BEST PRACTICES GUIDE

British Columbia Technology Education Association

A Provincial Specialist Association of the BC Teachers' Federation

BCTF BC TEACHERS' FEDERATION

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BC Technology Education Association
BEST PRACTICES GUIDE

Technology education in BC schools has undergone profound structural changes in recent years. These changes are not the result of curriculum revision. These changes are the result of current levels of funding and of class size numbers. At present, class sizes often exceed facility design. Current budgets do not meet the costs of supplies, equipment, or maintenance. Our members are committed to providing a safe and effective learning environment. This requires compliance with a variety of best practices and standards, including compliance with class size provisions. The Ministry of Education does not currently provide protocols or matching appropriate class sizes to technology education courses. Fewer teachers are being hired in these subjects and they are being tasked with 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 created this document outlining recognized best practices. Health and safety is paramount and is an underlying theme in all sections. Due to the nature of the subject, in many cases teaching and learning in technology education takes place in an environment where one must be sensitive to additional safety concerns as there is potential to inadvertently create hazardous situations if the proper protocols are not followed. 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 in order to avoid worker and student injuries.
As technology education teachers, we recognize the unique opportunity we have to equip students to enter the skilled labour force. Technology education teaches students a responsible sense of workplace safety and an array of skills they can eventually use to sustain and propel 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 in the Tech Ed classroom.

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EXECUTIVE SUMMARY

Technology education in BC schools has changed in recent years as a result of funding cuts and class size numbers. There are fewer technology education teachers teaching larger classes with fewer supplies, small budgets, inadequate equipment, and irregular maintenance on equipment. 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. WorkSafeBC health and safety policies cover the teachers and other school district employees, who work in these settings, but do not generally apply to students.[1] The BCTEA believes that WorkSafeBC should cover students, and that a separate set of WorkSafeBC 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, maintenance and budgets.

Class size and composition

Current class size legislation of the School Act allows technology education classes of 30 students, the same limit as any other subject area, unless the local teachers' union previously successfully bargained a lower class size number. Many locals have negotiated lower class sizes such as 24 or lower, for Technology classes. This would need to be confirmed at the local level. For those who do not have local language, the School Act provisions may even be exceeded under certain circumstances. Provincially, there is no acknowledgement in class size legislation of the unique safety issues in the industrial settings typical of shops in secondary schools. Complicating the issue is the growing trend of multi-grade, multicourse classes where a teacher is instructing two to four grade levels of students in different curricula during the same class. Furthermore, Technology Classrooms do not have standardized physical space or layout plans. Additional considerations should be made in regard to safe occupancy of the teaching space based on grade level, equipment, and subject matter.

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.*

[1] The *Workers Compensation Act* applies in some cases to students who are engaged in vocational training or apprenticeships. See *Workers Compensation Act*, [RSBC 2019] c. 1, s. 1 definition of "worker".

- *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 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. In these situations, the employer as well as the Ministry of Education are encouraged to assist teachers with the appropriate qualification process, including TRB certification, as well as a practicum in a Tech Ed shop. This will not only help the teacher with classroom management in the shop environment, but also help to ensure that both students and teacher have a positive experience. 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 are obligated under WorkSafe legislation 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:

1. 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

2. 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.

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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. https://www.bctea.org/
Many technology education teachers have industry credentials such as Red Seal certificates in trades, as well as their university training specific to teaching Technology education as well as a teaching certificate. The BCTEA plays an important role in ongoing professional development for technology education teachers through an annual conference, 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:

Applied Design, Skills and Technology https://curriculum.gov.bc.ca/curriculum/adst

- *Technology Education 8*
- *Technology Education 9*
- *Technology Education 10:*
    - *Drafting*
    - *Electronics and Robotics*
    - *Metalwork*
    - *Power Technology*
    - *Technology Explorations*
    - *Woodwork*
- *Technology Education 11:*
    - *Automotive Technology*
    - *Drafting*
    - *Electronics*
    - *Engineering*
    - *Metalwork*

    - *Robotics*
    - *Woodwork*
- *Technology Education 12:*
    - *Art Metal and Jewelry*
    - *Automotive Technology*
    - *Drafting*
    - *Electronics*
    - *Engine and Drivetrain*
    - *Engineering*
    - *Furniture and Cabinetry*
    - *Industrial Coding and Design*
    - *Machining and Welding*
    - *Mechatronics*
    - *Metalwork*
    - *Remotely Operated Vehicles and Drones*
    - *Robotics*
    - *Woodwork*

In partnership with Skilled Trades BC and post-secondary institutions Technology education teachers also teach various trades training programs which provide students with access to industry training while they are still enrolled in secondary school. Through these programs, students receive post-secondary credentials while still attending secondary school. https://skilledtradesbc.ca/

In addition, technology education teachers teach hundreds of 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, often using the same equipment as the industrial workplace.

