

NAWIC & NEF
Building Design Program



The Garage Project

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About NAWIC ***(National Association of Women in Construction)***

The National Association of Women in Construction (NAWIC) is an international organization founded in 1955 to promote women employed in the construction industry, which continues to be NAWIC's main goal. The Richmond Chapter #141 was organized in 1967. The Richmond chapter consists of more than 70 women actively working in the Central Virginia construction industry.

Education is a fundamental component of promoting the construction industry and women's roles within it. Each year, NAWIC sponsors the following NEF (NAWIC Education Foundation) K–12 Programs:

- Block Kids—Students are given interlocking blocks, cardboard, string, aluminum foil, and a rock and are instructed to design and build a model of an object, and to describe their process.
- Work It to Learn It Project—Middle school students participate.
- The Shed, The Garage, and The Commercial Projects—Middle and high school students participate.
- The Drafting Project—High school students are given a NAWIC-sponsored design problem to draw using CADD.
- Postsecondary and Career and Technical Education (CTE) scholarships—Each year, NAWIC awards more than \$5,000 to students majoring in construction-related fields or who are entering a construction-related CTE program.

The NAWIC Building Design program started with one school in 1997. Over the years, students from Henrico, Chesterfield, and Hanover public schools have participated. Through the 2009 school year, more than 6,500 students have worked in this program. Please go to the Richmond chapter of NAWIC to discover more:

www.nawic-richmondva.com

Introduction

The NEF (NAWIC Education Foundation) Garage Project is part of a versatile NEF Building Design Program that can easily be incorporated by Technology Education and Trade and Industrial Education instructors into their current curricula. Also included in this program are the Shed Project, the Commercial Project, and the Work It to Learn It Project. When supported by a local NAWIC (National Association of Women in Construction) chapter or other construction industry sponsor, the program may be offered as a national building-design competition. Local winners would advance to a regional competition, and one semi-finalist from each region would be entered in the national program competition.

The construction industry faces a workforce shortage that poses a serious problem for the national economy. In order to meet the demand for construction and construction-related jobs and careers, the industry needs to annually attract, educate, and train new workers.

The NEF Building Design Program introduces students to the construction industry in an effort to create an awareness of and to promote personal interest and a connection to essential professional knowledge and skills. In addition, the program helps immerse students in career exploration by exposing them to pathways within the Architecture and Construction Career Cluster.

The program is nondiscriminatory and, as such, is open to all secondary level students. All eligible students must participate through a recognized program sponsor to be considered for participation in any occurring national program competition.

Go to <<http://www.nawiceducation.org>> to determine current competition status.

Section 1: The Project

The Problem

Students act as building design contractors. Students must build a detached garage, using the site layout of their respective residences. Students may customize their garage to suit their tastes; however, the following criteria must be followed:

- The maximum size is 800 sq. ft.
- The total cost is not to exceed \$70,000.
- The garage must provide
 - space for at least one car
 - space for tool storage
 - sink with hot and cold water
 - lighting for entire space.

A garage can be used for a variety of things including but not limited to

- car storage
- general storage (e.g., mementos, clothing, household items)
- bike storage
- tool shop
- automotive maintenance area (e.g., changing oil, rotating tires)
- laundry area
- gardening area
- hobby area.

Students should be creative in the way they use their space and in sectioning off the garage for different uses.

Project Elements

Floor Plan

- Must be drawn to $1/4" = 1'$ scale
- Must be dimensioned
- Must label all areas of the garage
- Must show location of exterior and interior walls, doors, windows, plumbing fixtures, and any major appliances (e.g., washer, dryer)

Elevations: Front, Rear, Left, Right

- Must be drawn to $1/4" = 1'$ scale
- Must be labeled
- Must have one elevation per page
- Must show location of all exterior doors and windows

Quantity Take-off

- Must be completely filled in
- Must show calculations
- Must be accurate according to floor plan

Project Cost

- Must be completely filled in (check calculations)
- Must be accurate according to floor plan
- Must not exceed the allowable budget

Career Report

- Must be legible, may be handwritten or typed
- Must be written about a construction related career—either a management position or a tradesman position
- Must be approximately one page long

Project Report

- Must be legible, may be handwritten or typed
- Must describe the students' experience with this project from the design phase to the construction of the model
- Must be approximately one page long

Model

- Must be built to $1/2" = 1'$ scale— *Note:* This scale is different from drawings.
- Must be accurate compared to floor plan and elevations
- Must have base size no larger than 16" x 16"
- May be embellished as desired

Element 1—Floor Plan

Project Criteria

- The maximum size is 800 sq. ft.
- The total cost is \$70,000 or less.
- The garage must provide
 - space for at least one car
 - space for tool storage
 - sink with hot and cold water
 - lighting for entire space.

