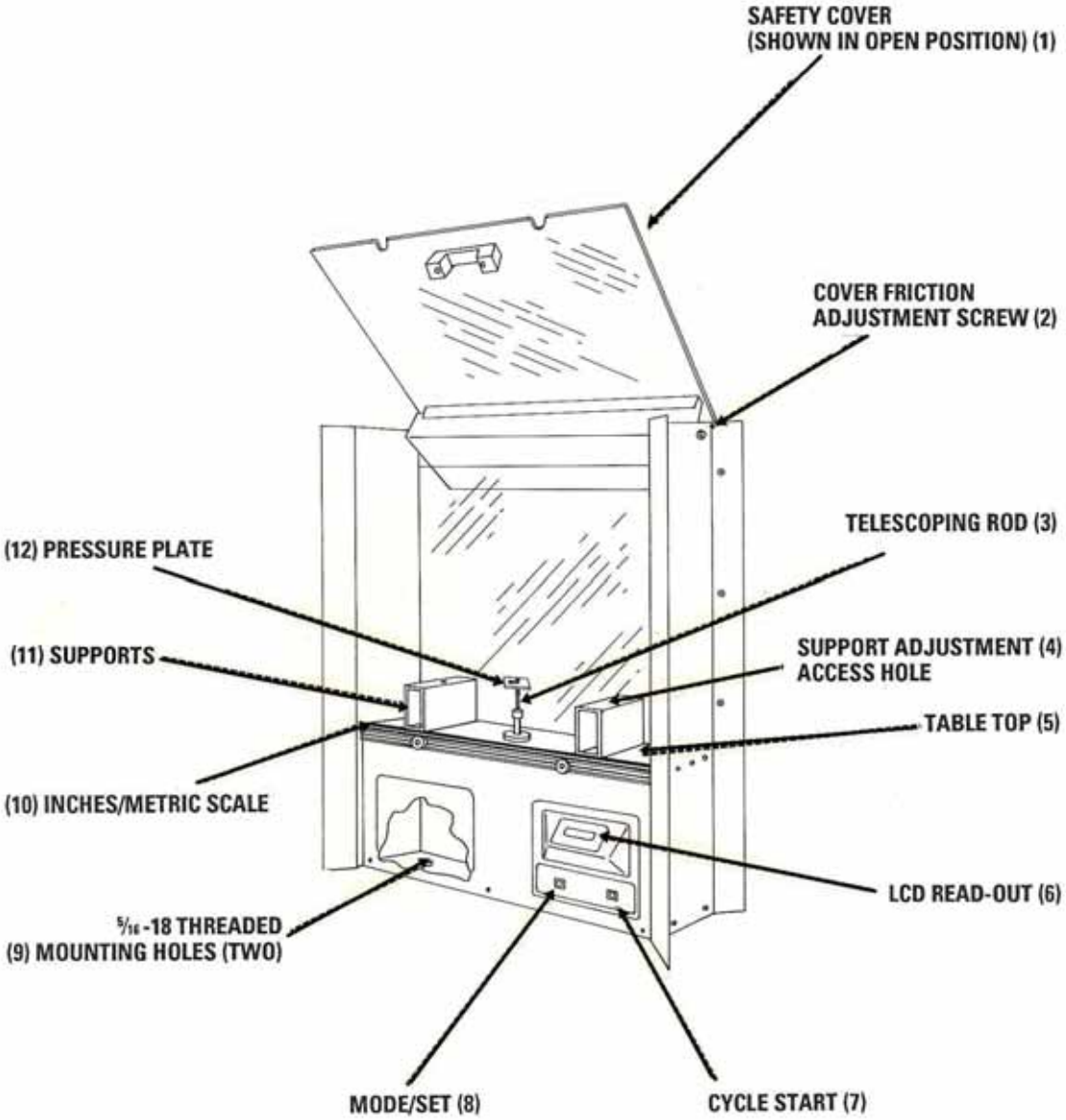
Table of Contents

FIG. 1


SAFETY COVER
(SHOWN IN OPEN POSITION) (1)
COVER FRICTION
ADJUSTMENT SCREW (2)
TELESCOPING ROD (3)
(12) PRESSURE PLATE
(11) SUPPORTS
SUPPORT ADJUSTMENT (4)
ACCESS HOLE
TABLE TOP (5)
(10) INCHES/METRIC SCALE
LCD READ-OUT (6)
5/16-18 THREADED
(9) MOUNTING HOLES (TWO)
MODE/SET (8)
CYCLE START (7)

Chapter 1

Important Safeguards

1. **Read and retain the safety and operating instructions.** Before operating this product read the operating instructions and then retain them to make full use of the safeguards and features incorporated in the STRUCTURAL STRESS ANALYZER (SSA).

2. **Follow the instructions, and be sure to heed all warnings** - on the equipment and in the manual.

3. **When you use the power supply cord.** Place the power cord so that it will not be subject to walking traffic or abuse, particularly at plug-in points, convenience receptacles, or cord exit points from the unit. Where an extension is needed, use the proper size wire to meet the power requirements of this unit. Additionally, the cord should not be any longer than needed.

4. **Turn off this product when not being used or during a lightening storm.** Disconnect from any power source to avoid damage due to lightening and power surges or when it is left unattended or will be unused for long periods of time.

5. **DO NOT ATTEMPT TO SERVICE,** repair or disassemble this product yourself, as removing covers may expose you to dangerous voltage or other hazards. There are no user serviceable parts inside. Refer all servicing to ADVANCED MANAFACTURING TECHNIQUES, INC.

6. **DO NOT OPERATE STRUCTURAL STRESS ANALYZER WITHOUT** permanently mounting the Structural Stress Analyzer to a bench top or an appropriate sized rolling cart. Bench or cart should be of sufficient size to insure stability during testing and transportation.

7. **DO NOT OPERATE THE STRUCTURAL STRESS ANALYZER WITHOUT** the safety shield in the closed position.

8. **AVOID STATIC ELECTRICITY.** As with any electronic equipment, static charges may eradicate operation of unit or units.

Chapter 2

Structural Stress Analyzer Set-up Procedure

1. Remove SSA from carton. Save and store original carton and packing material for use in the event you should need to return the unit for repairs.

