leader, scribe.

- **Problem Solving** – team games which require the group to solve a problem collectively, eg. in groups of 4/5 they are given 1 sheet of flipchart paper and have to work out how to cross an area of the room (one side to the other) without anyone's shoes touching the floor.

Introduction to the vocational area

Activities which allow the learners to 'have a go' at a task related to the vocational area and also encourage communication and participation include:

- **Celebrity Stuff** – eg:
  - a selection of celebrities' hairstyles which have to be matched to faces;
  - look through the keyhole – pictures of houses and pictures of celebrities – who do you think would live in each house and why?
  - selection of pictures of cars – who do you think would drive this car and what do you think might be in the boot?
  - celebrity dogs – whose pooch is this?
- Design/create a hairstyle/house/car/garden/game that you think you could sell to your favourite celebrity.
- Give students a selection of appropriate magazines and get them to make up a quick poster to show what they think working in the vocational area is all about.
- Using photos/pictures/PowerPoint images of the resources, environment and tools that are used in your vocational area to create observation games, eg:
  - 'spot the difference' between two similar pictures
  - find six objects that begin with '….letter of the alphabet'
  - arrange pictures in sequence to explain a task.
- Putting a time limit on the task – eg. do this in the time it takes to play 3 of their favourite music tracks – keeps the focus on the task.
- A team game to get students thinking about employability skills. Make up a selection of cards showing a variety of employability skills. The students' task is to decide which are the most important – line them up in order with the most

- important at the top and the least important at the bottom. (The answer doesn't matter – thinking, discussion and awareness is the goal.)

Warm-ups to learning

- Show photos/pictures/videos of people doing the tasks common in your vocational area, eg. driving a tractor, opening a bank account, shampooing a client, refereeing a game and ask groups to describe/explain what they see happening, eg. What do you think is in the cab of the tractor? – they may not know it can have a CD player with complete stereophonic sound. Some of the commercials made by banks on opening accounts have rich material in them for discussion.
- You can use the same resources to ease the way into tackling any unrealistic expectations the students might have about the course. Show pictures/video clips of people in the occupational area and have them make suggestions about what other tasks the person would have to do in their job. Give an example e.g. working in a restaurant isn't all about cooking wonderful food – the kitchen staff have to wash dishes, keep things tidy, pay attention to hygiene etc. and in the same way, working in a salon isn't all about cutting hair, working in a leisure centre isn't all about coaching basketball and working with animals isn't all about walking dogs etc.
- Encourage the students to think about the other jobs that need to be done to keep the workplace a happy and productive one and introduce the idea that these will be part of the course too, eg:
  - tidying away tools/equipment
  - keeping the workplace clean and tidy
  - helping out workmates etc.

  Have them put their ideas on 'stickies' and put on a flipchart.
- Word puzzles of the key words they are learning in the vocational area, eg. word finds, anagrams, crosswords all act as warm-ups as well as re-enforcing learning.
- Team building exercises which involve some aspect of vocational resources or skills, eg:
  - build a tower which can stand unsupported for 1 minute and support a tennis ball on top using 9 sheets of newspaper, some sellotape and 6 pipe-cleaners – time limit 15 minutes
  - create a game for 5 – 7 year olds using resources from the workshop; create an advert to sell a new shampoo complete with jingle.

All of the above activities encourage aspects of communication, teamwork and problem solving which are **key employability skills**. They also help to ascertain prior knowledge, skills and attitudes and provide opportunities for observational

assessment and, in addition, will hopefully give you lots of ideas on how you can adapt your Skills for Work curriculum to involve and interest learners.

To take these ideas forward and add to them, you can attend one of SFEU's *'Get Skilled Up'* half day workshops for lecturers delivering Skills for Work Courses, when we explore further the learning process and look at a range of specific teaching and learning techniques to use with the under 16 age group. To find out when the next event is visit our website www.sfeu.ac.uk or contact the Learning Process team at SFEU on 01786 892000.

Suggested Programme for Engineering Skills Induction

Chunks of learning activity are suggested below for Induction to the Course. The order, grouping and timing of these sessions are at the discretion of individual centres and will depend on factors such as timetabling, class size etc. It is recommended that significant time is spent on health and safety awareness and the rules and regulations of the learning environments.

The important point about any induction programme is that it should be lively, informative, motivating and enjoyable, with students having opportunities to interact with tutors and fellow students. Here are a few suggestions that you might wish to consider including in your induction programme:

- some Engineering based activity – that's why they're here! You need to engage young learners from the word go. This will also be a good way of getting to know others on the course and of breaking the ice a bit.

- using some of the activities outlined on the previous pages – icebreakers, introduction to the vocational area and warm up to learning activities.

- *Skills for Work* – what it's all about, and what makes it different from other courses they might do in school.

- Employability Skills: What are they and why are they important? Visiting speakers or a site visit could be useful here for students to hear at first hand what it means to work in engineering, about job prospects and to reinforce the value that employers put on employability skills.

- orientation – finding their way around the college/centre.

- what is expected of the student, i.e. behaviour, attendance etc.

- the Big Picture - more in depth information about what the course entails:
  - what units they will be undertaking
  - how they'll be taught and how they'll learn (doing and reviewing)
  - how they'll be assessed
  - how long the course lasts
  - who'll be responsible for delivering the course
  - where the course is being delivered

- practicalities – what day(s) do they have to attend, start and finish time, lunch time, travel arrangements etc

- options they might have at the end of the course

How about another activity to finish up with and leave the students raring to go?

A number of activities are contained in the **Student Support Section**. Centres may choose to use some of the material during induction, and use other parts at suitable points during the Course. If centres use some of the material during the actual induction programme, it is recommended that those marked with an asterisk* should be considered first:

- what are engineering skills*
- what is different about a *Skills for Work* course*
- the units of the course*
- how the course will be delivered including any domestic arrangements*
- group activity on what employability skills are*
- tutor feedback and summary of what employability skills are*
- self review and evaluation processes*
- timekeeping
- attendance
- planning and preparing for work (include interactive activity)
- working co-operatively with others
- following instructions
- health and safety awareness and practice
- rules and regulations of the workshop
- awareness of tools and engineering materials

Engineering Skills Induction Questionnaire

To help us to make the first steps of this course easier for new students, we'd be grateful if you would take a few minutes to complete and return this survey.

Please show how far you agree with the following statements by circling the appropriate number. Circle n/a (not applicable) if you feel unable to comment.

Many thanks.

Name: _____

Class: _____ **Date:** _____

		Agree completely	Agree mostly	Disagree mostly	Disagree completely	Not applicable
1	I received good advice before starting the course	4	3	2	1	n/a
2	Staff involved in the induction process were approachable, friendly and helpful	4	3	2	1	n/a
3	I feel ready to begin my course of study	4	3	2	1	n/a
4	During induction my course tutor clearly outlined the contents of the course	4	3	2	1	n/a
5	Rules and Health and Safety regulations were clearly explained	4	3	2	1	n/a
6	Things seemed well organised	4	3	2	1	n/a
7	I was given advice on where to go if I need help	4	3	2	1	n/a
8	I now have a good understanding about what this course is all about	4	3	2	1	n/a
9	I now understand the importance of employability skills	4	3	2	1	n/a

Please provide suggestions that could have made things easier for you when you started this course.

Many thanks for taking the time to complete this questionnaire.

Employability Support Section

Adopting a Team Approach to Employability Skills

Integration of employability skills throughout the Course is most effectively achieved when the tutors delivering and assessing the Course work as a team. This means that the Course team must meet prior to and regularly during the Course to discuss issues such as:

- where to highlight, develop and generate evidence for employability skills
- how effectively employability skills are being integrated into Course delivery and assessment
- student progress in developing self-evaluation skills
- when reviews take place and by whom and in what context etc.

For integration to be successful it is important that the team have a common understanding of what is meant by employability skills in the context of the Course, e.g. timekeeping and attendance – the messages communicated to students must be the same from all members of the course team. Everyone teaching on the course must adopt a consistent and transparent approach to the delivery and assessment of these skills. Students will appreciate consistency but conversely will find a lack of consistency in interpretation, approaches and tutor expectations both confusing and discouraging.

While it's important that employability skills specific to Engineering are highlighted during induction, equally important is the value which employers place on the generic employability skills – the idea of transferable skills and the fact that the Course will help them regardless of the employment area they eventually choose should be stressed.

The list of employability skills developed in this Course is provided in the *Reference Section* and in the table in the following section.

Guidance on Integrating Employability Skills

The course is designed to give the students the technical knowledge, skills and understanding associated with a range of skills in engineering at this level whilst at the same time helping the students to develop an awareness of what opportunities there may be within engineering in terms of the types and range of career options.

One of the distinguishing features of *Skills for Work* Courses is the importance given to the development of employability skills. The main employability skills felt to be relevant for this Engineering Skills Course are listed in the **Employability Skills Profile** in the Reference Section of this pack, and are further explained in this section.

The ethos of employability should be embedded throughout all aspects of this course. Opportunities will occur throughout the delivery of the Units to identify, develop, practice and assess the employability skills. The profile highlights where these opportunities arise for the assessment of each of the employability skills. These skills are developed in each of the four Units and are assessed at least twice during the course. These add value to the development of the specific vocational skills.

It is quite possible that different tutors will be involved in delivering various aspects of this course and it is therefore very important that all have an agreed interpretation of employability skills.

It is envisaged that the development and recording of employability skills will be ongoing throughout the duration of each practical unit. It should be stressed at unit induction that skills valued by employers such as timekeeping, attendance etc. will be monitored and recorded and that all students will be encouraged to show a positive attitude. Tutors should look for every opportunity to teach about the value of developing good employability skills whilst also teaching trade specific skills.

Every engineer needs to be able to communicate by written word, spoken word and by the use of graphics (drawings). This course is designed around practical assignments which should enable the students to develop and apply practical, technical and communication skills as a foundation for future learning and progression.

As instances arise naturally within the completion of practical assignments, job roles and career paths may be discussed so that all students are aware of progressions within the engineering sector. This will also hopefully foster and encourage an interest in engineering in general.

It is important that students develop the ability to reflect on how they performed in the completion of the tasks. Building this in to their routine should mean that they will develop an awareness of their individual strengths and weaknesses in relation to their performance in their chosen career.

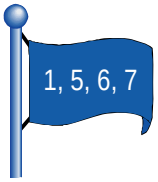
The course also encourages students to apply new found knowledge and understanding of engineering in the completion of practical assignments by using skills of evaluation and problem-solving in a vocational context. The skill of evaluation lets the students analyse what they did well and why and what needs some improvement.

Candidates who have previously completed the Engineering Skills: Intermediate 1 course will have developed employability skills appropriate to that level of course.

The **Engineering Skills: Intermediate 2 course** will allow further opportunities for each candidate to develop additional employability skills. For the candidates who have completed the Engineering Skills: Intermediate 1 course the following additional activities are suggested:

- Risk assessment completion
- Interpretation of drawings using CAD
- Organise a charity team event
- Use of recognised engineering planning process
- Analysis of a self review

Signposting of Employability Skills

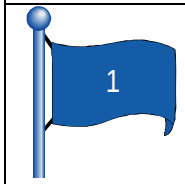


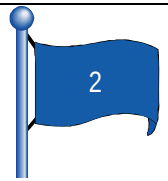
The handouts and activities in this pack each have a 'flag', like the one shown here, to identify the particular employability skill which they address, numbered as shown below.

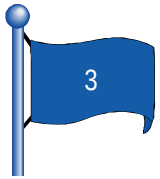
The Unit support packs for the other Units have similar 'flags' showing the places where there are opportunities for these same skills to be developed or assessed. It is vital that all those who are involved in delivery of the course familiarise themselves with such development opportunities. They may also wish to consider any other opportunities for developing the employability skills where they arise from their own delivery model.

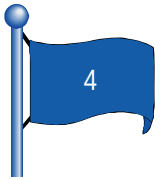
1	Maintaining good timekeeping and attendance	6	Planning and preparing for work
2	Showing health and safety awareness	7	Applying time management
3	Selecting and using engineering tools and materials	8	Awareness of environmental considerations
4	Interpreting engineering drawings and specifications	9	Quality checking own work
5	Working cooperatively with others	10	Self review and evaluation

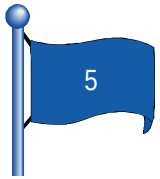
You will find or create countless opportunities to help students develop employability skills. Here are some ways of going about it to get you thinking!

Employability Skills	Delivery Advice	Possible Activities/Contexts
 **Maintaining good timekeeping and attendance**	• Make your expectations clear right from the start of the course or Unit. A good initial activity is to have the students write the class guidelines themselves by identifying pros and cons of good and poor attendance and timekeeping – the benefits in the workplace of one and the consequences of the other. These guidelines or ground rules can be posted in the workplace and referred to on a day to day basis. • Relate your ground rules to the world of work, eg. arrive on time, back from breaks on time etc. The measure of a student's success in this aspect is for them to be honest in their appraisal of their performance and in making progress. 'Distance travelled' should be adopted, rather than a particular minimum percentage of classes attended. Attendance and timekeeping should be monitored throughout the Course and Units. Students should be given feedback on their performance – both good and bad – in this regard. If you take note of patterns in performance it should be easy to give the students accurate feedback.	• turning up for class • returning from breaks • sticking to planned work schedules regarding timing of activities • staying in class for the duration of the planned activity (no extended toilet breaks)

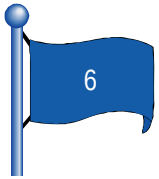
 **Showing health and safety awareness**	• Health and Safety is very important to employers and is a key part of the learning and teaching of each Unit from the first workshop session to the last and so there should be ample opportunity to collect evidence of health and safety issues. • Safe Working Practices • A basic Risk Assessment • Identification of hazards by candidates: • First Aid and Fire awareness • Discussion on what PPE might be required for specific tasks and the importance of PPE in the protection of everyone.	• Induction procedure • Behaviour in workshop • Routinely wearing PPE • Wearing correct PPE • Hazards • Cleanliness • Clear walkways • Manual handling • First Aid procedures • Fire procedures • Tool and equipment safety

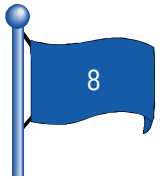
 **Selecting and using engineering tools and materials**	• The sourcing of tools means that each centre must inform the candidates of the procedures to be followed for the acquisition of tools and equipment. • The correct use of tools must be demonstrated before candidates are allowed to practice the skill. Reinforcement on the dangers of misuse of tools must be stressed. • Movement of tools to be completed in a safe manner. • Each tool has a function that it was designed for and use or misuse of the tool for any other task/purpose should be discouraged. • Candidates should be encouraged to report any faulty or worn tools. Each tool must be clean and free from defects at the start of the practical activities and at the end. Candidates must be made aware that if a tool is worn or becomes unusable that they are responsible for reporting the fault. • Tools should always be returned to their proper storage place. • Categories of materials - ferrous, non ferrous and non metallic. • Candidates informed of where each category is used. • Basic mechanical properties of materials explained. • Reasons for use of each material • The properties and reasons for use of common engineering materials.	• Tool acquisition procedures followed during practical workshop sessions. • Correct number of tools used. • Carrying tools safely • Using tools safely • Clean and store tools safely and correctly • No tools left at end of session • Use magnets • Use correct materials in practical activities • Use materials from drawing and specifications • Safe use of materials • Practising specific trade skills

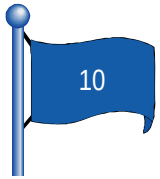
 **Interpreting engineering drawings and specifications**	• Students should be issued with drawings, sketches or specifications for all practical activities. • Drawings etc as a means of communication. • Correct interpretation reinforced.	• reading drawings etc • carrying out quality checks • planning sheets • following instructions and in the correct sequence

 **Working co-operatively with others**	• Young students can be wary of seeking advice for fear of highlighting their own lack of understanding or of being singled out for ridicule perhaps based on past experience. You should emphasise that in the workplace it is essential that they seek advice if they are not sure about something as the consequences of not doing so could be quite serious e.g. misusing tools, poor techniques can result in injury. Students should be praised for seeking advice and reassured that you welcome their questions and it also helps them to demonstrate a positive attitude to learning.	• Ask questions • Respect others • Check work progress • Check tool safety • Seek tutor feedback
	• It can be difficult to keep the attention of under-16s. When you want them to cultivate the skill of following instructions it's important to transmit the instructions clearly and concisely. Trying to get students to think of the reason behind an instruction can help them to remember it. Get them to repeat the instruction or explain it in their own words to make sure they've understood and know what's required. If an individual student is struggling with an aspect of their work they may appreciate personal assistance and quiet one-to-one instruction. This would be an opportunity for you to note their positive response to any instructions you give them at that time.	Following instructions re: • health and safety • practical work and trade techniques • sequencing of work • quality checking • planning and preparations
	• Working co operatively with others (sometimes referred to as WWO) is in many ways a question of communication. Get the class into the habit of working as a team to set up the workshop for activities and tidy up during and at the end of work sessions. Get them to speak to each other – and to you – about the sharing of workspace, tools, equipment and materials. Work in pairs or small teams where	• Social interaction • Students working in harmony • No raised voices • Sharing of experiences

	appropriate. Watch out for specific instances of the students working co-operatively together – they may also at any time demonstrate a specific awareness of health and safety issues. You should note this evidence. It is perfectly valid and in fact is more valuable in a sense than evidence that arises from a 'staged' activity because it shows that the students are working well without prompting.	• Mix different school groups • Workplace assistance evidenced

 **Planning and preparing for work**	• Guidance on how students should prepare to carry out tasks in their practical activities should become the norm from the first session. Spend a little time identifying the objectives of the session and encouraging the students to think about how they will go about it, what equipment they will need, what the sequence of the work should be etc (for example this will be of particular importance when marking out a measurement, line or squaring material). • You might devise a planning sheet that can be used at the beginning of every session so that planning and preparation becomes a routine part of each task.	• wearing PPE • following instructions and in the correct sequence • correct selection and use of tools • correct selection and use of materials • co-operation with others re use of tools, materials and workspace

 **Applying time management**	• Encourage a quick change into the correct PPE and continually stress Health and Safety and the need to ensure the safety of all. Prepare for the task in an appropriate manner with the tools and materials that will be used that session. Encourage each candidate to take time to plan a correct sequence of work and to see the benefits of having a sequence to follow and not to be haphazard with assigned tasks. • Candidates should listen carefully to instructions and seek clarification if they do not understand. Candidates must also work in the confines of the workshop with others and not talk too much or distract others. • Encourage candidates to take a reasonable break time and not to take too long at toilet breaks and lunch times.	• changing into PPE quickly • following instructions and ask advice • prepare with correct tools and materials • plan a sequence to complete any assigned task • co-operation with others • do not distract others from their work.
 **Awareness of environmental considerations**	• Candidates need to be encouraged to save energy where possible, switch off lights, equipment and machinery. Candidates need to be shown the correct methods of disposing of waste material safely. • Candidate need to be made aware of the Greenhouse Effect and any methods of minimising this effect should be strongly stressed. • Candidates should be encouraged to eliminate as much wastage of time materials as possible.	• use tools and equipment effectively and efficiently • save energy by switching off equipment not in use • plan an effective use of tools and materials • plan a sequence to complete work efficiently • work with others to maximise use of tools and equipment

 **Quality checking own work**	• Candidates constantly check against the drawings for dimensions, materials, fits and sequence of operations. • Candidates should be made aware of acceptable quality of work • Introduction to tolerances and why they are required.	• Quality checking as the work progresses • Quality at the end of practical activity • Checking and reporting on fit for purpose
 **Self review and evaluation**	• Candidates can be helped when you discuss their performance with them • Such discussions can help them get into the habit of evaluating their performance as a natural part of their work routine • Question candidates verbally about their performance as the work is proceeding in the workshop • Retain brief notes on the conversations of progress as evidence for employability • Candidates will have ample opportunity to demonstrate a positive attitude to learning because they have a lot to learn • A positive attitude to learning will also be reflected from the enthusiasm and expert knowledge of the staff member • Introduce practical activities very early • Interesting tasks and artefacts that will be enjoyed will aid with attention, following instructions, asking questions, taking advice, carry out quality checks and a desire to learn more	• Conversation with tutor • Quality checking • Self evaluation exercises • Number of attempts at tasks • Listen to instruction • Applying feedback • Asking questions • Practicing skills • Conversations with tutor • Quality checking • Assisting others • Genuine participation in review process • Perseverance All of the other employability skills

Assessment of Employability Skills

This section gives guidance on the assessment of the employability skills. It should be remembered that all employability skills are developed and assessed across the course. All employability skills are developed in each unit but only assessed on at least two occasions during the course.

