# Production Technology 11 and 12

*Guide*

NOVA SCOTIA
NOUVELLE-ÉCOSSE

1996

Website References

Website references contained within this document are provided solely as a convenience and do not constitute an endorsement by the Department of Education of the content, policies, or products of the referenced website. The department does not control the referenced websites and subsequent links, and is not responsible for the accuracy, legality, or content of those websites. Referenced website content may change without notice.

Regional Education Centres and educators are required under the Department's Public School Programs Network Access and Use Policy to preview and evaluate sites before recommending them for student use. If an outdated or inappropriate site is found, please report it to <curriculum@novascotia.ca>.

Production Technology 11 and 12


Prepared by the Department of Education and Early Childhood Development

This is the most recent version of the current curriculum materials as used by teachers in Nova Scotia.

# Production Technology 11 and 12

Curriculum Guide No. 148

1996

NOVA SCOTIA

Education

# PRODUCTION TECHNOLOGY 11 & 12

## PDT 11 & 12

Teaching Guide No. 148
August 1996

ISBN: 0-88871-383-5

For many years Eric Worden, Industrial Arts Technology Consultant with the Department of Education and Culture, undertook the difficult task of updating Industrial Arts Technology Curricula in this province. The curriculum guidelines for the final three courses, Production Technology, Communications Technology, and Energy, Power and Technology, mark the culmination of this work. These three documents are a memorial to Eric, who passed away in February, 1996, less than one month before they were presented at in-services for Nova Scotia's Industrial Arts Technology teachers.

# Table of Contents


Rational . . . . . 1

Learning Outcomes . . . . . 1

How to Offer the Production Technology 11 and 12 Courses . . . . . 1

- Production Technology 11: Custom or Mass Production . . . . . 2
- Production Technology 12: Entrepreneurship . . . . . 2
- Production Technology 11 and 12: Using Computers . . . . . 2

Links with Essential Graduation Learnings and Other Subject Areas . . . . . 2

- Communications . . . . . 2
- Citizenship . . . . . 3
- Science . . . . . 3
- Mathematics . . . . . 4
- Business Education/Entrepreneurship . . . . . 4

Suggested Teaching Strategies . . . . . 5

- Discussion . . . . . 5
- Inventing and Brainstorming . . . . . 5
- Technology Learning Activities . . . . . 5
- Cooperative Small Group Learning . . . . . 5
- The Design Problem Solving Process . . . . . 6
- Demonstrations . . . . . 6
- Lectures . . . . . 6
- Product Analysis . . . . . 6
- Learning Contracts . . . . . 6
- Neutral Questioning Techniques . . . . . 6

Production Technology in Different Cultures . . . . . 7

Assessment of Student Progress . . . . . 8

- Rationale . . . . . 8
- Assessment: An Integral Part of Teaching . . . . . 8
- Skills to be Assessed . . . . . 8
- Assessment of Performance . . . . . 9
- Formative Assessment . . . . . 10

Programming for Students with Special Needs . . . . . 10

- Planning for Students with Special Needs . . . . . 10
- Additional Techniques . . . . . 11
- Assessment . . . . . 13

Careers in Production and Design . . . . . 14

Co-operative Education and Job Shadowing . . . . . 14

Links with Industry and Business . . . . . 14

Model Production . . . . . 14
Concurrent Engineering . . . . . 15
Engineering Materials . . . . . 15

Safety Program . . . . . 15

Safety Considerations . . . . . 15
Safety Checking . . . . . 16
Precautions against Fire and Other Disasters . . . . . 16
First Aid . . . . . 17
Colour Coding . . . . . 17
Safe Machine Operation . . . . . 18
Lasers . . . . . 18
Video Display Terminals (VDTs) . . . . . 19
Working with Polymer Materials . . . . . 19

Entrepreneurship Options . . . . . 19

Option A--A School Production Lab . . . . . 19
Option B--A Research, Design, and Engineering Lab . . . . . 21
Option C-- A Custom Craft Business . . . . . 25

Unit 1 - Production and Humans . . . . . 28

Outcomes . . . . . 28
Content . . . . . 28
Sample Activities . . . . . 29

Unit 2 - Resources for Production . . . . . 32

Outcomes . . . . . 32
Content . . . . . 32
Sample Activities . . . . . 34

Unit 3 - Manufacturing . . . . . 36

Outcomes . . . . . 36
Content . . . . . 36
Sample Activities . . . . . 37

Unit 4 - Product Analysis . . . . . 39

Outcomes . . . . . 39
Content . . . . . 39
Sample Activities . . . . . 40

Unit 5 - Construction Production . . . . . 41

Outcomes . . . . . 41
Content . . . . . 41
Sample Activities . . . . . 42

Unit 6 - Computers and Manufacturing . . . . . 43

Outcomes . . . . . 43
Content . . . . . 43
Sample Activities . . . . . 43

Unit 7 - Future Production and Careers . . . . . 45

Outcomes . . . . . 45
Content . . . . . 45
Sample Activities . . . . . 45

Technology Learning Activities (TLAs) . . . . . 47

TLA #1 - Composite Materials . . . . . 47
Introduction . . . . . 47
Outcomes . . . . . 47
Terminology . . . . . 47
Procedure . . . . . 47
Background Information . . . . . 48
More Background Information . . . . . 48
Related Activities . . . . . 48

TLA #2 - Poly Materials . . . . . 50
Introduction . . . . . 50
Outcomes . . . . . 50
Terminology . . . . . 50
Procedure . . . . . 50
Background Information . . . . . 50

TLA #3 - Metal Materials . . . . . 52
Introduction . . . . . 52
Outcomes . . . . . 52
Terminology . . . . . 52
Procedure . . . . . 53

TLA #4 - Ceramic Materials . . . . . 55
Introduction . . . . . 55
Outcomes . . . . . 55
Terminology . . . . . 55
Procedure . . . . . 55

TLA #5 - Product Modelling and Product Analysis . . . . . 57
Introduction . . . . . 57
Outcomes . . . . . 57
Terminology . . . . . 57
Procedure . . . . . 58
Extended Activity . . . . . 58
Background Information . . . . . 59

TLA #6 - Design a Barrier Free Workshop . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 61
Introduction . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 61
Outcomes . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 61
Terminology . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 61
Procedure . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 61
Background Information . . . . . . . . . . . . . . . . . . . . . . . . . . 61

TLA #7 - Production Management . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 62
Introduction . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 62
Outcomes . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 62
Terminology . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 62
Procedure . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 62
Background Information . . . . . . . . . . . . . . . . . . . . . . . . . . 63

TLA #8 - Ideas for In-depth Research Projects . . . . . . . . . . . . . . . . . . . . . . . . . 64

# Production Technology 11 & 12

**Production Technology 11** and **Production Technology 12** are each full credit courses available for all senior high school students. Since they are activity-based courses, it is recommended that extended class periods be scheduled for them in the timetable. Class size should take safety into account.

Production is the rendering of a product or service into useable form, giving added value. This involves the seven M's of production: management, material, manpower, machines, market, money, and methods.

## *Rationale*

Using material processes and systems to produce artifacts to improve the quality of existence is commonly referred to as production technology. The first artifacts were produced entirely by hand in limited numbers, but later the concept of mass-producing items evolved. In this century ways of automating mass production have developed. Production technology includes not only manufacturing of relatively small items but also the construction of larger products such as houses and buildings. These constructed products are usually composed of items that are mass produced, although many components are also custom produced.

Students involved in Industrial Arts Technology Education have traditionally been involved with various aspects of Production Technology. These courses continue this orientation, but emphasize appropriate areas of new technology, processes, and systems.

## *Learning Outcomes*

The seven units of Production Technology have specific indicators of the learning outcomes.

By the end of the course students will be able to demonstrate an understanding of production technology. They will be able to demonstrate

- an understanding of the function of production technology in historical contexts and modern society
- the ability to analyse, critique, and evaluate the application and outputs of a variety of production technology methods
- an understanding of the major resources used for production
- an understanding of the impact of production technology on individuals, society, and the environment
- consideration of others during independent and collaborative activities
- an understanding of workplace health and safety requirements

## *How To Offer The Production Technology 11 and 12 Courses*

This curriculum document outlines the seven units available for the composition of two courses: Production Technology 11 and Production Technology 12. The two courses have different emphases but some aspects of all seven units should be covered in each course.

### *Production Technology 11: Custom or Mass Production*

The exact design of each course is at the teacher's discretion. Production 11 is not a prerequisite for Production 12; however students should be encouraged to complete Production 11 before enrolling in Production 12. Production I should have an emphasis in either custom or mass production or a mix of both. Either of these can involve students in the production of a product or products that use one main material or a combinatiou of materials.

### *Production Technology 12: Entrepreneurship*

The nucleus of Production Technology 12 is entrepreneurship. Three options are provided as examples. It is not intended that these three options he offered at the same time hut, in some situations two or three options may be offered simultaneously. Their purpose is to simulate the operation of a business enterprise; and the three choices should provide a range of options to meet the local needs of the student. It is recommended that the 'co-operative entrepreneurship' model be used as the model for the business operation and that close co-ordination with the husiness education department be established.

### *Production Technology 11 and 12: Using Computers*

The Computers and Manufacturing unit is common to each course. In many cases computers will he used to support the implementation of entrepreneurship, using word processors, spreadsheets, and desktop publishing programs to facilitate the development and marketing of a product, as well as to design "on time" cards and production schedules. Computers can also be used to facilitate the operation and control of a machine for custom production.

## *Links With Essential Graduation Learnings And Subject Areas*

### *Communication*

There are mauy possibilities for using production technology studies to develop communication. Students can

- make spoken and written presentations of production technology design proposals
- use books and data bases to research production techuology problems and processes
- use text in a variety of media, including guide books, textbooks, consumer reports, instructional manuals, information leaflets, directions, coutracts, brochures, newspapers and magazines, publicity materials, and electronically-restored information

Students will also have opportunities to write in a range of forms aud for a range of purposes, including describiug, explaining, giving instructions, aud reporting simple activities, which could include, for example:

- joint projects to develop career profiles and case studies of Canadian production companies
- the importance of advertisements and the use of English language and commuuication for the success of production technology and the sale of products
- safety reports and accident reports
- compiling production reports
- time and motion studies

- formulating research papers on various production topics, such as materials, ergonomics, plant layout, jig composition
- developing business plans
- writing letters for loans
- writing advertisement jingles, etc.
- developing marketing reports
- writing operational manuals, assembly manuals, and how-to-use manuals;
- writing advertising posters, newspaper ads, and radio and television commercials for the sale of a product
- writing applications and resumes and job descriptions

### *Citizenship*

Early humans were hunters and gatherers of food such as nuts, fruits, vegetables, and animals for meat. Natural materials such as straw, animal hides, wood, and stones were collected and fashioned into useful tools, utensils, clothing, and shelter to protect them from the different seasons and changes in climate. For example, flint was used to make cutting tools, and metallic ores of copper and iron were smelted to produce copper and iron that could be fashioned into durable tools for hunting and huilding shelters.

Originally the products were made by hand: in fact, the word manufacturing comes from the Latin *manufactus* meaning "made by hand." Manufacturing has come to mean making products either by hand or by machine especially in a factory. Today most common products are made in factories using sophisticated machines. The Industrial Revolution of the 1700 and 1800s was crucial in this change from hand to machine production. Production and mass production have been crucial in the development of our present standard of living. Production technology, therefore, is closely interrelated with historical and social development of human beings. Some specific ideas for correlation with social studies are as follows:

- study of some of the early pioneers of production technology, such as Henry Ford, Richard Arkwright, James Hargreaves, etc.
- study of how it would have been to live in the era of the Industrial Revolution, hours of the working day, the kind of work, and provision for school
- the current effects of production on the world's environment, as well as on the standard of living; noise in work areas
- other safety and health programs in relation to work aud production situations
- the effect of automated factories and computer-aided manufacturing on human heings and the production of products
- the development of different measurement systems in the world in relation to production technology
- the economic impact of the development of small production manufacturing companies
- the effect of factory work on people's social behaviour aud the effect on the larger community

### *Science*

Materials used for production technology have many important properties. Since most products produced in production are created by combining several basic materials, it is important that the engineer be aware of the nature of these materials and their basic characteristics. Raw materials found in nature are the basic resources from which all synthetic materials and products are made, as a result of planned chemical reaction or other changes. A typical example of a synthetic material is plastic. It is important that links with the science program are sustained, especially in relation to the following topics:

- mechanical properties of production materials, tensile, and compression alloys, strengths, elasticity, plasticity, brittleness, and toughness
- composition of materials, synthetic materials, iron, steel, aluminum, brick, wood, concrete, resin fibre, composite, plastics, etc.
- study of the human ear and how it works, especially in relation to noise in the
- study of the different finishes that can be used on materials, especially their chemical composition and durability
- new materials, such as space age materials, materials used in medicine, ceramic or plastic engines, composite materials
- study of the effect of heat on metals
- study of ergonomics in relation to production technology and the science of ergonomics
- matching production technology to the human body
- stress test on materials
- how materials will he manufactured in space in the atmosphere of micro-gravity

### *Mathematics*
Measuring accurately is extremely important in production technology. Production workers must be able to read customary measuring devices calibrated in inches as well as metric units.

Estimating the amount of materials to be used to determine the cost of production is especially crucial.

"Time and motion" is important in production technology, as different processes are timed and recorded, and the average time each process takes is calculated, leading to slight changes in operation, to more calculations, and then to comparisons.

A financial calculator is important in the operation of business, for example, in making calculations related to a balance sheet such as additions, suhtractions, multiplications, division, percentage, percentage change, add-on discount, markups, interest and amortization, statistical calculation in relation to pricing and profits, savings, loans and mortgages, leases, real estate, and stocks.

### *Business Education/ Entrepreneurship*
Many of the skills developed in a study of Production Technology can be used by students in the rapidly evolving "information age." A number of career avenues are open to students interested in production technology. There are many opportunities for establishing a small business.

The three examples documented in Unit Five provide ample opportunity for students to experience, on a limited scale, the methods needed to develop and operate an enterprise. Any one of these options would provide the opportunity for close links with the business education/ entrepreneurship program, to assist with various aspects of establishing a company. A joint project might provide the greatest potential. (Also see the Business Plan in the Appendices.)

## *Suggested Teaching Strategies*

The following are descriptions of sample teaching strategies. These are not complete nor is it expected that each strategy should be used for each class. Different students respond differently to different strategies. Any one particular strategy requires considerable time and practice to develop fully.