2. Carefully tilt SSA backward and note the locations of the two (2) 5/16-18 tapped holes in the bottom of the unit (see fig. 1-#9). These are for mounting the unit to a bench or cart. These holes and 20" apart and centered on the unit. Position and drill two (2) clearance holes in your bench or cart as desired and bolt the unit down using the 5/16-18 X2" long bolts provided.

3. The transparent guard material is made of a high impact polycarbonate (LEXAN) and is virtually indestructible but can be easily scratched. Therefore, a blue film has been intentionally left on the outside of the guards for protection from scratching during shipping. Please remove and discard this film (see fig. 1-#1). Note: Do not throw back the cover, as this will put undo force on the guard hinges. In the open position it should be about a 45-degree angle. In time it may become necessary to adjust tension on resistance bushings by tightening screws at the pivot points of the guard (see fig. 1-#2).

4. Find the power cord and install in the power entry module at the rear of the unit. Plug into a grounded 110-volt power source and you are now ready to run the Structural Stress Analyzer 1000.

5. This machine can be used as a "stand alone" unit and also be interfaced with other options and devices. Once you have familiarized yourself with the basic unit refer to Chapter 5 (Options) to learn about the various devices you may have purchased with your unit.

Chapter 3

Operational Procedures

1. Refer to the diagram at the beginning of this manual to familiarize yourself with the various components of this machine.

2. The SSA has been shipped with a wooden spacer installed between the 50mm square pressure plate. This spacer can now be used to test the unit and allow the operator to have an actual demonstration of the cycling of the machine.

3. With the front guard in the closed position, power up the unit using the rocker on/off switch at the rear of the machine.

4. The LCD message window (see fig. 1-#6) should read "PRESS START TO GO HOME". Press start and the ram will return to the home or start position. NOTE: the button will have to be pushed and held in momentarily to activate the various functions of this machine.

5. Now push CYCLE START (see fig. 1-#7) and notice the display will begin to read force and deflection as it begins to crush the spacer. When the peak force has been reached the control will "lock in" on that force and continue to move another 0.100 of an inch looking for any higher force, if none is found, it will stop. Now press the CYCLE START button to return the ram to home position. You have just witnessed the continuous cycle of this machine. NOTE: when the power is first activated, the SSA will always come up in this mode.

6. Listed below are the five (5) modes that can be selected by the operator. To scroll through these modes push the rocker switch in the select direction.

   CONTINUOUS MODE

   In this mode the SSA will run through a full cycle until the ultimate breaking force is reached. The force & deflection will be displayed until the start button is pushed again at which time the unit returns home. NOTE: be sure to record values achieved before returning home as the machine will reset itself at this time.

   INCREMENTAL MODE

   In this mode the operator can select a predetermined from 10 to 100 lb. Every time the CYCLE START is pushed the machine will advance by approximately the selected amount until the structure fails.

   UNIT MODE

   This mode allows the operator to select SAE (lb. & inches) or Metric (kilograms & centimeters)

MAXIMUM FORCE

This mode allows the operator to choose maximum force that can be exerted on structure from 10 to 1,000 lb., in 5 lb. increments.

STOP MODE ON

This mode allows the operator to select a "Continue After Break" or "Stop After Break" option. In the “Continue After Break" mode the machine will not stop after the peak force has been attained, but will continue to lower the limit, or can be stopped at any time by pushing the cycle start button again. In the "Stop After Break" mode the unit will shut down .100 in. after the peak force has been attained. NOTE: When you first power up the unit it will come up the "Stop After Break" mode automatically.

7. To activate any of the above modes the following procedure must be followed:

    a) Push "SELECT" until the desired mode is displayed.
    b) Push "SET" LCD displays "ENABLED"
    c) Push "SELECT" until desired reading is displayed.
    d) Finally, Push "SET" to lock-in on your selection.

NOTE: When the SET is pushed in the Continuous and Incremental modes the display will read "PRESS START TO BEGIN CYCLE", you are now ready to begin your cycle.

Chapter 4

Structure Set-up Procedures

1. Structure must have at least a 3/8" hole through the bottom so that telescoping rod (see fig. 1 #3) can be projected through the roadbed of the bridge.

2. Using the Allen Wrench provided, set supports (see fig. 1#4) to appropriate spacing. A scale has been provided on the table for symmetrical positioning of these supports, NOTE: Pull forward on supports slightly when tightening. This will keep them square with the tabletop.

3. Screw threaded shaft up or down until there is clearance to slide the pressure plate (see fig. 1 #12) into slot in shaft.

4. Place the large hole in pressure plate over shaft, drop it down until it aligns with slot in shaft and pull forward fully seating shaft in the middle of pressure plate. NOTE: allow some clearance between pressure plate and top of bridge roadbed.

5. You are now ready to begin your test cycle and remember the following notes:

    a) If at any time it becomes necessary to abort the test, push the CYCLE START quickly and the ram immediately returns to home or push and hold button momentarily, the unit will stop and display Force & Deflection until the button is pushed again.

    b) If front cover is not closed or is opened during testing the unit will stop until condition is corrected. This is for you and your student’s protection, do not attempt to override this device.

    c) The absolute maximum force in Continuous Mode or Incremental Mode will be 1,000 lb. and maximum travel of approximately 1-1/2 inches. If either is exceeded the machine will stop and you will be advised via the LCD readout.

    d) If you desire to return "HOME" in the Incremental Mode simply select Continuous and the ram will return home.

    e) The telescoping rod is approximately 8" long, if taller structures require more than this length, use the rod extension kit, enclosed with your unit.

    f) Many different set-ups can be achieved with a little imagination. AMT. Inc. will continue to develop additional adapters in the future and would welcome your comments.

Chapter 5

SSA1000 Windows Computer Interface

5.1 Package Contents

1 - CD ROM
1 - SSA Serial cable (25 pin to 9 pin connectors)
1 - SSA User's Manual (this manual)

5.2 Getting Started

5.2.1 General Description

The SSA program is a Windows interface program that was developed to enhance the Structural Stress Analyzers capabilities. With the use of a serial cable, the analyzer may be linked to a computer to allow it to directly control the analyzer. Additionally, the computer for analysis will record the force vs. deflection data. Using a computer to control the analyzer offers the ability to collect and save the data on disk for future reference and print the results on a printer. With a few simple key commands or mouse clicks, the analyzer can be made to start or stop, the test results saved and recalled, and the graphic results displayed or printed.