Review and Self-Evaluation

Students are expected to review and evaluate their own employability skills, twice in each unit. Centres should have their students carry out the self-review and evaluation tasks at points in the Course **after students have had a reasonable opportunity to develop and demonstrate the relevant skills**. This is likely to be after the students have taken part in some of the practical activities.

The specific skills referred to in this course, which the students have to review themselves on are:

- maintaining good timekeeping and attendance
- showing health and safety awareness – to include wearing PPE, safe working practices and understanding a basic risk assessment
- selecting and using engineering tools and materials – source and use tools in a correct and safe manner, use tools solely for the purpose for which they are designed and selection of engineering materials
- interpreting engineering drawings and specifications
- working co-operatively with others - to include seeking advice, following instructions and working in a team
- planning and preparing for work - to include selection of correct tools and equipment
- applying time management - to include working to schedule and undertaking a correct sequence of work
- awareness of environmental considerations - to include safe and correct disposal of waste/hazardous materials, waste minimisation and fume and dust control
- quality checking own work
- self review and evaluation - to include identifying strengths and weaknesses, identifying learning points from practical experiences and having a positive attitude to learning.

The NAB for each Unit contains review sheets which each student will have to complete.

Student Support Section

Tutor Notes on the Student Support Section

This section contains material that can be used to introduce students to the specific employability skills, health and safety considerations and engineering materials that feature throughout the course and in each Unit.

Centres may choose to use some of the suggested activities in this section in their induction programme and use other parts of the material at suitable points during the Course.

Please note that the material in this section is designed for use by the learner, including the activities, but is **not suitable for the learners to tackle without tutor guidance and discussion, particularly the activities related to self-evaluation**. You might feel that, in some cases, you would want to talk through the instructions with the learners and then give them out as reminders. The activities could be used for individual, pair or small group work.

Tutors are encouraged to use the materials creatively in ways which will engage the younger learner, perhaps adapting them to the type of activity suggested in the previous section.

Welcome To Intermediate 2 Engineering

Q: What's different about this course compared to other subjects at school?

A: It is vocational.

Many of the subjects that you've been studying at school may have been quite theoretical. This means that they are very paper-based and don't sometimes appear to relate to 'real life' as you see it. This can be quite difficult and depending on the subject, it's not always an exciting way to learn. If you want to learn to ride a unicycle or play volleyball, for example, you would probably find it much easier to actually do it and learn through first-hand experience. Professional athletes didn't get where they are today by reading books about running! This course should be different from many of your school subjects because you will be given the opportunity to develop some of the engineering skills through actually doing them or helping to do them. Where this is not possible because of practical or safety reasons, you may have the opportunity to visit and see real people using these skills in their daily jobs.

You may find that the engineering industry is not for you after all, or you may find that you are actually more interested in a different part of the sector than you originally thought. The course should help you to make choices about your future in the workplace, but will also equip you with important skills that you can use whatever career you eventually choose.

If you have previously completed the Engineering Skills: Intermediate 1 course you will find that you will develop additional practical and employability skills in this course. You will also be expected to work to closer tolerances in all practical activities.

Student Notes

The notes that you will be given are intended to help you to get to grips with what you will learn and do whilst on this course. You will find that there are several activities and self-assessment tasks, often followed by some answers. In some parts of this pack, you will be asked to think about things that you maybe don't know very much about yet but don't worry! They're not tests, so don't worry if your answers aren't as complete as those provided for you. The questions have been designed to get you thinking about everything you do rather than just rushing in there!

Preparing for Work

- This course is relevant to the real workplace.
- It has been designed so that your tutors will not only be helping you to develop specific skills that are important to engineering employers but also the skills that make you more **employable**.
- You'll be introduced to these **employability skills** in a lot more detail later on. These are very important and are skills that you'll be able to take from job to job as you move through life.

What are 'Engineering Skills'?

Activity

Discuss what you think is meant by the term 'engineering skills' and write down your ideas here:

Answer

- There's no absolute right or wrong answer to this question and it's very likely that what you have written down is a very relevant answer.

- **Engineering** means different things to different people, but to most people it means something that relates to the **manufacture** of goods or the **maintenance** and servicing of machinery in some way or another. The **skills** bit just means the practical abilities you will develop so that you can carry out tasks.

- Engineering skills often involve working with people, engineering materials, hand tools, power tools and machinery.

- Engineering can take place in an office, a workshop, a site, a garage, a ship, an oil/gas rig and even in space.

What you will Study

Here's a summary of the Units that you will have to study as part of this course.

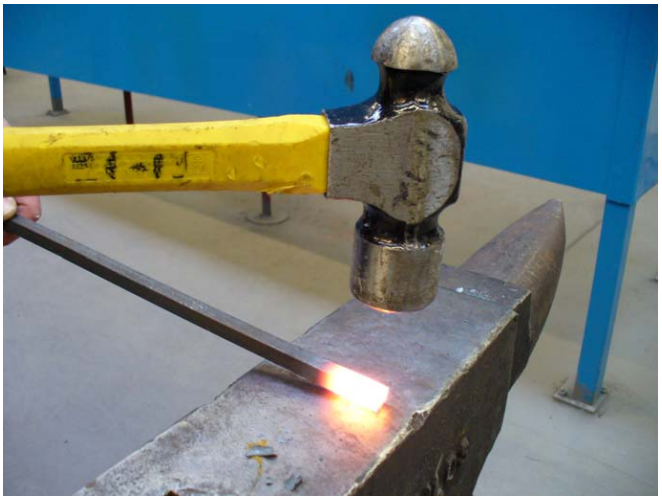
The 4 Units are:

- Engineering Skills: Mechanical and Fabrication
- Engineering Skills: Electrical and Electronic
- Engineering Skills: Maintenance
- Engineering Skills: Design and Manufacturing.

Engineering Skills: Mechanical and Fabrication

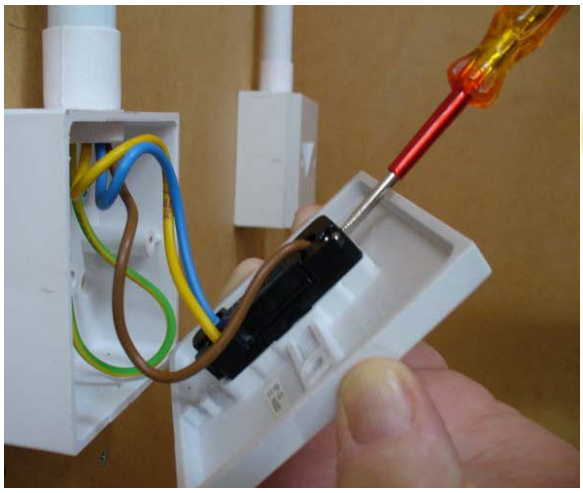
You will:

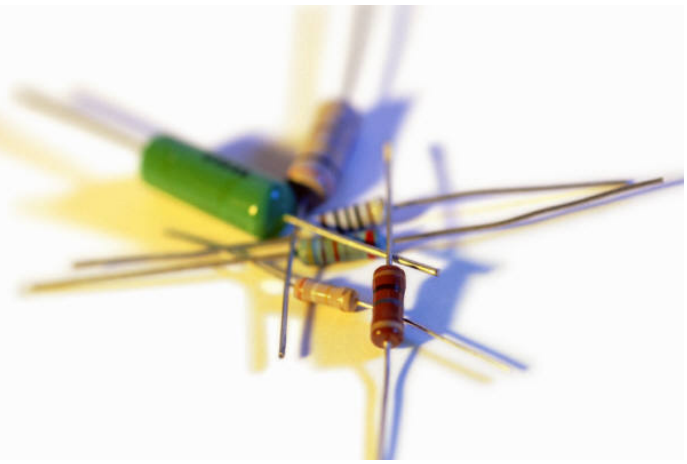
- use engineering drawings, engineering materials, tools and equipment to make artefacts by marking, cutting, shaping, drilling, tapping, forming and joining.
- be assessed practically - someone will watch you carrying out tasks
- develop all of the employability skills
- review your own progress during the unit.



Engineering Skills: Electrical and Electronic

- you will become familiar with a range of hand tools, cables, accessories, components and test instruments and make circuits
- be assessed practically - somebody will watch you carrying out tasks
- develop all of the employability skills
- review your own progress during the unit.





Engineering Skills: Maintenance

You will:

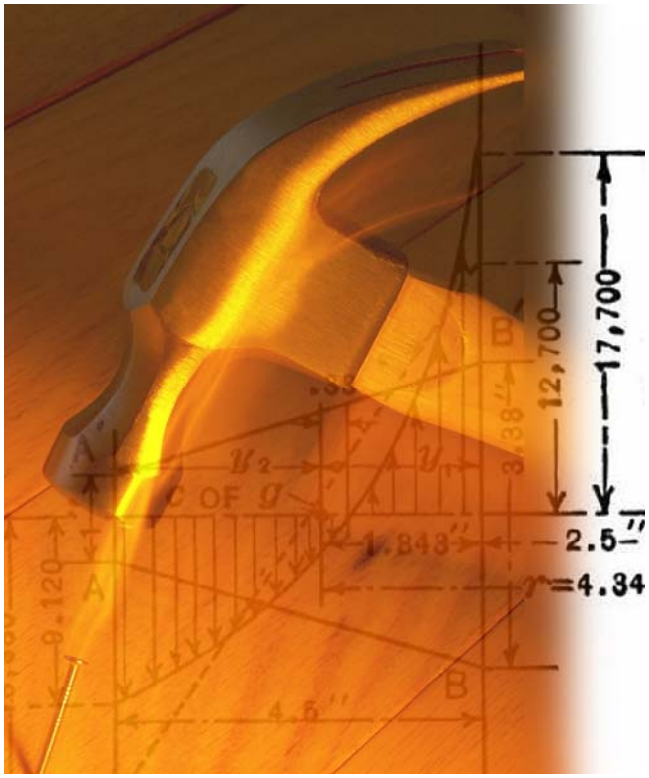
- use drawings, materials, tools and equipment required to test, disassemble, repair and assemble an engineering part.
- be assessed practically - somebody will watch you carrying out tasks
- develop all of the employability skills
- review your own progress during the unit.

Engineering Skills: Design and Manufacturing

You will:

- develop **Computer Aided Design** (CAD) skills (Computer Aided Design (CAD), also known as Computer Aided Drafting)
- use the skills developed to design, manufacture/construct and test a project from a given brief
- develop all of the employability skills
- review your own progress during the unit
- complete an evaluation of what you have made, prepare a report and report to your group on how well or otherwise things went.

In addition, you may also get the opportunity to visit an engineering firm or talk to someone from a firm.



General Health and Safety

It can be argued that the greatest investment in any firm is the workforce. If you are part of that workforce your employer will invest heavily in your Health and Safety. If you are injured at work your employers have to continue to pay wages.

There may also be **compensation** to pay depending on the severity and circumstances of your injury and the Health and Safety Executive can impose fines, or in some extreme cases, close down the workplace.

This makes employers very aware of their investment in your safety but you are also equally responsible for your own safety and indeed, the safety, of your workmates.

The **Health and Safety at Work Act** states clearly the roles and responsibilities of both employers and employees in the safety of all.

Added to that are **Safe Working Practices** which usually lay down the safety requirements for a particular workshop.

Personal Protective Equipment (PPE)

Each workplace can have different **regulations** about what protective clothing is necessary for that area. Even if you are in an area where no protective clothing is stipulated you must always remember to dress sensibly. Clothing should fit snugly to avoid danger of becoming entangled in moving machinery or creating a tripping or stumbling hazard.

In general the following are basic requirements for **PPE**:

- boots and overalls
- safety goggles/spectacles
- additional safety wear such as hard hat, ear defenders, face mask
- gloves or aprons etc may be necessary depending on the work that is being undertaken.

Basic Personal Protective Equipment

Safety spectacles

Ear Plugs

Dust Mask

Ear defenders

Gloves

Additional Personal Protective Equipment

Basic PPE

Overalls

Overalls not only protect you but also protect your clothing from wear and tear or damage.

Safety Boots

The minimum requirement is that **safety boots** have a steel toecap and a thick sole for protection against sharp objects such as nails. In most cases the safety boot will have soles that are oil and grease **resistant**.

Fashion

A workplace is not a catwalk and there is no room for fashion; in a workplace there is only room for safety. No matter whether you are a male or female, long hair should be confined by whatever method is safe, or hair should be trimmed. At all times - avoid placing your head close to rotating machinery.

Do not wear jewellery: no body piercings, no watches, no bracelets, no necklaces and no rings.

All of these just love to get stuck in machinery and you could get seriously hurt. Remember also that gold and silver are excellent conductors of electricity.

What do you want:

Keep jewellery out of the workshop
or
when counting, using your fingers, only get to 9½?

Safe Working Techniques

Safe working techniques are good practices that have been developed and practised by good workforces to ensure their safety and the safety of others. It is important that every person that enters a work area is kept safe and leaves the work area without injury.

Safe Working Practices include all safety and safe practices for a particular workshop and could include some or all of the following:

- Conduct and behaviour
- PPE and additional PPE
- Skin protection
- Safe walkways
- Correct use of tools and equipment
- Storage of tools
- Storage of waste material
- Storage of substances hazardous to health
- Manual handling

Practical Jokes

In the workshop, you can tell jokes but you **can't play practical jokes**. Practical jokes in a workshop can have serious consequences for all.

So no tricks or jokes hopefully means no injuries or deaths.

Basic Safety Rules

A workshop is a very dangerous place but it should also be a happy place - that is why Health and Safety is so important and necessary for everyone.

- Do not distract anyone or become a distraction to others
- Do not play practical jokes or try any tricks in a workshop
- Lead by example with people new to the workshop
- No horseplay, wrestling, bumping, tripping etc
- No feats of strength

First Aid

In the event of an accident, you should be aware of the **First Aid** procedures for your work area.

The first action you must take, if possible, is to inform your tutor. The tutor will know the First Aid procedures for your work area, which will be similar to the following:

- the location of the qualified first aider
- how to contact or call for first aid
- the location of first aid facilities
- who is responsible for reporting injuries/accidents
- who calls for transportation for the injured worker, if necessary.

First Aid Training

A first aider is a highly trained member of any workforce or community group.

A first aider is expected to take control of any injury situation from a cut finger to a life threatening injury. As you would expect, being a first aider takes intensive and regular training.

Various organisations train first aiders and you should perhaps consider training in the future.

Fire Alarm

Can you imagine the terror, the danger, the damage that a fire causes?

The chance of a fire anywhere is greatly decreased by good housekeeping. Keep a tidy workshop where tools are stored correctly and waste materials are disposed of in a safe and correct manner. Other materials that may need to be used and stored in or around the workplace such as chemicals, oil, alcohol, paint etc, should be stored in accordance with **Control of Substances Hazardous to Health** (COSHH) regulations.

Fire Safety

In the event of a fire, raise the alarm if you can then:

GET OUT - STAY OUT

Fire Extinguishers

Only fight a fire if you have been trained to do so, and if you are part of a fire fighting team. Always use the correct fire extinguisher for the class of fire.

Fire extinguishers are normally **RED**.

Fire extinguishers may be placed on a **red** background so they can be easily located.

Not all fires are the same. Different types of fires are created by different types of fuel and require different types of fire extinguisher.

Fires are classed:

Class of Fire	Type of Extinguisher	Fuel/Materials
A	Water Foam	Rubbish, wood and paper
B	Carbon Dioxide Foam Dry Chemical	Petrol, oil, paint and grease
C	Carbon Dioxide Dry Chemical	Electrical equipment
D	Dry Powder	**Combustible** metals
K	Wet Chemical	Animal and vegetable fats

You should assist any trained fire-fighters by telling them anything you know about the fire or information about the vicinity of the fire.

Control of Substances Hazardous to Health

The **COSHH** regulations are designed to assist in the control of any substance that would be a health hazard. Hazardous substances in our case are those which would be used directly in work activities. They cover everything from cleaning agents, paints and adhesives to acids and alkalis.

These substances, when used at the workplace, cannot be allowed to put your health or the health of others at risk. Therefore these substances, chemicals if you like, must be used properly in the correct manner, then stored in the correct environment.

These substances can be used in the workshop, office, shop, and farm. Is there anywhere you can think of, where in today's society, we don't use chemicals of some form or another?

The effects on us of misuse of any of these substances hazardous to health could be:

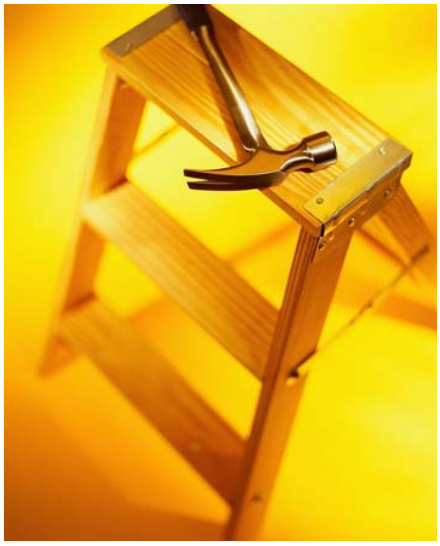
- breathing difficulties
- eye irritation
- infection
- skin irritation.

Continued breathing of dangerous fumes can make you drowsy or unconscious.

COSHH is a useful tool of good management which sets out eight basic measures that employers, and sometimes employees, must take.

These include a simple step-by-step approach which will help you to assess risks, implement any measures needed to control exposure, and establish good working practices.

Good Housekeeping



Good housekeeping is about:

- safety
- PPE
- behaviour and conduct
- tools and equipment
- the workplace.

Safety

Safety is the responsibility of everyone that enters or works in a workshop. In order to keep everyone safe, everyone must adhere to the safety guidelines laid down. Remember safety is not a choice - it is a legal requirement.

PPE

It's important that each time you enter the workplace that you think safety and are properly prepared to work. If you enter the mathematics room and you have forgotten your calculator that is not good, but you **cannot** even **enter** the workshop if you have forgotten your PPE. So you must consider your safety and always wear the correct and stipulated PPE even if it's uncomfortable or hot to wear. There is no such thing as compromise with safety.

Behaviour and Conduct

The engineering workshop is one of the most dangerous places you will ever work in. Your safety in the workshop is covered under Health and Safety Regulations but the biggest threat to you is **yourself**. You must maintain a high standard of behaviour, and conduct yourself in a safe manner at all times.

Remember one small stupid act can have serious consequences and can be dangerous for everyone.

Tools and Equipment

It is vitally important that all tools and equipment are used in a safe and correct manner and that tools are only used in the way they were designed to be used. It is important to you and the continued safe use of the tool that the tool is stored in the correct way and in the correct place.

Remember:

A place for everything and everything in its place.

An engineering workshop may be quite open and empty or it can be full of benches, equipment and machinery. If you have not been trained to operate the equipment and machinery you must not touch it in any way. We are all tempted to move levers or press buttons but not in a workshop situation.

Remember:

Do not touch equipment and machinery in a workshop.

The Workplace

Workplaces and workshops can be large or small. Both are full of dangers.

Your safety depends on the other people in the workshop but their safety also depends on you.

A **workshop** is usually full of machines that move or cut in some way, and it is full of people working in their own area, concentrating on their own work tasks. So it's very important that all areas can be accessed safely. Walkways must be marked and safe from obstacles, moving machinery and must be kept clean and dry. You should enter, exit and move in the workshop along the correct laid out route.

Three simple rules:

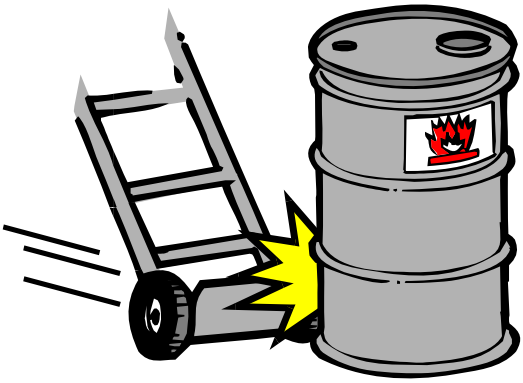
Listen **Look** **Walk**

Each machine in the workplace is a potential danger and requires the operator to be fully trained in its use, so:

If you're not trained on a machine – don't touch it

At the end of each session:

- Waste material must be placed in the correct bin.
- This waste material could be scrap metal, swarf and rags/paper.
- All tools and equipment should be cleaned and stored correctly.
- All benches and walkways must be cleaned.