Refer to the *Material Selection* and *Project Cost Worksheet* for specific information on elements for your floor plan, including item dimensions. For those students using this program electronically, there are also Web site links for material selection information.

Flow (Circulation)

Circulation is the movement from one area to another. Successful circulation means that there are convenient pathways between areas that have the most connecting traffic. You may need to consider some of the following design issues:

- Size of car to be stored
- Overhead garage doors
- Other entrance doors
- Tool storage near entry/exit for convenient access
- Proper lighting and ventilation
- Proper electrical outlets and receptacles
- Benefit of natural lighting/sun in planting area
- Storage cubbies for supplies
- Sink convenient to work area
- Laundry area
- Outside spigot convenient to access
- Storage shelving
- Bike racks for bike storage

Element 2—Elevations

Before completing elevations, students should complete the *Quantity Take-off* and *Project Cost* portions of the project. This will allow any additions or deletions to occur without having to redraw the elevations.

Building elevations are pictorial representations of the way buildings should appear from the outside. Elevations typically show

- exterior doors
- exterior windows
- exterior finish (e.g., vinyl siding, brick)
- roof slope
- roofing material (e.g., shingles, metal).

Students must include in their final project documentation the following elevations:

- Front
- Rear
- Left
- Right

Directions and Decisions

1. From the floor plan, students should draw lines from outside edges, exterior doors, and windows.
2. Students should determine the height of the garage, which is typically 10' for a garage on block foundation.
3. Door heights are typically 6'–8'.
4. Window heights vary. (See *Project Cost Worksheet* for window size options.)
5. Height to top of roof should be calculated by referring to *Project Quantity Take-off*.

Element 3—Quantity Take-off

The quantity take-off is a listing of all material quantities needed to construct a project. When a contractor looks at a set of plans, he or she estimates or has a “take-off person” calculate the quantities of all materials or types of construction involved. To standardize the take-off process, many items are priced according to an established unit value such as square footage, square yards, cubic yards, linear feet, and quantity of each. The following table represents items under their typical unit value type found on a quantity take-off sheet.

Square Feet	Linear Feet	Quantity/Each
Roofing	Cabinets	Doors
Insulation	Gutters	Windows
Exterior siding	Shelving	Electrical outlets
Flooring (sq. yards)		Light fixtures
Painting		Plumbing fixtures
Exterior walls		
Interior walls		

Element 4—Project Cost

Students should use the quantity of items found with the *Quantity Take-off* to determine the estimated project cost (see *Project Cost Worksheet*). If the cost of the project is less than the allowable amount, you can maximize value by altering material selections or adding items to the garage. Options may include

- adding items, such as shelving or a tool rack
- using more expensive materials, such as brick rather than vinyl siding
- adding additional square footage. (This step may require students to start over, so use this as a last alternative.)

If the cost of the project exceeds the allowable amount, then do the opposite of the above suggestions.

Element 5—Career Report

The Career Report is designed to provide students the opportunity to research a construction-related career of their choice. The report should highlight any job title within the Virginia Architectural and Construction Career Cluster (<http://www.doe.virginia.gov/VDOE/Instruction/CTE/careerclusters/Arch-portal.html>).

The report should be approximately one half page in length. Report should include

- job description
- education required
- salary expectations.

Helpful Web sites include

- Know How Virginia (<http://www.knowhowvirginia.org/>)
- Trailblazers (http://www.ctetrailblazers.org/live_data/live_site_page.php)
- Virginia Career VIEW (<http://www.vacareerview.org/>)
- Virginia's Career Planning System (<http://va.kuder.com/>)
- The Career Planning Guide (<http://www.cteresource.org/cpg/>)
- O*NET (<http://online.onetcenter.org/>).

Element 6—Project Report

The Project Report is designed to provide students the opportunity to write a summary report of their experience with the project, just as construction firms often do. The report should include

- any problems encountered in the design process
- the process of determining the design
- what was learned during the project
- things the student might have done differently.