The program also adds an additional testing mode to the analyzer which can be used to apply a programmed incremental force to the structure. This test mode is useful for analyzing the structure as the loads are being applied, which allows for a more detailed analysis of the structure under increasing loads. The computer also allows viewing of the force vs. deflection data table during or after the test.

5.2.2 Minimum System Requirements

- IBM PC or any 100% compatible computer (486 or faster recommended)
- 8 Mb RAM (16 recommended)
- 3.5 Mb free hard disk program space
- CD ROM Drive
- 9 pin serial port (COM1 through COM8)
- Windows 95/98 or XP properly installed (NOT Windows NT)
- Graphics printer (optional, color recommended)

5.2.3 Installation

1. Start Windows.
2. Insert the disk marked “SSA1000 Disk 1” into your floppy drive.
3. Click the Windows Start menu, and click **Run**.
4. When the Run dialog box appears, type **x:setup** (substitute your floppy drive’s letter for **x**).
5. Click **OK**.
6. Follow the on-screen instructions.

5.2.4 Un-installing

1. Click the Windows Start menu, and click **Settings** then **Control Panel**.
2. Double click the **Add/Remove Programs** icon.
3. Select the **Install/Uninstall** tab.
4. In the "pull-down" list box, find and click **SSA1000**.
5. Click the **Add/Remove** button.
6. Follow the on-screen instructions.

5.2.5 Connecting the SSA to the Computer

Turn off the power to the Structural Stress Analyzer (the switch is in back of the unit, next to the power cord). Connect the cable's 25-pin connector to the rear panel of the analyzer. Next determine which serial port the analyzer will be connected to (COM1 through COM8). Plug the 9-pin connector end of the serial cable into the computer. Once the serial cable is connected the analyzer can be turned on. If the optional tensile adapter is to be used please refer to the tensile adapter operation manual for assembly instructions.

5.2.6 Starting the SSA1000 program

If during program installation, you accepted the suggested program installation directories, start the program by:

1. Click the Windows Start menu, and point to **Programs**, then **SSA1000**.
2. Click the **SSA1000** icon.

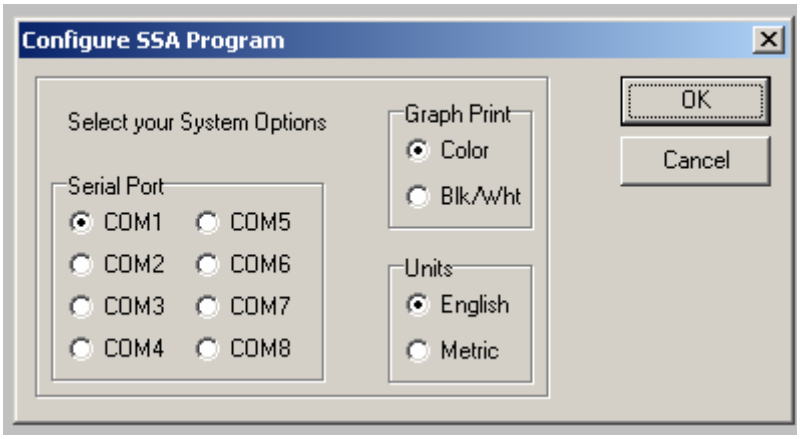
The program will normally briefly display the AMT logo and a "Loading Program and Installation Files" message boxes, and then displays the SSA main operation screen.

If you receive a message "Serial Port configuration error, PRESS - Ignore to Continue", the program has detected the SSA program's currently selected serial port, does not exists, or is not available. Do the following:

1. Confirm which serial ports your computer does have.
2. Close any program(s) that might be using the serial port.
3. Click the **Ignore** button, and proceed to the **Setting-Up the SSA1000 program** instructions below.

5.2.7 Setting-Up the SSA1000 program

The SSA1000 program was design for simple operation. As such, only the serial port need be configured. This is accomplished by using the title bar menu **Machine**, **Configure Program** selection. Menu selection is performed by any standard Windows method: a) mouse point and click, b) tabbing and ENTER press, c) using the arrow keys, or d) using the ALT + underlined letter keystroke.



To select the desired serial port, click the appropriate COM "radio" button, and click the **OK** button. If the selected port is available, the **Configure SSA's Serial Port** window box will disappear, and the **Create New Data** icon will show as enabled (brightly colored, not gray outline).

If the selected serial port does not exist, or is in use by another program, a warning message box will announce "The new Serial Port is not available". You may respond by either clicking the **Cancel** or **OK** buttons, but all communications with the SSA will be disabled until a functional serial port is selected. This will be indicated by a "gray outline" **Create New Data** icon.

5.3 Performing a SSA Test

The SSA control panel is activated by either clicking on the **Create New Data** icon, or by the main menu **Machine**, **SSA Control Panel** selection. The control panel provides the following functions (see Fig. 2)

5.3.1 Status (display)

A brief indication of the present operation or condition of the SSA machine.