Wordsearch

Find the following words:				
Safety	Workshop	Tools	Fire	Machinery
Overalls	Exit	Footwear	COSHH	Employability
Skills	Regulations	Electrical	Fire Alarm	Manufacture
Equipment	Engineer	Hard Hat	Mechanical	Health and Safety

H	E	A	L	T	H	A	N	D	S	A	F	E	T	Y	S	L	O	O	T
A	A	R	D	T	R	A	E	W	T	O	O	F	X	Y	L	O	A	T	S
R	T	R	T	W	O	R	R	K	K	S	H	O	O	P	D	E	D	I	F
T	R	S	D	J	D	L	A	S	D	G	N	R	A	L	A	E	R	I	F
E	C	G	K	H	N	F	C	C	O	S	H	H	H	E	N	R	F	A	R
M	V	T	J	K	A	B	S	L	B	M	A	N	F	A	J	T	Q	U	A
P	I	O	E	H	D	T	N	J	F	I	R	E	A	L	A	R	M	M	D
L	E	E	J	Q	N	O	T	T	H	I	S	O	N	S	L	L	I	K	S
O	C	R	S	T	U	S	T	A	N	V	A	R	G	R	A	D	I	E	V
Y	W	V	S	O	P	I	V	E	U	I	O	P	R	E	M	E	T	A	Z
A	O	D	N	A	H	Y	P	G	R	E	L	E	C	T	R	I	C	A	L
B	R	I	O	M	F	E	N	M	E	U	U	X	L	O	J	R	D	G	A
I	K	O	I	A	R	E	W	D	E	T	T	T	D	T	I	X	E	E	C
L	S	E	T	R	T	C	T	N	Q	N	N	C	C	P	I	X	T	A	I
I	H	N	A	T	Y	B	V	Y	Y	N	T	T	A	A	Z	D	V	U	N
T	O	G	L	E	E	N	G	I	N	E	E	R	Y	F	F	C	X	N	A
Y	P	F	U	F	J	N	G	O	L	D	O	R	E	W	U	U	L	D	H
H	U	S	G	A	Z	S	L	L	A	R	E	V	O	H	J	N	N	Y	C
A	R	G	E	C	Z	O	B	K	I	T	N	L	A	N	D	D	A	A	E
N	T	S	R	T	E	N	Y	R	E	N	I	H	C	A	M	N	L	M	M

See the following page for the answer.

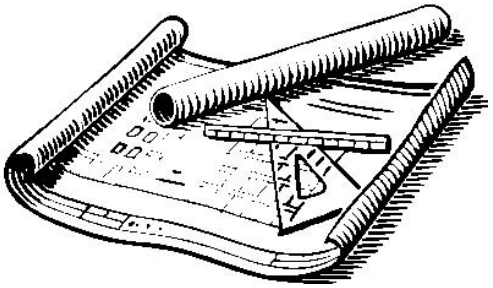
Wordsearch

Answers to the word search:				
Safety	Workshop	Tools	Fire	Machinery
Overalls	Exit	Footwear	COSHH	Employability
Skills	Regulations	Electrical	Fire Alarm	Manufacture
Equipment	Engineer	Hard Hat	Mechanical	Health and Safety

H	**E**	**A**	**L**	**T**	**H**	**A**	**N**	**D**	**S**	**A**	**F**	**E**	**T**	**Y**	**S**	**L**	**O**	**O**	**T**
A	**A**	R	D	T	**R**	**A**	**E**	**W**	**T**	**O**	**O**	**F**	X	Y	L	O	A	T	S
R	T	**R**	T	W	O	R	R	K	K	S	H	O	O	P	D	E	D	I	F
T	R	S	**D**	J	D	L	A	S	D	G	N	R	A	L	A	**E**	**R**	**I**	**F**
E	C	G	K	**H**	N	F	C	**C**	**O**	**S**	**H**	**H**	H	E	N	R	F	A	R
M	V	T	J	K	**A**	B	S	L	B	M	A	N	F	A	J	T	Q	U	A
P	I	O	**E**	H	D	**T**	N	J	**F**	**I**	**R**	**E**	**A**	**L**	**A**	**R**	**M**	M	D
L	E	E	J	**Q**	N	O	T	T	H	I	S	O	N	**S**	**L**	**L**	**I**	**K**	**S**
O	C	R	S	T	**U**	S	T	A	N	V	A	R	G	R	A	D	I	E	V
Y	**W**	V	**S**	O	P	**I**	V	**E**	U	I	O	P	R	E	M	E	T	A	Z
A	**O**	D	**N**	**A**	H	Y	**P**	G	**R**	**E**	**L**	**E**	**C**	**T**	**R**	**I**	**C**	**A**	**L**
B	**R**	I	**O**	M	**F**	E	N	**M**	E	**U**	U	X	L	O	J	R	D	G	**A**
I	**K**	O	**I**	A	R	**E**	W	D	**E**	T	**T**	T	D	**T**	**I**	**X**	**E**	E	**C**
L	**S**	E	**T**	R	T	C	**T**	N	Q	**N**	N	**C**	C	P	I	X	T	A	**I**
I	**H**	N	**A**	T	Y	B	V	**Y**	Y	N	**T**	T	**A**	A	Z	D	V	U	**N**
T	**O**	G	**L**	E	**E**	**N**	**G**	**I**	**N**	**E**	**E**	**R**	Y	**F**	F	C	X	N	**A**
Y	**P**	F	**U**	F	J	N	G	O	L	D	O	R	E	W	**U**	U	L	D	**H**
H	U	S	**G**	A	Z	**S**	**L**	**L**	**A**	**R**	**E**	**V**	**O**	H	J	**N**	N	Y	**C**
A	R	G	**E**	C	Z	O	B	K	I	T	N	L	A	N	D	D	**A**	A	**E**
N	T	S	**R**	T	E	N	**Y**	**R**	**E**	**N**	**I**	**H**	**C**	**A**	**M**	N	L	**M**	**M**

Employability Skills

The **Engineering Skills Course** is designed to help you learn and practise the engineering skills of:



- Fitting
- Fabrication
- Electrical
- Electronic
- Maintenance
- Design, and
- Manufacture

All through the course you'll be:

- completing practical assignments
- making various artefacts to practise these skills
- interpreting engineering drawings and using common engineering materials.

The course is designed to give you not only engineering skills but also an interest in engineering as a career. How will it do that?

- By giving you technical knowledge, skills and understanding associated with a range of skills in engineering.
- By focussing on health and safety - health and safety issues are uppermost in the mind of engineering employers. It is vitally important that you understand that health and safety is central to the world of work generally and engineering in particular.
- By helping you to develop and apply practical, technical and communication skills. Every engineer needs to be able to communicate by written word, spoken word and by the use of graphics (drawings).
- By getting you to reflect on how you performed when carrying out tasks. This means you'll develop an awareness of your individual strengths and weaknesses in relation to your practical and employability skills.
- Through evaluation and problem-solving the skill of evaluation lets you analyse what you did well and why and what you did that needs some improvement. Problem solving is something that all sorts of people do day in and day out but especially engineers - how will this work?, will it fit?, will it be safe?, how many are possible?, what tools are needed? and a thousand more problems.
- By preparing you for further study and training for employment in engineering and related occupations.
- By helping you to develop an awareness of what job opportunities there may be in engineering.

What are Employability Skills?

Employers are not only interested in employees that have knowledge of engineering.

They also need employees who:

- work in a safe and efficient manner
- attend work regularly
- arrive on time each day
- wear the proper protective clothing
- can solve problems associated with their work area
- will ask for advice and discuss their progress sensibly.

These are called **employability skills** and this Engineering Skills course is designed to help you to develop them. Employability skills are desirable skills to have for any industry.

Think for a moment of all these different jobs:

doctors, bank managers, nurses, teachers, plumbers, hairdressers, joiners, shopkeepers, policemen, painters, dentists, bus drivers, engineers, bricklayers, and all the rest.

- Think of the chaos if they all arrived late for work or didn't turn up!
- Think of the chaos if the police dressed in tee shirts and jeans.
- Think of the chaos if the pilot felt too proud to ask how to approach an airport.

Each and every one of us has already developed some employability skills and this course is designed to enable us to develop more.

In each course unit you'll be encouraged by your tutor to review the skills you have developed as part of undertaking the practical work. Initially you may need help with this, but remember that asking your tutor for help is also a very important employability skill. Only by asking for and taking advice, can we all become better at what we do.

It is hoped you find the Course and each course unit interesting and fun. It's also hoped you learn engineering and employability skills, but perhaps most

importantly it is hoped you begin to think about what it means to work well and accomplish your goals.

Group Activity: Employability

Suggested time: 20 minutes

In groups of 4 answer the following questions:

Decide roles in your group. You'll need to decide who:

- will take notes on your group's answers to the following questions (use the spaces on this sheet to take rough notes)
- will write your notes up on the flipchart or whiteboard
- is going to read them out to the rest of the group

Try and think about the following questions. Don't be afraid to give your opinions in all the group discussions - all sensible ideas are relevant and important.

1. Why do you think that being employable is important?

2. What sort of things do you think are likely to impress the people that you work with in any kind of job? (If any of you have part-time jobs, paper round etc, think about what impresses your **co-workers**/boss, or what they do that impresses you!)

3. What type of 'employability skills' do you think are probably most important for a job in the engineering industry?

How did it go?

Did everybody come up with similar sorts of ideas?

Here are some examples of the things that perhaps you thought about. You might have thought of some more - or some different ones.

1. A lot of you probably said that it's important to be able to get yourself a job that will help you to pay your way in life. It's not just important for you alone. Remember, that when you're older, you may have a family to support and you'll want to contribute to the society that you live in.

2. There are lots of different things that you may have said but here are a few of the main ones:

    - hard-working
    - reliable (always turn up)
    - good timekeeper (always turn up when supposed to)
    - prepared to start work, wearing the correct gear on time
    - think or plan ahead for work activities
    - tidy (correctly dressed)
    - pleasant and polite towards co-workers and any customers
    - do as told (follow instructions)
    - keen to learn
    - learn from mistakes
    - get on with everyone (work well with others)
    - good team player
    - work safely
    - aware of the dangers (hazards) in the workplace
    - don't waste anything
    - know when to ask for help (aware of own responsibilities in the workplace)
    - willing to come in at various times and at short notice (flexibility)
    - willing to try and do something that you were not originally employed to do (flexibility)

3. In the engineering industry, the following skills are probably the most important in making you 'employable'. These are the skills that your tutors will be trying to help you develop, and assessing you on, when you carry out all of the practical tasks associated with this course:

    - maintaining good timekeeping and attendance
    - showing health and safety awareness
    - selecting and using engineering tools and materials
    - interpreting engineering drawings and **specifications**
    - working co-operatively with others
    - planning and preparing for work
    - applying time management
    - awareness of environmental considerations
    - quality checking own work
    - self review and evaluation

It's important that we try and understand each of these by looking at them in more detail.

Employability Skills Specific to Engineering

In engineering we need to consider the types of knowledge and skills that are required to get and keep a job in engineering. These skills and knowledge are not the same skills and knowledge as for instance a hairdresser would require. For example, if you want to be an electrician you'll need to learn a lot about electricity and you'll also need to learn the practical skills to wire up domestic circuits, machines etc.

However, these are not the only skills you will have to learn if you want to get and keep a job. There are other skills, termed **employability skills**, which many employers regard as equally important.

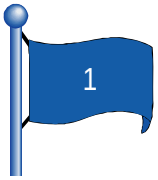
Employability skills include the following:

- maintaining good timekeeping and attendance
- showing health and safety awareness
  - wearing PPE
  - safe working practices
  - understanding a basic risk assessment
- selecting and using engineering tools and materials
  - source and use tools in a correct and safe manner
  - use tools solely for the purpose for which they are designed
  - selection of engineering materials
- interpreting engineering drawings and specifications
- working co-operatively with others
  - to include seeking advice
  - following instructions
  - working in a team
- planning and preparing for work
  - select correct tools and equipment
- applying time management
  - working to schedule
  - sequence of work
- awareness of environmental considerations
  - safe and correct disposal of waste/hazardous materials
  - waste minimisation
  - fume and dust control
- quality checking own work
- self review and evaluation
  - identifying strengths and weaknesses
  - identifying learning points from practical experiences
  - a positive attitude to learning

Timekeeping and Attendance

Have you ever arranged to meet someone and they are late and you have had to wait for them? This can be annoying! Perhaps you're going out somewhere special and looking forward to meeting up.

How did you feel about them being late?



Activity

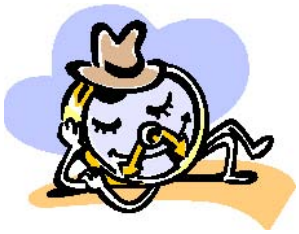
List three things that can happen to you if you are repeatedly late for work:

1. _____

2. _____

3. _____

Possible Answers:



- You hold up the job
- You might not know what to do because the boss has gone
- You'll lose the boss's respect
- You'll lose the respect of your fellow workers because they have to do your work
- You'll get into trouble and be disciplined.

Being late for the cinema annoys your friends. This is how your co-workers feel if you are often late for work: they are annoyed if they have to carry out your share of the work and your boss is annoyed because it costs him/her money!

We are all late on an odd occasion because of traffic, or weather, or something else that's beyond our control. However, if you keep on turning up late repeatedly, or always come back late from breaks people will start to resent you, making it more difficult for everybody to get on and get the job done. You may not do it on purpose but it's very annoying for everyone else.

In the real work place if you continually fail to turn up on time you are likely to lose your job!

Good timekeeping and attendance is something all employers look for in their prospective employees!

Hot tips for good timekeeping

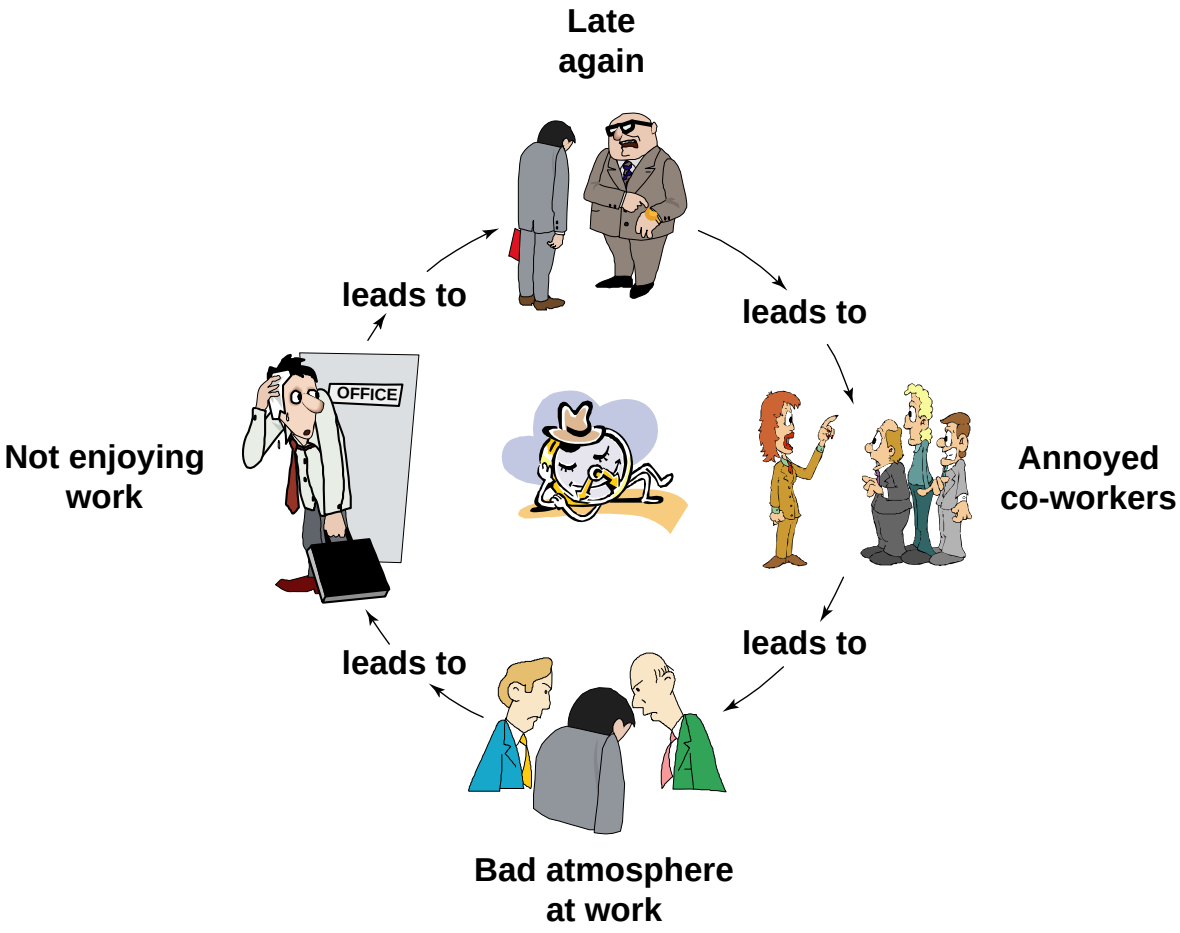
- set the alarm clock at least 10 minutes before you know is 'just the right amount of time to catch the bus'
- get up when it goes off – forget the snooze button!
- wear your watch and check it regularly for returning after breaks etc
- don't mess about when carrying out a job task: concentrate on getting the job done quickly and efficiently.
- If you are going to be late in to work:

  call ahead and let people know what the problem is

  when you arrive apologise to everyone who it may have an effect on.

Arrive on Time

Throughout your course, try to attend regularly, get to class on time and when you go to lunch or a break come back on time. If you know that you're going to miss a class let you tutors know in advance. If you are off, let your tutor know the reason for your absence.



Health and Safety Awareness

Health and safety awareness is probably the most important employability skill in the engineering workplace.

Almost everything in life can be a safety risk but we can minimise that risk if we are aware of what the hazards are and take steps to minimise them.

What is a hazard?

A hazard is anything within the workplace that could be a danger to the health and safety of the people in that workplace.

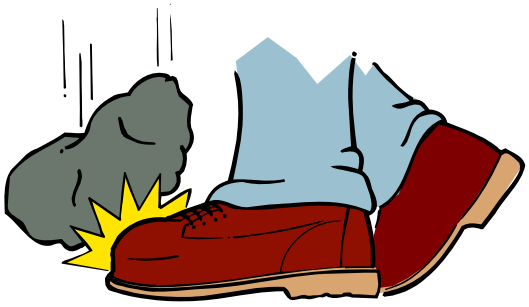
What is a risk?

A risk is the chance (high or low) that somebody is likely to be harmed by that hazard.
If the risk is high, it's vital that steps are taken to minimise that hazard. This is called a **risk assessment**. There is a risk assessment for every workplace, workshop or work activity. There will be a risk assessment for your workplace ask your tutor to explain it to you.

Health and Safety for You!!

Every time you enter the work area you are responsible for your own safety and the safety of others and this will include:

- Conduct and behaviour in all activities
- Safe working practices in workshops
- Safe use of tools and equipment
- Tools and equipment in good usable condition
- Removal of any form of jewellery
- Personal dress
- Personal Protective Equipment (PPE).



Personal Protective Equipment (PPE)

The most basic PPE items are:

- overalls, and
- safety footwear.

Overalls not only protect you, but also protect your clothing from wear and tear or damage.

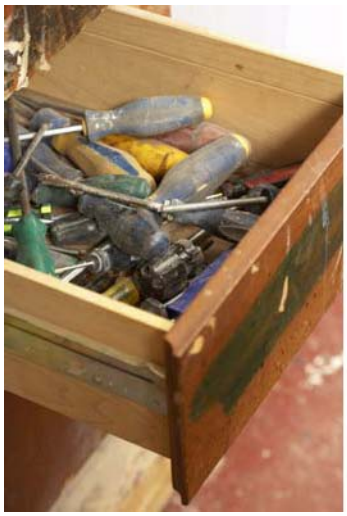
Safety footwear has steel toecaps and a thick sole for protection against sharp objects such as nails. In most cases safety footwear will have soles that are oil and grease resistant.

Maintaining a Tidy Workplace

Do you prefer things to be tidy or can you put up with untidiness?
For example, is your bedroom always tidy or is it sometimes a mess?

Untidiness in the home can be unsightly and in a few cases dangerous (e.g. where objects are lying about that someone can trip over).

Likewise, untidiness in the workplace can lead to many problems. Tools, equipment or materials can be mislaid leading to time wasting searches to find what you are looking for. However, untidiness in the workplace can be very dangerous



Activity

2, 3, 6, 8

Can you think of some examples of untidiness in the workplace that are dangerous?

_____

_____

_____

Suggested Answers

Examples of untidiness leading to dangerous situations:

- Electric cables lying about that people can trip over. In some cases the cable can be accidentally cut leading to **electrocution**.
- Sharp tools lying about which people can cut themselves on.
- Electric tools not turned off which people can start up causing themselves serious harm.
- Objects lying about on walkways which people can trip over.
- Objects above head height which are not well stacked and can fall on people.
- Objects hiding holes in the ground which people can fall down.
- Oil or other fluids on a floor leading to slippery conditions.