WorkSafeBC health and safety policies cover teachers and other school district employees who work in these settings, and may apply to students in some circumstances, such as those in vocational training programs or those undertaking an apprenticeship.[2] The BCTEA believes these provisions should be expanded to ensure safety policies reflective of WorksafeBC policies apply to all students. This is important to ensure proper protections for students where one must be sensitive to safety issues that have the potential to escalate into hazardous situations, given the unique issues pertaining to students working and learning in an industrial environment. These policies should examine the environment to consider things such as: class sizes, equipment suitability, equipment maintenance and who is responsible for what maintenance, facilities and accident mitigation plans. In post-secondary trades classes, the maximum number of students per class is capped at 18. These are mature students, not high school students. As the School Act does not differentiate shop and classroom types of classes, the maximum number of students remains at 30 with lower numbers bargained by locals in many districts.

"Heads Up! For Safety" is a safety handbook for technology education teachers developed by the Ministry of Education and Worksafe BC 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). This document was updated by the BC Technology Education Association in 2018.

The "Heads Up!" handbook is a teacher resource about teaching safety in school shop facilities. It does not address all of 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.

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[2] See *Workers Compensation Act* s. 1, which defines a worker as including an individual undertaking an apprenticeship or a person who is "a learner who is not under a contract of service or apprenticeship" and undergoing training or probationary work by the employer as a preliminary to employment; see also *Workers Compensation Act* s. 6, which stipulates that the Workers Compensation Board may, at the request of the Education Minister, deem a person enrolled in a vocational or training program to be a worker of the Crown.

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 and availability*
- *facilities*
- *equipment and maintenance*
- *budgets*
- *outside user groups*

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, unless the local teachers' union successfully bargained a lower class size number. Any local language would need to be confirmed with the individual district local union. In the cases where there is no local language, these School Act provisions 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. Furthermore, Technology Classrooms do not have standardized physical space or layout plans and additional considerations should be made in regard to safe occupancy of the teaching space based on grade level, equipment, and subject matter. It is the opinion of the BCTEA, that class size numbers should be provincially standardized at 20, provided that the floor area of the shop (allows for those numbers)permits it and identified students need to be effectively supported (through additional space, shop layout, qualified EA availability).
Historically, prior to 2002, many school districts collaboratively worked with various stakeholders including teaching staff, administration and Health and Safety Committees and agreed to class size limits of 20–24 students in collective agreements. Many collective agreements made these firm numbers that were exempted from a —flex factor. The majority of 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. These provisions, which had been stripped by the provincial government in 2002, were restored by the Supreme Court of Canada in 2016. However, many local unions have had to consistently monitor these provisions and file grievances in order to ensure compliance.

Responsibility for safe teaching and learning environments in technology education shops remains for both teaching staff and administration.

As technology education teachers, we teach our students in an environment that is often very similar to a commercial industrial shop. Our students, and by extension Education Assistants ("EAs') working with the students, use the same potentially 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 degree of prudence and carefulness that would be exercised by a reasonable person in a given situation.[3] WorkSafe BC advises that due diligence requires taking all reasonable steps to protect workers from harm.[4]

Technology education teachers are expected to exercise due diligence while supervising students using potentially hazardous equipment. Even the simplest or the most routine of tasks can become dangerous without proper supervision or instruction.

In 2004, the Criminal Code was amended by the Westray Bill to create a legal duty, and criminal culpability, related to the prevention of bodily harm arising from work. Section 217.1 of the Criminal Code stipulates:

> Every one who undertakes, or has the authority, to direct how another person does work or performs a task is under a legal duty to take reasonable steps to prevent bodily harm to that person, or any other person, arising from that work or task.

Violation of this provision results in criminal liability. Charges have been laid against both organisations and supervisors in circumstances where there was a neglect of duty, when safety standards were disregarded by a supervisor and when faulty equipment injured workers.[5]

Although teachers generally are not viewed as directing how EAs perform work, or students as workers, there is potential that the Crown could argue this provision applies to teachers in some circumstances. Even if not directly applicable, teachers should be aware of this Criminal Code provision.