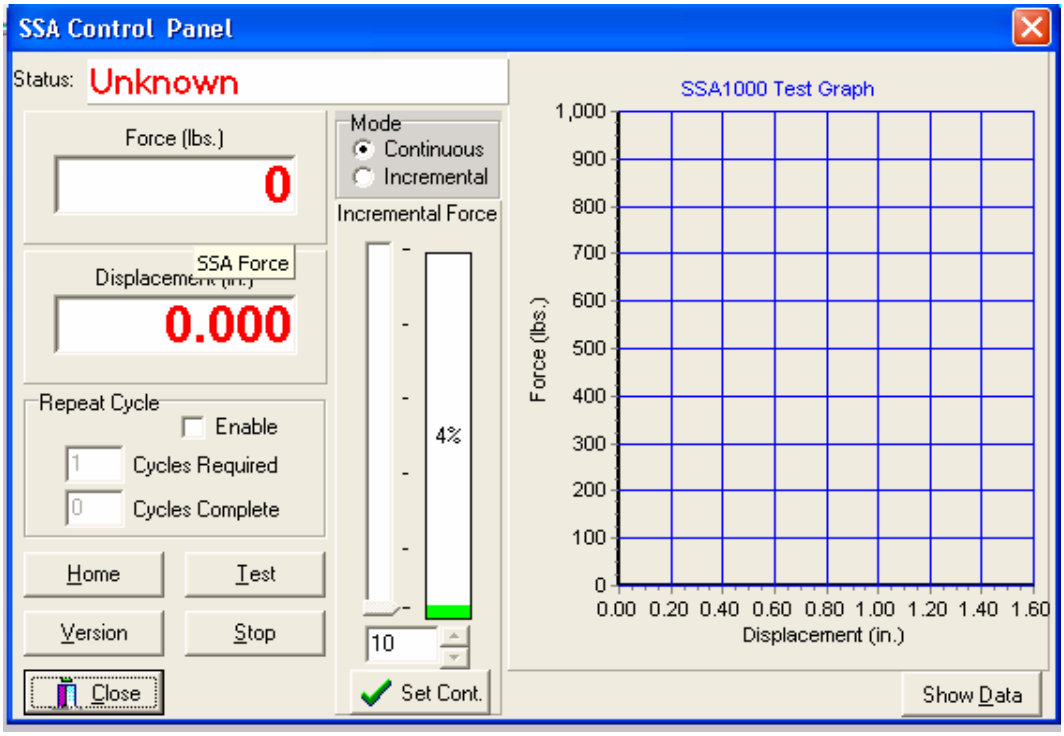
5.3.2 Force (display)

The present test force or peak force from the last completed test (in pounds).

5.3.3 Displacement (display)

The present test displacement (as measured from the point the force on the test specimen has risen above 10 lb.), or the displacement at which the peak force occurred during the last completed test (in inches x 1000).

FIG.2



5.3.4 Repeat Cycle (box)
Used to select the multiple automatic repeat cycles mode. When selected, if the structure's strength is greater than the SSA's set maximum force, the current stress test cycle will terminate, the "Cycles Completed" box will increment, the "Cycles Required" box will decrement, and if the "Cycles Required" box is greater than zero, a new cycle will be started. If the structure should break at any time during the repeating cycles, the SSA will terminate testing.

5.3.4.1 Enable (check box)
Check this box to select the automatic "Repeat Cycle" mode. Uncheck the box to return to the normal "1 cycle only" mode.

5.3.4.2 Cycles Required (edit box)
Enter the number of cycles to test repeatedly, between 1 and 50. Only settable if the "Enable" box is checked.

5.3.4.3 Cycles Complete (display box)
Displays the number of cycles repeatedly tested. Not operator settable.

5.3.5 Home (button)
Used to request the SSA to go to the "home" position (rod upper position).

5.3.6 Version (button)
Used to request the software version of the program within the SSA (not the Windows program).

5.3.7 Test (button)
Used to start the SSA in motion (ram begins to move downward). After the test completes, a new test graph window will appear in the background. This window contains all of the test data, and will be retained after the **SSA Control Panel** window is closed.

5.3.8 Stop (button)
Used to abort a structural stress test, while the SSA's rod is moving down.

5.3.9 Mode (box)
Contains the control devices for selecting the "Continuous" or "Incremental" test modes.

5.3.9.1 Continuous (radio button)
Selecting this mode will cause the SSA to apply increasing loads (force) to the test specimen when the **Test** button is pressed, until the occurrence of:

- The specimen breaks.
- The Control Panel's **Stop** button is pressed.
- The machine's START CYCLE button is pressed.
- The maximum force is reached.
- The lower limit is reached.

After the test completes, a new test graph window containing all of the test data will appear in the background. Note the continuous mode is not activated until the **Set Cont.** button is pressed. Also note the incremental slider control is disabled when the **Continue** radio button is selected. The Status display will confirm when the continuous mode is actually set.

5.3.9.2 Incremental (radio button)
Selecting this mode will cause the SSA to increase the force on the test specimen by the selected **Incremental Force** setting. The **Incremental Force** may be set from 10 to 250 lb., in steps of 10 lb. Example: If the **Incremental Force** setting is set to 50 lb., each time the **Test** button is pressed, sequential forces of 50, 100, 150, 200, etc. lb. will be applied until:

- The specimen breaks.
- The Control Panel's **Stop** button is pressed (only while rod is moving down).
- The machine's START CYCLE button is pressed (only while rod is moving down).
- The maximum force is reached.
- The lower limit is reached.

After the test completes, a new test graph window containing all of the test data will appear in the background. Note the incremental mode is not activated until the **Set Inc.** button is pressed. The Status display will confirm when the incremental mode is actually set. Also note the incremental slider control is enabled when the **Incremental** radio button is selected.

5.3.9.3 Incremental Force (slider bar)

The **Incremental Force** may be set from 10 to 250 lb., in steps of 10 lb., by positioning the slider pointer. This may be accomplished by dragging with the mouse (point to the slider, press and hold the mouse button, and drag the mouse to the desired value). Note the value box under the slider control, digitally indicates the exact value setting. The new **Incremental Force** is not activated until the **Set Inc.** button is pressed, and will be confirmed by the vertical meter bar raising (or lowering) to match the slider pointer position.

5.3.10 SSA1000 Test Graph (display)

As a test proceeds, the force vs. displacement data received from the SSA is graphed in X-Y format.

5.3.10.1 Show Data (button)

Clicking this button will replace the X-Y graph with a data table. The table is the actual data received from the SSA. The table contains lines of displacement (X), and force (Y) values, separated by commas (,). A scroll bar will allow viewing various portions of the table, if it can not be seen in its entirety. Points of cycle start and stopping are indicated by abbreviated commands (i.e. “ID” indicates an incremental start down; “CM” indicates a continuous test terminated by maximum force). Please refer to the Appendix for a list of all the SSA serial commands. This button works with the **Show Graph** button to allow alternate switching between data graph a data table views.