### *Discussion*

Talk is essential to learning. As the whole class or small groups take part in discussion, students are making sense to themselves of what they are dealing with as well as exchanging ideas with colleagues. Discussions can evolve spontaneously out of activities, mini-lectures, and demonstrations, or they can be arranged to deal with specific topics.

### *Inventing and Brainstorming*

This is a way to produce a large number of different and novel ideas very quickly. Working in groups, students are encouraged to think of many ideas as quickly as possible.

Four ground rules of brainstorming are as follows:

- Do not criticize ideas, note them and continue.
- Encourage"crazy" and "long-shot" ideas.
- The more ideas the better.
- Combine and improve ideas.

### *Technology Learning Activities*

A technology learning activity (TLA) involves students working on activities to become more familiar with new technology in the areas of communications, power, energy, and transportation, and production. Usually students work in small or large groups, and the activities include one or more of the following: problem solving, investigation, research, model making, or simulation. (See the TLA Section).

### *Co-operative Small Group Learning*

Co-operative learning can be used to promote higher achievement among students, to facilitate learning involving students of different levels of ability, and to develop social skills. The experience of working in a group provides students with opportunities to reflect on their understanding and practice.

Co-operative learning can help students to develop the following skills relevant to the problem solving process:

- exploring and developing ideas
- working with other students
- generating alternative ideas
- listening and analysing
- checking for understanding
- sharing ideas
- role playing and simulation
- assessing previously learned knowledge
- checking for understanding
- individual thinking and self-expression

The following are some ideas for structuring groups:

- use the multiple station workshop bench for a group structure base
- balance students' strengths and weaknesses for pairs and/or groups
- test sample group structures during the lab clean-up schedule
- encourage sharing of responsibilities practise using groups or pairs for doing special tasks or projects such as
  - unloading material supplies

- working on computer applications
- sorting and cataloguing lab materials and supplies
- measurement and surveying tasks
- equipment and machine trouble-shooting
- focus orientation of lab or workshop

Co-operative learning groups require careful organization, observation, and monitoring.

### *The Design Problem-Solving Process*

Experience and research show that learning can be more effective when students' interests, experience, and ideas are taken into account. This means not only helping students relate content to their everyday experiences but it also involves them in perceiving and finding answers to their own questions, and in exploring and developing their own ideas. The design problem-solving process therefore uses teaching methods that actively encourage students to participate in the learning process. (See *Design Technology Resource Book*, Industrial Arts Supplementary Curriculum Document No. 53, 1985.)

The design problem-solving process can he illustrated using various graphic representations. In its most elementary form it can be depicted as a loop kuown as the design loop. (See Appendix G for examples of design problem-solving schemata.)

### *Demonstrations*

Demonstrations can be given to an entire class, a small group, or an individual. They can help to provide students with an overview of a process.

### *Lectures*

Short, well-prepared lectures can provide a quick overview of a topic or specific information on a particular concept or process.

### *Product Analysis*

Analysing and evaluating a product are useful activities to increase students' awareness of everyday products and the technology used to produce them. This activity can be done by students working in groups or individually and is an excellent way of getting students to discuss purposefully. A sample product evaluation form is illustrated in the This can be used to record the students observations.

### *Learning Contracts*

A learning contract is an agreement between a student and teacher about virtually any expected kind of learning experience. It usually involves a clear statement of the purpose of what the student hopes to accomplish as well as a description of the experience, the resources to be used, and the general time frame for completion of the contract. Usually provision is included for the content to be negotiated to accommodate changes circumstances.

Student contracts can increase student motivation and provide a strong sense of ownership, as well as provide opportunities for students to use their own strengths and learning styles.

### *Neutral Questioning Techniques*

The role of the teacher in discussion and questioning sessions should be to facilitate discussion. To prevent the "guess what I have in my mind" approach, questioning should be as neutral as possihle. In general, it is important to help students articulate what they did and why, how they did it and why, and what they have learned.

In student responses, teachers should he looking for evidence of growth of understanding of products, processes, systems, and environments.

Specific questions should promote reflection. For example:

How did you...?

Why did you...?

What did you try...?

How do you know that...?

What would happen if...?

How do you feel about..?

Have you...?

How did you decide to...?

Can you describe...?

What do you think...?

If these statements are true, what do you think is most likely to happen...?

What would you do if...?

If this happened to your design, what would you do...?

What would you suggest in light of what you know about products? systems?environments? designing? technology?

What else could you change/try...?

If you do not know what to do next, how could you proceed?

## *PRODUCTION TECHNOLOGY IN DIFFERENT CULTURES*

The history of human beings has heen dominated hy trade. A major portion of this has heen the trade products for other products that were either better made or unobtainable locally, or just more attractive. An important part of producing a product is developing a design or inventing a way of producing it. Human beings the world over have developed a unique capacity for invention that helps to distinguish them from the other inhabitants of the earth.

Stone, which is found in most parts of the world, was a popular production material. Many cultures made remarkable use of it for producing tools, implements, carvings, or shelters of various kinds. The iron age followed the stone age, and North Africa hecame renowned for its production of iron and the clever use of iron, a technology that spread south and west and helped to create a worldwide revolution in agriculture. In another area of the world, the Inuit of the Arctic regions used a range of materials such as bone, stone, skin, and sometimes wood to produce a range of products ranging from carvings, to kayaks and to komatiks (sleds). Again this was done hy utilizing clever technology and processes for example — "water was then applied with polar bear fur on top of the mud in order to make the mud more slippery. This had to be done every time before the sled was used for any length of time." ("Inuit Arts and Crafts" unpublished thesis, E. Worden.)

To the south of the Canadian Arctic the Mi'kmaq peoples of eastern Canada displayed a similar capacity to use technology and manufacture the necessities of life by using a range of materials such as bone, ivory, fur, leather, stone, and wood and hark. Notable products produced included birchbark canoes, and also the snowshoe. The range of canoes included one as large as 8 metres which was designed for ocean water, a design adopted by European settlers.

European settlers brought with them extensive knowledge about the production of products hoth for utilitarian use and for leisure. At one time every cove in Nova Scotia harboured a shipyard, and although this is no longer true, boats and shipbuilding (quite often utilizing modern materials such as fihreglass) are an important area of enterprise in Nova Scotia. Other products included the production of harrels, furniture, chairs, glass, and pottery. In recent years these heritage crafts have evolved into a multimillion dollar business with over 5,000 craftspeople employed, full- or part-time. Nova Scotia crafts products are now sold across Canada and some have an international reputation.

## *ASSESSMENT OF STUDENT PROGRESS*

### *Rationale*

Assessment of student learning is at the core of successful teaching aud learning.

- It is a means for teachers to diagnose; to identify the learners' strengths and weaknesses: what they know, understand and can do; to remedy shortcomings; to involve the learner in evaluation and target setting.
- It provides the basis for planning future teaching and learning.
- It supports teachers in evaluating the effectiveness of their teaching.
- It provides a basis for reporting to parents on their children's achievements.

### *Assessment: An Integral Part of Teaching*

The major portion of instructional time should be directed to practical activity, and assessment should reflect such an emphasis. Teachers might refer to the following to assess the progress of their students:

- class participation
- notebook/journal/portfolios/3-ring hinders
- technology learning activities
- research and development projects
- out-of-school study
- correlated study
- practical projects and problem solving
- activities such as:
  - individual take-home projects
  - simulation model-making projects
  - group projects, especially the work done as a team member involved in the enterprise unit.

The progress of students working in the enterprise option will require careful development. Sometimes it will be appropriate for each member of the group to share the same assessment, but since not all activities require an even input or participation from all members, other strategies will have to he developed so that the progress of each student can he evaluated fairly and accurately.

Personal assessment can he helpful where students are asked to assess their own progress towards the objectives agreed upon by the group, and this assessment can be a good starting point for the teacher's assessment.

Students will he involved in research projects and other out-of-class activities, including in some cases the development of a notebook, design folder, or portfolio, and these should be assessed by the teacher to help ascertain the progress heing made.

### *Skills to be Assessed*

Following are suggestions.

**Communication Skills**
The ability to use effectively various kinds of language skills (reading, writing, speaking, listening), as well as nonverhal forms of communication such as graphic and electronic media.

**Numeracy Skills**
The ahility to estimate, measure, understand, and use numerical relationships.

**Physical and Practical Skills**
The ability to demonstrate manual dexterity and to coordinate body movements.

**Observation and Visual Skills**
The ability to observe accurately to record patterns and relationships using scale perspectives, shape and colour, and to interpret observations.

**Learning and Study Skills**
The ability to organize time and materials effectively, to use appropriate aids to learning, to weigh and interpret evidence and draw conclusions, and to extract and classify information.

**Problem Solving and Creative Skills**
The ability to diagnose the features of problems and propose feasible solutions, and to draw on ideas and use materials inventively.

**Imaginative Skills**
The ability to perceive new situations; to discipline imagination by drawing on evidence and experience; to order and reshape experiences and images.

**Social skills**
The ability to co-operate and negotiate; to express ideas in a variety of contexts to consider other viewpoints; to create and sustain effective personal relationships and to cope with basic expectations of society.

## *Assessment of Performance*

**Design (Investigation and Research)**

1. *Indicators of low performance*
    - little or no evidence of investigation or research
    - when a selection is made, only one solution is considered or attempted
    - some indication of research with negligible evidence of investigation or reading about the prohlem
    - an attempt to consider alteruative solutions but soon rejected for superficial or no reason
2. *Indicators of high performance*
    - some good research and investigation into the problem with the results well presented and good use of supporting illustrative material
    - in-depth consideration of more than one solution with good stated reasons
    - full evidence of good sound research and investigation into the problem
    - good selection and presentation of data and/or organization of experiments with full, written-up, and presented supporting work and conclusions

**Production**

1. *Indicators of low performance*
    - used resources from a narrow and mainly familiar range with little or no reference to suitability, cost, and availability
    - developed no designs or plans for the production of the product / system/ environment
    - used only simple processes in an illogical order to produce the product /system/ environment
    - used only basic skills to produce the product/ system/environment
2. *Indicators of high performance*
    - used resources from a wide familiar and unfamiliar range with extensive reference to suitability, cost, and availability
    - developed detailed designs and plans (in related stages) for the

- production of the product/system/environment

- used advanced skills to produce the product/system/environment

### *Formative Assessment*

Formative assessment provides teachers and students with the feedback on recent performance and helps form student learning. It indicates what the student can and cannot do and suggests to the teacher and the student what remediation is required.

Formative assessment instruments include:

- tests on a portion of a unit or on one unit
- projects (usually short)
- homework
- problem solving
- workshop laboratory investigations
- observing scientific and technological processes
- oral presentations
- role playing
- dehates
- group work
- media presentations

## *Programming For Students With Special Needs*

An Industrial Arts Technology Education course has educational benefits for all students, including students with special needs. It is important that teachers become aware of each student's unique educational needs and then plan instruction to meet these needs.

All the students in any industrial arts technology program will have a variety of strength areas, and a small percentage of such students will also have educational needs that may be different from the majority due to physical or cognitive disabilities. It is desirable for these students to participate in an industrial arts technology program that is aimed and developed with the total educational needs of these students in mind, rather than concentrating on a specific disability. When teachers are planning programs for such students they should attend to the following points: the ueeds of the particular student, the strength areas, any medical condition or physical limitations that will influence the student's success, the provision of safe facilities and accessories.

In general, the overall aims and goals of the program will remain the same as for all students, but those involved in the development of self-confidence, problem solving ability, and specific technical and manipulative skills may require a reduced numher of ohjectives, which should be presented in hoth practical and concrete approaches. While it is true that the depth and extent to which the material is presented and covered should be in accordance with the aptitudes of the student, the teacher should not lose sight of the opportunity to choose practical activities and project themes which have the potential for offering basic occupational preparation and the development of specific hase work skills.

### *Planning for students with special needs*

It is recommended that adequate consideration be given to the following aspects of planning for students with special needs

- Conduct assessment and if necessary, develop an I.P.P. (Individualized Program Plan) with team.

- Individualize instruction.

- Use contracts and independent study.

- Consider co-operative teaching.

- Evaluate all resource materials, especially reading materials, to determine their appropriateness.

- Invite the special education and resource teacher to the workshop/lab to learn about the program and to review students' strengths and needs and appropriate teaching and evaluation strategies.

- Set review dates and ongoing meetings to work with the special/resource teacher and any other support personnel necessary (eg., occupational therapist) in planning the I.P.P.
  Develop lists of terminology used in the course and advise the special education/resource teacher and reading specialist of these words.

- Try to involve the use of as many senses as possible; e.g., the smell of different materials such as wood shavings, lubrication oils, etcb different sounds of cutting, shaping, hammering, sawing, etc., the color of different materials and processes such as welding.

- Rely more on performing tasks and talking through the steps and procedures involved while the students observe; then encourage the students to perform the task while talking themselves through it. Present and implement steps one at a time.

- Use progress charts that provide constant feedback.

- Use the co-operative small-group learning approach where appropriate, including pairing of students with complementary strengths (e.g., a weaker reader who has good drawing skills with another student who can read well but has difficulty drawing).

- Use concrete examples continually, including models and graphic charts.

## *Additional Techniques*

The following sampling of techniques may be considered in meeting a variety of student needs. However, it should be noted that each student's program plan will provide the teacher with the direction necessary to ensure that strategies and modifications are appropriate.

**Gifted and Talented Students**

- Encourage the design technology approach, including research and development, problem solving and brainstorming.

- Use mentor ships and teaching modules from appropriate sources and situations.

**Students with Physical Disabilities**

- the physical nature of the shop or the lab may require some modification for this type of student.

- Two routes may be necessary to accommodate the wheelchairs.

- Hand bars on walls, benches and machines may be necessary.

- Ample safe passage ways around benches, technology learning stations and machines may also be required.

- Furniture benches, machine tools may require some modification.

- Depending on the severity of the disability, special devices for keeping tools and pencils from falling to the floor may be required, as well as, book and drawing holders.

- Employ a buddy system.

- Use strengths.

**Students with Speech Impairment and/or Communication Disorders**

- Use diagrams, pictures and charts often.

- Label tools, machines and work stations, etc.

- Pay full attention to students' speech.

**Students with Hearing Impairments**

- When teaching a student with hearing impairment, use visually oriented media extensively.

- Keep instructional sessions short.

- If possible always face the student when speaking and speak in a natural tone of voice. Use short sentences and make the most of body language (re-phrase when necessary).

