BEST PRACTICES GUIDE

British Columbia Technology Education Association

a Provincial Specialist Association of the BC Teachers' Federation

October 2011

BC Technology Education Association
BEST PRACTICES GUIDE

BCTEA best practices

Technology education in BC schools has undergone profound structural changes in recent years. These are not the result of curriculum revision. These changes are the result of current levels of funding and of the removal of maximum class size numbers by Bill 33. At present, class sizes often exceed facility design. Current budgets do not meet the costs of supplies, equipment, or maintenance. Providing a safe and effective learning environment is not possible unless minimum standards are met. No protocols are currently recognized for matching appropriate class sizes to technology education courses. Fewer teachers are teaching larger classes with less supplies, equipment, and maintenance than ever before.

In an attempt to address the resultant problems in program quality and teaching and learning conditions, the BC Technology Education Association (BCTEA) has compiled a comprehensive document outlining recognized best practices. Health and safety is paramount and is an underlying theme in all sections. Teaching and learning in technology education takes place in an inherently dangerous environment. Due diligence on the part of all—shop teachers, school administrators, school board trustees, the Ministry of Education, and government—must guide both policies and actions if we are to avoid student injuries and possible litigation.

As technology education teachers, we recognize the unique opportunity we have to equip students to enter the skilled labor force. Technology education fosters in students a mature sense of workplace safety and an array of skills they can eventually use to propel and sustain our economy. We recognize our obligations to provide a safe and effective learning environment. To this end the BCTEA has created this paper on best practices.

The *Best Practices* paper was written by a task force of the BC Technology Education Association:

Paul Boscariol	SD 8 (Kootenay Lake)
Rob Gibbs	SD 69 (Qualicum)
Mike Giesbrecht	SD 75 (Mission)
Doug Kearney	SD 72 (Campbell River)
Eric Munshaw	SD 33 (Chilliwack)
Brad Purves	SD 36 (Surrey)

EXECUTIVE SUMMARY

Technology education in BC schools has changed in recent years as a result of funding cuts and the removal of maximum class size numbers by government. There are fewer technology education teachers, and those remaining are teaching larger classes with less supplies, equipment, and maintenance than ever before. In an attempt to address the resultant problems in program quality and teaching and learning conditions, the BC Technology Education Association (BCTEA), a provincial specialist association of the BC Teachers' Federation (BCTF), has compiled a comprehensive document outlining recognized best practices. Health and safety is an underlying theme in all sections.

The technology education environment

Teaching and learning in technology education take place in school facilities that are similar to industrial workplaces. WorkSafe BC health and safety policies cover the teachers and other school district employees, who work in these settings, but not the students. The BCTEA believes that WorkSafe BC should cover students, and that a separate set of WorkSafe BC policies should be developed to address the unique safety issues pertaining to students working and learning in an industrial environment. The most significant factors which influence safe learning environments for technology education students are class size and composition, teacher qualifications, education assistant (EA) training, facilities, and budgets.

Class size and composition

Current class size legislation allows technology education classes of 30 students, the same limit as any other subject area, despite the unique safety issues in the industrial settings typical of shops in middle and secondary schools. Previously, 45 school districts had agreed to put class size limits of 20–24 students in collective agreements, often as firm numbers that were exempted from a "flex factor," and also agreed that the number of students in a shop shall not exceed the number of students which can be safely accommodated, or the number for which the facilities were designed or equipped. Complicating the issue is the growing trend of multigrade, multicourse classes that see a teacher instructing two to four grade levels of students in different curricula during the same class. The government stripped these provisions from teacher collective agreements in 2002, but the liability for safe teaching and learning environments in technology education shops remains.

The BCTEA takes the position that class size in technology education classes should be based on:

- the inclusion of EAs in any class count.
- an absolute limit of 20 students and EAs per teacher (with the exception of drafting classes) or the number that can be safely accommodated in the facilities as designed and equipped, whichever is lower.
- possible further reductions if the class includes beginning ESL students or students with special needs who require additional or unique safety supervision.
- a teacher-student ratio that allows for adequate supervision considering the number of courses running concurrently, and the equipment required for the course (e.g., a senior wood shop presents different supervision challenges than a senior electronics shop).
- a minimum floor area, defined in terms of *useable* floor area; i.e., not covered by machinery, furnishings, etc., that is adequate for the specific program and its associated equipment, storage, and workspace needs, and
- a minimum area per student to allow for safe working space in the context of the specific program and its associated equipment and activities.