5.2.10.2 Show Graph (button)

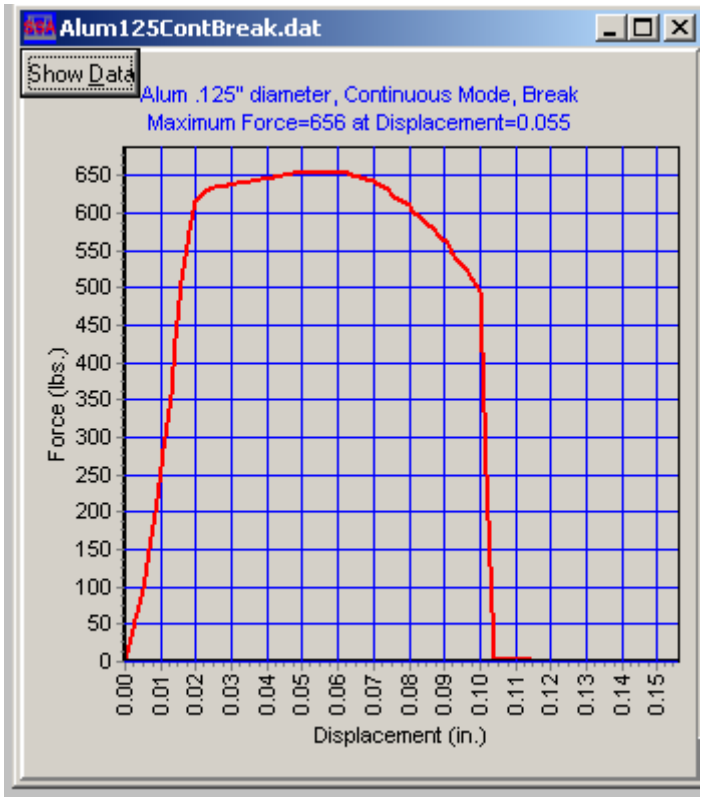
Clicking this button will replace the data table with an X-Y graph. Refer to **Show Data** above for additional information.

5.3.11 Close (button)

This button will remove the **SSA Control Panel** window from the screen. It is important to note that the main menu functions are not available while the **SSA Control Panel** is visible. Alternately, the control panel can be closed using the button (the ‘**x**’) in the upper right corner.

5.4 Working with Test Data Windows

After completion of a structural stress test, a test data window will appear. Initially, the window will have a title "Unsaved Test" indicating the data is in memory only and has NOT been saved to a disk file. Please refer to section **Saving Test Data to Disk** below on saving the data to disk.

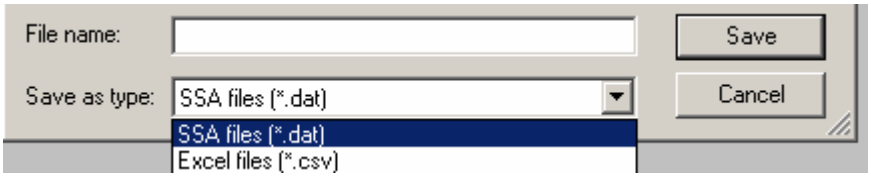


Upon creation, the data will be shown in an X-Y graph format; similar to that seen when the test was performed. The graph axis will automatically be re-scaled in the X (displacement), and the Y (force) dimensions, to show the maximum detail possible. The test data window provides the **Show Data** and the **Show Graph** buttons, operating in an identical manner as those in the **SSA Control Panel** window. The **Show Data** mode provides a windows scroll button, to allow viewing large data tables.

The test data windows can be moved and re-sized, in the typical windows manner. Use the "minimize" and "maximize" sizing buttons in the window's upper right corner to adjust individual test data windows. The SSA's main title menu provides an easy way of manipulating the test data windows simultaneously using the **Window**, **Tile** or the **Window**, **Cascade** methods. Test data windows are closed using the windows close button (the '**x**'), in the upper right corner. As a safety precaution, attempting to close an "Unsaved Test" window will cause a warning message to appear. Selecting the **Cancel** button will abort closing the window, providing an opportunity to save the data. Selecting the **OK** button will proceed to close the window, and the data will be lost.

5.4.1 Saving Test Data to Disk

When an "Unsaved Test" window is selected (title bar is blue), the **Save Data** icon will be enabled. Click this button and the standard window's "save file" window will appear. The window will default to the SSA's data file directory, and with the ".dat" file extension. The window will allow you to navigate to other directories, and other drives, and will allow naming the file. Upon saving the file, the test data window's title will change to the file name you provided in the save to file operation, and the **Save Data** icon will be disabled. The save data process can also be initiated using the **File**, **Save Test File** main menu selection.

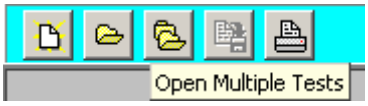


***Note:** After the test file as already been saved you can then convert the file to an Excel format if you wish to view and manipulate the data in Microsoft Excel. Open the file you wish to convert and then click the Save Test As icon. A Save As window will open and at the bottom of the window you can change the file to an Excel (.csv) file by pulling down the Save As Type menu.

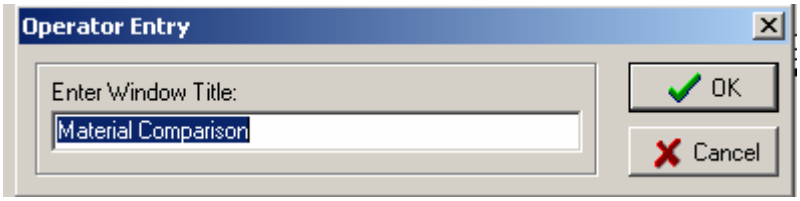
5.4.2 Load Test Data from Disk

SSA test data that was previously saved can be loaded from disk and displayed. Click the **Open Disk Data** icon, and navigate to the drive and directory, where the data file is located. You can double click the file, or click once, then click the **Open** button. The selected file will be read, and displayed in the X-Y graph format. The load data process can also be initiated using the **File**, **Open Test File** main menu selection.