Technology Education students may vary in age from 11 to 19, and enroll in various levels of courses. These range from Foundational Middle School Programs, to School Based Apprenticeship and Trades Training Post-Secondary Cooperatives. By nature, students are not always mature, responsible, young adults capable of extended periods

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[3] Barron's Canadian Law Dictionary.
[4] Due Diligence, WorkSafe BC website, available at: https://www.worksafebc.com/en/health-safety/create-manage/enhancing-culture-performance/due-diligence
[5] See for example *R. v. Kazenelson*, 2016 ONSC 25, affirmed 2018 ONCA 77.

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. Ultimately, class sizes are the decision of school administration, and district leadership, subject to bargained class size limits.

In the absence of WorkSafeBC 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).*
- *Personal Protective Equipment (PPE) must be supplied and available for all students, regardless of class size. This could come in the form of safety eyewear, hearing protection, and other specific PPE related to specialized machinery / equipment (welding etc.)*

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 challenging to teach more than one course per block for various grade levels and abilities of students. Multigrade and multi course 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. As a guideline, for every split of course or grade, the class size should be reduced by 3.

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. Locally bargained provisions may also address class composition.

Students with various abilities generally require extra teaching support. The BCTEA supports the inclusion of differently abled students in technology education classrooms, however, provisions must be made to accommodate them safely. Students with different abilities 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 area. 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 themselves or others at risk, an IEP should be written to mitigate these risks.

An IEP document's individualized goals linked to the student's assessed needs, adaptations and/or modifications to the curriculum or teaching methods, and in some cases, shorter term objectives. It may also provide strategies, give input for services and resources to be provided. Student achievement may be also measured for tracking, and monitoring progress in regard to IEP goals. As most people who write IEPs are not trained as Technology Education specialists, mitigation of risks is not within their scope. Risk assessments should be left up to the individual teachers of the course and those recommendations should be adhered to by the school and district.

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

Teacher qualifications The BCTEA holds the position that the minimum qualifications for teaching middle school or secondary technology education classes is successful completion of a Teacher Regulation Branch (TRB) recognized technology education training program, inclusive of practicums sponsored by teachers who hold 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 and management of the teaching and

learning environment, an environment with unique challenges and characteristics inside of the public-school system.

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 is of the opinion that priority should be given to hiring certified technology education teachers. Should none be available, priority should then be given to a person with a Red Seal or other form of certification in the relevant field. In these situations the employer as well as the Ministry of Education, are encouraged to assist teachers with the appropriate qualification process, including proper Tech Ed teacher training, TRB approval, as well as a practicum in a Tech Ed shop. This will not only help the teacher with classroom management in the shop environment, but also help to ensure that the students have a positive learning experience.*

The BCTEA holds 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. It is noteworthy that 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 in the event an injury or death occurs. All employers have an obligation to meet the minimal definition of "qualified" under the WorkSafeBC definitions, 1.1.*

- ***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. Poorly organized, maintained, equipped or stocked shops quickly degrade meaningful learning opportunities and are very difficult to restore to a relevant state.*

- ***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. As generalists, a qualified technology education teacher understands the scope and sequence of theory and activities that are necessary to cover what would best inform and prepare a student for further studies in the specific field. Teachers have an obligation to cover the major concepts in the 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 practicing a trade but are essential for teaching.*

Section 5: Education assistant (EA) training

Increasingly, technology education classes have EAs working with diverse learners. Educational assistants, like all other employees, are subject to rights and responsibilities under WorkSafe BC legislation and their collective agreement. These include the right to training and the right to refuse unsafe work, WorkSafeBC, OHS Regulations, 3.24ff. Employers have an obligation to provide training in safe work protocols before work begins and to ensure that these protocols are being followed. The BCTEA holds that 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. Such an understanding meets the minimal definition of "qualified" under the WorkSafeBC definitions, 1.1. 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 subject area specific equipment inventory. The advisory committee's recommendations would be used to plan and maintain shop facilities throughout the province.

In the meantime, the BCTEA recommends the following standards for both facilities 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 the facility in order 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 including EAs 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*
- *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 different genders to change their clothing, to clean up, and to store personal belongings*
- *other auxiliary space needed to meet curriculum needs, industry standards, and the types and shapes of project development.*
- *any additional requirements necessary for instruction of special education students*

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 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 Smart Boards 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.

More information can be found here: https://www.bctea.org/machine-safety-zones/

As well as in the Kavanaugh report here.
https://www.bctea.org/wp-content/uploads/2023/05/Noratek-Technology-Shops-Safety-Resource-Manual-Updated-May-2023.pdf

Tools and equipment

Program goals and objectives, including, but not limited to, the curricular competencies and content 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.