The BCTEA supports the inclusion of students with special needs in technology education classrooms but argues that many students with or without any identified special needs may

require an individual education plan if they are to function safely in a shop environment and achieve the goals of the curriculum. Aspects particular to technology education should be clearly defined in the IEP.

Teacher qualifications

For a variety of economic, social, and educational reasons it has become increasingly difficult to employ and retain well-trained technology education specialists in the province's public schools. This has resulted in many teachers without specific training in technology education teaching technology education courses. Some have industry experience and/or qualifications while others are self-taught or hobbyists. The BCTEA takes the position that the minimum qualifications for teaching middle school or secondary technology education classes is successful completion of a Teacher Qualification Services (TQS) recognized technology education training program, inclusive of a practicum sponsored by a teacher who has these qualifications. The nature of teacher qualifications is a factor in program quality and in the safety of the teaching and learning environment.

Training for Education Assistants (EAs)

Increasingly, technology education classes have EAs working with special needs students. Educational assistants, like all other employees, are subject to rights and responsibilities under WorkSafe BC legislation, including the right to training and the right to refuse unsafe work. For an educational assistant to effectively supervise and assist the assigned student(s), they must have a reasonable and verifiable understanding of the procedures, practices, machinery, and tools being used in a particular course and setting. Employers have an obligation to provide training in safe work protocols and to ensure that these protocols are being followed.

Facilities

The BCTEA recommends the establishment of a provincial program advisory committee, comprised of technology education teachers appointed by the BCTF and representatives from industry and post-secondary institutions, to establish provincial standards regarding facility design and a minimum equipment inventory.

Two areas critical to facility design are:

- a minimum floor area, defined in terms of *useable* floor area; i.e., not covered by machinery, furnishings, etc., that is adequate for the specific program and its associated equipment, storage, and workspace needs, and
- a minimum area per student to allow for safe working space in the context of the specific program and its associated equipment and activities.

The advisory committee's recommendations would be used to plan and maintain shop facilities throughout the province. In the meantime, the BCTEA offers standards for both facilities and equipment needed to effectively run technology education programs in our schools. The standards are intended to apply to new construction or renovations to existing facilities.

Budgets

The BCTEA recommends the formation of a provincial program advisory committee to assist in the establishment of a basic equipment inventory that school districts could use to develop realistic budgets. This group would be comprised of representatives from industry, post-secondary training, and teachers of technology education and would have a good understanding of costs relating to tools and equipment necessary to carry out technology education programs.

Table of Contents

Section 1: Technology education in BC schools

Who we are

The BC Technology Education Association (BCTEA) is a provincial specialist association of the BC Teachers' Federation (BCTF). It represents the interests of the technology education teachers throughout the province.

Many technology education teachers have industry credentials such as Red Seal certificates in trades, as well as their university training and teaching certificate. In addition, the BCTEA plays an important role in ongoing professional development for technology education teachers through an annual conference, newsletters, a listserv, and a website.

The BCTEA, through the BCTF, advocates for curriculum revision and the development of new curricula, and for policies that enhance the teaching and learning conditions in technology education shops.

What we teach

Technology education teachers, the "shop teachers" of common parlance, teach the following provincially prescribed curricula:

- Technology Education 8
- Technology Education 9
- Technology Education 10: General
- Technology Education 10: Drafting and Design
- Technology Education 10: Electronics
- Technology Education 10: Mechanics
- Technology Education 10: Metalwork
- Technology Education 10: Woodwork
- Automotive Technology 11
- Carpentry and Joinery 11
- Drafting and Design 11
- Electronics 11
- Metal Fabrication and Machining 11
- Automotive Technology 12
- Automotive Technology 12: Automotive Electricity and Electronics
- Automotive Technology 12: Body Repair and Finish
- Automotive Technology 12: Engine and Drive Train
- Carpentry and Joinery 12
- Carpentry and Joinery 12: Cabinet Construction
- Carpentry and Joinery 12: CNC Wood Processes
- Carpentry and Joinery 12: Residential Construction
- Carpentry and Joinery 12: Woodcraft Products
- Drafting and Design 12
- Drafting and Design 12: Advanced Design
- Drafting and Design 12: Architecture and Habitat Design

- Drafting and Design 12: Engineering and Mechanical Drafting
- Drafting and Design 12: Technical Visualization
- Electronics 12
- Electronics 12: Analog Systems
- Electronics 12: Digital Systems
- Electronics 12: Robotics
- Metal Fabrication and Machining 12: Advanced Fabrication
- Metal Fabrication and Machining 12: Advanced Machining
- Metal Fabrication and Machining 12: Advanced Welding
- Metal Fabrication and Machining 12: Art Metal and Jewellery
- Metal Fabrication and Machining 12: CNC Processes
- Metal Fabrication and Machining 12: Forging and Foundry
- Metal Fabrication and Machining 12: Sheet Metal

Technology education teachers also teach the Accelerated Credit Enrolment in Industry Training (ACE IT) programs and the secondary school apprenticeship programs, both of which provide students with access to industry training while they are still enrolled in secondary school. Technology education teachers also supervise ministry-authorized work experience courses.