It's easy to add to this list. Maybe you've come up with answers not in the list which highlight the dangers of untidiness.

If you did, well done!

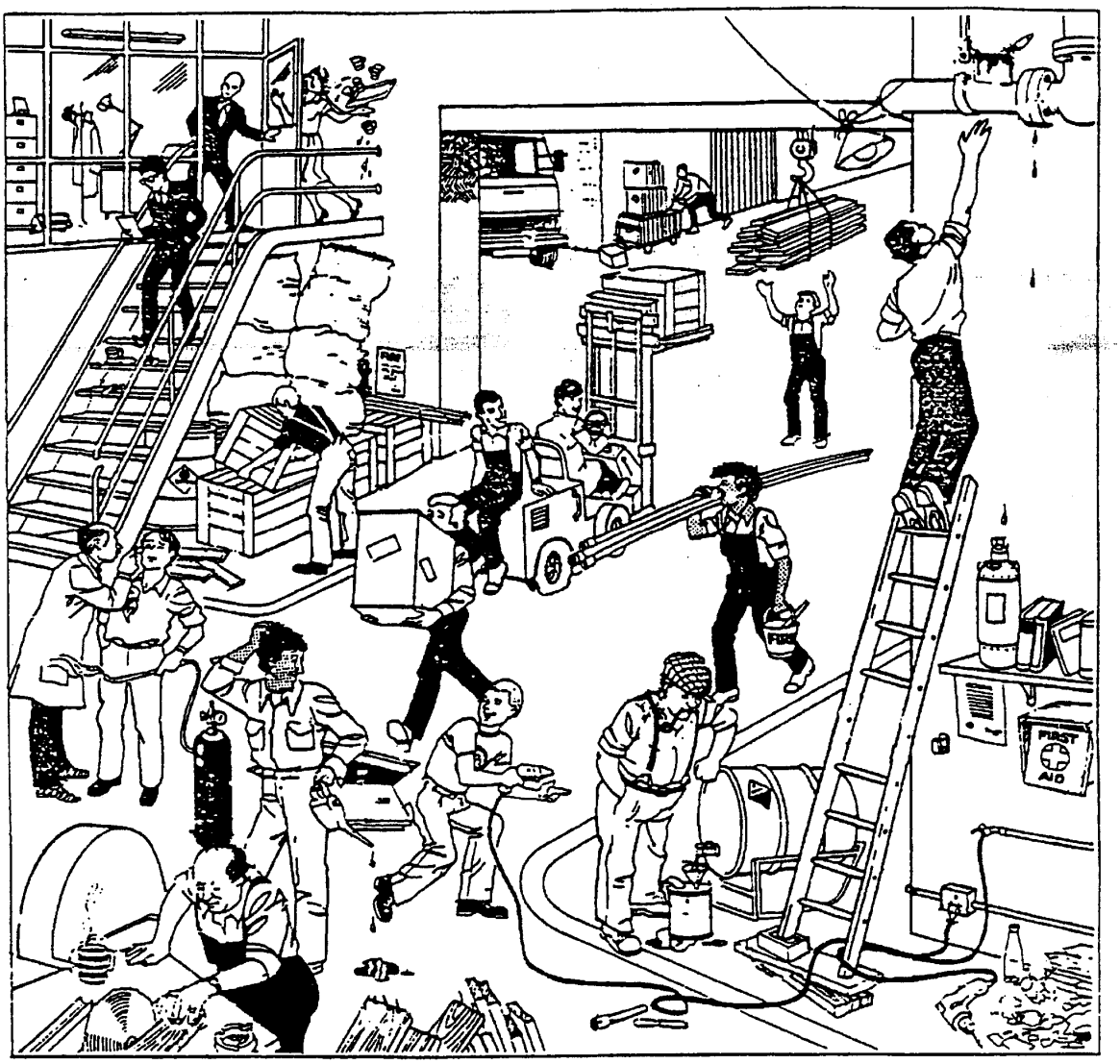
Untidiness doesn't go down well with your boss, your fellow workers or customers for that matter. Tidying up may involve some extra work to start with but it can lead to savings in time as you can find tools, materials and equipment more easily. An untidy workplace can also mean you have to dodge and weave around various objects to get to the job. Above all, tidiness reduces the risk of accidents which has to be good.

During the course always try to keep the area where you are working and the tools, equipment and materials you use in a tidy state.

Activity

2

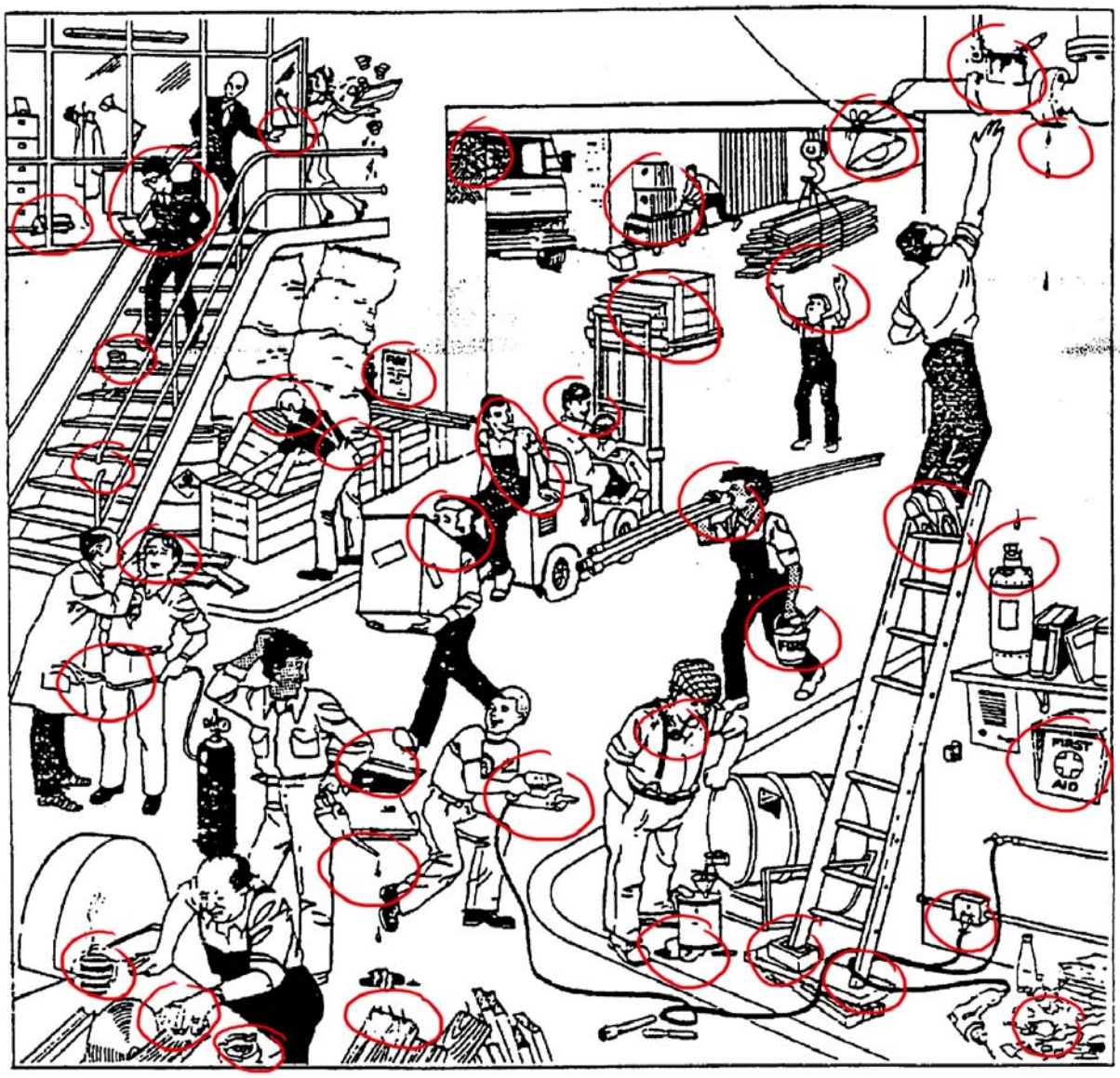
Look at the picture below and circle all the dangerous aspects that you can see:



For every workplace activity, somebody that is properly trained has carried out an official **risk assessment** and they will have thought of things that will affect your safety in the workplace.

However, it's important that you think about risk for yourself in every work activity that you carry out (you probably do in your day to day life but don't really think about it, e.g. you wear your seatbelt every time you sit in a car.

How many dangerous aspects did you find?



There are still some dangerous aspects in this drawing not circled.

Did you get them all – how did you score?

20 to 30 - very good
30 to 40 - excellent

Selection and Use of Engineering Tools and Materials

Tools

In all engineering workshops, no matter the discipline, tools are stored in a way that makes them accessible for use, so tools must be brought to the work area from the store location in a safe manner.

The proper and safe way to carry tools, use tools, clean tools and store tools must be repeated again and again with everyone's health and safety as a primary concern. As you develop your engineering skills you should be able to clean and store the tools in the correct manner. It is important that this becomes the normal repeated routine for any engineering activity.

Sourcing and Using Tools in a Correct and Safe Manner

Tools are the most expensive pieces of equipment that an engineer uses.

- Tools are expensive so take care of them.
- Use tools in a safe and correct manner and only use the tool in the way that it was intended.
- It is important that the tool is stored in the correct way and in the correct place.
- Check each tool after use to make sure that it is still in a safe and usable condition. Each tool must be checked for wear and tear and some tools may require sharpening or to be **calibrated** at times.
- Every tool and piece of equipment is a potential danger to everyone in the workshop. So unless you are trained and competent to use the tool or piece of equipment – leave it alone.

Using Tools Solely for the Purpose for which they are Designed

Tools are designed for a specific purpose and should only be used in the correct way.

- Screwdrivers, for instance, are constantly used as chisels, - but how dangerous is that if the handle shatters?
- If you were to ask most craftspeople, they would state that they are most comfortable using their own tools.
- Have respect for tools and only use tools in a safe and correct manner.

Cleaning and Storing Tools Correctly After Use

At the end of each session returned tools must be:

- clean
- in good condition
- stored correctly and in the right place.

Remember:

- Workshop and work benches should be made clean and safe. This will prevent corrosive damage to the tools.
- Tools thrown into a drawer or toolbox will quickly become damaged and unusable.
- Tools are too expensive to be abused.
- If tools are issued from a store then the tools must be returned to the store.
- If, in your opinion, any tool is worn or damaged you must report it to your tutor or the store person.

Remember:

A place for everything, and everything in its place.

Interpreting Engineering Drawings and Specifications

In order to plan correctly and efficiently for engineering tasks it's important that the information required for the task is taken from **the technical information supplied**.

This information could be in the form of a set of job instructions that detail the specification, and sometimes the sequence of the work.

The **specification** will give details of sizes, materials and may even state if special tools are required.

In addition, technical information can be given in the form of a **drawing**. Drawings can be anything from a simple sketch to a detailed diagram.

Activity

Take some time to think about what the purpose of a drawing is. Your tutor may want you to discuss this with others in the class in a group discussion. Write your answer below:

What is the purpose of a drawing?

_____

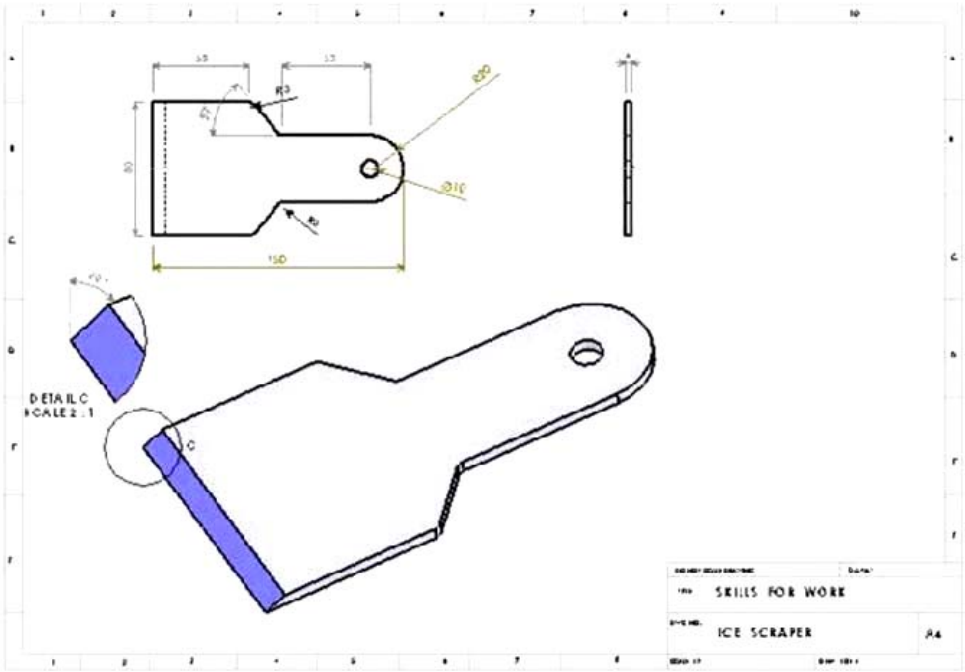
_____

_____

Purpose of a Drawing

In simple terms a drawing displays graphical information about a project.

- drawings can be in the form of a sketch giving an approximate outline of the project, or
- precise drawing showing all the relevant details including the dimensions of the various components and elements.
- drawings can be produced by hand or on a computer using a suitable drawing package (**CAD** - Computer Assisted Drawing). Nowadays such computer generated drawings can be displayed in two dimensions or three dimensions.



Most projects are much larger than the piece of paper we want to draw them on so we have to scale the sketch/drawing down. If this is the case we will be required to use a **scale** to produce the sketch/drawing in its smaller form but still keeping the correct proportions.

Tip

Remember that in the industrial workplace, all these drawings and specifications will be accessed through a computer system – so work hard at those IT skills as well!

Working Co-operatively with Others

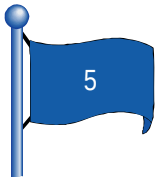
Seeking Advice and Responding Positively to Feedback

We all like to be praised for doing a good job. However, seeking advice and feedback on how we can improve a job can be a different matter. Yet the fact is that it's not possible to go through life without taking some advice and feedback from others. This will certainly be the case in this course. Your tutors won't expect you to be able to pick up new knowledge and skills the first time. After all, when they were learning their engineering skills they did not learn these the first time round.

You'll probably have to practise a skill a number of times and seek advice and feedback from your tutor on several occasions before you become competent in that skill. You may be aware of the old saying, **'practice makes perfect'**.

Seeking advice and feedback from your tutor in a positive fashion will almost certainly help you to learn new skills a lot quicker.

Learning to take constructive advice and feedback in a positive and constructive way is not only an important attitude to develop for this course but in many other areas of your life as well.



Activity

List two instances where you have sought advice from someone:

1.

2.

Possible Answers

Parents	-	can you help me with my homework?
School	-	which subject should I consider?
Bank	-	which account should I open?
Sport	-	which is my best position?
Travel	-	what bus should I get to go to Glasgow?

Following Instructions

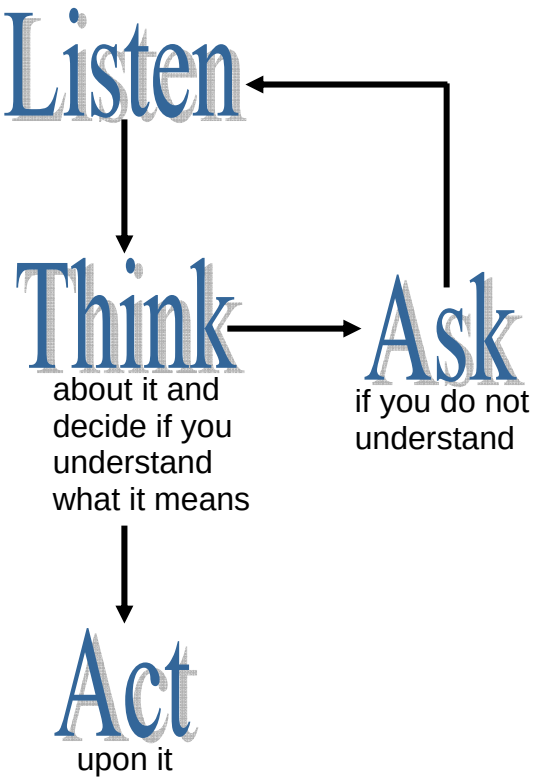
We're all learning new skills and developing new knowledge. Part of this is about learning from people who have experience and know what they are doing. On this course, your tutors are the experts and they know when something can go right or wrong; where there are dangers and how to avoid them. They will therefore also be the people that will give you instructions about how to carry out a task.

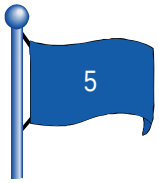
Listening is a vital part of following instructions and is not always that easy. It's easy to be distracted especially if someone is trying to interest you in something else. That's when you have to make more effort to listen and not to be put off.

How often have you switched off when someone's been telling you something?

How often have you thought you had listened but were then not very sure if you understood something and so just decided to stumble on hoping that it would all be OK in the end? In engineering, this can be very dangerous.

The sequence of **following an instruction** is:





Secret Codes Activity

The oldest means of sending secret messages is to simply conceal them. As long ago as 480 BC, the Greeks were warned of a planned attack. At that time wooden tablets were covered with wax and messages were written in the wax. The message was written on the wooden tablet itself and then covered with wax, allowing the vital information to be smuggled to the Greeks.

Instead of hiding the message we will change the message using a secret code with the key shown below. In this case the letter **a** is written as **X** and **b** is written as **Y**.

X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z

The coded part of the message is always in capitals, it is your task to decipher the following messages:

P	H	F	I	I	P

equals

P H F I I P
s k i l l s

B	K	D	F	K	B	B	O	F	K	D

B	J	M	I	L	B	X	Y	F	I	F	Q	B

X	Q	Q	B	K	A	X	K	Z	B

B	I	B	Z	Q	O	F	Z	X	I

C	X	Y	O	F	Z	X	Q	F	L	K

T	L	O	H	M	I	X	Z	B

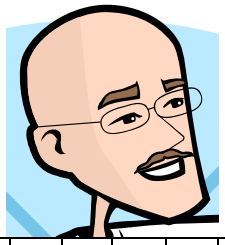
O	B	J	B	J	Y	B	O		Q	L		X	P	H

T	B	I	I		A	L	K	B

Secret Code Answers

Another way of hiding messages was to tattoo the message on the shaven head of the messenger then wait until the hair had grown back. When the hair was fully grown the messenger was then sent to whatever destination.

Hopefully this didn't have you pulling your hair out.



X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z

The coded messages are shown below:

P	H	F	I	I	P
s	**k**	**i**	**l**	**l**	**s**

B	K	D	F	K	B	B	O	F	K	D
e	**n**	**g**	**i**	**n**	**e**	**e**	**r**	**i**	**n**	**g**

B	J	M	I	L	B	X	Y	F	I	F	Q	B
e	**m**	**p**	**l**	**o**	**y**	**a**	**b**	**i**	**l**	**i**	**t**	**y**

X	Q	Q	B	K	A	X	K	Z	B
a	**t**	**t**	**e**	**n**	**d**	**a**	**n**	**c**	**e**

B	I	B	Z	Q	O	F	Z	X	I
e	**l**	**e**	**c**	**t**	**r**	**i**	**c**	**a**	**l**

C	X	Y	O	F	Z	X	Q	F	L	K
f	**a**	**b**	**r**	**i**	**c**	**a**	**t**	**i**	**o**	**n**

T	L	O	H	M	I	X	Z	B
w	**o**	**r**	**k**	**p**	**l**	**a**	**c**	**e**

O	B	J	B	J	Y	B	O	M	Q	L	M	X	P	H
r	**e**	**m**	**e**	**m**	**b**	**e**	**r**		**t**	**o**		**a**	**s**	**k**

T	B	I	I	M	A	L	K	B
w	**e**	**l**	**l**		**d**	**o**	**n**	**e**

Seek Advice

Sometimes we don't completely understand what we're being told. It's very important that you ask in order to be clear in your own mind what was meant. Your tutors will be patient with you, as they know that this is all new and different to you.