Where possible, duplication of essential tools and equipment is necessary so that all students will have ready access to them at all times. This may not be possible with larger equipment.

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

Nb. 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*
- *maintenance allowance*

Standards of maintenance

A standard program of regular preventative and corrective maintenance is essential for technology education shops. Not only is it necessary to properly run a workshop, but it will encourage students' investment and appreciation of the workspace if it is properly maintained. It is also critical to the longevity of the equipment as well as their safe usability. The failure to follow a preventative maintenance schedule set by the manufacturer of equipment may also void the warranty for the equipment. This maintenance work should not 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. Unless specifically hired to do so, it is not a teacher's responsibility to maintain equipment. Teachers have neither the time, nor necessarily the expertise to do so.

Nb. 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 given time and compensation for that work.

Storage—indoor and outdoor

Secure storage is required for tools, material, student work, and teacher materials, equipment and supplies. Storage rooms can isolate noisy shops from adjacent quiet areas. While inexpensive tools, equipment, or utensils frequently used can be stored on wall panels or in cabinets for easy accessibility and inventory. More expensive items, especially those used occasionally, require a lockable room or cabinets. Some programs, such as Automotive Technology, need storage for larger equipment that is only used occasionally, but which is necessary to the program.

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. Adequate 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 Youth Train in Trades 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, and prior to its installation. However, planners need to assume that changes will occur from time to time in the use of the facility and build in some flexibility for expansion, upgrading and re-allocation of the space.

CNC and laser equipment should not be connected to the general equipment shop power system so that power to these pieces is not lost when the shop power is turned off for routine end of class procedures. (Each unit should still have its own isolation switch provided if it doesn't have one on the unit.)

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. These should be plastic plugs

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 lockout 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. (This momentary NC contact switch should be Red and properly labelled above the switch to read "Power Shut off" to clearly identify it for the main teacher, TTOC, custodians, and for students of the class.)

All stationary equipment not having a momentary switch, must be equipped with magnetic switches to ensure equipment does not start up when the main power is

energized, as well as equipped with electrical lockout boxes unless they are not hardwired and are the plugged-in style. Automotive shops, finishing rooms, spray booths or other shops where volatile liquids or vapors will be present require special safety considerations and spark proof electrical devices to ensure exhaust and volatile vapors cannot explode.

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.

School districts are in the process of changing lightning fixtures to LED models. In some shops, the traditional tubes have been removed and replaced with fewer but more powerful lights. While this may produce the same amount of light, it can cause dangerous dark areas in the shops as well as potential shadows in work areas. A generally acceptable and workable solution is to simply replace the existing tubes with LED tubes and matching ballasts in the existing fixtures.

Air quality and extraction

Air handling must be adequate for the type of instruction conducted. Routine maintenance must be performed according to manufacturer's instructions. This must include but is not limited to filter changes. 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. These systems must be built and maintained according to local municipal and WorkSafeBC requirements. Due to changes in WorkSafeBC regulations since 2012, many school shops are being retrofitted or upgraded with new systems. When these upgrades are made, it is important to involve the teacher in the planning phase. A variable speed automatic blast gate type system is recommended by the BCTEA in order to be able to control the noise level in the room allowing the teacher to communicate important safety instructions to students as well as to provide long term energy savings. These systems are widely used in industry around the world.

More info can be found in a dust collector upgrade report prepared by the BCTEA found at this link. https://drive.google.com/file/d/1cKNCN5TvgJMS-UQJ8mED-e0RCXJF8uWU/view

Exhaust hoods and flexible exhaust units must be provided in soldering and 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. Laser engravers must be equipped with an appropriate filtration system or vented directly outside. Foundry extraction systems must vent to the outdoors and be designed to accommodate the BTU and CFM outputs of the furnace. A hood extending over top of the furnace and area used for degassing and grain refining is to be attached to the extraction system.

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:

- *All equipment must be installed and maintained according to the manufacturer's recommendations.*
- *Each shop must be equipped with basic first aid supplies such as bandages and antiseptic.*
- *Adequate lock out devices must be provided to the teacher.*
- *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 must be fireproof or fire resistant and must adequately screen the welding area.*
- *Exhaust hoods and flexible exhaust units must be provided in welding areas as well as any other area where toxic fumes could be generated.*
- *Curtains on booths should adequately screen the welding area.*
- *An engine exhaust system must be provided in automotive areas.*
- *Wood shops must have a properly engineered dust collection system. This system is to be quiet enough that a teacher can give verbal instructions to a student and be heard.*

- *All stationary equipment that do not have momentary on switches must be equipped with Mag switches.*
- *Motors, switches, and electric fixtures located in spray booths must be explosion-proof.*
- *CSA-approved safety containers must be provided for flammable liquid storage as well as for disposal of rags.*
- *Storage cabinets for eye protection devices should be provided.*
- *Eyewash fountains or portable eye wash stations must be provided where it is possible that students or staff get chemicals or debris in their eyes.*
- *Emergency showers may be needed in some shops.*
- *Clear and unobstructed access to emergency exits*

School planners and administrators 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.