In addition, technology education teachers teach many of the 378 locally developed Board/Authority Authorized (BAA) courses in the trades and technology category. Students taking these courses can get credit in areas as diverse as plumbing, roofing, engineering, art metal, warehousing, medieval armouring, robotics, and aviation technology.

Technology education teachers are proud of the diversity and sophistication of the courses they teach. They strive to develop quality programs and keep up with industry standards.

Section 2: The technology education environment

Teaching and learning in technology education take place in school facilities that are similar to the industrial workplace.

WorkSafe BC health and safety policies cover the teachers and other school district employees who work in these settings, but not the students. The BCTEA believes that WorkSafe BC should cover students, and that a separate set of WorkSafe BC policies should be developed to reduce acceptable class sizes given the unique safety issues pertaining to students working and learning in an industrial environment.

Heads Up! For Safety is a safety handbook for technology education teachers developed by the Ministry of Education and the Workers' Compensation Board of BC (WCB) in 2002 in response to concerns raised by the Schools Protection Program and the WCB at that time. This document notes that while the majority of school accidents occur on the playground or in the gym, the accidents that take place in shop classes are more likely to result in serious injuries or litigation (p. 1).

The *Heads Up!* handbook is a teacher resource about teaching safety in school shop facilities. It does not address the current contexts in which technology education teachers find themselves.

The *Heads Up!* handbook notes that educators' responsibility to provide a safe learning environment is compounded by the fact that students "generally have little or no experience working in hazardous environments where the knowledge of risks and the need for safe work practices are crucial" (p. 2) and may be "inclined to disregard safety instructions with a wave of bravado and misplaced confidence" (p. 3). While this is true, these are not the most difficult "compounding" factors faced by technology education teachers in trying to provide safe learning environments for their students.

The most significant factors in whether there are safe learning environments for technology education students are:

- class size and composition
- teacher qualifications
- education assistant (EA) training
- facilities, and
- budgets.

Section 3: Class size and composition

Class size

Current class size legislation in the section 76.1 (1) of the *School Act* allows technology education classes of 30 students, the same limit as any other subject area. This number may even be exceeded under certain circumstances. There is no acknowledgement in class size legislation of the unique safety issues in the industrial settings typical of shops in secondary schools.

Previously, 45 school districts had agreed to put class size limits of 20–24 students in collective agreements. Many collective agreements made these firm numbers that were exempted from a "flex factor." Most collective agreements also said something to the effect that the number of students in a shop shall not exceed the number of students who can be safely accommodated, or the number for which the facilities were designed or equipped. The government's January 2002 imposition of a contract on teachers and school boards stripped class-size and class-composition provisions from the collective agreement. However, the liability for safe teaching and learning environments in technology education shops remains.

As technology education teachers, we supervise our students and education assistants (EAs) working in an environment that is often very similar to a commercial industrial shop. Our students, and by extension EAs, use the same hazardous equipment and processes as industry. Even though students are not paid workers, as teachers we believe due diligence compels us to extend the same protection guaranteed under law to our students as is provided to salaried workers under the protection of WorkSafeBC.

Due diligence is a legal term that describes the level of care or judgment that a reasonable person would be expected to exercise in a given situation. The standard of due diligence is described by the *Workers' Compensation Act* as taking all reasonable care to protect the well-being of employees or co-workers. The defence of due diligence is when all reasonable precautions to comply were taken in the circumstances (Ministry of Labour: *Due Diligence Checklist*).

Technology education teachers are expected to exercise due diligence while supervising students using hazardous equipment. The students may vary in age from 12 to 18. These are not always mature, responsible, young adults capable of extended periods of concentration. They are, after all, kids. The teacher must be in a position to see and control class dynamics. Beyond a certain class size, adequate supervision is not possible. The occurrence of accidents involving property and injury (or worse) may not only be possible but may be probable if class sizes are too large.