- Proper amplification for hearing impaired students is vital; warn students using hearing aids to adjust the aids when turning on certain machines.

- Always precede demonstration with actual instruction.

- Develop some competence in communicating by using manual instruction such as sign language, finger spelling, mime, etc.

- Maintain eye contact with the student; and to aid lip reading, maintain visual contact.

- Introduce procedure outlines and vocabulary lists for a complicated topic.

- Ensure students pay full attention.

- Use visual aids and written materials.

- Use peer-note taking systems.

**Students with Visual Impairments**

The following learning modes are important to visually impaired or blind students: memory, imagery, auditory perception, factual perception, kinaesthetic memory. Therefore, all of these should be used for improving instruction.

- Encourage the memorization procedure steps for the correct use of tools and machines.

- Encourage the thorough touching of tools and machines and materials.

- Encourage the development of the correct sound recognition of tools, machines, and processes as they are being used (cassette tapes may be helpful here).

- To assist visual impaired students, place guards and bumpers and guide posts or rails around the machinery.

- Proper lighting is essential. Give students the level of light where he or she can work comfortably.

- Providing it is made safe to do so, allow the students to position themself so that their eyes are close enough to do the work.

- Make special jigs and fixtures to assist the student in the use of certain machines. For example a round clear plastic guard placed over the work is useful in many cases; this helps the student to know exactly where his or her fingers are in relation to the cutting edge of a blade.

- Make no major changes in the location of either equipment or materials without making the students well acquainted with these changes.

- Use the student's name when communicating.

- Give consistent, clear directions.

- Keep physical plant rearrangements to a minimum and inform student when changes are made.

**Students with Intellectual Impairments**

- Organize learning in small incremental stages and use aids.

- Provide constant feedback and positive reinforcement.

- Facilitate peer teaching and co-operative grouping techniques.

- Use imitation and modelling techniques.

- Use demonstration and provide as much visually oriented instruction as possible (advance organizers).

**Students with Emotional and/or Behavioral Disorders**

- Keep tasks simple with a small number of elements.

- Establish one goal at a time in a step- by-step method.

- Keep phases of information brief so that the learner will grasp the most important aspects easily.

- Make sufficient practice opportunities available.

- Give frequent praise for correct effort and good achievement.

- Try to control visual and auditory distractions.

- Use a consistent structure and routine.

- Use discipline that is firm, fair and consistent and understood by the student.

- Use positive reinforcement constantly.

**Students with Learning Disabilities**

- Use A-V materials, tape cassettes, films, and filmstrips.

- Double-space handouts and highlight key words.

- Keep assignments as directed as possible — one task at a time.

- Pre-teach unknown terminology.

- Ensure that questioning strategies allow time for the student to process the question and produce an answer.

- Modify evaluation strategies to meet students' needs, while still assessing course objectives.

**CAD and Students with Mobility Impairment**

Adaptation of hardware and the use of special software may be necessary for students with mobility impairment. Input devices such as the joystick and mouse may possibly be used, together with some minor adaptation such as a small extension to the joystick handle.

The working environment may also require adaptation such as ensuring that the doorways and aisles are wide enough to allow for wheelchairs.

**Assessment**

Assessing students with special needs should be part of the student's individual program plan. Alternative assessment methods may be developed. These plans could include outcomes in the following areas:

- Inclusion and participation
- Accommodating and adaptation, see (previous notes)
- contribution
- personal and social adjustment
- academic and practical literacies
- achievement and satisfaction

## CAREERS IN PRODUCTION AND DESIGN

The production industry offers a wide variety of careers. Participation in the industry by women has been steadily increasing. In recent years mentor programs in which female professionals offer friendship, knowledge, and networking contacts to senior women engineering students have evolved. Several programs are in effect across Canada. For example, a gender-specific program for women in engineering is sponsored by the University of British Columbia and the Association of Professional Engineers and Geoscientists of B.C. This program was a catalyst for B.C. Association to launch a mentor ship program for new engineering recruits, both women and men.

People with special needs are finding increased opportunities for roles in production technology, especially with the advent of the computer and computer control of machines and processes.

## CO-OPERATIVE EDUCATION AND JOB SHADOWING

Co-operative education provides opportunities for students to earn a high school credit when taken in conjunction with a public school program course. Co-operative education integrates a student's in-school program with community-based learning in an educationally beneficial way. This provides students with opportunities to apply classroom learning to out-of-school experiences and to apply out-of-school experiences to classroom learning. Students enrolled, for example, in a production technology course have the opportunity to earn a co-operative education credit. (For more information see: *Guideline for Co-Operative Education and Work Experience in Public Schools*, Curriculum Development Supplementary Document No. 60.)

## LINKS WITH INDUSTRY AND BUSINESS

### Model Production

Links with industry and business can be an important feature of Production Technology I and II through an emphasis on one or more of the following concepts: product modelling, concurrent engineering, and engineering materials. (See the Industrial and Business Links section, as well as, the TLA titled Product Modelling and Product Analysis.)
Industrial models are an important tool for designers developing manufactured products. They permit designers and engineers to study many alternative design solutions, and to analyse the relationship of the design's function, form, material, and aesthetics. Links with local industry can be facilitated by establishing a joint project that focuses on developing models to facilitate the manufacture of a product.

If it is not possible to establish a concrete link with a local industry, or if one is not available locally, then another way students can come to appreciate the importance of research and design is by producing accurate models of intricate products. These could include models of compact disc players, pull-out car stereos, vest-pocket video systems, camcorders, cordless phones, wireless headphones, portable/tahle radios, multimedia CD-ROM players, cassette tape recorder/players, portable CD players etc. (see the TLA Product Models).

## *Concurrent Engineering*

Concurrent engineering is a process whcreby the total process of desigu, planniug, productiou, and impact (human and environmental) is viewed and practised as a synergistic whole. The Production Technology I and II courses provide many opportunities to develop an understanding of this concept. The TLA titled Design a Barrier-Free Workshop provides a practical example for the development of this concept.

## *Engineering Materials*

A knowledge of the classification, strength, and composition of materials is crucial to the successful manufacture of products. Wood, metal, and plastic materials have always been an important emphasis of the program. Therefore, with the rapid developments taking place in the area of engineering materials and their value to the production cycle, it is important that the emphasis be continued and expanded. Furthermore, this is another area where valuable links with business and industry can he developed.

An understanding of engineering materials can provide students with a knowledge of the nature of materials and their property- structure relationships. It also provides an opportunity for students to develop a working knowledge of the various mechanisms and techniques for modifying materials with respect to both properties and for and an insight into the uses of materials and how these are continually developing and changing. (Also see 1 TLA Composite Materials and AMEC charts and Appendix - Engineering Materials, Queensland, Australia).

# *SAFETY PROGRAM*

The nature of industrial arts technology education requires that correct safety practices he established as soon as students start their studies. The teacher must provide instruction so that students work safely in school shops, laboratories, classrooms, or elsewhere. It is of paramount importance that the teacher establish a comprehensive safety program and develop a wholesome safety consciousuess among students.

## *Safety Considerations*

The following is a list of considerations that should be included in all safety programs:

**Instruction in the Use of Machine Tools and Portable Power Equipment**
Before a student may operate a machine the student must pass a test covering the essential points of technical knowledge and safe procedures to operate this machine. This test should be recorded and kept on file.

**Student Dress**
Students should be dressed correctly and safely before operating any machine. Students should be instructed to dress so that no part of their clothing constitutes a hazard when operating a machine or tool or participating in a course activity.

**Guards on Machinery**
Guards should be kept in place during the operation of all machines and equipment.

**Supervision of Students in a Shop Class**
The teacher of au iudustrial arts technology program or course must remain in the workshop, classroom, or laboratory area of instruction at all times when the program is in operation. If the teacher has to leave in the case of an emergency, the power should be shut off aud appropriate instructions left with the students. Note: for specific integral areas in the lah, such as a dark room or tool storage area, the teacher should institute

procedures that facilitate student safety at all times, for example, adopting a buddy system or utilizing safety monitors.

**Ground Wires on Portable Electric-Driven Machines**
All portable electric motor-driven machines must be adequately grounded.

**Housekeeping**
Established procedures to ensure that the instructional area is kept in good, clean, and safe condition. Excessive dust and dirt and accumulation of waste materials contribute to a careless attitude toward safety. Shop cleaning procedures should be established and form a continued part of any program.

**Tool Condition**
An organized plan for maintaining tools and equipment should be an important part of any safety program. For example, sharp tools are safer than dull tools, and a student will do better work and develop correct technique if tools are always kept sharp and in good condition. Broken tools should be removed from service until they are repaired or replaced.

**Operator's Zones**
Most machines should be operated by one person only. Ohservers or students waitiug to use a machine must stand clear of the operator's zone. Specially designated machine operation zones can be instituted to assist in this regard.

## *Safety Checking*

**Control Systems**
If a design is controlled by a mechanical, electrical/ electronic or pneumatic system it should he checked to work as expected.

**Mechanical Systems**
If a mechanism is powered by electricity it should he tested before switching on to ensure that belts do not slip, that gears work safely, aud that the appropriate guards are in place.

**Electrical/Electronic Systems**
All parts should he fully insulated and grounded, and the circuit should he checked for short circuits.

**Pneumatic Systems**
The system should hc checked before switching on the compressed air. The components in the circuits should be checked hefore switching on to avoid possibility of injury to those operating the circuit.

**Materials**
Materials should be safety checked.

- Are they strong enough to carry the loads and stresses?
- Arc they flexible or rigid enough to resist stresses and strains?
- Are they stroug enough to stand up to the working conditions?
- Freed from sharp cdges and corners?

## *Precautions Against Fire and Other Disasters*

A workshop, lahoratory, classroom or work site used to offer an industrial arts technology program can present many hazards, and it is important that precautions he taken to prevent possihle accidents or disasters. The following factors need to be considered.

1. It is recommended that school systems ask their local fire departments for recommendations regarding the type and capacity of extinguishers to hc placed in each shop or lahoratory.

2. Students should know and understand how fire extinguishers work. Fasten opcrating instructions to the outside of the container (place them near it).

3. Fires are less likely to start in shops or lahoratories that are clean (see Housekeeping section).

4. Properly designed containers should be provided for each kind of scrap and waste material and should be emptied daily. Rags used to wipe up oil, paint or other flammable liquids should he placed in a safety metal container, with a self-closing cover (See WIIMIS information).

5. Flammable materials such as wood and metal finishers, solvents and cleaners must be stored in steel cabinets and must have the correct WHMIS designation (See WHMIS information).

6. Electrical equipment should be checked regularly for defects and worn live wires. This is especially important where extension cords are used with lights and equipment.

7. Electrical equipment such as soldering guns and coppers and heating elements should be inspected daily to ensure that they are not left turned on. This should be part of the end-of-session housekeeping procedures.

8. Gas equipment must be checked frequently for leaks, and all defective equipment must be replaced immediately.

9. Special precaution procedures should be established as part of the safety program to light and operate gas-powered and fuelled equipment.

10. Evacuation procedures should be established and practised regularly by the students. Specifically, students must know the signal used for a fire drill, how to stop work safely, which exit and alternative exits to use, and what to do when outside the building.

### *First Aid*

1. A cabinet to he used exclusively for first aid materials should be provided for each shop or laboratory or work site. The cabinet should be sanitary, dustproof, and compartmentalized so that it is easy to determine if any materials need updating.

2. Local or provincial health officials should be contacted for information ahout the amount and kinds of first-aid materials that should be contained in the cabinet.

3. Procedures should be established for recording and reporting accidents. School authorities should be consulted to establish the proper procedures and necessary forms to be completed.

### *Colour-Coding*

Workshops and laboratories that are colour coded provide students with a pleasant place to work and learn. Colour coding also emphasizes safety by helping students identify potential hazards in the workshop situation.

1. The standard colours used for identifying specific hazards are as follows:

   *Red* — generally indicates danger. It identifies fire protection equipment and emergency stop buttons and switches.

   *Orange* — indicates dangerous parts of machines or equipment.

   *Yellow* — indicates caution. It is the standard colour for working hazards that can result in accidents.

   *Green* — designates the location of first aid and safety supplies and equipment other than firefighting equipment.

   *Blue* — is used for informational signs. In some situations it replaces the excessive use of orange.

   *Black and white* and comhinations of black and white in stripes or checks are used for housekeeping and traffic markings.

2. Examples of items in the workshop and the correct colour identification are as follows:

   *Red* — fire extinguishers, emergency stop switches, fire exit signs, cans and cabinets that contain flammable material

   *Orange* — the following parts of a machine: parts that cut, parts that crush, parts that shock, guards that cover pulleys, belts, and blades, machine switch-box covers.

   *Yellow* — parts of a machine that move and make adjustments, such as hand wheels, knobs, adjustable levers.

   *Green* — first aid kits (with a white cross) safety bulletin boards; general information and safety supplies.

   *Blue* — the outside of large switch boxes.

A non-gloss pale blue, green or grey can be used to identify the main body of all machines other than specific parts listed above.

## *Safe Machine Operation*

The following is a sample machine operation safety program which is included here as a guide for teachers.

Various methods have been used for preparing students to operate power equipment. One that has been used and found quite workable is: require each student to pass a test similar to the procedure for securing a driver's license.

To begiu, the teacher has an introductory lesson for the whole class on the particular machine. The students are then required to read and study the corresponding material in their textbooks. The teacher can then schedule a test in which the students answer questions concerning the care and safe operation of the machine. An alternative method is to allow the students to write as they are required, making certain that all of the necessary machines are covered by a certain date. The advantage of this is that the more progressive students may proceed at a faster rate than slower students.

After students complete the test (and a high percentage should be required for a pass, plus the correction of all mistakes), a practical part must also be done. Under the teacher's supervision, each student must demonstrate how to adjust and operate the machine properly. Any errors or unsafe procedures should be pointed out at this time. Having shown his/her ability to operate the machine safely, the student is given an operator's permit which must be shown when asked. A good plan is to have the license stapled to the student's notebook (this places a little more emphasis on having the notebook in class).

See Appendix B for information pertaining to specific items for the Exploring Technology course, and WHMIS information.

## *Lasers*

Even though the power of a helium-neon laser is low, the beam should be treated with caution and common sense because it is intense and concentrated. The greatest potential of harm from the laser is to the eyes. No one should look directly into the laser beam or stare at its bright reflections, just as no one should stare at the sun or arc lamps.