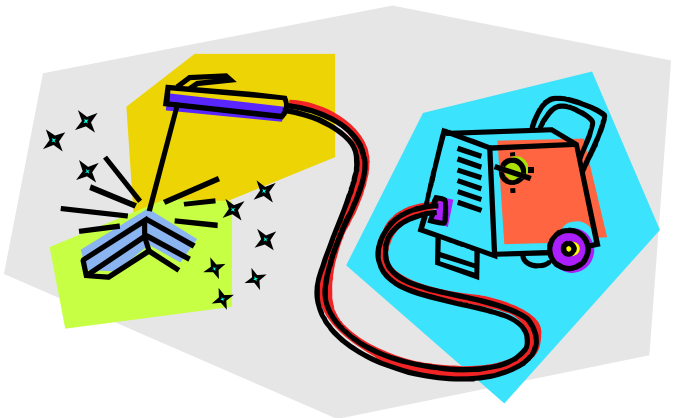
Follow Instructions

Instructions are sometimes for everyone in a group, or you may be given instructions as an individual. Often there are different tasks to be done in the workplace that contribute to getting the job done, so that the instructions given to your friend might be different from the ones you get – you both need to listen!

Develop Skills

Sometimes the tutor might simply be helping you to refine a particular skill or actually teaching more advanced skills because you are learning more quickly than others.

It's vital that you do understand what you are doing before acting – you could be a danger to both yourself and others if you don't.



Important instructions:

On a few occasions your tutor will give you instructions that you simply **must** follow without question.

Activity

Can you think of examples where this may be the case (i.e. you must follow instructions correctly for safety reasons)?

_____

_____

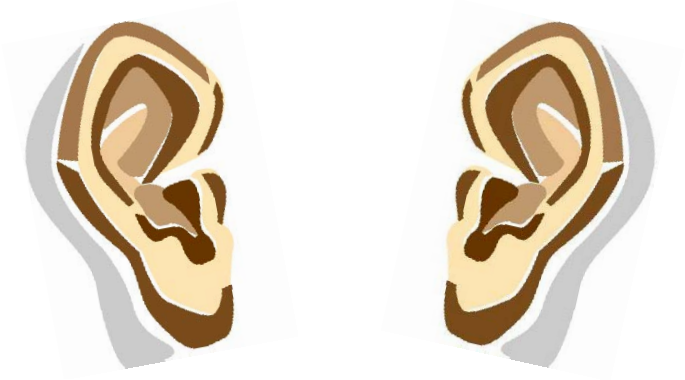
Suggested Answers

Some examples of when you **must** respond to instruction:

- Wearing safety clothes, boots, hard hat etc.
- When an accident or emergency occurs in the class.
- When there is a fire alarm.

Have you thought of other examples?

Remember to be a good listener - take in instructions and learn.



Working in a Team

There are many jobs in the engineering industry that involve working co-operatively with other people and it's a very important skill for any workplace. Sometimes the jobs that people do in engineering can be hard, dirty and tedious, yet they are very important. However, we need to be able to carry out tasks together such as:

- lifting something heavy
- moving long materials
- moving tools and equipment
- helping to secure work-pieces
- getting material and tools from the store or storage area.

In the workplace, we can't choose the people that we want to work with and we may not have a great deal in common with them. However, it's better for you and the other people, if you **work together as a team** in order to get the tasks done.

It can often be frustrating working with others when we feel that we are not getting to do things our way or we are not being helped properly.

When you're working with other people and you begin to feel a little unhappy about something, say what is bothering you politely instead of bottling it up. You'll often find that things can get sorted out much quicker and you can all get on with the job.

Activity

Sit back and think about a time you wouldn't join in an activity because you didn't want to work with the people that you were asked to for some reason. (We all have these times!)

How did you feel in the end?

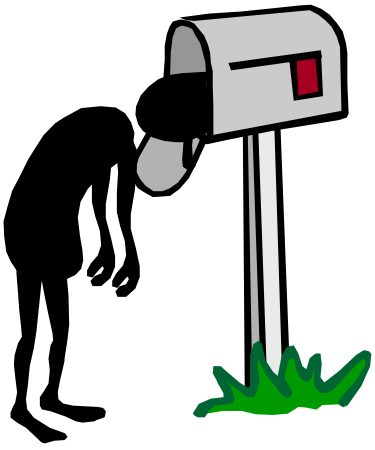
_____

_____

Did your behaviour make other people respect you any more or less? Was it (honestly) really worth it in the end?

_____

_____



Planning and Preparing for Work

Problem Solving

In every engineering task there will be problems to be solved. This is the case even if you have a sequence of instructions, specification and drawings.

The problems will arise even with careful planning, but without planning the problems will be multiplied.

Problem solving might include thinking about:

- cost
- tooling and equipment
- time
- materials
- how do I do this
- how it works
- how to repair it
- how to replace it
- do I require assistance?

Engineers require a variety of skills to problem solve but sometimes one of the most important things is **experience**.

Your tutor has a wide variety of skills and lots of experience – so if you have a tricky problem to solve, go ahead and just **ASK**!

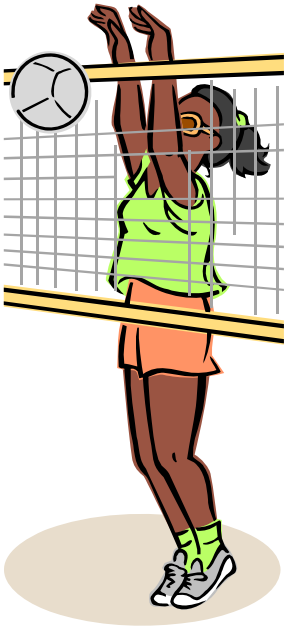
Ask your tutor about

Skills and

Knowledge

Planning and Preparation

If you are undertaking any activity or work task you must **plan** for that activity. For a volleyball tournament, for example, a great deal of **planning** can be involved:



- venue
- teams
- strips
- catering
- referees/umpires/timekeepers
- programme of games/starting times.
- winner's medals.

It's the same with a work task. It's important that:

- the correct amount of material is available
- the correct tools are available
- the correct amount of time has been allocated
- the correct clothing (PPE) is worn
- an appropriate work area is available
- the person assigned to the work task has the required skills.

Activity

Think about a time that you started something without really planning it out properly.
For example, did you ever start making a model aeroplane or model car without checking to see if you had the right paints, glue and had set aside enough time for the job?

Did the model making go well or badly?

You were probably a bit annoyed and unhappy with the job that you did because you knew it could have been better.

Most likely it went better when you did the necessary planning and preparation, such as reading the instructions and following the instructions through in sequence.

Sometimes it's very tempting 'just to get on with the job' without doing the necessary **planning and preparation**.

Think carefully about planning and preparation when you are doing the course. In every engineering task, it's very important that you plan ahead before you start to do something. For example sometimes you are going to work in a different part of the plant or off-site. In these cases you need to take the correct tools and equipment. You can't keep popping back for another tool. What about health and safety? There could be an increased risk of danger to yourself and others if you fail to plan ahead.

Hot tips for good planning and preparation:

- Think about what you need to **wear** for the job, including any extra PPE, such as gloves or a facemask.
- Think about what **tools** and **equipment** need to be brought together before starting.
- If it's a job that involves more than one of you, think about **who is doing what**. Also make sure that everybody is clear about what they are doing.
- If you are ever unsure you must **ask** before carrying on.

Time Management

Maybe only Doctor Who can really manage time, - but what we can do is try to use our time constructively and not waste it.

This means that every time we are given a practical task we need to plan what we are trying to achieve in the class time and the tools, equipment, resources and materials that we need to achieve it.

So time management is not so much managing time but managing ourselves to use our time.

When given a practical task it is easy to kid ourselves that we are working when really we are not, so in what way can we minimise time wasting?

- Talking to others, wastes their time and yours but sometimes it is necessary so you need to decide when it is necessary and not just chatting.
- Taking too long to put on your PPE.
- Taking long toilet breaks, we all need to go to the toilet but it usually only takes a short time.
- Taking a longer than scheduled break.
- Allowing your work area to become too untidy will slow you down.

To use the time effectively we need to have a plan:

- We need to prioritise what we want to achieve, in other words set a goal that is achievable.
- Planning the work means that you know what to do and how you are going to do it.
- Plan the sequence of tools, equipment and materials that you will need, check against the specification and drawings.
- Plan who you would ask for assistance and help if you need it.
- Plan your quality checks or tests:

  functional – **dimensional** – **continuity**.

  Try to predict problems.

Tips for Good Time Management

Here are some top tips for good time management:

- Break down each practical assignment into small manageable tasks
- Make a list of tasks that need to be done and tick them off when you have achieved them
- Put the tasks into the correct sequence – which ones are more important?
- Use a small amount of time to complete tasks if they can be easily done
- Use a longer amount of time to complete challenging tasks
- Use the tasks you dislike as a challenge! Set yourself a target and give yourself a reward when you have achieved them.
- If you can't complete the work in time, inform your tutor as soon as possible, and ask for help and support
- Don't waste time, try and always organise your time well.

Activity

List four ways in which you can help to achieve good time management:

1	
2	
3	
4	

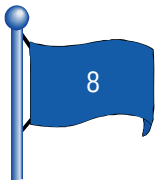
Compare your list with a colleague and discuss what you think are the most effective.

Answers to Activity

List four ways in which you can help to achieve good time management:

1	Break down assignments into small parts
2	Use your time well
3	Prepare a plan – tools materials etc
4	Plan the sequence of work

Awareness of Environmental Considerations



Resources

What do we mean by resources? Discuss in your group what you think this means in engineering?

- Resources are the **materials, time, machinery, equipment and tools** that are required to complete a task or activity. Remember in modern engineering, tools can be hand tools, but could also be computers, fax machines or phones.

- Another important resource is the **energy** required to complete the task. This will almost certainly be electrical energy but could also be gas, coal and/or oil.

Unfortunately as a population, we use and waste a tremendous amount of resources on a day to day basis. Waste material can never be fully eliminated but it must be minimised as much as possible.

It is quite common now, **not to leave electrical appliances on standby**, to switch off lights and to **use low wattage bulbs** to save on energy. In the engineering sector waste is minimised as much as possible and corrective steps are being taken to conserve energy and lessen the effect of emissions on the environment. Raw materials must also be used in an effective and efficient manner.

In the real world of engineering, everything costs money and the consumer has to pay for it. How great would it be, if by careful use of resources, we could lower the price of all consumer goods and fuel?

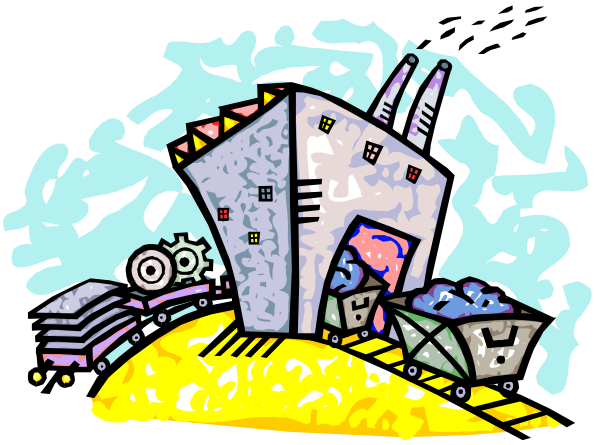
Think of the benefits inexpensive goods and fuel would have on developing countries as well as our own.

Think of the damage we will do to the environment if we continue to waste resources, and the cost to your generation and generations to come!!!

The future of the world is in your hands!

Activity

You are given a practical engineering assignment to complete in the workshop.



List all the resources that you think you might need to complete the practical assignment.

Answer to Activity

1. You would probably need the following (you may have thought of others):
    - materials – metal – plastic – accessories - components
    - tools – hand – power - ICT
    - time
    - energy – power – light – heat – gas – oil etc
    - PPE
    - water
    - costs – which will include all of the above

Being wasteful with your time will cost your engineering employer money.

Remember timekeeping and attendance

Safe and Correct Disposal of Waste Materials

We are all responsible for the safe and correct disposal of waste material. This waste material might be excess material that we have removed from a piece of metal or plastic in the production of an artefact, but it could also be waste in the form of oil, paper or chemicals.
The safe and correct disposal of waste metal or plastic will be indicated by your tutor and in the case of metal is usually a scrap bin.
If the waste is oil or chemical then the safe and correct disposal of it is stated in the **Control of Substances Hazardous to Health Regulations (COSHH)**.

The COSHH regulations set out eight basic measures that must be taken to safely dispose of waste material, but COSHH also states how to increase productivity through more effective use of raw materials.

If a substance requires safe and correct disposal under COSHH regulations, there will be a warning label attached to it. If there is no label, for instance on your soft drink bottle, then it does not fall under the COSHH regulations but you must still dispose of the drinks bottle in the correct manner – **recycle**.

Waste Minimisation

Every time we go shopping, we buy too much! It might be food, or DIY items but we have this great tendency to overbuy. This means we use more energy to return the goods or we simply waste some of the goods, especially food.

Some waste is unavoidable but we must try and save our natural resources and be more efficient in the use of them.

Manufacturing industries by their nature use a lot of natural resources. Fuel, electricity, water and raw materials are usually part of any manufacturing process and it is these resources we must protect by effective and efficient use.

Activity

Complete the following set of questions:

List two ways we can reduce the waste of resources?

Your answers:

_____

_____

List two ways that should **not** be used to dispose of any waste material.

Your answers:

_____

_____

List two ways in which the environment is affected by industry.

Your answers:

_____

_____

What does the greenhouse effect refer to?

Your answers:

_____

_____

In your team, try to come up with an imaginative way to use waste engine oil.

Your answers:

_____

_____

Answers to Activity

List two ways we can reduce the waste of resources?

Switch off lights, use low wattage bulbs, do not leave electrical equipment on stand by, careful use of engineering materials, **recycle**.

List two ways that should not be used when disposing of any waste material.

Scrap metal thrown under the workbench, pour waste oil down drain, burn waste paper, throw waste metal in paper bin.

List two ways in which the environment is affected by industry

Smoke/fume emissions, use of raw materials, greenhouse effect.

What does the greenhouse effect refer to?

It is the erosion of the ozone layer due to gases used by man. This means that some of the heat that used to be reflected back towards the sun is now getting through the ozone layer and will eventually lead to global warming.

Discuss a novel use for waste engine oil.

Recycle into a fuel for heat; recycle into a fuel for cars.

Fume and Dust Control

It would be great if we never had to inhale any form of **fumes** or **dust**, but in the real world this never happens unless you are marooned on a desert island.

Even a simple thing like walking or cycling to school will involve breathing in some form of fumes from cars and buses, and if you pass a construction site or road sweeper you will breathe in some form of dust.

The effect of fumes and dust on our bodies should not be ignored. For many years in engineering, fumes and dust were a normal daily occurrence for some employees but this is not acceptable any more.

We must all take great care with fumes and dust and use every available method to minimise the dangers.

Quality Check Your Own Work

Have you ever watched an expert craftsperson at work? He/she frequently checks their work to make sure it is conforming to the correct standards.

Remember, the standards are set out in the **specification** or **drawing**. The specification or drawing is constantly referred to until the task is completed.

Checking your own work is a very important skill to develop especially if you would like to be a skilled engineer. Engineers measure twice and cut once.

- During the course, check your work regularly to ensure that it is meeting the necessary standards.
- If you can get things right first time you can move on to something else, perhaps something even more interesting than the task you've already completed.

The difference between a **craftsperson** and a good DIY person has been defined like this:

The good DIY person will work out a method to complete the task and carry it out. The craftsperson will work out several methods to complete the task, select the best method, and carry it out.

This ability will come with experience:

- it will come if you actively seek advice
- it will come if you check your work.

Self Review and Evaluation

Identifying Strengths and Weaknesses

Throughout this course, you'll be carrying out practical activities and you'll be expected to evaluate your own progress in relation to the employability skills mentioned previously. Your tutor will also be assessing your progress.

You'll also have to reflect on this evaluation and think about your **strengths** and **weaknesses** and consider how you are going to try and improve on your weak areas.

Strengths and Weaknesses

A **strength** is something that you do well. It might be a practical skill like drilling a hole in metal but it could also be a listening skill. It's important to remember that all the skills required to be a good engineer can be practised and learned.

A **weakness** is something that you don't do well. It might be a practical skill or it could be another skill like talking to someone. Before a weakness can be turned into a strength, you must firstly recognise that there is room for improvement and take steps, with the help of others, to turn it into a strength.

The table on the next page shows examples of strengths and weaknesses – and the big differences there can be between them!

Please remember that a weakness does not mean that you are weak or soft in any way, it simply means that this is an area in which you need to develop your skills more.

Strength and Weaknesses Table

Profile	**Strength** 	**Weakness** 
Health and Safety	I worked safely and was aware of the safety of others.	I was not aware of any other people; safety is the responsibility of the tutor.
Attendance and time-keeping	My attendance was good. I was always prepared to start my work at the right time.	My attendance was pretty poor. I often arrived late and not prepared to start work.
Waste minimisation	I always tried to be aware of the use of energy and to use engineering materials without too much waste.	I sometimes forgot to turn off the pedestal drill and I used too much metal at the start of the course.
Planning and preparation for work	I planned and prepared for each task. I made sure the tools and materials were right.	I did not plan or prepare for tasks. How would I know what tools and materials to use?
Working with others	I worked well with others. I helped others at times and at other times they helped me.	I did not work with the others. Why should I work with other people?
Use tools in a correct and safe manner	I used the tools correctly and safely. I always cleaned the tools and stored them in the proper place.	I did not use some of the tools correctly and forgot to store them properly.
Following instructions	I always followed instructions and if unsure I asked.	I ignored instructions completely.
Quality check own work	I was good at this. Twice I found measurements that were wrong and I corrected them.	I just assumed it was OK.
Self review and evaluation	I was always on time and wore the correct PPE. I was very good at filing and drilling.	I was never ready to start. My tutor was always telling me to wear my PPE. I was not so good at sawing.

Activity

This activity should not be attempted until you have attended at least 6 weeks on the course.

Write a strength **or** weakness in the appropriate cell; you don't have to write both, one strength **or** one weakness will do.

Profile	**Strength** 	**Weakness** 
Working with others		
Self review and evaluation		
Following instructions		
Planning and preparation for work		
Waste minimisation		
Use Tools in a Correct and Safe Manner		
Attendance and time-keeping		
Quality check own work		
Health and Safety		

Need help? Don't forget to ask your tutor.

Identifying Learning Points from Practical Experiences

A very important part of developing practical skills and becoming better at any job is to review your own progress. This means that at each stage of a task and especially at the end of a task you reflect on what went well and maybe what did not go so well, and why.

Don't worry if you make mistakes sometimes - most people need time and practice to get things right every time!

Learning from mistakes and good and bad experiences is something that we do in everyday life. For example, if you cut yourself with a bread knife, you would reflect on what it was that caused you to do that and try to make sure that you didn't do it the next time you were cutting bread!

We can also benefit from the opinions of others who are watching or helping us to do a task. Sometimes this can be difficult; we're all very happy to be told that we have done something very well but it's much more difficult to accept any sort of **constructive criticism**.

If you think about it though, even the most successful sportspeople in the world are still accepting feedback and reflecting on their skills from their coaches because everybody, no matter how good they are, has room for improvement and for superstar sportspeople: **improvement means more money**.

Improvement for the engineering apprentice also will mean more money. If you are good enough or lucky enough to be employed as an engineering apprentice then during the years of your apprenticeship you will develop both:

- practical skills
- employability skills.

Remember: one without the other is of no use to an employer; he or she requires both.

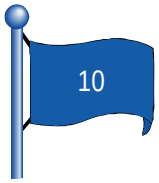
Positive Attitude to Learning

Nowadays, it's not possible to leave school and think that you'll never need to learn another thing if you want to keep yourself in a job! Everyone who is employed is constantly learning new skills and knowledge. So remember, learning will not be all books and boffins; in the workplace, you can learn from the people around you and from your own experiences.

Your employer and co-workers will be pleased if you show that you are interested in learning new things.

Don't be put off by those who are faster at learning than you are. Sometimes, those of us who learn more steadily actually learn more thoroughly!

Activity



Can you think of one example where you have learnt something that was easy and one example where you learnt something that was a struggle?

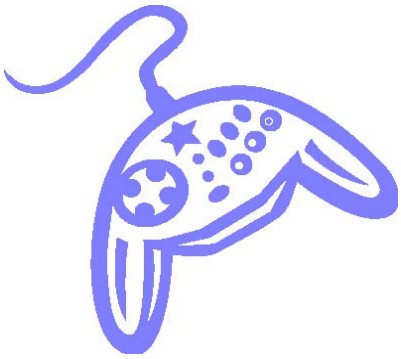
Easy to learn	Difficult to learn

Suggested Answers

Some possible examples might be:

- a ball skill (e.g. keeping up a football)
- playing a new game on your computer
- making a model by following instructions
- learning to ride a bike
- learning to swim
- learning to skate

You might find something easy that others find difficult.