Element 7—The Model

Models are typically constructed using foam core. Students must be very careful when cutting this material. The model will be based on the final floor plan. The model base is to be no larger than 16" x 16". The model must be in 1/2" scale. (Note: The floor plans are 1/4" scale). Students may embellish the model with interior finishes, siding, roofing, exterior trees, grass and driveways. However, any additional effort put into the model will not help in the overall point evaluation, though it may score points in the bonus category (refer to *The Garage Project Evaluation Form* for a detailed rubric.)

Section 2: Project Forms

Project Checklist

- Floor plan

- Elevations: front, rear, left, right

- Quantity Take-off Worksheet*

- Project Cost Worksheet*

- Career Report*

- Project Report*

- Model

School _____

Teacher _____

Company name _____

Team members _____

NAWIC representative _____

Quantity Take-off Worksheet

Please show all calculations. For the purpose of the example calculations herein were based on a 24' x 20' garage with an 8/12 ("A"-style) roof pitch.

The values from this worksheet are entered into the *Project Cost Worksheet* to calculate the total cost of the garage.

Concrete footing and masonry foundation—This is the foundation of your garage. For this project, these items are measured in linear footage (lf), or length in feet.

If your house is rectangular: $2 \times (\text{length}) + 2 \times (\text{width})$

If your house is not rectangular: Add the length of all the sides = perimeter

Calculations:

Example

$$2 \times (24') + 2 \times (20') =$$

$$(48') + (40') =$$

88 lf

4" concrete slab on grade—This is the area of your garage and is measured in square feet.

If your garage is rectangular: $\text{length} \times \text{width} = \text{area}$

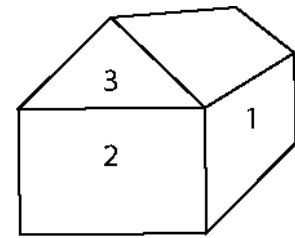
If your garage is not rectangular: Divide the space into smaller rectangles, find the area of each rectangle, and sum the areas.

Calculations:

Example: $(24') \times (20') =$

480 sq. ft.

Exterior walls and siding—Exterior walls are measured in square feet. Divide the exterior walls into sections where the area can be easily calculated.



The example to the right was divided into three sections.

- Section 1 = Length of garage x height
- Section 2 = Width x height
- Section 3 = (1/2 x base x height of roof)

Height is calculated by the pitch of the roof.

For example a 20'-wide garage with a 8/12 roof pitch would have the following height:
(20lf wide / 2 = 10lf > 10 lf x 8 in rise per foot = 80 inches or 6'-8")

H = 5'-10"

If your garage is rectangular: Area = (Section 1 + Section 2 + Section 3) x 2

If your garage is not rectangular: Find the area of each exterior wall and sum.

Height of roof = Width of garage / 2 x ??? inch per foot rise / 12 (to convert to feet)

Calculations:

Example

Section 1 = (24') x (10' - 2') = 24' x 8' = 192 sq. ft. (Note: deducted 2' for the masonry foundation wall)

Section 2 = (20') x (10' - 2') = 20' x 8' = 160 sq. ft.

Height of roof = (20' / 2 x 8 in/ft / 12 in/ft) = 6.67' or 6'-8"

Section 3 = (1/2 x 20' x 6.67) = 66.7 sq. ft.

Area = (192 sq. ft. + 160 sq. ft. + 66.7 sq. ft.) x 2 = 837 sq. ft.

Drywall—Students may wish to install drywall on the interior walls of their garage. If so, they should calculate the interior square footage of the perimeter walls.

If your garage is rectangular, the walls are:	$(2 \times \text{length} + 2 \times \text{width}) \times \text{height} = \text{area}$
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Calculations:

Example

$(2 \times 24' + 2 \times 20') \times (10' - 2')^* =$

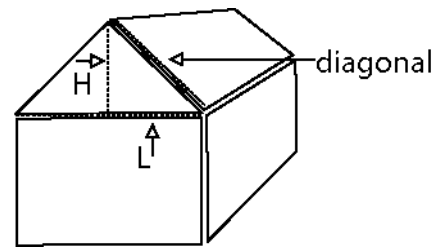
$(48' + 40') \times 8' =$

$(88') \times 8' =$

704 sq. ft.