In the absence of WorkSafe BC policies that cover students and their learning conditions in industrial settings, the BCTEA takes the position that class size in technology education classes should be based on:

- the inclusion of EAs in any class count.
- an absolute limit of 20 students and EAs per teacher (with the exception of drafting classes) or the number that can be safely accommodated in the facilities as designed and equipped, whichever is lower.
- possible further reductions if the class includes beginning ESL students or students with special needs who require additional or unique safety supervision.
- a teacher-student ratio that allows for adequate supervision considering the number of courses running concurrently, and the equipment required for the course (e.g., a senior wood shop presents different supervision challenges than a senior electronics shop).

- a minimum floor area, defined in terms of *useable* floor area; i.e., not covered by machinery, furnishings, etc., that is adequate for the specific program and its associated equipment, storage, and workspace needs (see section 7), and
- a minimum area per student to allow for safe working space in the context of the specific program and its associated equipment and activities (see section 7).

Multigrade, multicourse classes

In BC, many technology education classes include students from multiple grades working on multiple courses, especially at the senior level. Such multiple grade classes are becoming more prevalent as teachers and schools try to keep programs going, in the face of underfunding and budget cuts, in order to meet the needs and interests of students. The prevalence of this practice tends to marginalize technology education courses. It is impossible to do justice to three courses per block for various grade levels and abilities of students. Multigrade and multicourse classes require smaller class sizes in order to enable teachers to adequately teach the different curricula, to provide the significantly different levels of instruction required, and to supervise for safety.

Class composition

The *School Act* limits the number of students with Individual Education Plans (IEPs) to three (3) in any class, although this may be exceeded in some cases.

Students with social, cognitive, and/or physical disabilities generally require extra teaching support. The BCTEA supports the inclusion of students with special needs in technology education classrooms, however, provisions must be made to accommodate them safely. Students with special needs can present significant challenges with respect to safety in shops. The *Heads Up!* handbook cites a case in which the Supreme Court applied a higher duty of care and supervision for deaf students: "This case suggests that closer supervision may be necessary for special needs students who are more vulnerable to risk of injury because the usual precautions may be ineffective" (p 19).

Many students with or without an identified special need may require an individual education plan if they are to function safely in a shop environment and achieve the goals of the curriculum. A general risk assessment should be performed for each shop class to identify the hazards and risks associated with each hazard. The risks would include each student's ability to perform the required tasks and whether behaviours or abilities would impact the risk of injury. If a student's abilities are identified to put himself or others at risk, an IEP should be written to mitigate these risks.

An IEP documents:

- individualized goals linked to the student's assessed special needs, and in some cases, shorter term objectives.
- strategies to be used.
- services and resources to be provided.
- measures for tracking achievement.
- adaptations and/or modifications to the curriculum or teaching methods.

Part of the IEP would include a safety plan for the student if the risk assessment identifies a risk of injury to the student or others. If an educational assistant is assigned to the student, the roles and responsibilities of the educational assistant would be described in the IEP as well.

Section 4: Teacher qualifications

The BCTEA takes the position that the minimum qualifications for teaching middle school or secondary technology education classes is successful completion of a Teacher Qualification Services (TQS) recognized technology education training program, inclusive of a practicum sponsored by a teacher who has these qualifications.

The nature of teacher qualifications is a factor in program quality in all subject areas. Additionally, in technology education, it is a factor in the safety of the teaching and learning environment.

For a variety of economic, social, and educational reasons it has become increasingly difficult to employ and retain well-trained technology education specialists in the province's public schools. This has resulted in many teachers without specific training in technology education teaching technology education courses. Some have industry experience and/or qualifications while others are self-taught or hobbyists.

The BCTEA takes this position on teacher qualifications for the following reasons:

- **Safety** of students and employees is paramount; only those persons with accredited training can be expected to meet the requirements of the curriculum in a manner uncompromising to the safety of all persons in the learning environment.
- **Liability** may and can fall on those who appoint unqualified and/or inexperienced persons to teach a course where inherent dangers are integral to the learning activities and where an injury or death occurs.
- **Equipment inventory maintenance**: As technology education shops contain very expensive and easily lost, stolen, or broken equipment, the maintenance and improvement of equipment inventory is important. Technology education specialists are trained to organize and improve their equipment inventory and facilities in order to meet curriculum and program requirements. If a teacher without this training is assigned to a shop, the degradation to the facility and its contents may be very high within a short period of time, rendering the facility incapable of meeting the minimal learning outcomes of the curriculum or program.
- **Curricular completion**: Trades persons hold expertise and skill sets in a specific trade area. Conversely, technology educators are generalists with the knowledge and skills required to teach the diverse curricula and programs that are taught in schools. Teachers have an obligation to cover all the learning outcomes in a curriculum. To that end, the BCTEA endorses educators who can deliver all portions of the curriculum and recognize that this is most probable for those who have completed a comprehensive technology education degree.
- **Pedagogical expertise**: Trades persons hold expertise and skill sets in specific trade areas but do not necessarily possess the skills to be an educator. The successful completion of an education degree is needed in order to effectively teach, assess, organize, and supervise students. Additionally, technology educators must maintain equipment inventories, calculate and work within budgets, communicate well with suppliers, parents, colleagues and other members of the community, and keep abreast of technological and environmental changes in their teaching areas. These skills are not necessarily requisite for a trade but are essential for teaching.

Section 5: Education assistant (EA) training

Increasingly, technology education classes have EAs working with special needs students. Liability may fall on those who appoint unqualified persons to assist in a technology area containing inherent dangers. Educational assistants, like all other employees, are subject to rights and responsibilities under WorkSafe BC legislation. These include the right to training and the right to refuse unsafe work. Employers have an obligation to provide training in safe work protocols and to ensure that these protocols are being followed. For an educational assistant to effectively supervise and assist the assigned student(s), they must have a reasonable and verifiable understanding of the procedures, practices, machinery, and tools being used in a particular course and setting. There is currently no provincial training program to address this need although it would seem to be required by WorkSafe BC Occupational Health and Safety Regulation 3.23, *Young or New worker orientation and training*.

Section 6: Facilities

The BCTEA recommends the establishment of a provincial program advisory committee, comprised of technology education teachers appointed by the BCTF and representatives from industry and post-secondary institutions, to establish provincial standards regarding facility design and a minimum equipment inventory. The advisory committee's recommendations would be used to plan and maintain shop facilities throughout the province.

In the meantime, the BCTEA offers the following standards for both facility and equipment needed to effectively run technology education programs in our schools. The standards outlined here are intended to apply to new construction or renovations to existing facilities. If programs operate in facilities that do not meet these standards, class size numbers should be reduced to reflect the size of facility to ensure safety.

Recommended floor area allowances for shops
The calculation of total shop area requirements should be based on the following:

- the adopted student/teacher ratio maximum (recommended not to exceed 20 students per shop class)
- the type of activity to be performed and the frequency of that particular activity
- safe working conditions, with adequate space around each piece of equipment relative to the learning activity being performed
- the required working, storage, and assembly areas
- the size, quantity, and type of equipment used in the industry
- the size of the related classroom/instructional area
- the area required for instructor's offices
- the amount of space necessary for each student workstation
- storage space for projects, materials, visual aids, tools and portable equipment, files, and reference books
- space for students of both sexes to change their clothing, to clean up, and to store personal belongings
- any additional requirements necessary for instruction of special education students
- other auxiliary space needed to meet curriculum needs, industry standards, and the types and shapes of project development.

Table 6.1 gives minimum shop sizes, minimum working area per student, and the appropriate shop ceiling clearance for the type of shop and shop equipment required for different courses. This should be used as a guide in planning new facilities, renovating existing shops, and determining class size limits for shops that do not meet these minimum shop areas and minimum working area per student which are based on a class size of 20, including both students and EAs. In each case the minimum shop area is based on the minimum shop equipment expected to be found in each type of shop.

PROGRAM	Minimum shop working area (m^2) (area not occupied by benches, racks, cupboards, and stationary equipment)	Area per student/EA (m^2)	Shop ceiling clearance height (m)
Automotive Technology 11/12	512	25.6	5.49
Carpentry & Joinery 11/12	418	20.9	5.49
Drafting and Design 11/12	204	10.2	3.66
Electronics 11/12	204	10.2	3.66
Metal Fabrication & Machining 11/12	372	18.6	5.49
Technology Education 10 Drafting	204	10.2	3.66
Technology Education 10 Electronics	204	10.2	3.66
Technology Education 10 Mechanics	418	20.9	5.49
Technology Education 10 Metalwork	372	18.6	5.49
Technology Education 10 Woodwork	372	18.6	5.49
Technology Education 8, 9, 10 General and Middle School Shops	372	18.6	3.66

Table 6.1 Recommended floor area allowances for shops based on 20 students per class

The development of instructional space needs can no longer only be determined by calculating the total number of square feet needed per student times the number of students. Changes in curriculum, equipment, and instructional tasks require a facility that can adapt to change in the curriculum reflected by the changes in the industry.