What was the most important thing that made you learn something new?

Maybe you saw the skill performed then really wanted to be able to do that skill.

Why was it that you saw real benefits in learning that new skill?

It might be because it meant that you could do something that others would respect you for, or so that you wouldn't be left lagging behind your friends.

What was your attitude to learning that new skill?

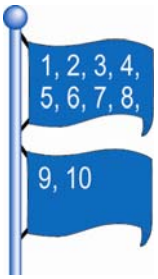
Almost certainly it was very positive. You were determined to learn the skill and you practised until you mastered it. As a result you succeeded.

In this course you'll have the opportunity to learn a number of new craft skills. These skills will be helpful to you even if you decide not to pursue a career in engineering. It's important that you take a positive attitude to learning into the course if you hope to get the most out of it:

- get involved and watch the way the tutors carry out specific craft skills
- ask your tutors questions - this is an important way to learn.

Try not to be distracted by others – **concentrate**, **listen** and **learn**. **Ask if you are not sure**.

Most of all enjoy your learning experience on the course!



Activity

List three things you can do to show that you have a positive attitude to work.

1.
_____

2.
_____

3.
_____

Suggested Answers

- be aware of health and safety
- arrive on time every day
- attend every day
- wear the correct PPE
- work with others
- come prepared to work and learn each session
- ask questions – seek advice
- keep to the workshop code of practice and behaviour
- tidy up after each session
- take care of tools and equipment
- use tools and equipment correctly.

Tools and Materials

Tools

This section deals with tools that are common to all areas of engineering.

Tools are a major part of each and every engineering activity and should be treated in accordance with safe working practices.

Tools must be stored in a way that makes them accessible for use, and they must be brought to the work area from any store location in a safe manner.

The proper and safe way to carry tools, use tools, clean tools and store tools will become the normal repeated routine for all engineering activities.

Measuring and Marking Tools

Most engineering work requires you to be as accurate as possible. This means that the measuring and marking of a work piece is very, very important.

Rule

Engineers usually use a steel rule marked off in millimetres and centimetres.

They are usually identified by the imperial measurement system as 6 inch, 1 foot and 2 foot rules.

Tape Measure

For longer distances steel or cloth tapes are used for marking – these come in lengths from 3 metres to 30 metres.

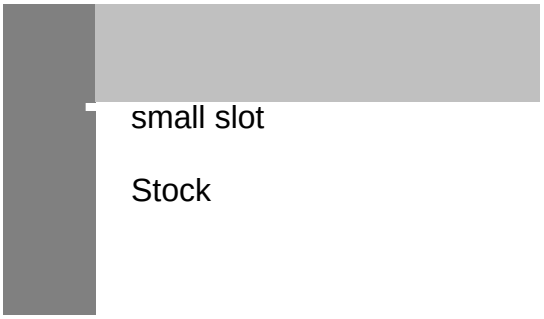
Care should always be taken with measuring tools, as they are precision instruments.

Scriber

The scriber is made of hardened steel with a fine sharp point for marking fine lines on a metal surface. The sharp point must be maintained to keep the lines fine for accurate marking. If the point becomes blunt it must be re-sharpened.

Engineer's Square

The Engineer's Square is made up of two parts, the **stock** and the **blade**. It is usually made from bright mild steel with the blade being **hardened** and **tempered** so that it resists damage. It is normally used to mark out material for cutting/shaping.



An interesting feature of the engineer's square is the **small slot** that has been cut into the stock. This prevents dirt or metal filings from altering the accuracy.

The square is held against the straight side of the material, the scriber is then used to scratch a line onto the surface of the material.

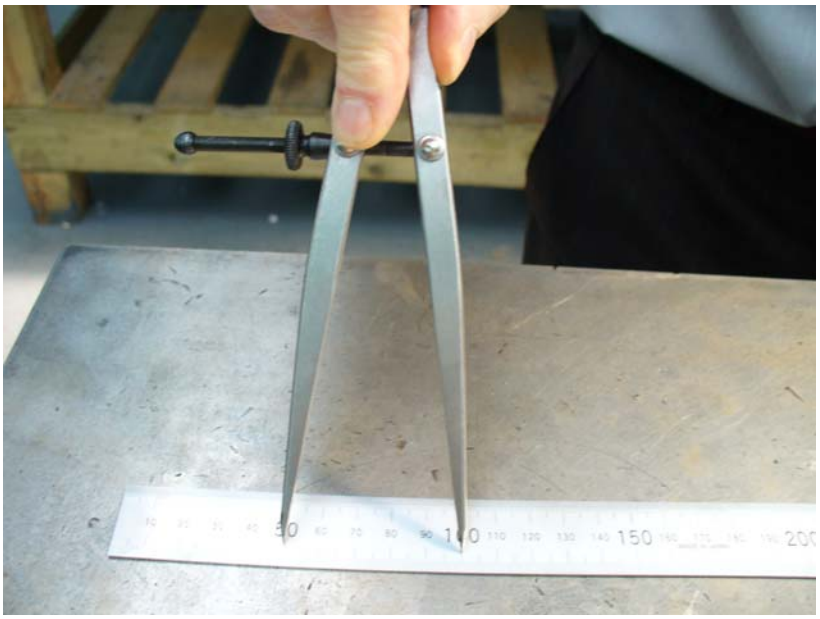
The square is also used to test that a right angle exists across the edge of the material.

Divider

The divider is like a set of compasses - it is used for marking out arcs, radii and circles.

The divider points, like the scriber, must be kept sharp to give a fine marked line; likewise the divider legs must be the same length to ensure an accurate measurement.

The divider is set the same way as compasses. Put one leg on the rule start line then open the divider until the other leg matches the correct measurement.



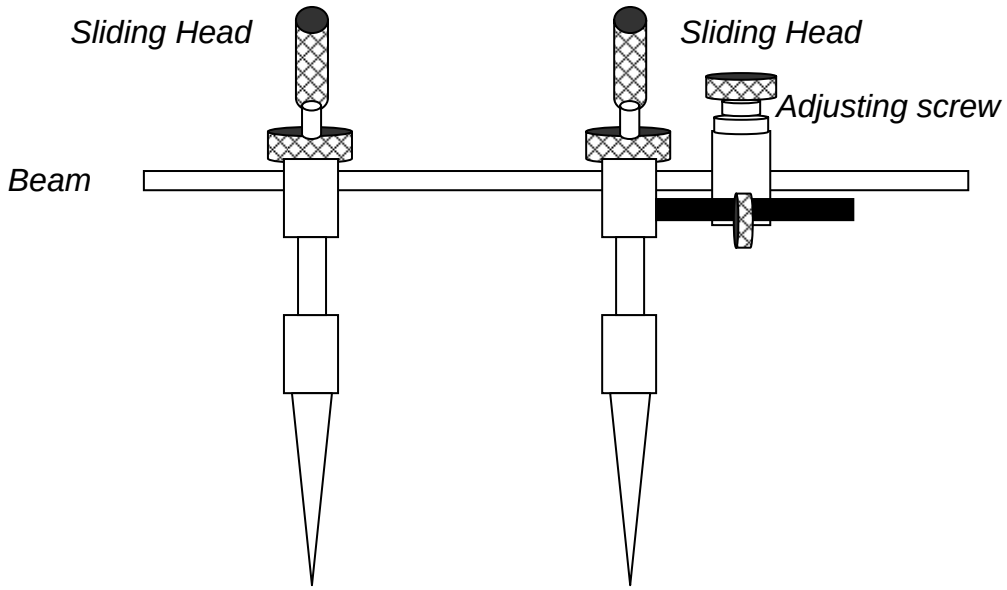
In the photograph above the start of the measurement is at 50mm, finishing at 100mm.

Trammel

A trammel is used when the arcs, radii and circles are too large for dividers. So a trammel is used for marking out large work pieces, it is made of three main component parts:

- beam
- two sliding heads
- adjusting screw

The **beam** allows the heads to slide closer or further away from each other, the **adjusting screw** is attached to one of the sliding heads. The trammel is set in exactly the same way as dividers and can be made to scribe larger distances with the use of extension rods.



Oddleg Callipers

The oddleg callipers are used to mark lines that are parallel with the edges of the work piece. It can also be used to locate the centre of round work pieces.

Inside Calliper

Inside callipers are used to measure the internal size of a hole, pipe or tube.

Outside Calliper

Outside callipers are used to measure the external size of an object.

Vernier Scale

The **vernier** scale allows more accurate reading of straight or circular measurement. It is fitted with a sliding extra scale that is used to indicate where the measurement lies when it falls between two of the marks on the main scale.

Vernier Calliper

These callipers give a more accurate measurement than the manual callipers.

Surface Gauge

A surface gauge is a very useful marking out tool.

It is used to scribe parallel lines on a work piece.

Vernier Height Gauge

A vernier height gauge is used in metalworking to accurately measure or set vertical distances.

The pointer is sharpened to allow it to be used to mark on the workpiece surface.

Micrometer

The **micrometer** is a very accurate measuring device. It is mainly used to measure diameters. Micrometers come in many different types depending on the use, such as internal, external, depth, bore etc.

Digital Instruments

All instruments require a great deal of operator skill to read the measured values accurately.

Digital instruments are more accurate and are very much easier to read.

Digital instruments give the measured value in mostly numerical terms with as many decimal places after the point as you require.

The measured value from a digital instrument is similar to the display of your calculator and just as easy to read.

The digital instruments you will possibly use during the course will be micrometers and callipers.

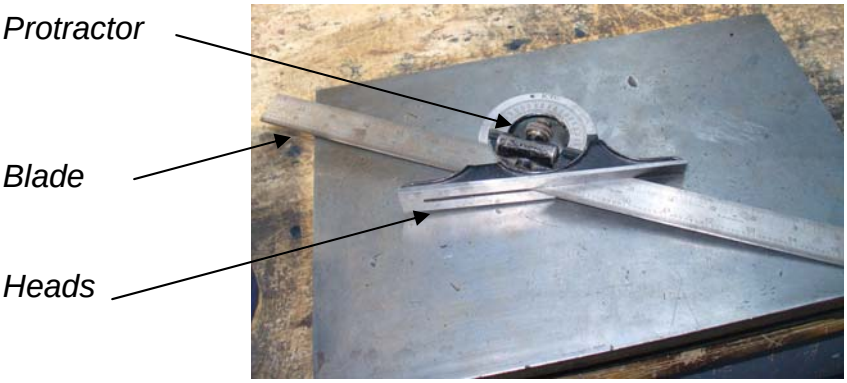
Surface Plate

The **surface plate** gives a smooth even plane surface. It is used with surface gauges as a level base on which the gauges and the work piece are placed to obtain accurate measurements and marking.

The surface plates can be made from steel or granite and should **never** be used with any work piece that would damage the surface. A damaged surface plate would affect the accuracy of work pieces.

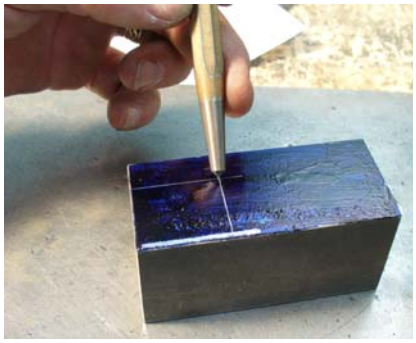
Combination Set

The **combination set** is used for various marking out operations. The set consists of a blade with a graduated rule, square head, protractor, and centre head.



Centre Punch

The **centre punch** is made from mild steel with a hardened and tempered point. This is so that it can withstand impact with the material it is marking. It is normally used to mark the centre of a hole, circle or arc.



A centre punch is used with a hammer to make a small indentation on the surface of the material.

General Workshop Tools

The following are the main hand tools you will find in all engineering workshops. Your tutor will show you how to use the tools and explain any special safety requirements.

Files

A **file** is perhaps the most common hand tool for engineers. All apprentices will be instructed in the basic skill of filing at the start of their training.

Most trades-people would not be expected to use a file for any length of time on a day to day basis, but all engineers need to learn this basic fitting skill.

Files come in all shapes and sizes so you have to select the correct file for the task.

Flat File

Half Round File

Round File

The main part of the file is called the body and the sharp part at the end is called the **tang**. The tang is so shaped so that a file handle will fit snugly on the end.

No matter the shape or size of the file it should never be used without a handle. Imagine the damage a file tang could do to your wrist.

File Selection

Files can be classed by the file shape or by the spacing of the file teeth. The spacing of the file teeth is called the **pitch**, and it is the pitch that decides the use of the file for a particular material.

Name of File	**Use**	**Finish**
Bastard	rough work	rough
Second Cut	general work	reasonable
Smooth	finishing work	smooth

Saws

A hand saw used to cut metal or plastic is known as a **hacksaw** and comes in various sizes. The main type of hacksaw consists of a frame and a blade. The frame is adjustable to allow different sizes of blade to be inserted. The blade must be tensioned and inserted correctly.

Blades are classified by the number of teeth per unit length. The greater the number of teeth, the finer the cut. Normally thick materials are cut with a coarse blade and thin materials with a finer blade. When cutting the whole length of the blade should be used. The hacksaw blade should never be used without the frame.

Junior hacksaws are not adjustable and the blade is tensioned by the spring of the frame.

The **pad saw** is different from hacksaws because it only has a handle and a blade. The blade is a narrow strip of steel having cutting teeth on one side and this tool can be used in awkward or confined spaces. The pad saw might be used for cutting thin metal but more often it is used to cut shaped holes in wood or plasterboard.

Hammers

Hammers are important tools that must be used correctly and safely. They have a number of uses such as shaping metal, driving things into position, tapping marking tools.

Hammers are available in a wide range of weights from 200g to 900g.

Bigger hammers are known as **sledge** and **lump hammers** and are used for heavy work.

Hammer handles or shafts are normally made from wood but some are now made from plastic. These materials absorb the shock when striking.

You should never strike one hammer with another as parts may chip off and damage your skin. When using a hammer you should not look at the hammer itself but at the end of what is being struck – this should help you not to hit your thumb!

A **mallet** is a hammer in the loosest sense. This tool is used for the forming and shaping of sheet metal and is usually made from boxwood or hide. This allows metals with polished surfaces to be worked without undue surface damage. Mallets come in different forms depending on the use.

Chisels

Chisels are used in engineering and joinery work and are an important cutting tool for any workshop. In engineering chisels are divided into two main categories:

- hot chisels
- cold chisels

Hot Chisel

Hot chisels are used to cut metal that has been softened by heating and would normally be used by a blacksmith.

Cold Chisel

Cold chisels are made from steel and the tip is hardened and tempered by heat treatment. Cold chisels are used for cutting metals.

Cold chisels come in different types and sizes, from fine engraving tools that are tapped with small hammers, to massive tools that are driven with **sledgehammers**.

Bolster Chisel

The **bolster chisel** is used by electricians to split floorboards along the tongue and groove to gain access under floors to wiring.

Screwdrivers

There are several types of screwdrivers:

- Electricians' screwdrivers
- Slotted screwdrivers
- Cross-point screwdrivers.

Electrician's Screwdrivers

These normally have round blades with either parallel or flared tips. The handle is always made of an insulating material and the blade is often sheathed in plastic so that only the tip is exposed. Sometimes a neon indicator is incorporated into the handle as a safety device so that live voltage sources can be detected safely. The tip is slotted and is mainly used for connections in terminal strip, lighting switches and sockets.

Slotted Screwdrivers

These are for use on slotted screws and have a flared tip on the end of a round or square section blade.

They are available in lengths up to 450mm with tip widths of 10mm. Normally a wider tip means a longer blade and larger handle.

However special purpose screwdrivers are available with wide tips and short blades – these are usually called **stumpy screwdrivers**.

Cross-point Screwdrivers

There are several types of crosshead screw in use. The most common are "Phillips" and "Pozidrive". The screws are made so that the screwdriver is located securely into the head. It is important that the correct screwdriver is used with the relevant screw as the heads are easily damaged and can be particularly difficult to remove.

Screwdrivers should not be used if the tip becomes damaged because it will not fit properly in the screw head.

Screwdriver handles are normally made from wood or plastic.

Screwdrivers should **not** be used as chisels.

Pliers

Pliers are gripping tools that are used to hold components that would otherwise be difficult to hold and control. They are made from forged steel with hardened and tempered jaws to resist wear. The following are common types of pliers:

Flat nosed pliers:

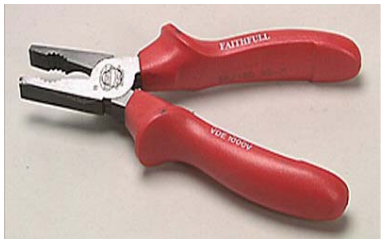
These are basic pliers used for gripping and holding.

Combination pliers:

These pliers are more versatile than flat nosed pliers and incorporate side cutters (for cutting wire), a pipe grip and joint cutters.

Electrical pliers:

These pliers are similar to combination pliers but with heavily insulated handles to withstand high voltages.



Pin nosed pliers:

These pliers are more delicate than the heavier pliers and are used for holding or bending small components where access may be limited.

Pliers should never be used to tighten or undo nuts or bolts as the heads of the nuts etc will be damaged by rounding the corners.

Multi-purpose pliers – these include circlip pliers and side cutting pliers:

Side cutting pliers

Side cutting pliers or snips – are used extensively in all areas of engineering to trim/cut wire.

Circlip pliers

Circlips are used to secure bearings, shafts, drives and valves etc.

The circlip must be removed using the proper circlip pliers to avoid damage to the circlip which can be reused.

Snips

These tools are used to cut sheet and thin material and there are several types in everyday use:

Straight snips - used for general purpose cutting, straight cuts and trimming excess material

Curved snips - are used for cutting circles or irregular shapes

Universal snips - have offset handles allowing cuts to be made in any direction and come in right and left-handed versions.

Jewellers' snips – are used on material or when small cuts are required.

All of the above operate in a similar way to a pair of household scissors.

Spanners

Spanners are used to hold or turn:

- bolts
- screws
- nuts etc.

Spanners are normally made from high tensile steel forgings and are often kept in sets covering a range of sizes.

Each spanner head is marked with its size. There are six types of spanners, each intended for use in different circumstances:

Open-ended spanner – this is the general purpose spanner widely used throughout engineering. Most spanners are double-ended with two heads fitting a different size of hexagon head.

Ring spanners – these do a similar job to the open-ended spanner but the hexagon head of the nut etc is surrounded by the spanner, which is easier to use when the swing of the spanner is restricted. The heads of nuts etc must be in good condition when using this spanner or it may slip in use.

Combination spanner – these have an open-ended spanner at one end and a ring spanner of usually the same size at the other end.

Adjustable spanner – these can be used instead of an open-ended or ring spanner. The jaws of the spanner are adjustable to accommodate various sizes of nuts etc within a certain range.

Box spanners – these are usually formed out of steel tube and are used when a nut etc is in a recess.

Hexagon socket wrenches

These are also called **Allen keys** and are made from a piece of hexagon bar bent at a right angle, and are used on hexagon socket head screws often found on bicycles. If the wrench develops rounded edges it should not be used as it is likely it will slip in the socket possibly injuring you.

Socket sets – these sets are made up of a range of socket heads with a selection of turning handles. They are invaluable when the nut etc is located in a fairly inaccessible position. The set will normally incorporate a range of sizes. This is the favourite set used by motor mechanics.

Drilling

- '**Drill'** refers to a **drilling machine**, or to a **drill bit** for use in a drilling machine.
- Drill bits are used to cut round holes and are held in the **chuck** of a drilling machine. The drilling machine is used to rotate the drill bit to cut the hole.
- Drills and drill bits come in a variety of different types and sizes depending on the application.
- The **twist drill** is the most widely used to cut holes in metals and plastics and is available with a parallel or **taper shank**.

Drilling Machines

The three main types of drilling machine used in engineering are:

- bench drill
- pedestal drill
- hand drill

Bench drill

The bench drill is mounted on a bench but cannot take large work pieces or drill large hole diameters (approximately 13mm maximum). The **spindle** is belt driven and the speed is changed by altering the position of the belt on a pair of stepped pulleys.

Pedestal drill

The pedestal drill is floor mounted and is a large and versatile drilling machine capable of drilling diameters up to 50mm or more with the use of additional tooling. The speeds are altered by selecting different gears through a lever system.

The pedestal drill can also take a range of drill sizes similar to the bench drill if required.

Hand drill

The hand drill is often found in the home - being used by the DIY enthusiast for small diameter holes - but also used in the engineering industry due to its portability. Some of the more powerful drills can drill diameters up to 20mm but these machines are heavy and require double insulation. Some drills are classed as cordless and need batteries for operation.