Always observe the following:

1. Never look into the laser beam.

2. Never direct the laser beam into the eyes of another person or animal.

3. Do not operate the laser without the teacher's permission.

4. Operate the laser only with prior instruction.

5. Use the laser only for the designated purpose.

6. Always turn off the laser when finished using it.

### *Video Display Terminals (VDTs)*

According to authorities no radiation hazard is emitted from VDTs. Measurements of X-ray, radio frequency, ultraviolet, infrared and visible radiation associated with VDTs show that exposure levels from display screens are well below current exposure standards. However, extended eye exposure can lead to fatigue and eye irritation. Similarly, muscle strain of the neck and back often occurs with long sitting sessions or improper positioning of the equipment. Since students will only be involved with computers for short periods of time, these hazards should not present any difficulty. Computer equipment should be positioned so that it is convenient to use and away from other potential hazards.

### *Working with Polymer Materials*

Adequate ventilation is essential when working with polymer materials. It is also important to protect the eyes from dust, particles of waste, and organic liquids. Note: the catalyst used for curing polyester resin can be hazardous to the eyes and it must be used only under direct supervision of a teacher and by using the appropriate dispenser. Disposahle plastic gloves are highly recommended when handling some polymer materials, for example, glass fibre, which can irritate the skin. It is recommended that hands be washed thoroughly after using resins and catalysts.

## *Entrepreneurship Options*

Technology education courses teach that the function of technology in society is to develop and make artifacts needed by people. Seen from an entreprenenrial point of view it is important that the product has good quality and can be sold for a reasonable price. These ideas should be incorporated in the Production Technology courses.

This section describes three entrepreneurship options; A School Production Lab, A Research Design and Engineering Lab, and A Custom Craft Business.

Administration approval should be sought before proceeding with any of these optional units. Corporate assistance may be appropriate especially if the school board is participating in such ventures.

At least one of the following options must be offered:

### *Option A — A School Production Lab*

Students will

- participate in the planning and utilization of a school shop factory

- construct various line production layouts, including the design and construction and placement of jigs and fixtures

- develop and implement material flow handling plans

- develop, organize, and implement various production techniques appropriate to the enterprise under way

- develop and perform various product tests

- design a marketing and sales plan

- recover and recycle materials used during the production of a product

## *Planning and Using A School Production Lab*

Starting a Business

- sole proprietorship
- partnership
- corporation

Organization

1. Purpose of a school shop enterprise, choosing a company name and logo
2. Research and preliminary market analysis
3. Permission
4. Type of enterprise
5. Business plan
6. Company organization
   - establishing operational rules
   - executive committee
   - leadership
   - director position
   - president position
   - policies
   - record keeping
   - budgeting/auditing
7. Company responsibilities
   - starting small
   - team building
8. Design and planning
9. Financing
   - requirements
   - shares
   - credit
   - loans
   - marketing
   - dividends
   - trading shares
   - resources
   - space
   - materials
   - tools/machines
   - insurance
10. Financial strategies
    - sources
    - control
11. Budgeting and accounting
12. Obtaining materials
13. Choosing a product or service
    - market analysis
    - needs and opportunities
    - design developments
    - selling a product
    - distribution
    - packaging
    - competition
    - liquidation
    - reports

Tooling-up

1. Line production layout
2. Flow charts
3. Jigs and fixtures
4. Tooling
5. Machines placement
6. Floor and bench layout
7. Safety program and practices

Material-Handling Procedures

1. Material flow
2. Storage

Production Techniques

1. General production techniques
2. Special production techniques
3. Modifications and alterations

Product Testing, Marketing and Sales

Closing Sale of the Company

1. Paying off bills
2. Rewarding investors

Product Service Centre

1. Type of products
2. Organization
3. Procedure flow charts

Recycling Centre

1. Types of recycling
2. Recoverable materials
3. Recycling equipment

**Procedures For a School Production Lab**

- Organize a school factory and choose a product to be produced, such as picnic tables, step tools, go-karts, stereo cabinets, fireplace set, yard furniture, toys.

- Design a consumer survey using a desktop publishing program to determine consumer demand for a product. Identify and compose approximately 10 questions about the use of the item, the size of the item, the quality expected, the cost, range, and any other relevant information.

- Canvass the school staff about a product they have purchased recently that does not work well. Ask them to bring it in and then interview the teacher to find out what is wrong with the product and have the students work in groups to brainstorm how the product can be improved. This may lead to the students producing a replacement product or substitute product.

- Identify a local entrepreueur and arrange a visit and write a report describing his or her business. The report should include the influence the company has had on the community both economically and iu jobs created.

- Use a CAD program or an office layout program to plan the layout of a business office for the operation of a workshop enterprise or a design and research lab.

- Use a desktop publishing program to produce an organizational chart for the organization of au enterprise or business organization.

- Have students huild a scale model of the lab or workshop layout using small- sectiou lumber, cardboard, or LEGO and then use this to plan the layout for a production enterprise.

- Have students develop a production sequence for the production of a product using a flow chart feature of desktop publishing program.

- Do a survey of places where money can be obtained for starting small husinesses.

- When the students have chosen a product to be produced, have them develop a factory layout for the school shop. This can be done utilizing a computer aided drafting program and could include such items as the factory rest room, finishing room, planning room, conveyer locations, passageway for movement of carts to move products from one area to another, as well as the location of work tables and stationary power tools, etc. In co-operation with the mathematics department, conduct time and motion study of the operation of the factory. Use a stop watch to do the time and motion study and work out changes iu operation that will help to decrease the average time or different ideas for design and production of the product. Develop quality control tests as an important part of this time and motion study.

- Design at least one jig and fixture to be used in the school shop factory or the design and research lab or busiuess enterprise.
- View "The Spirit of Adventure" series dealing with successful ideas and the development of ideas and seizing opportunities.

- Students enrolled in the school's I.A. Technology 'Communications Technology' course could be invited to plan, develop, and produce a promotional video to advertise the output of the enterprise unit.

### *Option B — A Research, Design, and Engineering Lab*

Note: Students could establish as part of the workshop or lab situation a "think tank" area. In addition to black boards and white boards and lots of open wall space to display charts and flow charts for recording the process of problem solving, a computer would be a useful aid. An important feature of this lab will involve the students in empirical research; that is, research by experience, for example, through modelling or testing partial or whole solutions.

A school could establish a research, design and engineering lab which could be involved with the following.

**Research Into Problems for People With Special Needs.**
Community organizations directly involved with people with special needs could be contacted to identify problems that the lab could work on. Hospitals or rehabilitation centres would be ideal places to start. Students will need to become familiar with the specific needs of people with special needs and the special requirements that have to be considered. The assistance of and consultation with an occupational therapist will also be a good idea. Mock-ups and prototypes of aids for people with special needs will require extensive testing and evaluation, especially to see if improvements are needed. (See TLA #5 Product Modelling and Product Analysis).

**Research Into Recycling Materials**
For example, for aluminum cans, a can crusher could be developed and produced by the students, utilizing wood and/or metal materials. When a good workable prototype has been developed, it could be mass produced and could be distributed for home use in the community. Extensive evaluation of a prototype and the application of advance design features could be further used.

**Joint Projects With Business and Industry**
A feature of the lab could be to do research for business and industry, to mirror an actual local business or industry research lab, or to participate in a joint tandem project.

Following is an example framework of tandem research with industry and business.

1. The research or engineering problem should be at a suitable level of difficulty for the students to solve over a period of approximately 120 hours. The project should be to investigate, design and where appropriate build a solution to the problem.

2. A liaison engineer should be appointed from the company to act as an advisor to a group of students. This person could provide guidance on report writing and presentation skills using the company's own resources. A schedule of formal meetings should be arranged between the students, the teacher(s), and the advisor.

3. The company or business could arrange an induction date to enable the students to spend a day at an industrial site to see the environment and materials and systems available.

The following advantages are available to the co-operating company:

- long-term contact with teams of students

- opportunity to assess students as potential employees

- opportunity to demonstrate the company's training opportunities and career opportunities

- opportunity to strengthen education and private enterprise links

- publicity potential for the company

**Research Links With University and Community Colleges**
Specific days or weeks could be allocated for student(s) to gain experience of

relevant university and community college programs. Eugiuccring discipliues usually associated with universities include chemical, civil, electronic and electrical, manufacturing and mechanical, metallurgical and materials, aeronautical, building (structural and environmental) and materials science. The week could be planned to give students a sample of the range of experiences they would expect to find while studying iu an enginceriug program.

Research projects could include:

- robotics and computing and manufacturing
  energy usc iu building
- control of electrical equipment for integrated power supplies
- composite material research
- highway traffic planning and bridge construction
- signal processing
- digital systems and motor drives
- automobile component dcsign aud testing and the use of robots
- metal, plastics, and composites in vehicle construction
- computer-aided design
- testing analysis of composites
- electronic music
- desigu and testing of electronic circuits
- computer-aided manufacturing
- computer simulation
- computer and digital electronics
- dcsiguing engineering materials
- behaviour of materials
- manufacturing control
- mechanical design vibration and noise analysis
- stress analysis
- lasers and electronic signalling
- highway construction
- multisensory car parks
- tensile testing of materials
- tcst to destruction of construction materials
- control smoke and tunnel demonstrations
- mechanical vibrations and internal combustion enginc tcsts
- tuning engines with a computer
- seminars on engineering as a profession

Following is a list of some of the relevant programs currently offered by the Nova Scotia Community Collcgc:

Aircraft Tecbnician

Automated Manufacturing Technology

Cartography

CNC Macbining Technician

Computer Programming Technician

Construction Administration Technology

Drafting - Architectural/Mechanical/ Construction

Electric Engineering Technology/Technician

Electronics

Electronics Engineering Technology

Instrumentation/Indnstrial

Marine Electronics

Marine Engineering

Mechanical Engineering Technology

Pre-Technology

Stationary Engineering

Snrvey Technician/Technology

Welding Engincering Technician

**Community Projects**
A community depends very largely npon support from people with all kinds and interests. Some of the most exciting and rewarding projects and design problems can be pursued by identifying community needs. Specific areas to investigate would be to identify people with special needs, play groups for yonng children, or homes for the elderly.

**Team up with a local industry** to design a computer station for use in a school situation. This wonld entail the analysis of ergonomics and anthropometric data, especially in relation to the ages of different students and the locations in the school situation.

**Visit a local hospital** and, with the approval and the aid of the administrative staff, develop a simple survey form to help to identify prohlems that patients experience during a hospital stay that can he improved by the design of a cnstom-made aid.

**Team up with a local fisheries industry** and zero in on a specific problem they have in relation to processing fish, the storage of fish, and getting the fish to and from market.

**Contact local restaurants** to identify a problem they have in the work sitnation, which could be in the preparation area or in the food servicing area. This could include the layont of furniture and the type of furniture nsed, serving eqnipment, etc.

**Do an analysis of the school office** to define a specific problem that needs a design solution. This could include administration/student communication and access or administration/teacher communication or access. Identify solntions to commnnication needs that conld help in commnnication including the passing of information and the posting and display of information, etc.

**Contact school departments** to identify a prohlem that they may have such as physical edncation, family studies, or science, for the safe use and storage of eqnipment.

**Contact a local drawing office or architectural firm** to identify a prohlem they may have in the nse and storage of equipment.

**Contact a local hospital or doctor's office** to identify a problem for storage and use of eqnipment or communication with the general public.

**Contact a local automobile sales office** to identify a problem they may have in relation to the display of publicity materials.

**Contact a local hotel or motel office** to identify a problem they may have in relation to the display of publicity materials or storage and use of cleaning eqnipment.

**Contact the local Chamber of Commerce** to coordinate the identification of a problem in the local business commnnity.

**Contact a local elementary school** to identify a prohlem they may have in relation to the nse and storage of equipment and the use of equipment in different suhject areas.

**Visit a local museum** to identify a problem for the display of materials or communication to the general public.

**Contact the local recreation department** to identify a problem for the storage of equipment or the safe operation of leisure activities.

### *Option C — A Custom Craft Business*

Students should simulate the establishment of a custom craft business. Students could be involved identifying various crafts that are pertinent to industrial and arts technology could be developed as a craft business, for example: enamelling, graphic arts, jewelry, decorative art work, art metalwork, musical instruments, photography, scrimshaw, silk screen printing, toy making, wood carving, wood turning, wood crafts, etc.

Students could conduct research into the local area to determine what crafts are already produced, the type of crafts sold locally, and those in demand but not available, as well as how to identify "a market niche." Students could he introduced to wholesaling and consignment approaches as well as direct retailing. Design prototypes could be produced and tested and costed, and then a husiness established following the usual procedure as identified in unit, 3-Manufacturing.

Students could also research where craft-type products could be merchandised such as at mall shows and mall outlets, farmers markets, galleries, gift shops, department stores, trade shows, craft shows, etc. To start with, students could establish the goal of entering an item in a specific craft show they have identified. Students should also investigate maintaining good customer relations, how to achieve high-quality products, and how to maintain good customer relations.

Students could gain practice by establishing a hooth at a craft show and creating the most appropriate selling environment for the products produced. The actual design of a booth could be developed by the students to ensure that it can be assembled and disassembled easily and is of an appropriate size.

# Production Technology Units

## UNIT 1 — PRODUCTION AND HUMANS

### OUTCOMES

Students should be able to

- describe the role and value of production and identify basic and advanced human needs
- compare and judge the advantages and disadvantages of hand and mass production techniques
- explain the highlights of the industrial revolution and their impact on production and society
- recount and interpret contemporary developments in the field of production
- describe and demonstrate the general principles of the organization of production
- define, demonstrate, and apply the basic technology system used in productiou
- specify and communicate the major impacts of production on society, economy, culture, and the environment
- identify the needs and preferences of users reflected in coutemporary products
- recognize potential conflicts between the needs of individuals and of society

### CONTENT

**Production and Human beings**

Role and value of production:

- Basic human needs
  - food
  - water
  - shelter
- Advanced human needs
  - comfort
  - pleasure
  - leisure
- IIand-made techuiques
- Manufactured techniques
- Mass part production
- Mass production techuiques
- Industrial revolution
- Contemporary developments
  - CAM
  - CIM
  - human/machine interfacing
  - numerical control
  - robots
- Impact of Production
  - human
  - commuuity
  - environment
  - economic growth
  - employment
  - material and energy
  - depletion
  - pollution
  - consumer nonchalance

**Organization of Production**
Conceptual idea of a product
- R & D
- Industrial research
- Quality control
- Design and planning
- Tooling up
- Production
- Marketing and sales
- Safety programs

**Production Systems**
- Input
  - humans
  - materials
  - tools/materials
  - financing
  - energy
- Process
  - material management
  - business management
- Output
  - components
  - products
  - parts
- Feedback
  - product success
  - customer feedback
- Product service
  - manufacturer responsibilities
  - dealer responsibilities
  - consumer rights and responsibilities

**SAMPLE ACTIVITIES**

- Study how different cultures starting with North American cultures such as native Indian and inuit met the basic human needs of food, water, and shelter. Compare these to the pioneer cultures who settled in Nova Scotia and how they met these basic needs.