School planners need to take into consideration (1) the space required to safely carry out the goals and objectives of the program and safely accommodate the number of students to be included in the program, the teacher(s) and any required support staff; (2) the equipment necessary to complete the objectives, and (3) additional space adequate to provide a safe instructional environment.

Careful planning will permit maximum usage of the shop. Most trade and industrial programs require as much wall space as possible. Wasted wall and floor space are as expensive as usable space.

The classroom area should be separate from the shop but adjacent to it to permit ease of demonstrations with equipment and to minimize of students' travel time from the classroom to the shop. This classroom should be equipped with Internet access and, at a minimum, whiteboard space and an LCD projector. Other enhancements such as Smartboards would be beneficial in the delivery of curriculum. The classroom area should also have filing cabinets capable of storing documents relating to the courses being taught, including safety tests.

It is important to keep in mind the needs of the students with disabilities in order to make the facilities as accessible and usable for these students as possible. Each program will need to purchase, adapt, or modify any equipment needed for students with disabilities.

Tools and equipment

Program goals and objectives, including the prescribed learning outcomes in provincial curricula, should be used to determine equipment and tool needs. The teacher is the logical source of information regarding what equipment and tools are needed. Teachers should develop a workstation list of tools, and a list of auxiliary tools and stationary machines and equipment

necessary to deliver the curriculum in a safe manner. The tools and equipment should be of the type, size, and purpose to that used by the industry.

Both proposed and actual inventories of tools and equipment might include the following information:

- name, type and quantity of tools and/or equipment
- size and capacity
- attachments and accessories
- electrical and/or other utility specifications
- preferred manufacturer and model
- delivery costs
- estimated installation cost
- life estimate, depreciation, and maintenance allowance.

Duplication of essential tools and equipment is necessary so that all students will have ready access to them at all times.

It is crucial that shops for construction/craft programs are designed to simulate the industrial setting. The equipment must duplicate that used in the industry and the training be conducted on actual or simulated projects as much as possible.

Standards of maintenance

A standard program of regular preventative and corrective maintenance needs to be developed for technology education shops. This work should not be assumed to be part of a technology teacher's responsibilities. As technology education teachers have not been trained as millwrights, automotive hoist technicians, electricians, etc., it should not be expected that they perform machine maintenance and repair.

In remote and rural areas where access to tradespersons may not be possible, it may be necessary to have teachers do some of their own machine and equipment maintenance. A liability may accrue when teachers conduct their own maintenance and teachers who are expected to do so should have additional training, when and where necessary, and be compensated for that work.

Storage—indoor and outdoor

Storage is required for tools, material, student work, and teacher materials and supplies. Storage rooms can isolate noisy shops from adjacent quiet areas. Inexpensive tools, equipment, or utensils frequently used can be stored on wall panels or in cabinets for easy accessibility and inventory. The more expensive items, especially those used occasionally, require a lockable room or cabinets.

Materials' storage requirements vary with the types of activities but should be located convenient to the receiving door and should provide an orderly flow of materials into the shop work areas. Storage should accommodate materials necessary for the programs. For example, lumber comes in lengths of up to 7.62 m (25 ft.), while steel stock is 7.32 m (24 ft.) in length and steel pipe is 6.4 m (21 ft.) long. For security reasons, tool and materials storage rooms should not have windows or skylights. Masonry wall construction and doors with louvers are appropriate. Storage should also be available for safeguarding student work and projects.

Covered and secured workspaces outside the building, either for staging or instruction, are essential to the successful implementation of certain trade and technology education programs. These spaces include outdoor storage for metalwork supplies and automobile storage spaces for Automotive Technology or Collision Repair and Refinishing. Additionally, programs such as ACE-IT residential construction and automotive repair require these areas. Such spaces need to be tailored to meet the needs of the curricula of specific courses or programs.

Electrical and mechanical system requirements

An electrical system for a shop should be planned after the identification of the equipment and where it is to be located. However, planners need to assume that changes will occur from time to time in the use of the facility and build in some flexibility.

Duplex receptacles (120-volt) should be located at 3 m (10 ft.) intervals on perimeter walls and should be placed 1.22 m (48 in.) over the floor. Double duplex outlets should be located from drop locations above workbenches to eliminate the need to run extension cords across floor areas.