5.4.3 Opening Multiple Test Files



The SSA software has the ability to view multiple saved test files at the same time giving you the ability to compare the graphs of multiple structures simultaneously. To begin click the icon with the two folders on the toolbar. The data folder where the test files are saved will open and you will be able to select a file for comparison. You will then be asked to enter a Window Title for the comparison. Enter the title and press OK. You can now add multiple files by clicking the Open Multiple Tests icon and they will automatically be added to the graph you see on screen.



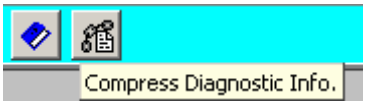
5.4.4 Printing Test Data

Test data windows can be printed individually, by making the desired data active (title bar blue), and clicking the **Print Graph** icon. Alternately, printing can be initiated by selection of the main menu **File**, **Print** items. Printing by either of these methods will sent the graph to the Windows default printer. Addition printers, which may include faxing or other devices, may be selected using the **File**, **Print Setup** menu items. (Note! The graph will not print correctly using Windows NT)

5.5 View Manual

If at anytime while using the program you wish to reference the manual you can do so by using the "View Manual" icon. This will open the manual in PDF format.

5.6 Compress Diagnostic Info



Pressing this icon will perform a diagnostic check on your SSA unit as well as the software. It will be saved in a format that can then be sent to AMT where they can address any problems that you may be having with the unit and software. Simply click the "Compress Diagnostic Info" icon on the toolbar and the error information will automatically be saved to a new file.

5.7 Program Termination

Clicking the File, Exit main menu items will close the SSA1000 program. Alternately, the SSA1000 window's title bar close button (the '**x**'), in the upper right corner, will close the program. If any "Unsaved Test" windows exist, a warning message or multiple messages will be displayed. As previously described, selecting the **Cancel** button will abort closing the window, providing an opportunity to save the data. Selecting the **OK** button will proceed to close the window, and the data will be lost.

Chapter 6

6. Optional Tensile Testing Adaptor

If you have purchased the tensile testing option you will soon find that it opens a whole new area of materials testing and evaluation to you and your students. A tensile can be made of aluminum, steel, brass or even wood to demonstrate the yield strengths, maximum tensile strengths and elongation properties of various materials (i.e. the strength to weight ratio between aluminum and steel would be a good example of why airplanes are not made of steel). These and other ideas for lesson plans are included with the Tensile Testing Package. See instructions included with the Tensile Adapter for proper set-up procedures.

6.1 Tensile Tester User Instructions

CAUTION: The TT 1000 Tensile Tester has the capability to apply up to 1000 pounds of tensile force to a given test specimens. **NEVER OPEN THE SSA SAFETY COVER WHEN THE TEST SPECIMENS IS UNDER LOAD. IF THE SAMPLE DOES NOT RUPTURE DURING THE TEST, CYCLE THE SSA TO HOME TO RELIEVE STRAIN ON SPECIEMNS.**

OPERATING INSTRUCTIONS:

1). Remove the threaded telescoping rod from the unit.

2). Install the tensile adapter into the 3/8-16 tapped hole in the ram. Utilizing wrench flats, lightly tighten the adapter in place.

3). Using fingers only, screw ¼-20 threaded tensile fully into the tensile adapter. NOTE: to insure that the threads do not strip out, as with any threaded device, it must be engaged at least one diameter into the adapter. In this case about ¼".

4). Place the housing over the tensile, being careful to align the housing over flange on SSA table. Engage the rod attached to hand knob with the upper section of the tensile. Turn the knob until there is 1/16" gap between the Tensile Tester Bushing and the bottom of the Palm Knob.

BE SURE THERE IS NO TENSION ON THE SPECIMEN PRIOR TO STARTING

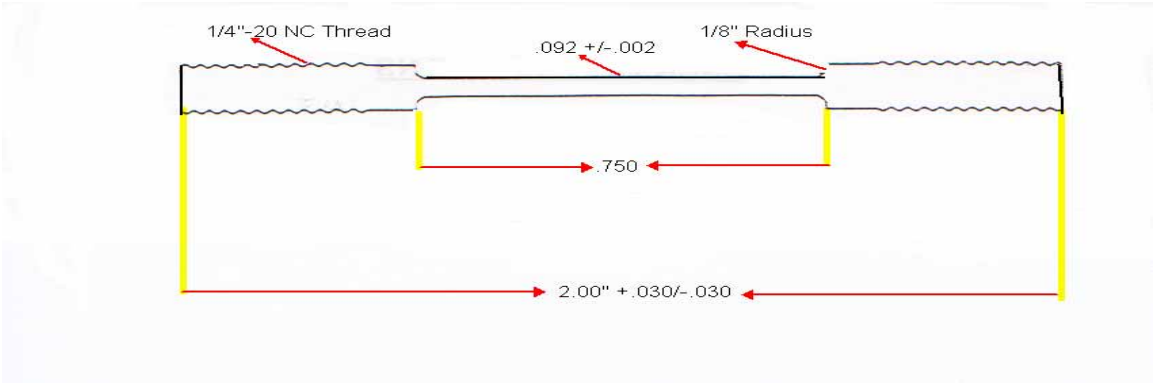
5). Close the safety cover.

6). You are now ready to begin the test.

THE TEST CAN BE IN EITHER THE CONTINUOUS OR INCREMENTAL MODES

6.2 Tensile Test Specimen Sample

This will aid you in the reapplication of test specimens. The diameter of the gauge section in the center will change the type of material you are testing. The SSA in the tensile mode will test to a force of 1000 psi. Calculations using 1000 pounds, as force for a specimen may not fracture for the ultimate strength of the material may be higher. If the strength of the material in unknown select a diameter which will be within the 1000 pounds range of the SSA.



6.3 Tensile Calculations Example

Material to be tested: 1018 Cold Rolled Steel
Ultimate Strength: 64,000 PSI
Yield Strength: 54,000 PSI

Calculations:
P-sA Where : P = Force to be applied to test specimen.
S = maximun allowable stress of the material
A = Cross sectional area of gauge section of specimen.
P= 850 pounds (picked at random from 1 – 1000 lbs. Range of the SSA in tensile mode).
S= 64,000 PSI (chosen from a manufactures data chart for 1018 Cold Rolled Steel).
A= Unknown (this is what we will solve for).