- Make comparisons between how the needs identified above were met and how current needs of the people in Nova Scotia are met, especially the advanced needs such as comfort, pleasure, and leisure.

- Research the handmade techniques used to produce crafts in Nova Scotia such as wood crafts, wood turning, jewelry and art metal work.

- European settlers arrived in Nova Scotia during the 18th and 19th century and brought with them traditional production designs, skills, and patterns. Do a survey of one of these that is of particular interest locally to examine the techniques and processes used in the production of the product.

- Obtain a copy of the book Head, Heart & Hands: Craftspeople in Nova Scotia by Jim Lotz and develop a career profile on one of the craftspeople identified in the book who work in the following areas: fibre, glass, leather and paper/jewelry/ metal/ pottery/ wood.

- Research the impressive birch bark construction used for the production of Mi'kmaq canoes including the four basic types made: the 3-4 metre hunting canoe, the 4-6 metre large river canoe, the 5-7 metre ocean-going canoe, and the war canoe.

- Research the construction of the Inuit komatik sled, especially the techniques used for making a flexible joint between the sled runners and the slats, as well as investigating how waste material is used to make the front end curve and how this higher front end facilitates movement when crossing rough sea ice at the shoreline. Also investigate why the sled is lashed so that there is also a certain amount of give, in contrast to being joined by nails or screws.

- Conduct a visit to one of the leading Nova Scotia crafts industries near to your locality to discover how products have been invented and developed or manufactured and marketed.
- Visit a local industry to study the manufacturing techniques used, especially any special line production techniques. Emphasize that a report should he formulated and that good communication links be established with the field trip location.
- Conduct a characteristic survey of a local manufacturing industry to gauge the number of employees, type of products produced, type of resources used, human and environmental impact, etc.
- Use an electronic atlas such as *PC Globe* to compose a world global map listing places where parts are produced for a product, such as a VCR, an automobile, or an aircraft.
- Compose a glossary of special production words that have evolved recently such as "short-live" products, "just-in-time production," "throw away," "technophobia," "consumer awareness," "environmental awareness," "environmentally friendly."
- Do a detailed study of a machine that is currently replacing skilled workers in industry/manufacturing/production.
- Conduct a hazardous material audit of the school lab, school, or home or community.
- Together with the social studies department compose a list or inventory of renewahle and nonrenewable and synthetic resources or materials commonly used in Nova Scotia. Make a display of new materials, especially plastic and synthetic materials that have become common over the last 10 or 20 years.
- Utilizing scrap materials or a mechanism kit like Lego, produce a working model of a resource extraction method. View a film or video illustrating resources extraction and manufacturing and processing. Video example:
- Take apart an automatic pencil and catalogue the parts; then reassemble and demonstrate how the pencil illustrates the four-part system model of input, process, output, and feedback. Also show how the eraser component is an integral system. List environments in which the pencil can be either stored or used, e.g., a pocket or drawing paper and categorize each environment.
- Have students produce graphic charts (manually or by computer) to illustrate the universal systems model and the resources needed, such as people, information, materials, tools, machines and energy, capital, and time, as well as the system model for input, process, output, and feedback.
- After studying the different types of manufacturing such as custom, intermittent, mass production, flexihle, computer-aided, computer-integrated and just in time; have students design models of tbe application.

- Do a material audit of the materials used in the school building or in a new car.

- Visit a local furniture and hardware store and compile a list of items that have been custom produced and those that have been mass produced.

- Make a list of the different materials used in a school building (e.g., steel, brick, glass, etc.). Develop a plan to recycle waste materials in the school or home environment.

## UNIT 2 - RESOURCES FOR PRODUCTION

### OUTCOMES

Students sbould be able to

- define the major categories of resources used for production
- explain tbe general structure of materials and describe major material properties
- specify and communicate the personnel involved in the production technology team
- list and explain thc basic tools and machines used in production
- select productions tools, machines, and equipment appropriate to the task at hand, and use them safely, accurately, and economically
- describc the general organization of business involvcd with production, including capital and financing, management, and research dcvelopment
- explain bow people are an important resource wbo need to be trained, organized, and motivated for roles in production
- demonstrate that in production the control of stock is important

### CONTENT

**Resources for Productiou**
**Materials**

- Renewable/ nonrenewable
- Softwood
- Hardwood
- Manufactured wood products
- Ferrous and non-ferrous
- Thermoplastics
- Thermoset plastics
- Synthetics
- Composites
- Ceramic materials
- Finishing materials
- Standard stock sizes and forms
- Choosing materials and assessing properties

**Engineering Materials**

- Classification of materials
- Strength of materials
- Crystalline materials
- Ceramics
- Polymers
- Deformation and manufacture
- Composition and materials modification
- Degradation

**Structure of Materials**

- Microstructure
- Atomic structures
- Bonding
- Macrostructures
- Material properties
  - physical
  - mechanical
  - chemical
  - thermal
  - electrical
  - magnetic
  - acoustical
  - optical

**Personnel**

- Organizing the production personnel
- Levels of organization and management
- The technology team

- The production team
- Training and retraining and professional development
- Relations and responsibilities
- Health and safety
- Equal oppormnities

**Tools and Machines**

- Preparation tools
  - design, planning & drafting tools
  - tools for marking out and laying out
  - tools for checking and evaluating
- Cutting Tools
  - shearing
  - sawing
  - cutting
  - planning
  - joining
  - drilling
  - routing
  - punching
  - grinding
  - sanding
  - hot cutting
  - chemical cutting
  - laser cutting
- Forming tools
  - bending
  - laminating
  - twisting
  - forging
  - stamping
  - molding
  - extruding
  - conditioning
- Joining and fastening
  - mechanical fastening devices
  - tools for achieving fastening
  - adhesives
  - soldering/brazing/welding
  - contact fasteners (Velcro)
- Finishes/coatings
- Tools and machine maintenance

**Mock-up Materials**

1. Kit systems
   - Lego
   - fischertechnic
   - meccano
   - electronic
   - pneumatic

2. Pliable Materials
   - cardboard
   - foamboard
   - balsa
   - polystyrene
   - carroflute sheet

**Capital and Financing**

- Financing sources
  - private
  - entrepreneurs
  - stocks and shares
  - loans
  - grants
- Business management and organization
  - proprietorship
  - partncrsbip
  - corporation
  - management
  - labour
  - labour relations
  - public relations
- Profit and loss
- Debt servicing
- Taxes
- Legal aspects of establishing an enterprise
  - legal requirements
  - forms, documentation

**Time Management**

- Efficiency evaluations
- Production time planning
- Just in time manufacturing
- Production line coordination

- Production schedules
- Flow charts

**Research and Development**

- Evaluating materials and processes
  - brittleness
  - hardness
  - ductility
  - elasticity
  - malleability
  - tensile strength
  - material science
- Product history and competition
  - market place research
  - needs assessment
  - regulations and limitations
  - competitors
  - construction site information

**SAMPLE ACTIVITIES**

- Obtain a catalogue from a hardware supply house and then compose a data sheet showing standard stock material sizes and forms used.

- Visit a hardware store and divide the students into small groups to spend half an hour searching various aisles of the store and then cataloguing and tabulating the various supplies available in the store.

- Collect and display samples of materials and standard stock supply items.

- Use a computer simulation program like *A TRAIN* or *FACTORY* to simulate the use of resources for facilitating production.

- In co-operation with the physical education department, work out a list of fitness activities to help improve work performance, by developing such things as aerobic capacity, upper body strength, abdominal strength, and flexibility.

- Conduct an experiment to produce a composite material (e.g., honeycomb sandwich) using found materials such as cardboard, foam board, variegated cardboard, straws, plastic materials, etc. Test the strength of the different composite materials produced.

- Have students experience the various basic tools used for cutting, shaping, and forming.

- Compose a list of safety rules to be used when using the basic selection of hand and power tool machines.

- Have the students produce a work lab safety manual by working in groups, each group to be responsible for producing materials and under the following headings: general safety rules, tool and equipment safety, fire safety, first aid, WHMIS. Or have students plan and make a safety video that could relate to a specific activity or a general list of safety rules.

- Conduct a survey of the units used in imperial system of measurement and the metric system of measurement, i.e., length, weight, volume, area, temperature, pressure, energy, power, speed, force, and torque and formulate a chart to illustrate their application in production technology.

- Make a list of major ways of separating materials, for example, shearing, planing, jointing, drilling, routing, punching, and sawing. Also find examples of heat separating such as oxyacetylene cutting and hot wire cutting, as well as chemical separating.

- Practise using layout, cutting, shaping and forming tools and portable power equipment used in the production course.

- Practise the major ways of forming, forging, bending, pouring, extruding, and conditioning materials for use in production technology.

- Practice the major ways of combining materials, including mechanical fasteners, bonding, welding.

- Discover the different coatings used for decorating and protecting materials, including paint, varnish, oil, wax, and plastisols.

- Visit a bank to discover how the various capital and financing arrangements for an enterprise take place (FBDB reference).

- Visit a local entrepreneur to find out bow he or she established a business.

- Invite a leader from a local industry to discuss busiuess management organization.

- Do a survey or study of a company that is involvcd in complex production time planning and just-in-time manufacturing, such as an automobile manufacturer.

- Make a list of the major categories used for testing materials, i.e., brittleness, tensile strengtb, hardness and malleability, and design tests that can be done within a work lab situation to test wood, metal, plastic, and synthetic materials.

- Conduct a range of tests on various materials to learn the different characteristics of basic materials, such as brittleness, hardness, etc. Investigate the various metals used by the local dentist for fillings for tooth cavities, for example, gold, amalgam, dental composites, (e.g., glass powder with heavy metal such as barium, strontium, or zirconium).

## UNIT 3 —MANUFACTURING

### OUTCOMES

Students should be able to

- explain how designs for the production of an item can be granted a patent
- demonstrate awareness of the competition that surrounds the development of inventions and the control of patents
- define the major types of manufacturing
- plan a total sequence for the production of a product
- demonstrate basic manufacturing processes during the production of a quality product
- explain and demonstrate various ways of packaging/promoting and selling a product
- define acceptable tolerances for manufacturing
- resolve conflicting demands to produce an optimum solution
- develop and implement plans for the packaging, promotion, and sale of at least one product
- explain that goods may be designed to he produced singly or in quantity and that this affects what each item costs
- devise methods of production that show a comprehensive understanding of tools, materials, equipment, and processes

### CONTENT

**Design and Invention**

- How products are invented
- Identifying needs
- How inventions are developed
- How inventions are protected
- Patent protection

**Types**

- Custom
- Quantity and mass production
- CAD/CAM/CIM
- Flexible and mixed
- Just in time

**Planning**

- Product development
- Research
- Product design
- Invention and patents
- Production flowcharts
- Jigs/fixtures/templates/patterns
- Line arrangements
- Maintenance, repairs, retooling
- Safety programs and practices
- Prototypes and trial runs
- Production runs
- Product assembly
- Product finishing
- Handling material resources
- Controlling production
  - cost
  - quotas
  - quality control
  - sampling
- Packaging and storage

**Processes**

- Preparatiou
  - marking out
  - measurement
  - drawing
  - planning
  - layouts
- Forming
  - molding
  - compression
  - extrusion
  - drawing
  - stamping
  - bending
  - joining and fastening
  - mechanical
  - adhesives
  - cohesion
  - mixing
  - coatings
- Finishing
  - wood
  - metal
  - plastics
  - coating applications

**Packaging/Promotion/Selling**

- Reasons
- Package design
- Pricing aud costing
- Market research
- Advertising
- Distribution methods
- Product maintenance and servicing

**SAMPLE ACTIVITIES**

- Conduct a survey of custom and mass produced products and tabulate such items as the durability and life expectancy of each product, whether natural or synthetic materials were used for the productiou of the product, and how popular the products are with the user of the product either at home or in the school situation

- Plan a visit to a museum which that features a study of industrialization of manufacturing to study how tools and machines developed and revolutionized the production of products.

- Take apart the parts of a hand tool used in the work lab, for instance, a jack plane, uame and list all the parts, and then do a test to see how interchangeable the parts are from tool to tool.

- Collect items used at home or in the school made out of different materials such as wood, metal, plastic, glass, paper, etc., and then divide the class into groups and brainstorm ways of how each material could be recycled.

- Have students research and make a list of inveutious that have been developed by womeu aud have had an important influence ou the development of society.

- Conduct a safety audit of the work lab or lab situation, make a list of potential safety problems and hazards, and then suggest ways to rectify these problems.

- Take an item of sports equipment and do an analysis of the pros and cons of the design of the item when in use.

- Have studeuts produce a list of local Nova Scotia eutreprencurs and list their achievements and the development of their companies. Try to visit one of these businesses.

- Divide the students into groups and conduct competitions for doing as series of tests, such as replacing the drill bit in a drill. Conduct time test to determine the fastest.

- Have students design and make one product using a composite material they fabricate themselves; this could be wood, metal, plastics.

- Design and produce a concrete block, using recycled materials, such as ash, paper, cardboard, glass, etc., by mixing these with ready mix concrete and using a mold to produce the product.

- Develop designs for small furniture items, such as storage and display units, stools, and bench seats, book shelves and book cases.

- Develop designs for cabinet construction, including drawer and slide construction and leg and rail construction; methods for fastening tops; the application of special hardware; and special assembly problems.

- Design a quality control step for use in a production line approach, and develop an inspection gauge to check the size or thickness of the piece of materials used in the production of the product.

- Videotape a selection of ads shown on the television or do an audio recording of radio ads and then do a critical analysis of these.

- With the co-operation of a local hardware store, visit the store, together with the staff choose various items off the shelves and then meet with the staff to do an analysis of the packaging that is used for the individual products.
- Interview automobile sales agents to determine the techniques they use for selling the product.