Where debris on the floor is common, outlets mounted in cast boxes on rigid conduit at least 0.3 m (12 in.) above the floor are recommended. Outlets which must be placed on the floor under student furniture should be in surface-mounted tombstone fixtures.

In medium- to heavy-duty shops where equipment is driven by electric motors, 208 or 240-volt, three-phase current should be provided. Where flexibility in equipment location is desirable, overhead drop cords are generally more flexible than the expensive overhead bus duct system. For equipment that is hardwired, an electrical lock box must be attached to each machine so the instructor will be able to disconnect each piece of equipment from its power source. For equipment that is plugged into an electrical outlet, access to the electrical panel to switch off the appropriate breaker is required.

As a safety factor, the instructor must be able to disconnect and lock the electrical service to all equipment from a master panel that is easily accessible. All machinery should be coded at the power panel so that the circuit can be killed quickly in an emergency. Emergency power switches must be available around the shop to permit cutting all power in the event of an emergency.

All equipment must be equipped with magnetic switches to ensure equipment does not start up when main power is energized, as well as equipped with electrical lockout boxes to isolate power to each piece of equipment. Automotive or other shops where volatile liquids or vapors will be present require special safety considerations to ensure exhaust and volatile vapors will be vented outside and away from windows and doors to prevent it from re-entering the shop.

Lighting

Lighting should be planned to substantially reduce energy consumed while still providing students with the quality and quantity of illumination required for the performance of their tasks. Effective lighting must be achieved in a manner consistent with student and program requirements such as productivity and visual comfort, aesthetics, and provincial codes and ordinances.

A well-lit shop includes both natural and artificial lighting. An artificial lighting system should provide a uniform distribution of shadow-free, glare-free illumination. In addition to ceiling-mounted fixtures, supplemental lighting may be necessary for some pieces of equipment. Illumination levels will vary with activities. Local lighting should be used for certain activities such

as grinding and machining operations. Explosion-proof lighting must be provided in areas such as spray booths/finishing rooms where volatile fumes may be present

Lighting systems must also be designed so that stroboscopic effects, which would make turning machines appear to be still, are not present.

A uniform colour scheme should be used throughout the laboratory to maximize the effectiveness of the lighting. Ceilings should be white. Walls should reflect about 60–70% of the light that strikes them.

Air quality and extraction

Air handling should be adequate for the type of instruction conducted. Overhead exhaust systems are recommended in all facility areas. In wood-related shops airborne dust must be controlled through properly designed and engineered exhaust systems.

Exhaust hoods and flexible exhaust units must be provided in welding areas. An engine exhaust system must be provided in automotive areas. Likewise, all finishing rooms must be properly vented to ensure worker safety and prevent buildup of combustible fumes.

Health and safety

Adequate provision must be made for the safety of the students and the instructional staff. No consideration in facility planning is more important than safety. While various points related to safety are alluded to throughout this publication, the following are specific points to consider:

- Machinery should be located to allow the operator protection from traffic patterns.
- Kickback areas for machines should be oriented away from student work areas.
- Electric equipment should not be located near sinks or water fountains.
- Welding booths and curtains should be fireproof or fire resistant. Exhaust hoods and flexible exhaust units must be provided in welding areas. Curtains on booths should adequately screen the welding area.
- An engine exhaust system must be provided in automotive areas.
- Motors, switches, and electric fixtures located in spray booths must be explosion-proof.
- CSA-approved safety containers should be provided for flammable liquids and rags.
- Storage cabinets for eye protection devices should be provided.
- Eyewash fountains should be provided where students or staff are likely to get chemicals or debris in their eyes.
- Emergency showers may be needed in some shops.

School planners should keep abreast of current statutes and codes related to building and occupant safety as they relate to the design of technology education programs and facilities.

7. Budgets

Budgeting formula should reflect the reality of the costs of safety apparel, materials, consumables, maintenance, tools, and machinery for a given course.

The BCTEA recommends the formation of a provincial program advisory committee to assist in the establishment of a basic equipment inventory that school districts could use to develop realistic budgets. This group would be comprised of representatives from industry, post-secondary training, and teachers of technology education and would have a good understanding of costs relating to tools and equipment necessary to carry out technology education programs. The advisory committee's recommendations and opinions should carry the weight of practitioners with industry experience.

The budgeting process at the school district level should include the development of a long-term plan to address repair and replacement of worn, damaged, or outdated equipment.