Safety when drilling

- Always use guard if available
- Wear goggles at all times when drilling
- Secure material or use a drill vice
- Never hold materials by hand
- Allow the swarf to clear the drill by drilling a small amount at a time
- Allow drill bit to stop before cleaning or adjusting material
- Isolate the drilling machine before adjusting speeds
- Follow safe working practices at all times
- Follow all Health and Safety instructions carefully.

Tapping and Threading

A **tap** is used to cut a **thread** on the inside of a hole, enabling a bolt or screw to be screwed into it, similar to the function of a nut. Taps come in a variety of thread diameters and thread types e.g. Metric, UNC, UNF, Whitworth.

Three different taps are required to cut a thread in a material.

These taps have different names and shapes:

- Taper tap
- Intermediate tap
- Plug tap

Taper tap

The taper tap, sometimes known as ‘number 1 tap’ is used to start the thread. This tap does not cut the thread too deeply and has only a very gradual cutting action.

Intermediate tap

The intermediate tap, sometimes known as ‘number 2 tap’ is used to cut a deeper thread and in many cases is the final tap used.

Plug tap

The plug tap, sometimes known as ‘number 3 tap’ is the final cutting tap for threaded holes and gives a good deep thread.

Tap wrench (Dwang)

The tap wrench holds the tap securely for thread cutting.

Practical Tip

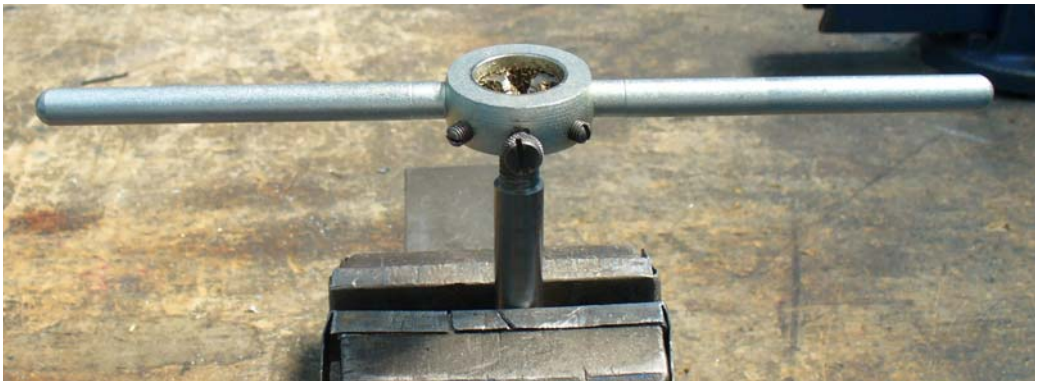
The tap cuts a cleaner thread if it is kept as clean as possible, so all swarf must be constantly cleaned away.

Button (Split) Die

A die is used to cut a thread on the outside of a bar or cylindrical section. Dies come in a variety of thread diameters and thread types e.g. Metric, UNC, UNF, Whitworth.

Unlike the tap, only 1 die is required to cut the thread. The die is split, hence the term split die, and is held in the holder which can be adjusted to give a shallow or deep cut thread.

To gain the shallow cut the centre adjusting screw is tightened to open up the split of the die, the outside adjusters are not tight at this time.



Tools for Work Holding

Vice

The vice is the most basic tool for any work bench. The jaws are made from hardened carbon steel with replaceable interchangeable jaws.

Clamp

Clamps are an essential tool in the workshop and come in a range of sizes. They are generally used for clamping work securely to a surface or workbench.

They can also be used to hold parts together during assembly.

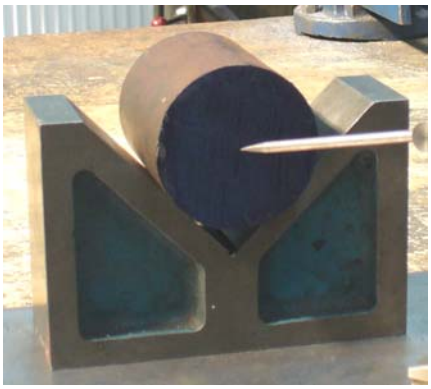
The frame of a **G-clamp** is normally made from drop-forged steel, with the thread bar made from hardened and tempered steel which means it does not wear with use.

Drill vice

The drill vice is used during the drilling operation to secure the material to the drill bed in order to stop the material from spinning or rotating.

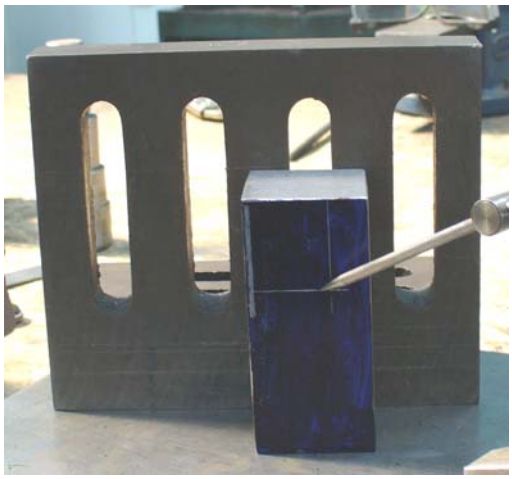
Vee block

The vee block is used to hold a round work piece in position for marking.



Angle bracket

The angle bracket is used to hold rectangular, square or flat work pieces in position for marking.



Footprints

This is a gripping tool that can be adjusted to have a narrow or wide grip and is used to hold and turn metal conduit, couplings.

It has serrated (grooved) jaws and will leave a noticeable mark if used wrongly.

It has a trademark small 'footprint' symbol imprinted on each tool hence the name.

Water Pump Pliers

Similar to footprints, this tool can also be adjusted to different jaw sizes to grip and turn.

This tool may also be found in a plumber's tool kit.

Plumbers and electricians use them mainly to tighten decorative chrome or 'bright' metal fittings.

Locking Pliers

The jaws on locking pliers can be locked to give a very secure grip of any engineering part.

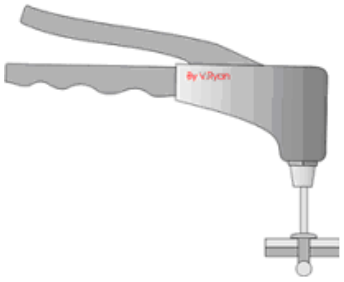
Closing the handles has the effect of locking the jaws into position; the jaws are released by pulling a special release lever. They are also known as **mole grips**.

Joining Methods

Riveting

Light gauge sheet metal work is usually joined by **'pop' riveting** which uses a special tool – sometimes called pop rivet pliers to close the rivet. This method has the advantage of completing the joint from one side.

- The rivet pliers are pushed on to the pin of the rivet and the handles are pulled together.
- As this happens the pin head is pulled into the rivet and the end of the rivet is expanded.
- Eventually the pin will break off leaving the rivet permanently fixed in position holding the two pieces being joined together.



- Solid riveting is used on thicker materials and can be carried out either hot or cold depending on the diameter of rivet.
- A rivet set is used to close the rivet by striking with a hammer.
- Solid rivets range in size from 3mm to 20mm diameter.

Bolting

- The key feature of bolted joints is that they can be dismantled comparatively easily.
- However they are costly in that frequently additional parts are needed (e.g. washer, nut) compared to riveted or welded joints and they require more skill/ effort to assemble.
- For these reasons they should only be used where there is a strong possibility that the parts will at some stage require to be separated.

There are several considerations when designing a bolted joint:

- Firstly the required clamping force (and hence size) of each bolt
- Secondly the distribution of the fasteners when more than one is needed (which will normally be the case).

There are several types of bolts depending on the application and these are supplied in relative material compositions. – Can you think of other types of bolt?

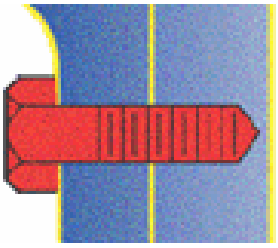



Bolts are tightened, sometimes to specified loads called **torque** (pronounced 'tork'), by spanners which are made from high tensile steel forgings.

Screwing

Screws can be used to join materials together permanently, although as they can be unfastened with relative ease they are also good as a way of fixing materials temporarily.

Screws are normally used to fit wooden materials such as chipboard, MDF and natural woods together although there is a type of screw called a **self-tapping screw** that can be used for joining thin metal sheet. A hole is drilled in the metal, a fraction smaller than the width of the screw. The self-tapping screw is then turned into the hole cutting a thread.



Machine screws are used in engineering for permanent fixings by tapping a thread in the hole of one of the materials and tightening the screw through the other material. The joint is frequently made permanent by the use of a thread locking liquid.

Adhesives

The main adhesives used in engineering are:

- general purpose
- impact
- epoxy resins
- jointing and sealing compounds

Adhesives are now widely used as an alternative to bolting, riveting and welding in the automotive and aerospace industries for **non-stressed** parts.

These adhesives are suitable only for lap joints.

All adhesives require a clean environment in which to work and this may include chemical or **abrasive** cleaning.

In the use of all of the above care should be taken in the handling of adhesives by:

- not allowing them on to your skin
- not breathing in the fumes
- following the manufacturer's instructions on the container at all times.

General purpose adhesives

General purpose adhesives are used for fixing light materials where no special conditions exist. This type of adhesive is put between the surfaces to be joined and allowed to dry or cure. It often comes in a single container.

Impact adhesives

Impact adhesives are used to bond large areas of flat materials together. The adhesive is placed on both surfaces and spread to fully cover each surface. The surfaces are left to nearly dry then carefully aligned and pressed together.

One of the surfaces is then firmly struck all over to create the final joint.

Epoxy resins

Epoxy resin adhesives are supplied in two parts – a resin and a hardener.

Check the manufacturer's instructions and mix the two parts together in the correct proportion. It is then essential that the mixed material is used as quickly as possible as it **cures** quickly in air and even faster if the **ambient temperature** is high.

The mixture is then spread on the surfaces to be joined and left for a prescribed time to harden. Some mixtures will be safe to handle in as little as 10 minutes although the joint will take longer to cure.

Jointing and sealing compounds

Jointing and sealing compounds are used to give a gas or watertight seal and modern compounds can now incorporate an adhesive. They are applied in a continuous bead using a tube or a cartridge applicator gun. The compounds are supplied in a variety of colours depending on their use.

Engineering Materials

The engineering material that you would use will normally be given in either the drawing or as part of the specification.

If you have to select a material suitable for a task, you will need to consider the following:

- material use
- service conditions
- environmental conditions
- cost.

Here are some examples of the materials that you might use in this course:

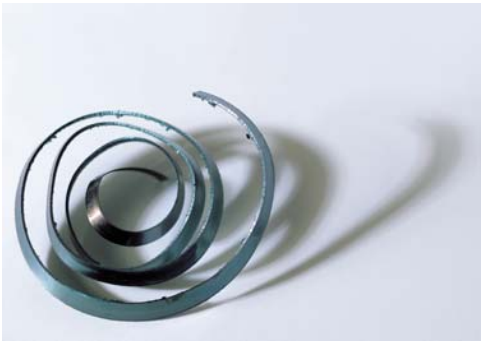
Plastic	Polyurethane	Polyvinyl Chloride (PVC)	
Metals	Copper	Aluminium	Brass
	Mild Steel	Stainless Steel	Tin
Others	Wood	Glass	Ceramics

The three ‘main’ groups of engineering materials used are:

- ferrous
- non-ferrous
- non-metallic.

Ferrous metals contain iron (this material will rust).

Non-ferrous materials don’t contain iron (this material will not rust or corrode).



Non-metallic materials contain no metals (generally these are resistant to corrosion).

An example of the use of each type of engineering material is shown on the next page.

Ferrous Material:

Steel structures – Eiffel Tower

Non-Ferrous Material:

Aircraft fuselage

Non-Metallic Material:

Computer keyboard

Selection of Material

At the start of every engineering task a decision has to be made about the most suitable material for the task, e.g. do you require a material that is:

- resistant to corrosion
- resistant to current
- waterproof
- rigid
- flexible, or
- impact resistant?

The meaning of these terms and their importance - properties of materials - are discussed later.

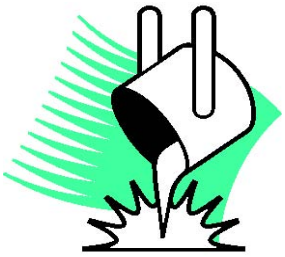
Because of its properties, the selected material could be ferrous, non ferrous or non metallic.

On this course you will need to know about:

- steel
- aluminium
- stainless steel
- copper, and
- plastics.

Ferrous Materials

Steel is one of the most common materials used by engineers and is ferrous. Remember ferrous means it can **rust** (corrode). Steel is a mixture of carbon and iron.
Steel can be supplied as either 'black' or 'bright' steel.



Black steel has a black, scaly surface and is the cheaper of the two.

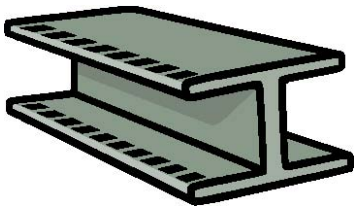
Bright steel does not have a scaly surface and is slightly more expensive.

Steel comes in many varieties, usually determined by the amount of iron and carbon in the steel. The amount of carbon which is added to the steel will change its properties.

Low Carbon Steel or Mild Steel

Mild steel is the cheapest steel and contains between 0.1% and 0.3% carbon. This steel can be shaped (ductile) at both high and low temperatures and is used for car body panels, forgings, rods and bars.

Medium Carbon Steel



This steel contains more carbon than mild steel; somewhere between 0.3% and 0.65%.
Medium carbon steel is stronger than mild steel and therefore is harder to form and cut.

Alloy

An **alloy** is a mixture of two or more materials, but at least one of the materials must be a metal. This mixture is to change the properties of the metal.

Alloy Steels

In **alloy steels** other materials such as chromium, tungsten, or cobalt are added to change the properties. This makes the steel very hard and tough, so that it is used for machine tools and it is rust resistant.

Tinplate

Tin was one of the first metals known to man. The use of the metal increased with advancing technology.

The largest single application of tin is in the manufacture of tinplate (steel sheet coated with tin), which accounts for about 40% of total world tin consumption. This process makes the steel non-corrosive, but care must be taken when working with the material not to scratch the surface as the atmosphere will attack the steel base.

The traditional method of making tinplate has changed over the years. In modern production tinplate can be produced with either equal or unequal amounts of tin on the two surfaces of the steel base metal. Tinplate is produced in thicknesses from 0.15 to 0.60 mm.

Over 90% of the world's production of tinplate is used in making containers (tin cans). Tinplate cans find their most important use in the packaging of food products, including beer and soft drinks. Tinplate cans are also used for holding paint, motor oil, disinfectants, detergents and polishes.

Other applications of tinplate include the fabrication of:

- signs
- toys
- gaskets
- containers (e.g. for **pharmaceuticals**, cosmetics, fuels), and
- numerous other commodities.

Non Ferrous Materials

Remember **non-ferrous** materials usually contain **no iron**.

Aluminium

Aluminium is manufactured from a naturally occurring material called bauxite, which is then refined by a process called smelting. Pure aluminium is seldom used as it is very soft. However it's often alloyed with other materials to give it strength and other properties.

Characteristics of aluminium:

- light, silvery grey appearance
- light in weight
- cannot rust
- easy to shape.

Aluminium is used to make:

- paints
- motor car parts
- kitchen ware
- aeroplanes, and
- aluminium foil (cooking).

Stainless Steel

Stainless steel was developed by Harry Brearley around 1913, and was originally called ‘rustless steel’ but this was later changed to ‘**stainless steel**’.

Stainless steel is an iron-carbon alloy containing a high percentage of chromium. The name ‘stainless’ originates from the fact that stainless steel does not stain, corrode or rust as easily as ordinary steel.

Common uses of stainless steel are:
cutlery, kitchen appliances, watch straps, medical and dental instruments,

There is more than one type of stainless steel. Each stainless steel is manufactured to have different properties and uses.

The three main types of stainless steel are:

- ferritic
- martensitic
- austenitic

Depending on the application of stainless steel, different chemical and physical characteristics can be achieved alloying with other elements, for instance:

- resistance to heat
- resistance to cold
- high strength
- resistance to corrosion.

Activity

Using a suitable resource find out what each type of stainless steel is used for.

Austenitic is used for:

Martensitic is used for:

Ferritic is used for:

Answers to Activity

Austenitic is used for kitchen sinks.

Martensitic is used for cutlery.

Ferritic is used for surgical instruments.

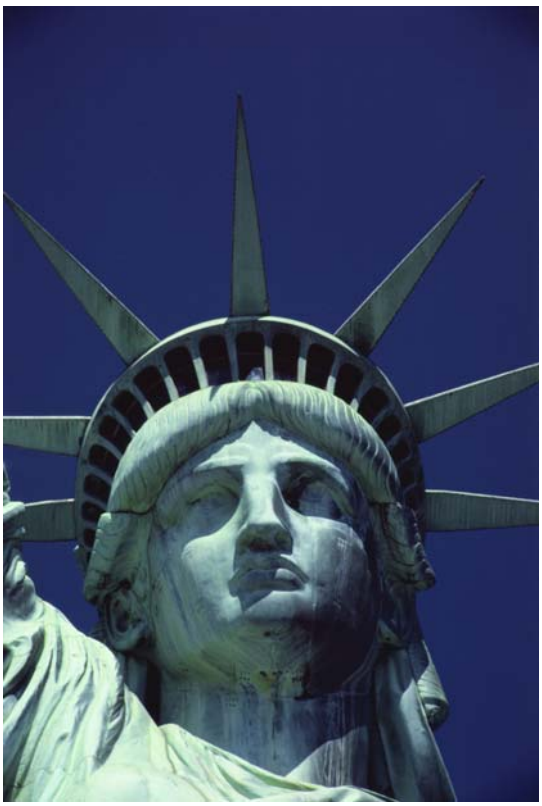
Stainless Steel is used:

in the house	-	crockery, cutlery, pots and pans, sinks, barbecues and garden furniture
in town	-	telephone kiosks, bus shelters, bus and train stations
in industry	-	pipes, tanks, valves and containers.

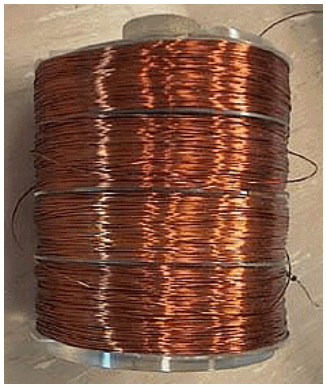
Copper

Copper is a naturally occurring metal that has been used in various societies for thousands of years. Copper is a relatively soft metal that is easy to shape and form. Copper is also a very good conductor of both heat and electricity.

The Statue of Liberty which was given to the United States of America by France is made of copper and like all copper that is exposed to the elements it has turned a green colour.



Copper is usually alloyed with tin to produce bronze and alloyed with zinc to produce brass.



Brass

Brass is used extensively in the electrical and plumbing trades. It's also used in jewellery, musical instruments, door fittings, ornaments and tourist souvenirs.

Characteristics of brass:

- alloy of copper and zinc
- yellow colour, (similar to gold)
- good conductor
- resistant to corrosion
- easy to shape.

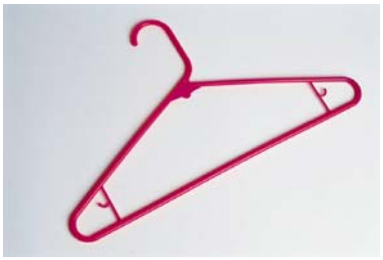
Other non-ferrous materials are: copper, gold, silver, lead.

Non-metallic Materials

Non-metallic materials are increasingly used across industry. More plastic and plastic composite materials are being used because they are **strong**, **lightweight** and will **not corrode**.

Metals were used previously for many of the applications but are now considered unsuitable. Metal used in a production line can slow the process.

Plastics



There are two basic types of plastic:

- thermosetting
- thermoplastic.

Thermosetting plastics

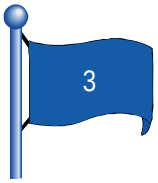
- cannot be re-softened after being subjected to heat and pressure
- are used to make: casings, car parts and electrical sockets.

Thermoplastic plastics

- can be repeatedly softened and remoulded by heat and pressure
- are used to make: tubing, electrical cable insulation and frames for double glazed windows.

Plastics are so long lasting (**durable**) that they won't rot or decay as do natural products such as those made of wood. As a result, huge amounts of used plastic products end their life as waste. Plastics are difficult to recycle, whereas paper waste is not so difficult to recycle.

Other non-metallic materials are: glass, ceramics, wood, concrete, brick.



Activity: Engineering Materials

Fill in the table below.

List 3 commonly used materials in each category – ferrous, non-ferrous and non-metallic.