## UNIT 4 — PRODUCT ANALYSIS

### OUTCOMES

Studeuts should be able to

- analyse and evaluate products produced by different methods of manufacturing such as handcrafted, custom, mass, CIM, etc.
- apply critical thinking skills for developiug and evaluating ideas
- define the conceptual framework associated with the design prohlem-solving process
- demonstrate the application of the design problem-solving process during the production of numerous products
- control quality effectively during the production of a product
- perform regular tasks on a mauufactured product
- be aware that the appearances of products and their relatiouship to their environment is important to the cousumer
- use techniques, processes, and resources creatively to achieve a high-quality product that matches the specifications

### CONTENT

#### Decision making

- Critical and Creative Thinking
  - developing different ideas
  - evaluating ideas
- Know how to
  - diagnose a situation
  - identify a problem
  - collect data
  - analyse and evaluate data
  - make a decision
  - implement a decision
  - evaluate results
- Analysing and Evaluating Products
  - specification linking
  - material suitability
  - accuracy of production
  - care of use and maintenance
  - safety
  - value for money
- Design (Problem Solving)
  - design vocabulary
  - design process
  - research
  - safety
  - cost
  - maintenance
  - design communication
- Quality Control
  - quality determination
  - product liability
  - warranties
  - assuring quality products
  - inspection tools and materials
  - random sampling
  - defects
- Servicing Products
  - parts
  - maintenance
  - installation
  - repair
  - altering
- Establishing a Product Service Centre
  - service centre layout
  - tools/machines/benches
  - service records
  - clientele
  - cultivating a clientele
  - flow chart and procedures

## SAMPLE ACTIVITIES

- Have students conduct a survey of some of the uew products that are beiug used in the community to determine how well the product performed, where the product was purchased, the reason for purchasing the product, and the main dissatisfaction with the product.
- Working in groups, have students bring in a broken product that is used around the house, such as a lawn mower, a hair dryer, a vacuum cleaner, etc., and dissemble the product to show the major parts and subsystems, then mount on the display.
- Have students conduct an ergonomic evaluation of study and work environments. This could be done around the school or in a local production company in consultation with the management.
- Conduct a product part disassembly procedure to catalogue and identify the major parts used in the product and their material composition.
- Obtain drawings used in the manufacturing of a commercial product. Study and compare the parts list used in these drawings.
- Study the organization of a local company which produces products.
- Design, develop, and produce a product using the common material-forming processes and involving wood and/or metal and/or plastic.
- Be involved in the school. (See Entrepreneurship options).
- Using a computer program or manual drafting procedures and templates produce an organizational chart for a school manufacturing company.
- Design and develop inspection jigs and fixtures and production inspection equipment.
- Consider the establishment of a home or handtool power maintenance business. This could be of a stationary type or a mobile type and could concentrate on garden tools or general household maintenance tools.

## UNIT 5 — CONSTRUCTION PRODUCTION

### OUTCOMES

Students should be able to

- identify the features relevant to small and large-scale construction production projects
- design, plan, and complete a custom production project
- identify and use the materials, tools, machines, and techniques used in construction production
- overcome obstacles when making by applying knowledge of materials, components, tools, equipment, and processes to change working practice

### CONTENT

#### Small Construction

- Frame and carcase construction
- Stock preparation
- Marking out and layout procedures
- Jointing procedures
- Custom Construction
  - design — computer/traditional
- Materials
  - choosing materials
  - properties
  - standard stock
  - specialty stock
  - fittings
- Tools
  - measuring and layout tools
  - separating, forming and molding tools
- Machines
  - power tools
  - portable
  - stationary
  - separating, forming and molding machines
  - use and maintenance
- Techniques
  - forming
  - separating
  - combining
  - finishing/conditioning
- Safety
  - safe practices
  - safety rules

#### Large Construction (optional)

- The Construction Industry
  - human needs
  - environmental impacts
- Construction Trends
- Planning a Structure
- Construction Measurement and Layout tools
- Power tools
  - stationary
  - portable
- Materials
  - wood
  - metal
  - insulation
  - finishing
  - new
- Light Construction
  - site preparation
  - foundation and flooring
  - wall and roof framing
  - exterior sheathing
  - finishing
- Non Structural Systems
  - plumbing
  - electrical
  - climate control
- Safety
  - safe practices
  - safety rules

## SAMPLE ACTIVITIES

- Estimate the cost and materials needed to complete a small storage barn.
- Construct a model of a primitive structure.
- Lay out a grid system on a lot; draw a plot plan with grid showing ground elevations and contour lines.
- Compile a specification sheet for a 4' x 8' tool shed.
- Identify the types of band and power tools that cut, saw, and drill, currently in use in the construction industry and determine which stationary power tools are necessary for on site building.
- Break a construction project down into steps and use an estimate sheet to estimate material cost and time required for the completion of each step.
- Design and construct a model of a small building such as garden shed or a hunting lodge/camp. Research local newspapers for construction jobs commonly available locally and examples of construction production.
- Solder copper joints on a mock-up of a supply system.
- Study how climate control is controlled in a building.
- Develop the frame or carcase construction for a project to be made out of wood or metal or plastics or combined materials.
- Develop designs for small furniture items such as storage and display units, stools and bench seats, book shelves and book cases.
- Develop designs for cabinet construction including drawer and slide construction, leg and rail construction. Methods for fastening tops and the application of special hardware and special assembly problems.

## UNIT 6 — COMPUTERS AND MANUFACTURING

### OUTCOMES

Students shonld be able to

- describe and demonstrate the basic operation of a computer

- demonstrate and use a computer to support production manufacturing in a variety of ways as follows:
  - for the management of production
  - for research and development
  - to assist the promotion and sale of a product
  - for planning production
  - for the control of manufacturing/ production

- save, restore, and print products of computer applications listed above

### CONTENT

- Computer Hardware and Software
  - development of computers
  - accessories
  - software applications and categories
  - hardware/software
  - basic operation
- Computer Applications in Manufacturing
- Business Management and Operation
- Managing Resources
- Managing Production
  - CAD/CAM
  - CIM
  - JIM
  - Factory Management TQM
  - Robot Control
- Research and Development
  - design problem solving
- Sales and Promotion
  - advertising
  - desktop publishing
- Project Design and Development
  - CAD Futures and Careers-
  - smart control
  - résumés
  - suiall business operations
- Computers and Enterprise
  - record keeping (spread sheets)
  - word processing
  - graphics
  - data base management
  - accounting
  - tax preparation
  - machine control
  - flow chart design
  - graphing
  - statistics
  - business progress

### SAMPLE ACTIVITIES

- Use a desktop publishing program to develop and design a purchase order form for use iu the production company for the materials used. This should include such items as to, from, date, catalogue numbers, description, quantity, price, total sections, etc.

- Use a desktop puhlishing program to develop a line production routing sheet, which would include operation, description, production rate, number of operators or operations, number of machines, lahour rate, cost per so many parts, as well as a production schedule, which would list the product name and number, projected sales, desired inventory, total required, beginning inventory total to make, per week, etc.

- Have the students program a robot using a computer to do a simple step-by-step process.

- Use an operation analysis chart to study specific operations and work stations to improve efficiency production of a product. Develop the design for this on a desktop publishing program.

- Design a warranty card for the products being used in either of the three entrepreneurship options. This should include what is to be covered on the warranty, specifying the length of time the warranty will be honoured and a copy of the warranty.

- Use a desktop publishing program to design an advertisement for use in a publication to advertise the product being produced in any of the three entrepreneurship options.

- Use a desktop publishing program to design a market survey form.

- Use a desktop publishing program to design inspections tabs, employee time cards, and iuspection report forms to be used for the production of a product.

- Use a computer software program, such as *Floor Plan* or *Design Your Own Office* to design the floor layout for a business office to operate the business enterprise.

- Use a computer software program to develop the plans for the enterprise being planned. Use the program to

  evaluate market plans and strategy, set goals and organize raising capital.

- Do a survey of the use of computers in business including IBM and Macintosh systems. Include such questions as what operations are performed, what automated elements are used, what are the precise benefits, who uses the computers, what space is needed, to what use are they put, and what programs are used (e.g., as accounting, word processing, desk top publishing, spread sheet, data base and management).

## UNIT 7 — FUTURE PRODUCTION AND CAREERS

### OUTCOMES

Students should be able to

- identify and distinguish the advantages and disadvantages of new materials for use in production technology
- describe and discuss the impact of production on resources available, the environment, and human beings
- display and develop the personal qualities and attitudes beneficial to careers in the production and job applications.
- identify the careers available in the area of production technology
- work as a member of a team in a production enterprise

### CONTENT

**New Materials and Applications**

- For use underwater
- On land
- In the air and space
- Future analysis
- Simulations
  - *sim city*
  - *A TRAIN*
- Communication
  - listening, speaking
  - speaking
  - writing
  - reading
  - visual literacy
- Impacts of Production
- Resource consumption
- Environmental impacts
- Human impacts
- Automation
- Cottage production

**Careers**

- Identifying interests/aptitudes and abilities
  - skills and abilities
- Personal qualities
  - self-confidence, responsibility, and perseverance
  - adapting to change
  - making decisions and calculated risks
  - tolerance for ambiguity
- Personal attitudes
  - motivation
  - nutrition
  - values
  - ethics
  - integrity
  - decisiveness
  - patience
  - team player
- Working in a team
  - human relations
  - establishing, maintaining, and ending relatiouships
- Career searches
- Education opportunities
- Careers in production metals
- Careers in production plastics
- Careers in production wood
- Job search techniques
- Résumés and applications
- Interview techniques
- Small business opportunities

### SAMPLE ACTIVITIES

- Visit the personnel office of a local production company and interview the personnel office about desirable qualities desirable and the prohlems that relate to employment of workers.

- Working in league with the business education department, have students produce a chart of the gross national products of different countries and the trade balances that are mounted by each country. Make comparisons and have students discuss and brainstorm why there are differences.

- Have students produce a world manufacturing chart to show differences that have evolved over the last 40 years in the number of countries participating in the world's manufacturing and their share of the total. (Use an electronic atlas type software program and a desktop publishing program.)

- Have students identify the values that influenced the design, manufacture, promotion, use, and disposal of two products and explore how the products work and their impacts on people and the environment.

## TLA#1 COMPOSITE MATERIALS

### INTRODUCTION

Composites exist in natural state such as wood (cellulose, fibres in a lignin matrix), sea shells, bamboo and human and animal bone. For example, discarded antlers from caribou were used by the Inuit of Baffin Island to construct many items. (See background information.) Throughout the ages people have designed composites such as straw-reinforced clay or plywood for building materials. Materials exist in composite form probably just as much as they do as monolithic materials.

High-performance composites serve as design materials for sporting and recreational gear, such as tennis rackets, golf clubs, fishing rods, canoes, and trail bikes.

The aim of this TLA is to gain a knowledge of how composite materials are engineered by designing and producing a sample for a specific product.

### OUTCOMES

Students should be able to

- describe the trend towards high-performance composites and why they are often chosen over traditional materials
- draw cross-sections of sample composite materials to illustrate their structure
- list several products made from engineered composites and explain why composite material was used in the product
- solve technological problems through application of knowledge about materials technology

### TERMINOLOGY

| | |
|---|---|
| baleen | monolithic |
| ceramic matrix composite | performance |
| composite material | polyester |
| constituents | polymer matrix composite |
| epoxy | polyurethane |
| fiberglass | primordial |
| inuit | recreational |
| isotropic | reinforce |
| laminar | thermoplastic |
| macroscopic | thermoset |
| matrix resin | translucent |
| metal matrix composite | tundra |

### PROCEDURE

Have students observe the use of materials in products around the local community to gain an insight into the application of high-performance composites. For example, visit a sporting goods shop or outdoor camping gear store to learn about materials used, e.g., the material used to reinforce fibreglass ski-poles, the impact-resistant polyethylene used in children's ski helmets, the composition of foam core sandwiched between layers or fibreglass in downhill skis.

The students will use that information to make an engineered composite that will improve a product with which they are familiar.

Students could investigate materials such as reinforcing fibre sheet and/or particles such as woven glass fibres, and matrix resins such as polyester and epoxy or Portland cement.

Students should observe the properties that these materials possess, such as toughness, hardness, water resistance, and outdoor weatherability, and their relevance to the composite material design they are to develop. Have students subject the material and finished product to stress tests such as: compression, tension, shear, and sun and rain to see how the material reacts.

**BACKGROUND INFORMATION**

A composite material is a complex solid material composed of two or more materials that on a macroscopic scale (visible with the unaided eye) form a useful material. The composite is usually designed to exhibit the best properties or qualities of its constituents or some properties possessed hy neither. Composite materials come in the following forms — ceramic matrix composite (CMC) polymer matrix composites (PMC), and metal matrix composite (MMC).

Laminar composites consist of layers and are a laminate of at least two different solid materials honded togetber. Lamination allows the designer of this composite material to use the best properties of each layer to achieve a more useful material, with such properties as wear resistance, low weight corrosion, resistance, strengths, stiffness, etc. A typical example is plywood, which has isotropic properties in the plane of a sheet of plywood due to the layers of wood bonded witb a thermoset resin so that the longitudinal direction is at right angles in adjacent plies.

Note: (The National Research Council of Canada is pursuing research on lumber substitute materials.)

"Shell, coral, horn and tusk have heen described as 'organic stone. This 'stone' has been used hy humans, plants, and auimals from primordial times to fight a life-and-death struggle in the seas and on the cold tundra and steppes of a hostile world. In the bitter north winds, brave hunters with twanging bones of horn and flint-headed spears made their world liveable, and in leisure moments they carved bone and the flat tines of reindeer antlers into useful and decorative objects.

The Inuit use of natural composite materials includes carving in haleen, whale bone, polar bear fang and claw, as well as, walrus ivory.

Walrus ivory possesses when carved and polished the translucent glow of snow lighted by mid-day sun. Human and animal forms are usually represented in these carvings but also geometrical designs."

**RELATED ACTIVITIES**

Have students

- Investigate how metal/plastic-layered composites are produced into drumsticks used by popular music entertainment bands. The drumsticks combine the strength and vihration absorption efficiency of an aluminium core, with the strong sound-making ability of the cover molded of thermoplastic polyurethane resin.

- Develop a chart illustrating the advantages of using composite materials in relation to the following: strength/stiffness, resistance to wear, corrosion, fatigue, creep and stress, forming and molding potential, non-conductive/conductive potential, marketahility properties, and cost.