8. Recommended resources

BC resources

British Columbia Technology Education Association (BCTEA) *bctea.org*
BC Ministry of Education *Technology Education IRPs*
www.bced.gov.bc.ca/irp/subject.php?lang=en&subject=Applied Skills

BC Ministry of Education and Workers' Compensation Board of BC (2002) *HEADS UP! for Safety. A Safety Handbook for Technology Education Teachers*
www.bced.gov.bc.ca/irp/resdocs/headsup.pdf

Industry Training Authority ACE-IT Program *www.itabc.ca/Page36.aspx*

Industry Training Authority. Secondary School Apprenticeship Program (SSA)
www.itabc.ca/Page37.aspx

WorkSafe BC Due diligence checklist
www2.worksafebc.com/PDFs/common/due_dil_checklist.pdf

WorkSafe BC Due diligence video
www2.worksafebc.com/Publications/Multimedia/Videos.asp?ReportID=34539

WorkSafe BC *Occupational Health and Safety Regulation*
www2.worksafebc.com/publications/OHSRegulation/Home.asp

WorkSafe BC *Occupational Health and Safety Regulation. Part 1. Definitions*
www2.worksafebc.com/publications/OHSRegulation/Part1.asp

WorkSafe BC *Occupational Health and Safety Regulation Section 3.12 Procedure for refusal of unsafe work*
www.worksafebc.com/publications/OHSRegulation/Part3.asp#SectionNumber:3.12

WorkSafe BC *Managing Safety from the Supervisor's Perspective* brochure
www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/managing_safety.pdf

WorkSafe BC *Safety on the Job is Everyone's Business* brochure
www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/safetyonthejob.pdf

Other resources

Association for Career and Technical Education (USA)
www.acteonline.org

Collective Agreement between the Government of the Yukon and the Yukon Teachers' Association (July 2009)
www.psc.gov.yk.ca/pdf/yg_yta_collective_agreement_2010_09_08.pdf

Connecticut State Department of Education (May 1981) *Industrial Arts Curriculum Guide for Safety*
www.eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED204629&ERICExtSearch_SearchType_0=no&accno=ED204629

Education Resources Information Center (July 2009) *Infusing Career and Technical Education into High School Reform—Lessons from California*
www.eric.ed.gov/ERICWebPortal/recordDetail?accno=ED506280

Massachusetts Department of Elementary and Secondary Education Massachusetts General Law Chapter 74 *Selected Sections* and *Vocational Technical Education Regulations 603 CMR 4.00 and Guideline*
www.doe.mass.edu/cte

Massachusetts Department of Elementary and Secondary Education *Manual for Vocational Technical Education Programs, Chapter 74*
www.doe.mass.edu/cte/programs/manual.pdf

Michigan Department of Education. (October 2009). Administrative Guide for Career and Technical Education in Michigan.
www.michigan.gov/documents/mde/Administrative_Guide_for_CTE_297418_7.pdf

Montana Office of Public Instruction (2002) *Standards and Guidelines for Secondary Career and Vocational/Technical Education in Montana*
www.opi.mt.gov/PDF/CTE/combinedguidelines.pdf

New Zealand Post Primary Teachers' Association (2007) *Class Size Policy Statements Advice for inclusion in Timetable Policies*
www.ppta.org.nz/index.php/collectiveagreements/sct/doc_details/68-class-size-policy-statements

PEI Department of Education and Early Childhood Development (October, 1996) *Minister's Directive No. MD 96-20. Vocational, Career and Technology Courses Designated for the Special Staffing Ratio*
www.gov.pe.ca/eecd/index.php3?number=1028014

Utah State Office of Education (2010) *Fact Sheet Utah's Career and Technical Education System*
www.schools.utah.gov/cte/documents/month/CTEFactSheet.pdf

Vermont Department of Education (2001) *Vermont School Construction - Planning Guide and Standards for Technical Education Centers*
www.eed.state.ak.us/facilities/br&gr/VT_School_Construction_Planning_Guide.pdf

Virginia Department of Education (VDOE) (April 2010) *Career and Technical Education Requirements 8V AC20-120-140*
www.doe.virginia.gov/administrators/superintendents_memos/2010/106-10b.pdf

Wyoming Department of Education (May 2007) *New Directions for High School Career and Technical Education in Wyoming*
www.k12.wy.us/A/JEC/June%2007/MPR_report07.pdf

Y11-0031
http://livelink.bctf.ca/livelinkdav/nodes/826090/BCTEA Best Practices Guide Oct 18 11.docx
AMC/cep:mh/bg/tfeu