(*Note: Deducted 2' for the masonry foundation wall.)

Roof framing and roofing—Roof framing measures the area of the roof. Because the roof is not flat, the area must be calculated using the Pythagorean theorem.



Pythagorean Theorem

$$\text{Length}^2 + \text{Height}^2 = \text{Diagonal}^2$$

(Note the L in this equation is equal to 1/2 of the total width of the shed.)

$$\text{Diagonal} = \sqrt{L^2 + H^2}$$

If your garage is rectangular: Roof area is equal to the diagonal times the length of the garage times two. (Multiply by two, because the roof has two equal sides.)

If your garage is not rectangular: Divide the roof into rectangular sections, follow the steps above for each section, and add all of the section areas together.

Calculations:

Example

L = 20' and H = 6'-8" (6.67) from the siding calculation above

$$(20' / 2)^2 + (6.67)^2 = \text{diagonal}^2$$

$$(10)^2 + (6.67)^2 = \text{diagonal}^2$$

$$100 + 44.5 = \text{diagonal}^2$$

$$\text{Diagonal} = \sqrt{144.5}$$

$$\text{Diagonal} = 12'$$

$$\text{Area of roof} = 24' \times 12' \times 2 = 576 \text{ sq. ft.}$$

Interior walls—This item is measured in square feet. Add the lengths of all interior walls and multiply by the height. Typically, garage ceiling heights are 10'.

Calculations:

Example

The sample floor plan does not have any interior walls; however, if it did, you would calculate as below:

$$\text{Length of interior walls} = 10'$$

Multiply this by the height of the ceiling in the example (10').

$$10' \times 10' = 100 \text{ sq. ft.}$$

Doors and windows—These are count items. Simply count the number of each that you have included in your garage, and put the number on the *Project Cost Worksheet*.

Storage base and wall cabinets—These items are measured in linear feet. Measure the length of the wall where the cabinets will be located.

Calculations:

Wall cabinets:

Example: $(3' + 4') = 7'$

Base cabinets

Example: $(3' + 3' + 4') = 10'$

Countertop:

Example: $(3' + 3' + 4') = 10'$

Shelving:

(length x number of shelves)

Example: $(12' \times 3) = 36'$

Flooring—These items are measured in square feet or square yards. Calculate the area of each type of flooring. This is done by multiplying the length of the area by the width of the area. To convert square feet to square yards, divide the square footage by 9.




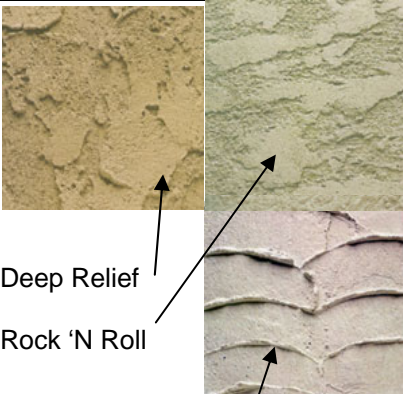

$$1 \text{ yd}^2 = 9 \text{ ft}^2$$


Calculations:






Room	Length	X	Width	Total (FT ²)
Work area				
Storage				
Others				
Total sq. ft. of garage:				





Plumbing and Electrical—These are count items. Simply count the number of each that you have included in your garage, and put the number on the *Project Cost Worksheet*.





Material Selection

Siding Options	
	<p>Vinyl Siding</p> <p>Price per sq. ft.: \$4.00 (furnished and installed)</p> <p>http://www.vinylsiding.org/aboutsiding/</p>
	<p>Hardboard Siding</p> <p>Price per sq. ft.: \$6.00 (furnished and installed)</p> <p>http://www.jameshardie.com/homeowner/prodhome/hardi plank.php</p>
	<p>Cedar Siding</p> <p>Price per sq. ft.: \$8.00 (furnished and installed)</p> <p>http://www.wrcla.org/cedar_benefits/cedar_vs_competition/siding.htm</p>
 <p>Deep Relief</p> <p>Rock 'N Roll</p> <p>Trowel Sweep Frieze</p>	<p>Stucco</p> <p>Price per sq. ft.: \$10.00 (furnished and installed)</p> <p>Stucco is a cement mixture used for siding, usually on mission or other Spanish-style homes. The cement is combined with water and inert materials such as sand and lime. Usually, wooden walls are covered with tarpaper and chicken wire or galvanized metal screening. This framework is then covered with the stucco mixture. Sometimes, the cement mix is applied directly to specially prepared masonry surfaces. Stucco can be applied in a variety of colors and finishes.</p> <p>http://www.cement.org/stucco/color_texture.asp</p>
	<p>Brick</p> <p>Price per sq. ft.: \$15.00 (furnished and installed)</p> <p>http://www.maconline.org/tech/consumers/brickhomes/brickhomes.html</p>