- Develop a chart illustrating the potential of CMC, PMC, and MMC composite materials in various industries, snch as transportation, communication, aerospace, and automotive.

- Design a chart illustrating the attributes and shortcomings of the following fibre types, used in composite materials: glass, boron, graphite, aramid, and polyethylene.

- Compose a chart illustrating the potential of metal matrix composites, ceramic matrix composites, and polymer matrix composites, in relation to strength, afford ability, toughness, corrosion resistance, formability, and joinability.

The following three TLAs deal with plastic, metal and ceramic materials. These could be done individually or collapsed into one if students decide to develop a product which incorporates more than one of these materials in the solution, or incorporates a composite material.

# TLA#2 POLYMER MATERIALS

## INTRODUCTION

A polymer is a type of molecule formed when two or more molecules called monomers combine in process called polymerization. Rubber, plastic, and adhesives are examples of polymers. Polymers are light weight and have good corrosion resistance but have relatively low strength and do not hold their shape at high temperatures. Polymers are classified as thermoplastic, thermosetting, and elastomer materials.

## OUTCOMES

Students should be ahle to

- describe, classify, define, and explain the properties of common polymer materials
- name and specify common forms of polymer materials
- relate the common methods of molding polymer materials
- explain and demonstrate the design potential and wise utilization of polymer materials
- recount and show at least one of the following polymer molding techniques: injection molding extrusion, molding, blow molding, compression, and transfer molding
- explain and exhibit at least one plastic-forming or laminating process, such as vacuum suction, thermoforming, or pressure molding
- describe and demonstrate various methods of casting polyester resins
- explain and display methods of forming plastic by various fusion processes
- machine, cut, and fabricate a variety of plastic materials
- design and produce a product utilizing several molding and forming techniques
- explore various methods of coating and/or decorating plastic materials

## TERMINOLOGY

| | |
|---|---|
| acetate | polypropylene |
| acrylic | polystyrene |
| elastomer | polyvinyl chloride |
| high density | silicone |
| low density | solvent |
| nylon | styrene |
| plasticizer | thermoplastics |
| polyethylene | thermosets |
| polymer | |

## PROCEDURE

Have students

- collect, display, and tabulate a variety of polymer materials and compile a classification table of thermosets and thermoplastics
- collect a variety of commonly used plastic products and identify the molding procedure used in their manufacture
- study the development of the plastic industry; produce a chart illustrating the history of its development and the current and future potential of the plastic industry, including the space, health, medicine, computer, and electronics sectors

- design, plan, construct, and produce a product that can be injection molded or a product that can be made using the different types of extrusion processes.

- design a small blow-molding cavity out of hardwood that can be used for producing a product; experiment with the cavity produced

- design, produce, and use a small vacuum former

- design and construct holding fixtures and forming guides used to stretch and form plastic materials

- experiment with different fibreglass-reinforced materials such as glass matt, cloth, chopped roving, burlap, cotton, etc., and design and produce at least one reinforced product.

- experiment with various polymer-casting resins comparing times, colours and densities and design a product and mold

- experiment with processing foam beads; fabricate the appropriate molds using a variety of materials (aluminum urethane or silicone rubber, tin plate, plaster, etc.) and make comparisons as to the effectiveness for producing a product

- design and produce molds, using aluminum for dip coating in vinyl plastisol ( experiment with heating times, temperatures, pre-heating, colour dyes, and curing times)

- practise cutting and shaping plastic materials using a variety of hand and machine techniques when designing and producing a product

- experiment bonding a variety of plastic materials using different types of cements and conduct comparative strength tests

- design, plan, construct, and produce a product utilizing polymer materials and involving a selection of molding, forming, and fabrication techniques

# TLA#3 METAL MATERIALS

## INTRODUCTION

Metals are classified as ferrous or non-ferrous. Ferrous metals contain iron, which is one of the most common elements in the crust of the earth. Today about 90% of all iron is produced as mild steel. Mild steel cannot be hardened or tempered, but it has excellent ductility and can be easily drawn into needed shapes such rods, bars, sheets. Carbon is added to mild steel to increase its hardness and strength, however, it loses ductility. High carbon steel is used to make cutting tools. Stainless steel an alloy with iron, is used for making specialized products, such as kitchen utensils and medical equipment.
Non-ferrous metals contain no iron; the most common one is aluminum. Other non-ferrous metals include titanium, copper, zinc, magnesium, tin, and lead.
Most metals used today are alloyed, which means they are a combination of two or more metals. Metals are very useful materials for design selections in which high strength or stiffness are required. Metals have good ductility, conductivity, and toughness.

## TERMINOLOGY

| | |
|---|---|
| alloy | extrude |
| anneal | ferrous |
| brittleness | fusion |
| chase | hone |
| cohesion | hydroforming |
| corrosion | investment casting |
| crimp | malleable |
| crucible | mandrel |
| ductility | molydenum |
| elasticity | normalize |
| electrode | parting line |
| emboss | permeability |
| etch | plasma |
| quench | riser |
| sprue | swage |
| temper | tensile |
| titanium | ultrasonic |

## OUTCOMES

Outcomes one to four are general outcomes for this TLA. The remaining outcomes relate to specific projects that students may undertake during the unit.

Students should be able to

1. describe the composition and properties of ferrous metals and non-ferrous metals.

2. Define the terms used to describe the properties of metal materials such as hardness, toughness, tensile strength, malleability, deductility, elasticity, heat and electrical conductivity.

3. Describe and apply the tbree stages in heat treatment, heating to the correct temperature, keeping the correct temperature, the required length of time, cooling in the correct way to give the design properties and annealing to make the metal as soft as possible to relieve internal stresses.

4. Distinguish and demonstrate the terms of normalizing, hardening and tempering, case hardening.

AND/OR

5. Show a broad competency in working sheet metal into a variety of shapes in relation to a product.

AND/OR

6. Display a working knowledge of shaping fabricating, and decorating metal into simple art form in the production of a product.

AND/OR

7. Exhibit a general competency in bench and wrought metalwork techniques and skills in the production of a product.

AND/OR

8. Cut aud shape metal by using hand machine tools for the production of a product.

AND/OR

9. Form metal by heat and pressure and display a competency in forging, heat treating and casting metal for the production of a product.

AND/OR

10. Join metal by heat and demonstrate the techniques of soldering, or welding metal materials.

11. Explain the importance of protecting metal from the effects of corrosion and demonstrate several metal finishing techuiques for the production of a product.

12. Research at least one advanced technique in the production and use of metal materials such as powder metallurgy, chemical milling, electrical discharge machining, electro-mechanical machining, ultrasonic machining, explosive forming, spark forming, magnetic forming, gas forming, cold forming, orbital forging, photochemical machiuing, cutting metal by lasers, self-shield flux-cored arc welding (FCAW), gas metallic arc welding (GMAW), submerged-arc welding, gas tungsten arc welding (GTAW), plasma-arc welding, electron-beam welding (EWB), pulsed-laser welding, explosive bonding, higb powered microscope, use of computer operations in the design and manufacture CAD/CAM and industrial robots.

**PROCEDURE**

Have students

1. Design, plan and construct a product using sheet metal in ferrous or non ferrous metal.

AND/OR

2. Design, plan and construct an art metal product which is appealing, as well as, functional and apply surface decoration.

AND/OR

3. Design, produce and construct a product using bench and wrought metalwork tecbniques.

AND/OR

4. Design, produce and construct a product involving shaping of metal by machine for the production of a product.

AND/OR

5. Design, plan and construct a product involving the shaping of metal by

forging or heat treating or by casting.

AND/OR

6. Join metals by a variety of means including mechanical, and by the application of heat, for the production of a product.

AND/OR

7. Apply a variety of finishes to metal after appropriate surface preparation.

AND/OR

8. Design a product using a variety of metalworking techniques such as machining, bench and wrought metalwork, welding, sheet metal, or advanced techniques.

AND/OR

9. Study at least one area of advanced processing of metal material and visit an industry where this is practised or do a simulation of one of these processes.

# TLA#4 CERAMIC MATERIALS

(Courtesy of Lucy Kanary, President, Advance Materials Engineering Centre, P. O. Box 1618, Station M, Halifax, NS B3J 2Y3)

## INTRODUCTION

Ceramics are becoming one of the most widely used types of materials (see chart) The field of ceramics as an engineering material is quite diverse. Glass, porcelain, and tiles are examples used in construction engineering. Ceramic materials are light-weight, wear-resistant, excellent insulators, and extremely strong at high temperatures. These characteristics make them very attractive for application in automobiles for spark plugs, oxygen sensors, and catalytic convertor cores. Automotive engine valves made from ceramics can withstand stress, temperatures, and a corrosive environment better than metal valves. It is anticipated that some day automotive engines maybe made of ceramic materials.

The process of slip casting is used for manufacture of ceramic articles, which may be of simple or relatively complex design. Included are various forms of pottery, refractory products, and articles such as sinks and tubs.

## TERMINOLOGY

| | |
|---|---|
| aluminum oxide | mold |
| blender | particle |
| crucible | shrinkage |
| dimension | sintering |
| ethanol | suspension |
| methanol | volumetric |
| micron | |

## OUTCOMES

The process involves several steps, which vary slightly with the material to be cast. Generally, the objectives of the procedure are as follows:

Students should be able to

- prepare powder of suitable particle size (approximately 1 micron) of the material to be cast (this generally involves grinding of a coarser particle size under ethanol or methanol)
- prepare suspension of the required powder in water, ethanol, or methanol (if the water is used, pH control using HC1 or NaOH is necessary)
- fabricate a hollow mold of the required shape (this can be plaster of paris and dimensions should take into account shrinkage of the article on firing).
- pour slip in the mold for a predetermined length of time and drain off the excess.

## PROCEDURE

The laboratory project will consist of the production of a simple aluminum oxide ($Al_2O_3$) crucible, following the procedure outlined below.

Preparation of the Plaster of Paris Molds

1. Weigh out 100g plaster of paris, and place in blender with 1000 ml water.
2. Blend until thoroughly mixed, then add to the volumetric flask and stir under vacuum for 10 minutes.
3. Pour plaster of paris into mold form.

### Preparation of the Slip

1. Place a mixture of $Al_2O_3$ powder and water (2 parts $Al_2O_3$ to 1 part water) in the blender. Mix, and adjust the pH to 4.5 with addition of HC1.

2. Pour the suspension into a volumetric flask and stir under vacuum until all visible bubbles have disappeared.

### Preparation of the Crucible

1. Pour slip into prepared mold. Top up mold with additional slip until required wall thickness has been obtained.

2. Pour out remaining slip, and leave mold in an inverted position for a few minutes.

3. Right the mold and leave upright until the crucible begins to release from mold.

4. Remove article from mold and leave to air dry.

5. Measure the outside diameter of each crucible.

### Firing (sintering) of crucible

1. After air drying for 4-6 hours, place crucible in furnace.

2. Fire for two and a half days at 1400° Celsius.

# TLA#5 PRODUCT MODELING and PRODUCT ANALYSIS

## INTRODUCTION

Industry must be able to sell products, and to do this they must be able to communicate their ideas effectively. Product designers create the products that are to be used. They give products their colour, texture, and personality, and they design them to be safe to use and to fit well into their surroundings.

Product designers present their ideas in many different ways, depending upon the product and the stage of the design. They use drawings, models, photography, and computer-generated video models to explain and sell their ideas.

Product designers rely on models both to work ont an idea and to show their clients precisely how it will look, and sometimes how it will work hefore it is mass produced. Product modelling is a name given to the creation of models for the whole range of consumer products, ranging in size from calculators to car body shells.

Many models are created full size, but for some large products this is not possible, and instead scaled-down models are built sometimes using materials and parts specifically built for the purpose.

In some instances, before an actual full-size prototype is constructed, it is produced quickly and cheaply in model form and then enlarged using photography or video to simulate the full-size product.

## TERMINOLOGY

acrylic
airhrush
hlock model
cellulose fillers
epoxy fillers
expanded polystyrene foam
fillers
labels
lettering
parts drawings
pictorial views
polyester-based
polystyrene
polyurethane
prototypes
sketch model
sub-assembly
texture
vacuum forming
water based fillers
working model

## OUTCOMES

Students should be ahle to

- explain and demonstrate the importance of communicating and presenting ideas by using models
- choose materials for product modelling
- produce sketch models for product modelling
- design and produce block models
- produce assemblies for models from wood and or metal and or plastic materials
- machine parts for models from solid materials
- prepare the surface of models prior to finishing
- choose and apply a variety of finishes

- finish a model, including the application of product lettering.

**PROCEDURE**

Have students (individually or in pairs or small groups) decide upou a product to be modelled.

1. There are several alternatives which could be considered.

    - as a joint project with a local or provincial based industry/business

    - by identifying a product with which they are familiar and dis-assembling the product with the purpose of producing a model illustrating the design improvement

    - by producing a sketch model or a block model, or a working model of a commercial product with which they are familiar

2. Produce a series of drawings and perspective sketches of the product to be modelled, either by hand or CAD, including layouts, general arrangements drawings, and orthographic projections as appropriate.

3. Produce parts drawings for cach of the separate parts

4. Produce a sketch model or a concept model made out of modelling materials such as card, laminated cardboard, plastic-laminate board, foam, polystyrene, or clay.

5. Produce a block model out of solid material and with no moving or working parts. This should show all the surface detail, including screws and joints, and display the correct texture and colour as a faithful representation of the design for the product.

6. Produce a working model similar to the block model, but with working and or moving parts. The model may need to be hollow to contaiu batteries or electronic circuitry, or it may need to unfold, have an hinged lid, or be constructed so that it can be taken apart.

7. Produce a prototype using the exact material the product is manufactured from. This should include all external and interual detail and be produced identical in everyway to the finished product.

**EXTENDED ACTIVITY**

Have students take apart a product that has beeu discarded, such as a portahle radio, cassette recorder, or hair dryer, and develop a 'matrix of materials used' chart, which lists the materials used, the material properties and characteristics and the application factors.