User groups coming in to use Tech Ed. shops

The shops and facilities that Tech Ed teachers teach in belong to the school district. The school district has the right to rent or lease the space out to other responsible groups while classes are not in session. District staff or school administration should coordinate and consult with the Tech Ed teacher who normally uses the facility well in advance of this taking place.

Some of the considerations that need to be taken into account are:

- *Timing of the group's use of the shop. Does this give the Tech Ed teacher sufficient time for prepping?*
- *Areas of the shop and equipment to be used*
- *Standards of cleanliness*
- *Storage of projects -user group as well as regular students*
- *Consumption of shop materials, tooling, and consumables. A budget must be created for this and the shop must be compensated.*
- *Equipment maintenance including tool sharpening.*

Section 7: Budgets

School District budgeting formulas should reflect the reality of the costs of safety apparel, materials, consumables, maintenance, tools, and machinery for a given course. An annual review of changes in costs, especially for materials and consumables, should be undertaken in consultation with teachers and is necessary to arrive at reasonable operating budgets. Capital budgeting most likely needs reviewing on a less regular basis, ideally every three years and not more than every five years.

The BCTEA recommends the formation of a provincial program advisory committee to assist in the establishment of a minimum component of necessary supplies and equipment inventory that school districts could use to develop realistic budgets for Technology Education courses. This group would be comprised of representatives from industry, postsecondary 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 as well as technological updates to incrementally maintain the relevance of what can be taught.

8. Recommended resources

BC resources

British Columbia Technology Education Association (BCTEA)
https://www.bctea.org/

ADST curriculum link
https://curriculum.gov.bc.ca/curriculum/adst

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

Updated 2019
https://www.bctea.org/heads-up-(for-safety/

Skilled Trades BC (previously known as ITA): https://skilledtradesbc.ca/
Youth - https://youth.skilledtradesbc.ca/PROGRAMS/
Educators - https://youth.skilledtradesbc.ca/educators/overview/
Discover - https://youth.skilledtradesbc.ca/programs/discover/
Train - https://youth.skilledtradesbc.ca/educators/youth-programs/train/
Work -https://youth.skilledtradesbc.ca/educators/youth-programs/work/

WorksafeBC – New and Young Workers
https://www.worksafebc.com/en/health-safety/education-training-certification/young-new-worker

Worksafe BC – Forms & Resources
https://www.worksafebc.com/en/forms-resources#sort=Relevancy

WorksafeBC – Posters – Construction
https://www.worksafebc.com/en/forms-resources#sort=Relevancy&f:topic-facet=[Health%20%26%20Safety]&f:industry-facet=[Construction]&f:content-type-facet=[Posters%20%26%20signs]&f:language-facet=[English]

WorkSafe BC Occupational Health and Safety Regulation
https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation

WorkSafe BC Occupational Health and Safety Regulation. Part 1. Definitions
https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-01-definitions

WorkSafe BC Occupational Health and Safety Regulation Section 3.12 Procedure for refusal of unsafe work

https://www.worksafebc.com/en/health-safety/create-manage/rights-responsibilities/refusing-unsafe-work

The Kavanaugh report about room sizes and safety zones can be found here:
https://www.bctea.org/wp-content/uploads/2023/05/Noratek-Technology-Shops-Safety-Resource-Manual-Updated-May-2023.pdf

BCTEA Dust collector upgrade report and recommendations 2019.
https://drive.google.com/file/d/1cKNCN5TvgJMS-UQJ8mED-e0RCXJF8uWU/view

Floor area allowances information:
https://www.bctea.org/machine-safety-zones/

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

Massachusetts Department of Elementary and Secondary Education Massachusetts General Law
Chapter 74 Selected Sections and Vocational Technical Education Regulations 603 CMR 4.00
https://www.doe.mass.edu/ccte/cvte/

https://www.michigan.gov/mde/0,4615,7-140-2629---,00.html

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

https://www.princeedwardisland.ca/en/search/site?keys=career+and+technology&op=search