Substituting the numbers into the formula we get:
850 lbs. = 64,000 psi X A Or A=850 lbs./64,000 psi A= .0132812 Sq. in.
Using the formula for area of a circle : Area = 3.14 X r2 or
Area = .7854 X d2 we get:
.0132812/.7854 = d2 or d2 = .0169101 so D = .130”
The diameter of the test specimen gauge section will be turned down from .250” to .130”.
Testing of acrylic plastic will give more dramatic results and give students a medium that is easier to work with. We at AMT, Inc. hope this information will provide a bas to start with in making and testing tensile specimens.

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7. Optional Top Loading Adapter

7.1. Installation Instructions

1). Your student's structure should be designed with a minimal 3/8" clearance hole through the center, this is to allow the 3/8"-16 extension rod to pass through the center of the model.

2). Adjust the aluminum support blocks to the desired width. (NOTE: If the structure to be tested is smaller than the minimal span of the support blocks, you will be required to fabricate bars to span the gap between the aluminum support blocks).

3). Remove the 3/8"-16 extension rod from the pull rod cap.

4). Insert the 3/8"-16 threaded rod several turns into the pull rod cap.

5). Place the structure over the rod through the top of the structure into the extension nut. Adjust the entire assembly to approximately the working height of the structure.

6). Now install the 3/8"-16 pull rod through the top of the structure into the extension nut. Adjust the entire assembly to approximately the working height of the structure.

7). Now place the 6" X 7" aluminum plate over the top of the structural so the rod is through the hole in the center of the plate.

8). Place the 2" square Pressure Load Plate over the extension rod and lock into place. (NOTE: Be sure to allow enough clearance between the plate assembly and the structure so it will "float" over the structure.

You are now ready to test your structure.

Appendix 'A'

Computer and Structural Stress Analyzer serial commands

Through the serial port, the SSA can be commanded to perform basic functions. The serial format is fixed at 9600 baud, 1 start bit, 8 data bits, no parity, 1 stop bit, and no flow control. The following is a list of PC commands and SSA responses:

Command	**Function**	**Normal Response**
C	Set Continuous Mode	C<cr>
H	Go Home	H<cr> (if home) or U<cr> (if going home)
I	Set Increment Mode	I<cr>
S	Stop Test	S<cr> (if at stop) or TU<cr> (if in test)
T	Start Test	D<cr> (if test started) TL<cr> (if test aborts at bottom limit) TM<cr> (if test aborts at maximum force) TT<cr> (if test completes by breaking structure)
V	EPROM Version	Vx.x<cr>
MIxxx<cr>	Set Incremental Force	<cr>
RE	Read last Error Code	xxx<cr> values 0 - 255
RF	Read current System Force	xxxx<cr> (force in lb.)
RM	Read current Motor status	OFF<cr> or DOWN<cr>

Appendix 'B'

Error log files
The SSA1000 program creates 2 different log files, for the detection and diagnosing of program errors. These files are located in a sub-directory of the program directory. If the installation default suggestions were accepted, the directory is "\Ssa1000\errors". These files are simple text files, and can be opened and viewed by any word processor, or the Windows supplied NOTEPAD editor.

Installation Errors
Within the "…\errors" directory, a file named "install.errors.txt" will be created, each time the SSA1000 program is started. If the file already exists, it will be deleted, and a new file created. Normally, there will not be installation errors, and this file will be empty, and the directory will show its size as "0KB". If an installation error occurred upon program execution, this file will contain a list of the offending lines, and the nature of the error. Below is a list of the various errors detected.

Serial Errors
The second error log file is also a standard text file, with the name "serial.errors.txt". Unlike the "install.errors.txt", which is deleted each time the SSA1000 program is executed, the program never deletes this file. The SSA1000 program will always "append" any new error to the existing lines of errors. This provides a complete list of all serial related errors that have occurred since the program was installed.

Error Code	Detected By	Module Detected	Fault Description
-2	WSC	SerialComm	Port already open
-3	WSC	SerialComm	Port is not open
-4	WSC	SerialComm	Can not allocate memory
-10	WSC	SerialComm	Hardware error
-103	WSC	SerialComm	Can not open Port (does not exist, is open)
-1001	ACT	InstallData	Can not create "...\errors\install.errors.txt"
-1002	ACT	InstallData	Can not open "SSA.dat"
-1101	ACT	InstallData	Unknown command in "SSA.dat"
-1201	ACT	SerialComm	Port not software supported
-1202	ACT	SerialComm	Baud not software supported
-1203	ACT	SerialComm	Parity not software supported
-1204	ACT	SerialComm	Stop Bits not software supported
-1205	ACT	SerialComm	Word Length not software supported

Appendix 'C'

Teaching Guide
MESSAGE TO THE TEACHERS

This Technology Learning Packet is designed to help teachers get started with this type of design problem. The twenty day teaching plan is a reference guide and may be altered to meet the teachers needs. Student work sheets are suggested and may be changed as needed.

The Truss bridge design activity is planned so that junior high school students can readily adapt to the activity requirements. Wood coffee stirrers are easily cut with scissors and assembled with glue guns.

The design problem may be altered for higher level students by substituting 1/4" balsa wood or other materials facilitating the need for more careful joint construction and use of other glues. Additionally, a tower design problem may be substituted for the bridge design problem following the same format.

CAUTION ! Teachers must use the same care regarding the use of safety glasses with this activity as with any other laboratory activity. **SAFETY GLASSES MUST BE WORN AT ALL TIMES !**

The use of the glue gun must be carefully supervised like other shop tools. **GLUE GUN SAFETY MUST BE PRE-TAUGHT** before students are permitted to use the glue gun.

Numerous design contests have been conducted across the country and around the world. More information on design competitions and activities may be available by contacting your state education department or Olympics of the Mind.

Structural design activities have mainly revolved around the bridge theme for the past few years. Hopefully now, because of the Structural Stress Analyzer, teachers and students will be able to focus attention on numberous types of load-bearing structures that may include towers, girders, trusses, multi-stroy buildings, box beams, joists, booms. derricks, shipping containers and footings. This activity has been used with students with a high degree of success. Students and teachers can enjoy the activity and we sincerely hope you do also.