For example:

Hair Dryer

| PART | MATERIAL | PROPERTIES | APPLICATION |
|---|---|---|---|
| Housing | Acrylonitrile-Butadiene-Styrene (ABS) | Tough and high impact strength and toughness, easily molded, light and durable, scratch resistant, high surface finish | This material is appropriate for injection molding and affords an attractive surface presentation. |
| Nozzle | Stainless steel | Corrosion resistant | Heat resistant |
| Electrical switch | Polyethylene | Corrosion resistant, insulator, hard and tough | Heat resistant and durable |
| Graphics | Ink | Heat resistant, colourful, durable | Suitable for screen printing application |

## BACKGROUND INFORMATION

### Materials

Quite often a combination of materials, including wood, metal, and plastics, are used to fahricate models. A wide range of materials suitable for building models. Many materials can be used in exact product model making, provided they can be worked easily, can be joined precisely, and finish well. For example wood, acrylic, polystyrene, aluminum, and ABS. Polystyrene has the advantage that it can be vacuum formed as well as fabricated from small pieces.

1. Soft materials that are useful for sketch models which need to built quickly and include wood, cardboard and foam.

2. Engineering materials, such as metal and rigid plastic, as well as acrylic sheet, are very popular hecause they are flat, rigid, and have hard surfaces. Acrylic sheet is available in a wide range of colours, both opaque and transparent, and it can be honded successfully using cement. Since it is a thermoplastic it can also be heated and formed.

3. Polystyrene has a hard and almost metallic surface, and is available in various thicknesses aud standard sheet form, in both gloss and matt finish and a wide range of colours.

4. Curved shapes, which in production might be injection molded in rigid plastic, can be built quickly from foam plastic block, such as expanded polystyrene of Styrofoam. This material can be cut easily with a band saw or coping saw (kept moist to control the dust).

5. Small miniature parts and fittings, often found in model supply catalogues, such as binges, tubing, electrical components, pumps, switches, batteries, and motors, are also invaluable when producing models.

## Designing Models

There are a number of questions that need to be thought about, sucb as

- how strong must the model be
- which materials will be the most suitable
- how the model will be constructed
- which processes will produce the most accurate model in the least time
- how will curved shapes he produced
- how will flat shapes be produced
- how will working parts be produced

The corner joints may need to be reinforced, and small jigs or elastic bands can be used to help to hold parts in place during the assembly and to apply gentle pressure while cement sets.

## Choosing the Finish

A variety of finishes can be used, and there are several types of paint available, including polyurethane and acrylic paint. Different processes can be used, such as hand painting, spray painting, or air brushing. Sometimes surfaces such as wood will need to be sanded, primed, and filled. Water-based or polyester, epoxy, or cellulose fillers can be used to help to get rid of dips and hollows. Not all products are designed to have a high gloss finish, and it may be necessary to simulate an area of texture on the model surface. Texture paper or the spatter effect from an aerosol can be used to achieve a textured finish.

## Applied Graphics

Graphics should be applied to the final model to give it a finished appearance, and a brand name will have to be chosen and included on the model. Instant lettering is good for this. There are also lines, borders, and hatchings, which can be used effectively. Labels can also be made from many different materials such as thin cardboard or pieces of thin plastic. Relief lettering can be achieved in the same way, using die-cut stick-on letters with a layer of primer applied over the top.

## Texture Finish

Practically any material that in itself is textured can be applied to a surface. This includes coarse and wet-dry paper, polystyrene sheet, and self-adhesive reflective sheet. Self adhesive paper stickers and labels are also excellent sources of texture and surface details. Self-adhesive paper address labels can be cut with a sharp knife to make low-relief logos. They can also be given a texmre surface by heavily lining with an cmpty hall-point pen. Relief lettering on a model can be achieved in many ways, for example, injection-molded alphabets. These can he glued in place, and they will stand out in sharp relief when sprayed over. Dynamo tape can also he effective but needs to recessed to disguise the edge of the tape.

## Membrane Panel Switches

Switches can be modelled realistically and can he made to work without difficulty. They can be constructed using thick paper, and the electrical tracks can be made of self-adhesive copper or aluminum tape. Wires to the tracks can be soldered or can be fastened using just adhesive tape.

# TLA#6 DESIGN A BARRIER FREE WORKSHOP

## INTRODUCTION

The aim of this TLA is to design a barrier free work lab and lab area, to facilitate special needs studeuts' study of Industrial Arts Technology.

Students with physical disabilities want to be as independent as possible. Depending on others is necessary at times, but many tasks cau be accomplished independently by the physically challeuged when given the proper equipment and access. A primary concern has been that many facilities are not available for students with disabilities because of physical barriers.

Quite ofteu a device can be developed to aid a person in doing something that he or she is otherwise unable or finds difficult to do. A device could be a modification of an existing device, or a totally new concept and device unlike any other invention.

## OUTCOMES

- Students will investigate typical barriers found in the work lab situation
- list possible solutions or corrective actions to these barriers
- design as barrier-free an environment as possible
- design and build an adaptive device.

## TERMINOLOGY

| | |
|---|---|
| artificial | electrouic |
| barrier | handicapped |
| device | prosthesis |
| disability | rehabilitation |

## PROCEDURE

Have the students work in teams to build a device that would allow students with physical disabilities to improve their work lab environment. For example, this could concentrate in wheelchair access. A wheelchair could be borrowed or a student in a wheelchair could be used to perform realistic tests to facilitate the desiguers and builders. Assistance could be received from special education teachers and teacher aids to define the problem and evaluate and assess the solution. Mechanical, hydraulic, electrical, aud electronic devices could also be investigated to help with the solution of this problem.

## BACKGROUND INFORMATION

Wheelchair systems are usually quite complex aud require many components. They are constructed for oue individual and are not usually interchaugeable. Wheelchair systems usually consist of a solid seat with a wedged cushion, hip guides, abductors, a solid back, lateral trunk supports, a pelvic belt, headrest, lap tray, harness, and shoe holders. Materials and construction vary from mauufacturer to manufacturer and also vary by physiciau and therapist request.

# TLA#7 PRODUCTION MANAGEMENT

## INTRODUCTION

This TLA should be done in close collaboration with and utilizing the expertise of the school business education department.

The aim of this TLA is to have students keep an electronic inventory of parts used in the enterprise uuit.

When operating a company or business, it is necessary to keep track of all kinds of information, which would normally be kept on forms in file folders, such as names, addresses, accounts, supplies, inventories, business contracts, personal information, etc. It is possible to store this information on a database file by creating a form design to hold this information to be stored. Integrated and word processing programs can be used to create datahases.

## OUTCOMES

Students should be able to

- use the database management component of au integrated computer program to produce records for the organization of information used in the enterprise unit
- prepare a letter to a company that combines a simple spreadsheet or database report.

## TERMINOLOGY

| | |
|---|---|
| backup | calculations |
| cliphoard | column |
| cursor | data |
| database | default |
| directory | display |
| edit | field |
| file | headings |
| menu | merge |
| record | search, |
| save | summary |
| tab | |

## PROCEDURE

- Have students create a database from the main menu of an appropriate computer program. (for example, *PFS First Choice, Microsoft Works* etc.) First, have them map out on paper the headings that will be needed for the record form for the database. The form design should be simple and have a logical layout that is easy to work with and read. The purpose should be to reduce the time spent in filling out and maintaining records. (An example form is shown for a simple inventory of tools and machine used in a work lab situation.)
- Have the students give the form a name and add the design elements as shown: item, make, serial number, date purchased, cost, in service date, out of service date. These are field names, and the form can have as many field names as required providing sufficient room is left in between the fields to complete the form.
- Have the students save the form design by using the appropriate feature in the program.
- Have the students set the field type using the appropriate code.
- After setting field types and saving the form design, have the students complete

the forms listing the parts for the product used in a simulated service centre or items in the school production lab. Demonstrate how the tab key can be used to move from field to field.

- When the required number of record shave been completed, have students choose and display the records and the database by showing the table view option.

- Have students sort the records according to a predetermined or desired format.

- Have them work at printing, editing, and erasing information and removing the records where appropriate. The records can also be viewed as a table and then transferred to a spreadsheet program by copying to a clipboard.

**BACKGROUND INFORMATION**

Introductory-level integrated computer programs are probably the best for this application. (e.g., *PFS First Choice, PFS WinWorks* etc.). Frequently the business world requires that tables of numbers for lists of items be included within the letter or a proposal. The advantage of an integrated program is that these are combined with the word processor, the data base, the spreadsheets and the graphics, all in one program, and they facilitate easy movement from one function to another without worrying about the compatibility of the various files. An example is also included using the spreadsheet example. The students can work closely with the business education department in the creation of these reports, databases, and spreadsheets.

## TLA#8 - IDEAS FOR IN-DEPTH RESEARCH PROJECTS

Have students

- Study why industries such as manufacturers of electro medical equipment, surgical and medical instruments, semiconductors, motorcycles and bicycle parts, farm machinery equipmeut, household appliances, sporting and athletic goods, measuring and controlling instruments, pharmaceuticals, plastic plumbing fixtures, oil and gas field machinery, household audio and video equipment, and surgical appliances and supplies are amongst Canada's fastest-growing industries.

- Develop two charts of the top10 manufacturing industries for two years 1973 and 1993 to make comparisons.

- Investigate why items such as motor vehicles and parts, aerospace, computers and semiconductors, aud instrumentation and radio and TV are included in this top 10 list and why items such as steel mill products and textiles are no longer in this top 10 list.

- Obtain a list of the major industries in Canada under the following headings:
  - finance iusurance and real estate
  - government administration
  - service industry
  - wholesale and retail trade
  - transportation and communications
  - manufacturing
  - construction
  - forestry and fisheries
  - agriculture
  - mining

  List several industries under each heading and obtain a rating of the amount of knowledge needed in each one, according to the following rating: low, medium, and high.

- Choose one of the following high tech areas and investigate the implications of the technology for the future:
  - distributed computing
  - artificial intelligence
  - lasers
  - optical data storage
  - digital electronics
  - micro mechanics
  - photovoltaic cells
  - molecular designing
  - fibre optics
  - fibre-reinforced composites
  - high-tech ceramics
  - super conductors
  - microwaves
  - anti-noise technology
  - parallel processing computers
  - electronic notepads
  - desktop video conferencing
  - telecomputer
  - personal communication networks
  - computer-integrated manufacturing (CIM )
  - diamond-thin film
  - genetic eugineering
  - advanced biochemistry
  - advanced video displays (DTV)
  - advanced computers
  - microwaves
  - advanced satellites
  - new polymers
  - mixed media polymers
  - conductive polymers
  - stereo lithography
  - thin film deposition
  - chemical vapour deposition (CVD)
  - diamond thin film coating

- molecular beam epeitaxy
- ion implantation
- ion beam-assisted deposition

- Investigate how molecular designing might affect the production of automobiles. (Molecular designing uses layers to lay down atoms in a precise pattern on surface. Molecular designers can alter the properties of materials such as making metals become glass and insulators become conductors.)

- Examine the technology development time line listed below for a product that is important to them in their personal lives.
  - discovery - development of a new idea or theory
  - observation -possihle practical applications are identified
  - feasibility - proof of technical practicality
  - development- market-oriented experiments
  - production
  - introducing the new process or product into the market place

- Choose one of the commonly referred to 'future engines' and investigate what effect these engines may have on their individual lives in the uext 20 years.

  Instrumentation
  - optical instruments and lenses
  - engineering and scientific
  - equipment
  - environmental consulting and equipment
  - process controls

  Computers and semi conductors
  - information services
  - computer equipment
  - semiconductors
  - software

  Communications and telecommunications
  - telecommunications services
  - radio and microwave
  - communication
  - guided missiles and space
  - equipment
  - entertainment

  Health and medical
  - surgical and medical supplies
  - surgical and medical instruments
  - pharmaceuticals
  - medical care and diagnostics

  Future engines
  - genetic engineering and
  - biotechnology
  - the business of space
  - artificial intelligence
  - new materials (composite materials and combinations)

**Production case study ideas:**

- Have students write or contact Canadian entrepreneurs in the production and manufacturing areas to find out what made their business successful and what obstacles they had to overcome, for example:

Star Trucks Inc. of Kelowna, B.C., started the manufacture of specialized trucks for the Canadian logging, mining, and oil industry and then expanded it into owner-operator highway trucks with the development of heavy-duty models with double axles and higher horsepower for use in rough remote terraiu around the world, such as Australia, Indonesia, Iran, Zimbabwe, and Kuwait.

IPL Incorporated, a 500-worker plastic

fabricator in St. Damien, Quebec, holds the coveted standard ISO 9002 certificate, which facilitates international trade.

SR Telecom Incorporated, St-Laurent, Quebec, produces microwave telecommunications systems used to link remote users with phone companies and has sales to over 70 countries, including Mexico, Kenya, and Turkey.

Husky Injection Molding Systems Ltd. Bolton, Ontario, makes machines that make plastic parts and consumer goods and sells to 61 countries.

Gennum Corporation in Burlington, Ontario, manufactures integrated circuits for hearing aids.

IPC Construction Limited, Calgary, Alberta, makes oil and gas processing equipment that removes water and contaminants at the well head and has sales directed mainly to the Middle East as well as Southeast Asia.

Auto Parts Manufacturer, Stackpole Limited of Oakville, Ontario, molds power train parts such as sprockets, oil pump components and synchronizer plates from powder metal to specifications as exact as 5 microns.

PCL Eastern Packaging Limited, St. John, New Brunswick, supplies plastic carrier bags to supermarket chains in Atlantic Provinces. PCL and Eastern Recycling collects from 650 supermarkets in Atlantic Canada and northern New England and melts the bags, screens the molten plastic, extrudes it, and chops into pellets, which are then mixed with virgin feed stock. It exports 39% of its production, most of it to the U.S. northeast but also to Bermuda and California.

Palisser Furniture Limited, Winnipeg, Manitoba, employs 1800 people with sales of more than $200 million and is Canada's current biggest home furniture manufacturer;

Pivko Merfin Hygienic Products Limited makes strong biodegradable cloth-like paper, which is highly absorbent. Business extends to Europe where 40% of sales are made.

## *Acknowledgements*

***This guide has been reviewed and revised by the following:***

Chris Curtis — CEO, Centre for Entrepreneurship Education and Development, Department of Education and Culture

John Wilson — Curriculum Consultant, Nova Scotia Community College

Don Hill — Oxford Regional High School

Ken Johnson — Eastern Shore District High School

Victor Thibault —Ecole Secondaire de Clare

Ivano Andriani — Manager of Human Resources, Pratt & Whitney, Canada

Eric Worden — Curriculum Consultant (Chair), Department of Education and Culture

Cecil Smith — Oxford Regional High School

Ken Johnson — Eastern Shore District High School

Reg Pauley — Hants East High School

John MacKinnon — Strait Area Educational Recreational Centre