	<p>Field Stone</p> <p>Price per sq. ft.: \$22.00 (furnished and installed)</p> <p>http://www.tennessee-fieldstone.com/stone-examples.html</p>
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Roofing Options	
 <p>Royal Sovereign® Shingles</p> <p>Standard 3-Tab</p>	<p>25 year – 3-Tab Shingle by GAF</p> <p>Price per sq. ft.: \$3.00 (furnished and installed)</p> <p>http://www.gaf.com/General/GafMain.asp?Silo=RES1&WS=GAF</p>
 <p>Timberline® Select 40™ Shingles</p> <p>Architectural</p>	<p>40 year – 3-Tab Architectural Shingle by GAF</p> <p>Price per sq. ft.: \$3.75 (furnished and installed)</p>
 <p>Grand Timberline®</p> <p>Premium Architectural</p>	<p>Premium Architectural Shingle by GAF</p> <p>Price per sq. ft.: \$4.50 (furnished and installed)</p>
	<p>Gutters</p> <p>Price per lf: \$4.00 (furnished and installed)</p>
	<p>Gutters with Leaf Guard</p> <p>Price per lf: \$8.50 (furnished and installed)</p>

Storage Options	
	<p>Wall Cabinets</p> <p>Height: 30" Depth: 12" Price per lf : \$65.00 (furnished and installed)</p>
	<p>Base Cabinets</p> <p>Height: 35" Depth: 23 3/4" Price per lf : \$90.00 (furnished and installed)</p>
	<p>Countertop</p> <p>Height: n/a Depth: 24" Price per lf : \$20.00 (furnished and installed)</p>
	<p>12" Wall Shelving</p> <p>Height: n/a Depth: 12" Price per lf : \$10.00 (furnished and installed) *this price is for (1) shelf. If you want to stack multiple shelves (like the 3 shown in picture), you will need to count the number of shelves times the length)</p>

	<p>24" Shelving Unit</p> <p>Width: 48" Depth: 18" Height: 72" Price each: \$150.00 (furnished and installed)</p>
	<p>Rolling Tool Cabinet</p> <p>Width: 28" Depth: 19" Height: 44" Price each: \$315.00 (furnished and installed)</p>
	<p>Bike Rack</p> <p>Width: 10" Depth: 8" Price each: \$25.00 (furnished and installed)</p>
	<p>Peg Board</p> <p>Width: determined by design Height: determined by design Price per sq. ft.: \$1.50 (furnished and installed)</p> <p>Tools not included</p>

Plumbing Options



Sink

Width: 20"
Length: 20"
Depth: 10"
Price Each: \$700.00
(furnished and installed)

Electrical Fixture Options



Light Fixture—Interior

Width: 15 ½"
Length: 48"
Depth: 3 ¼"
Price Each: \$200.00
(furnished and installed)



Light Fixture—Exterior

Width: 9"
Length: 12 ½"
Depth: 9"
Price Each: \$150.00
(furnished and installed)