Type of Material		
Ferrous	**Non Ferrous**	**Non Metallic**

Suggested Answer

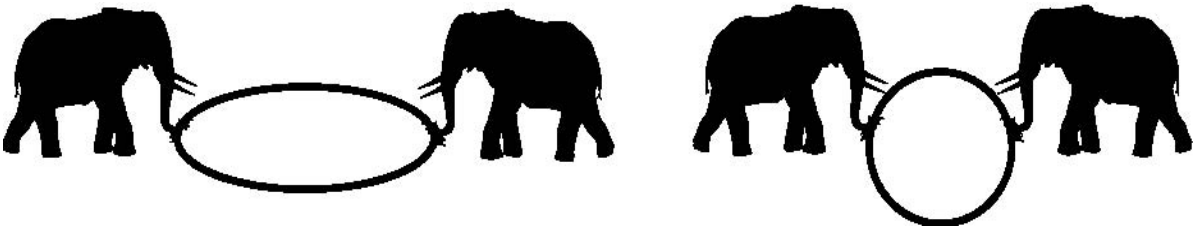
Some materials for each category are included in the table:

Type of Material		
Ferrous	**Non Ferrous**	**Non Metallic**
Low Carbon Steel	Brass	Plastic
Medium Carbon Steel	Aluminium	Glass
Alloy Steel	Copper	Wood

Properties of Materials

It's important to understand something about the properties of materials so that the right material can be selected for the right job. It's also important to remember that the cost might be what decides the material that's selected. There are many ways to describe material properties, the more common ones are listed below.

Elasticity is the ability of a material to return to its original size and shape after being stretched or pulled out of shape.



In the picture above the elephants have stretched the rubber ring. Notice though in the diagram how it returns to its original shape.

Plasticity is the ability of a material to change in shape permanently.

This happens when a molten metal is poured into a mould and is allowed to cool. The same thing happens when a joint is soldered. The solder becomes plastic, then sets as a soldered joint.

Ductility is the ability of a material to be drawn or stretched permanently without breaking. A good example would be copper that is drawn into fine wire or pipes for water.
Metals that lack ductility will crack or break before bending

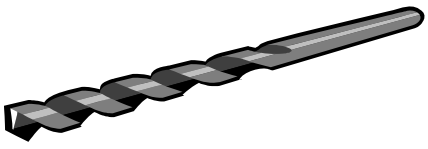
Malleability is the ability of a material to be hammered, rolled, or pressed into various shapes without breaking.

A blacksmith uses the malleability of metal to construct horse shoes

Toughness is the ability of a material to resist fracture, plus the ability to resist breaking after the damage has begun. A tough metal can withstand considerable stress, slowly or suddenly applied, and will change shape before breaking.

A cold chisel needs to have the property of toughness to withstand the impact from the hammer and the impact on the artefact being chiselled.

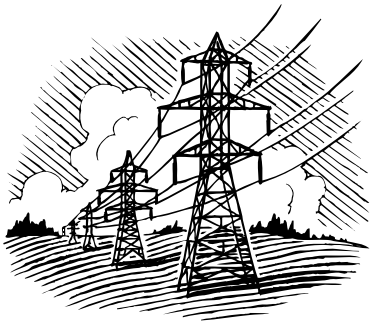
Hardness is the ability of a metal to resist being holed, scratched or worn away by another metal or material. It takes a combination of hardness and toughness to withstand heavy pounding. The hardness of a metal limits the ease with which it can be machined, since toughness decreases as hardness increases. The hardness of a metal can usually be controlled by heat treatment.



Brittleness is when material fractures or breaks with little or no deformation (change of shape), bending, or twisting. Brittleness is not usually a desirable mechanical property for a metal. Normally, the harder the metal, the more brittle it is.

Compare a glass bottle to a plastic bottle. Which one is brittle if dropped onto a concrete floor?

Electrical conductivity is the ability of a material to let a current flow.



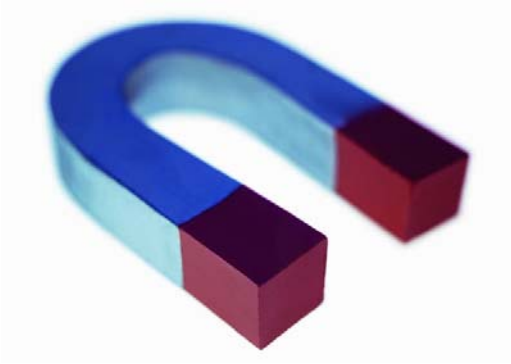
Silver, gold and copper have good conductivity but silver and gold are too expensive to be used for electrical wiring, so copper is widely used.

Electrical Insulation is the ability of a material **not** to allow a current to flow and is the opposite of conductivity.

Plastic and rubber are good insulators and are therefore used to cover copper wires to stop the wires from touching each other or from touching us.

Thermal conductivity is defined as how easily the material conducts or transfers heat.

Magnetism is the ability of a material to become magnetised.



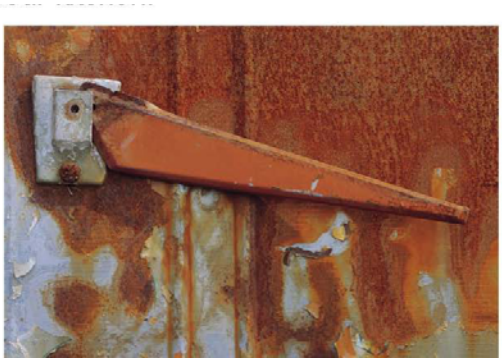
Materials containing iron can be magnetised by:

- coming into the influence of an existing magnetic field, or
- having an electric current passed through them.

Magnets are used in industry for various purposes e.g. holding work pieces; lifting scrap cars.

Modern manufactured magnets are very strong, light in weight and can be made into almost any shape.

Corrosion resistance is the ability of a material to resist chemical attack. Corrosion can come from many sources including water, air or chemical agents. Compare a piece of metal that has been left outside to a stainless steel sink unit inside.

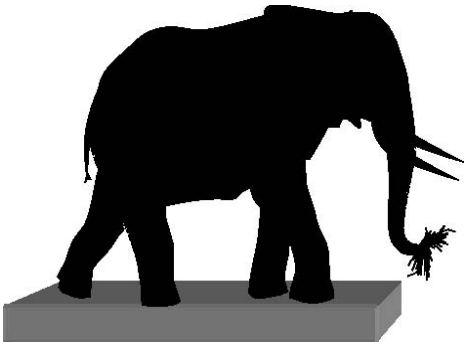


Machinability and **weldability** are terms describing the ease or difficulty with which a material can be machined or welded.

Strength is the ability of a material to stand up to forces being applied without it bending, breaking, shattering or deforming in any way.

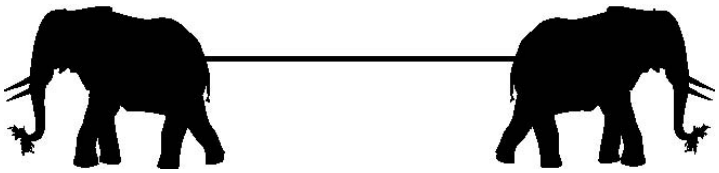
In the diagram shown, the elephant is standing on a metal plinth, yet the plinth does not change shape in any way.

Imagine what would happen if the plinth was constructed from cardboard.



Shear strength is the ability of a material to resist being split. If a material fails by shearing, it splits into two parts that slide past each other.
Shear strength can be controlled by varying the hardness and toughness of the material.

Tensile strength is the ability of a material to resist being pulled apart by opposing forces acting in a straight line.



In the diagram above the elephants are pulling a steel rod in opposite directions to test the tensile strength.

Compressive strength is the ability of a material to withstand pressures acting on a given face or plane.

Activity: Material Identification

Your tutor will show you a selection of numbered materials – fill in the table with:

- what the material is called
- what the material can be used for
- the property the material possesses.

Use simple workshop tests to identify the materials.

Material	Material Name	Use	Mechanical Property
1			
2			
3			
4			
5			

Suggested Answer: Material Identification

A selection of sample answers for different materials:

Material	Material Name	Use	Mechanical Property
1	Low Carbon Steel	Car Body	Malleability
2	Brass	Plug Top	Good Conductor
3	Aluminium	Aircraft Fuselage	Lightweight
4	Stainless Steel	Kitchen Sink	Non Corrosive
5	Plastic	Electrical Socket	Poor Conductor

Review Sheet

As part of your development of employability skills you'll be asked to complete Review Sheets that will plot your progress throughout the course/unit.

The **Review Sheet** is rather like a strength and weakness table. The process of reviewing your progress will be a big challenge for you, especially the first time you are asked to do it.

In almost every modern job every employee is interviewed at least once a year to review their progress and development in their job.

This is necessary because the employee may think that he/she is doing a great job but the employer may not agree, or he/she might want to go on a training course to develop specific skills, for example.

It is also right that the employer and employee discuss appropriate training/development that may be required.

During the process of completing the review sheet your tutor will help you because it is a difficult process but will become easier in time.

It's important that you are honest when you review your own progress. There is no point in trying to 'cheat' by rating yourself higher than you really are in any particular skill.

This is not like an exam where you have to get as good a mark as possible. This is all about knowing what you are good at and recognising what you need to get better at.

Skills, both employability and practical, have to be practised and the review sheet is merely a snapshot of where you are at any moment.

Remember this review process is important to employers, and if completed honestly, will be one way of showing a positive attitude to learning.

With support from your tutor here is how the process should work:

Review and Evaluation

Stage 1

After you've completed several practical activities, your tutor will talk to you about the review process and will ask you to complete your first review.

Stage 2

Your tutor will issue you with the Employability Review Sheet. Read it carefully and remember if you are unsure – ask. Complete *Section 1.* remember to be as honest as you can.

Stage 3

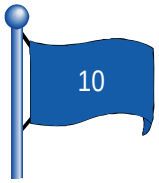
Your tutor will now also complete Section 1 giving a rating of your employability skills.

Stage 4

The tutor and you should now agree a common rating of your skills and agree any action, if improvement/development is necessary.

Stage 5

Complete *Section 2*: remember to be as honest as you can. On completion of both *Sections 1 and 2* sign and date at the bottom. Ensure your tutor signs the sheet as well.



Self Assessment - Activity

Read through this paragraph and fill in the missing words (sometimes letters have been provided to help you). Once you have filled in the words, find them in the word search on the following page.

Engineering S _ _ _ _ _ are abilities you learn that are used for carrying out jobs in the engineering sector. The engineering sector can be concerned with over 20 different industries including El _ _ _ _ _ _ _ _ , Ae _ _ _ _ _ _ _, M _ _ _ _ _ _ _ _ _ _, Au _ _ _ _ _ _ _ _ and F _ _ _ _ _ _ _ _ _ _ _ .

This course is different from many other school subjects because you are going to actually take part and have a go at many of the activities. It is also different because it includes e_ _ _ _ _ _ _ _ _ _ _ y skills, which make us more attractive to prospective employers.

In the engineering sector, the main employability skills include attendance and being p _ _ _ _ _ _ _ – if I don't turn up ready to start work on time, it will affect how well I do and if I am working with other people, lateness could actually affect the progress of the work.

I will also have to plan and prepare for p _ _ _ _ _ _ _ _ work: this means getting all my tools, m _ _ _ _ _ _ _ _ and e _ _ _ _ _ _ _ _ ready before I start work. When I am not sure about what an instruction is all about, I must ask the tutor and then _ _st_ _ very carefully to the answer.

This will be a working en _ _ _ _ _ _ _ _ _ and I could be putting myself and others at r _ _ _ if I don't recognise a particular h _ _ _ _ _ and try to follow instructions very carefully.

This course is all about learning by doing and reflecting on how well things went; this is called self _ _ _ _ _ _ _ _ _ _. I also have to be able to take some feedback

and constructive criticism from the tutor; this will lead to me becoming a more em

_ _ _ _ able person in the end of the day!

Suggested Answers

Self-assessment exercise

The missing words are inserted on this page.

Engineering **Skills** are abilities you learn that are used for carrying out jobs in the engineering sector. The engineering sector can be concerned with over 20 different industries including **Electronic, Aerospace, Mechanical, Automotive** and **Fabrication**.

This course is different from many other school subjects because you are going to actually take part and have a go at many of the activities. It is also different because it includes **employability** skills, which make us more attractive to prospective employers.

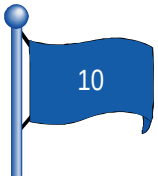
In the engineering sector, the main employability skills include attendance and being **punctual** – if I don't turn up ready to start work on time, it will affect how well I do and if I am working with other people, lateness could actually affect the progress of the work.

I will also have to plan and prepare for **practical** work: this means getting all my tools, **materials** and **equipment** ready before I start work.

When I am not sure about what an instruction is all about, I must ask the tutor and then **listen** very carefully to the answer.

This will be a working **environment** and I could be putting myself and others at **risk** if I don't recognise a particular **hazard** and try to follow instructions very carefully.

This course is all about learning by doing and reflecting on how well things went; this is called self **evaluation**. I also have to be able to take some feedback and constructive criticism from the tutor; this will lead to me becoming a more **employable** person in the end of the day!



Activity

Self-assessment - Word Search

List of words:

Automotive	**Evaluation**	**Punctual**	**Employability**
Mechanical	**Employable**	**Electronic**	**Aerospace**
Fabrication	**Listen**	**Risk**	**Practical**
Skills	**Materials**	**Hazard**	**Environment**

E	A	U	T	O	M	O	T	I	V	E	A
M	C	I	N	O	R	T	C	E	L	E	T
P	P	Q	S	F	R	H	A	R	R	T	N
L	U	P	K	A	I	R	T	O	S	N	E
O	N	N	I	B	S	E	S	M	T	E	T
Y	C	O	L	R	K	P	L	E	L	M	S
A	T	I	L	I	A	L	A	C	A	N	I
B	U	T	S	C	D	I	I	H	C	O	L
I	A	A	E	A	R	T	R	A	I	R	S
L	L	U	W	T	A	T	E	N	T	I	K
I	S	L	A	I	Z	L	T	I	C	V	I
T	O	A	T	O	A	I	A	C	A	N	L
Y	L	V	E	N	H	S	M	A	R	E	M
E	D	E	L	B	A	Y	O	L	P	M	E

Answer to Self-Assessment – Word Search

List of words:

Automotive, Evaluation, Punctual, Employability, Employable, Listen, Hazard, Risk, Mechanical, Electronic, Fabrication, Aerospace, Skills, Materials, Practical and Environment.

E	***A***	***U***	***T***	***O***	***M***	***O***	***T***	***I***	***V***	***E***	**A**
M	***C***	***I***	***N***	***O***	***R***	***T***	***C***	***E***	***L***	***E***	T
P	***P***	Q	***S***	***F***	***R***	H	A	R	***R***	***T***	***N***
L	***U***	P	***K***	***A***	***I***	R	T	***O***	S	***N***	***E***
O	***N***	***N***	***I***	***B***	***S***	E	***S***	***M***	T	***E***	***T***
Y	***C***	***O***	***L***	***R***	***K***	***P***	***L***	***E***	***L***	***M***	***S***
A	***T***	***I***	***L***	***I***	***A***	L	***A***	***C***	***A***	***N***	***I***
B	***U***	***T***	***S***	***C***	***D***	I	***I***	***H***	***C***	***O***	***L***
I	***A***	***A***	***E***	***A***	***R***	T	***R***	***A***	***I***	***R***	S
L	***L***	***U***	W	***T***	***A***	T	***E***	***N***	***T***	***I***	K
I	S	***L***	A	***I***	***Z***	L	***T***	***I***	***C***	***V***	I
T	O	***A***	T	***O***	***A***	I	***A***	***C***	***A***	***N***	L
Y	L	***V***	E	***N***	***H***	S	***M***	***A***	***R***	***E***	M
E	D	***E***	***L***	***B***	***A***	***Y***	***O***	***L***	***P***	***M***	***E***

Engineering Skills Course Evaluation Questionnaire

To help us to make the first steps of this course easier for new students, we'd be grateful if you would take a few minutes to complete and return this survey.

Please show how far you agree with the following statements by circling the appropriate number. Circle n/a (not applicable) if you feel unable to comment.

Many thanks

Course: _____ **Date**: _____

		Agree completely	Agree mostly	Disagree mostly	Disagree completely	Not applicable
1	The course lived up to my expectations	4	3	2	1	n/a
2	Staff involved in delivery of the course were approachable, helpful and supportive in their teaching	4	3	2	1	n/a
3	Things seemed well organised	4	3	2	1	n/a
4	I spent more time outside, learning new skills than in the classroom	4	3	2	1	n/a
5	I now have a better understanding of what employability skills are	4	3	2	1	n/a
6	I now know the importance of self-evaluation and review in all aspects of my life	4	3	2	1	n/a
7	I now have a better understanding of health and safety awareness and practice in the workplace	4	3	2	1	n/a
8	I enjoyed my time on this course and feel that it is a good way to learn	4	3	2	1	n/a
9	I believe that I am now more 'employable' in the engineering sector as a result of studying this course	4	3	2	1	n/a

Now, please answer the following questions about the engineering skills course:

1. The thing(s) I liked best about the course was:

_____

_____

_____

_____

_____

2. The thing(s) I liked least about the course was:

_____

_____

_____

_____

_____

3. What I think could improve the course is:

_____

_____

_____

_____

_____

Many thanks for taking the time to complete this questionnaire.

Glossary of Terms

Term	Meaning
Alloy	a material that is added to another to improve its properties
Ambient Temperature	the temperature of the surroundings
Austenitic Stainless Steel	Austenitic stainless steel is non-magnetic and has excellent corrosion and heat resistance.
Brittleness	Brittleness is when material fractures or breaks withlittle or no change of shape, bending, or twisting.
Calibrated	the setting of an instrument or tool to be accurate before use
Computer Aided Drawing	CAD also called Computer Aided Drawing (or Computer Aided Design or Computer Assisted Drafting) uses computer software and systems to design and create 2D and 3D drawings of goods and products as used in engineering or architectural drawings.
Combustible	able to catch fire
Compensation	usually a monetary sum to cover an injury gained through the neglect of someone else.
Continuity Test	an electrical test to check a circuit is complete.
Corrosion resistance	Corrosion resistance is the ability of a material to resist chemical attack.
COSHH	Control of Substances Hazardous to Health Regulations
Cures	the process in which adhesives will set or harden
Dimensional Test	a check that will verify that all measured sizes of an artefact or engineering part are accurate
Digital Instrument	an instrument with a readout that is numerical
Ductility	Ductility is the ability of a material to be drawn or stretched permanently without rupture or fracture.
Elasticity	Elasticity is the ability of a material to return to its original size and shape after being stretched or pulled out of shape.
Electrocution	from an electric shock – usually fatal

Ferritic Stainless Steel	Ferritic stainless steel is magnetic and has good heat and corrosion resistance but is not as strong as Austenitic.
Functional Test	a check that will verify that an artefact or engineering part works correctly.
Hardened and Tempered	a process that uses heat to make tools hard and tough in use
Hardness	Hardness is the ability of a metal to resist being holed, scratched or worn away by another metal or material
Magnetism	Magnetism is the ability of a material to become magnetised.
Maintenance	repairing or routine servicing of a component or part
Malleability	Malleability is the ability of a material to be hammered, rolled, or pressed into various shapes without rupture or fracture.
Manufacture	making a component or part
Martensitic Stainless Steel	Martensitic grades is magnetic and is the hardest of all the stainless steels but is not as corrosive resistant as Austenitic or Ferritic.
Micrometer	an instrument used for measuring diameter to a high degree of accuracy
Pharmaceuticals	making of medicines
Plasticity	Plasticity is the ability of a material to change in shape permanently.
PPE	Personal Protective Equipment
Recycle	Common materials such as paper, plastic, metal and glass can be used again and again thus saving on raw materials.
Regulations	rules that are used for safety etc.
Resistant	will not rot or wear away
Specification	a list of what is required to manufacture a component or part
Strength	Strength is the ability of a material to stand up to forces being applied without it bending, breaking, shattering or changing shape in any way.
Stainless Steel	an alloyed steel that was developed to be corrosion resistant
Swarf	sharp metal cuttings usually from machining

Thermal conductivity	Thermal conductivity is defined as how easily the material conducts or transfers heat.
Thermoplastic	can be repeatedly softened and remoulded by heat and pressure
Thermosetting	cannot be re-softened after being subjected to heat and pressure
Torque	specific preset load
Toughness	Toughness is the ability of a material to resist fracture, plus the ability to resist cracking or breaking after the damage has begun.
Two/Three Dimensions	how a drawing is displayed on a screen
Vernier	a small scale for precise readings