Project Cost Worksheet

School: _____ Group Name: _____

	DESCRIPTION	COST	QUANTITY	TOTAL
Foundation and Floor				
	Concrete footing and masonry foundation	\$85.00/lf		\$ -
	4" concrete slab on grade w/ 4" stone	\$5.00/ft ²		\$ -
Exterior Walls				
	2" x 4" wood studs, 4" faced insulation	\$5.00/ft ²		\$ -
	1/2" OSB exterior sheathing			
	2" x 4" wood studs, no insulation	\$4.50/ft ²		\$ -
	1/2" OSB exterior sheathing			
	1/2" drywall on exterior walls	\$2.25/ft ²		\$ -
Siding				
	Vinyl	\$4.00/ft ²		\$ -
	Hardboard	\$6.00/ft ²		\$ -
	Cedar	\$8.00/ft ²		\$ -
	Stucco	\$10.00/ft ²		\$ -
	Brick	\$15.00/ft ²		\$ -
	Field stone	\$22.00/ft ²		\$ -
Roofing				
	Roof framing	\$6.50/ft ²		\$ -
	Shingles, 25 yr.—three tab	\$3.00/ft ²		\$ -
	Shingles, 40 yr.—architectural	\$3.75/ft ²		\$ -
	Shingles, premium architectural	\$4.50/ft ²		\$ -
	Gutters	\$4.00/lf		\$ -
	Gutters with leaf guard	\$8.50/lf		\$ -
Interior Walls				
	2" x 4" wood studs, 1/2" drywall each side	\$6.25/ft ²		\$ -
	4" insulation in walls	\$0.75/ft ²		\$ -
Doors				
	Interior 2'-6" x 6'-8"	\$285.00/ea		\$ -
	Interior 3'-0" x 6'-8"	\$295.00/ea		\$ -
	Exterior 3'-0" x 6'-8"	\$375.00/ea		\$ -
	Garage Door 9' x 7"	\$350.00/ea		\$ -

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	DESCRIPTION	COST	QUANTITY	TOTAL
Doors (continued)				
	Garage Door 16' x 7"	\$500.00/ea		\$ -
Windows				
	Double hung, 2'-4" x 4'-6"	\$320.00/ea		\$ -
	Double hung, 2'-0" x 3'-0"	\$265.00/ea		\$ -
Storage				
	12" wall cabinets	\$65.00/lf		\$ -
	24" base cabinets	\$90.00/lf		\$ -
	24" laminate counter top	\$20.00/lf		\$ -
	12" wall shelving	\$10.00/lf		\$ -
	24" x 18" x 72" shelving unit	\$150.00/ea		\$ -
	Rolling tool chest—(28"W x 19"D x 44" H)	\$315.00/ea		\$ -
	Bike rack	\$25.00/ea		\$ -
	Peg board (for tool storage)	\$1.50/ft ²		\$ -
Painting				
	Walls	\$0.75/ft ²		\$ -
	Doors	\$40.00/ea		\$ -
	Windows	\$40.00/ea		\$ -
Flooring				
	Vinyl composition tile (VCT) 12" x 12"	\$2.50/ft ²		\$ -
	Concrete sealer	\$0.75/ft ²		\$ -
	Sheet vinyl	\$3.00/ft ²		\$ -
	Epoxy	\$5.00/ft ²		\$ -
Plumbing				
	Water from house to garage	\$1,500.00/ea		\$ -
	Sink	\$700.00/ea		\$ -
	Washer hookup	\$350.00/ea		\$ -
	Outside spigot	\$300.00/ea		\$ -
Electrical				
	Power to garage	\$750.00/ea		\$ -
	Receptacles	\$50.00/ea		\$ -
	GFCI receptacles	\$60.00/ea		\$ -
	Light fixtures—interior	\$200.00/ea		\$ -

NEF The Garage Project

	DESCRIPTION	COST	QUANTITY	TOTAL
Electrical (continued)				
	Light fixtures—exterior	\$150.00/ea		\$ -
	Dryer hookup	\$125.00/ea		\$ -
	Garage door opener	\$200.00/ea		\$ -
	Exterior light motion sensor	\$75.00/ea		\$ -
Building Permit		\$75.00/ea		\$ -
Subtotal				\$ -
Overhead and Profit 10%				\$ -
TOTAL				\$ -
			Total must be LESS THAN \$70,000	

Congratulations. You have completed the project.

The Garage Project Evaluation Form

School _____ Group Name _____

CATEGORY		Points Possible	Points Given	Notes
Overall Layout and Appearance of Folder		5		
Daily Job Log				
	Content	5		
Drawings				
	Floor plan	12		
	Front elevation	2		
	Rear elevation	2		
	Left elevation	2		
	Right elevation	2		
Quantity Take-off				
	Accuracy	8		
	Show mathematics	2		
Project Cost				
	Mathematical accuracy	4		
	Under cost constraint	2		
	Use of different Items	2		
	Accurate per floor plan	2		
Career/Trades Report				
	Content	10		
Project Report				
	Originality	3		
	Content	7		
Project Model				
	Construction	15		
	Follows floor plan and views	6		
	Detail	9		
Bonus Points (max of 10)		0		
TOTAL (without bonus points)		100		
Evaluator's (name)				