OVERVIEW OF LEARNING CONCEPTS

Students need to know and experience a system for solving problems. This activity guides students through a process where observation, research and experimentation lead them to problem solving approaches and eventually to solutions.

The teaching plan places much responsibility for learning on the student. The use of co-operative learning groups called **engineering teams** is prevalent. The teacher is more an adviser than a source of information. Try to avoid giving answers. Sometimes a carefully posed question is the best answer to give a student or an engineering team question.

Your students will be naturally motivated by the challenge of making "the bridge" that supports the greatest force and by the use of the **Structural Stress Analyzer.** Your challenge will be to keep them focused on the larger purposes for learning:

* It is important for students to learn that a systematic method for problem solving leads to greater success.

* It is important for students to learn that always looking for the concept to **THE FOREST** (total concept) helps in knowing correct direction and conclusions.

* It is important for students to learn that the highest level of learning occurs when students can transfer learned concepts to new problem solving situations.

STUDENTS PERFORMANCE OBJECTIVES

Students will learn linear measurement to the nearest 1/16", weight to the nearest gram and force in pounds.

Students will learn direction of force and their relationship to bridge design.

Students will learn the importance of correct structural member connections and their effect on overall bridge strength.

Students will learn the safe and proper use of tools and that **SAFETY GLASSES ARE WORN AT ALL TIMES.**

Students will learn the engineering team process and it's potential for problem solving.

Students will learn the application of oral, written, and graphic communications skills.

Students will learn and appreciate the importance of manual dexterity.

Students will learn of career opportunities in the field of engineering and technology.

Students will learn critical thinking as well as transfer of learning to new situations.

LIST OF SUPPLIES AND MATERIALS

- Class set of safety glasses
- Legal size paper 8-1/2" X 14"
- Wax paper
- Masking tape
- Glue gun(s)
- Hot melt glue sticks
- T-square(s)
- Triangles(s)
- Drawing board(s)
- Triple beam balance scale
- Ruler(s)
- Wooden coffee stirrers- available through Canal Paper Co. 3631 State St. Schenectady, NY 12304
- Scissors
- Cardboard
- Pencil(s)

A 20 DAY TEACHING PLAN
DAY- BY- DAY

DAY 1

Divide the class into engineering teams of three students per team. Give each engineering team a piece of wood (no knots) pre-cut to 1/4" X 3/4" X 12" and five minutes to list its physical characteristics.

As a teacher directed activity, make a composite class list on the chalkboard. Have the class divide the characteristics into two groups: Group one (load bearing characteristics), Group two (non-loading bearing characteristics). The primary observation that students should make is that the wood member is able to support a greater load on edge.

Place a wood member in the Structural Stress Analyzer flat on its 3/4" surface and test its ability to support a load. Because the wood member is flat the Structural Stress Analyzer reading should be low.

Place a wood member in the Structural Stress Analyzer on its 1/4" edge and test its ability to support a load. You will need to construct two slotted support blocks and one slotted force block to prevent the wood member from twisting under force.

Small block (2 required) -3/4" X 1-1/8" X 4-3/4". Groove (1/4" wide) centered and cut 3/8" deep.
Large block (1 required)- 3/4" X 3-1/2" X 6". Groove (1/4" wide) centered and cut 3/4" deep.

Discuss with the class some examples of this structural application. e.g. floor joist, I-beams, load beams, etc.

DAY 2

Present the class with the following problem:

Connect all the dots with four straight lines without lifting your pencil from the paper.

PROBLEM	**SOLUTION**
* * *	* * *
* * *	* * *
* * *	* * *

Allow students three minutes to individually solve the problem.

Discuss with the class the limitations of problem solving where a problem is approached individually and without a systematic method for problem solving.

Present the following problem solving method.

1. Define the problem
2. Identify any limitations and constraints.
3. Survey sources of information (technical books, reference materials, and people).
4. Identify alternative solutions to the problem.
5. Select the best solution.
6. Apply the solution to the problem.
7. Evaluate the results.
8. Adjust the solution as needed and apply.

Divide the class into engineering teams of approximately five students per team. Give all teams 10 minutes to identify three factors/procedures/techniques that they might have used through the use of the problem solving method. Give students 5 minutes to solve the problem, using the identified factors/problems/ techniques. Discuss with the class their results.

DAY 3
Introduce students to the four categories of bridge styles. The following is a suggested teaching strategy for teaching Pier and Span, Truss, Arch and Suspension bridge types.

Divide the class into four engineering teams. Assign each team the responsibility of researching one bridge type and prepare an oral report. The report will be presented to the class on day four, and shall include the following outline:

1. Bridge type
2. Advantages
3. Disadvantages
4. Applications
5. Local/regional bridges of this type and why they were used at that location.

OPTIONAL: The team may choose to prepare a simple model, which illustrates the characteristics and advantages of their bridge type.

DAY 4
If you choose to present the material in day three as a teacher directed activity, go to DAY 5. If engineering teams were used in Day 3, divide today's period into equal blocks of time and let each team know their respective presentation time. You may want to prepare a separate handout on which students may take notes about the four bridge types. The oral report should address the items on the presentation outline. Time should be allotted for questions by the class and teacher at the end of each oral report.

DAY 5
Divide the class into truss bridge design teams of two students each. Each engineering team will begin their project today and will remain as a team for the remainder of this design problem.

Go to the library or resource area of the lab and have each engineering team study truss bridge designs. Refer to **References and Resources** in this booklet. Each team should note important design features of truss bridges that they may want to incorporate into their own design.

DAY 6
Each engineering team is to apply previously learned supportive information and research by designing their own truss bridge. Give each engineering team a copy of the Truss Bridge Design Activity sheet.

Have each engineering team prepare two sketches of a truss bridge design. Meet with each team and provide advice leading them to a final sketch. Approve the final sketch.

DAY 7
Use this day to teach linear measurement. Each engineering team will need to be able to measure to the nearest 1/16".

You may want to meet with your school's remedial and/or resource room teacher prior to this day so that students with special needs receive pre-instructions on linear measurement.

The following is a suggested teaching strategy for teaching measurement.

Divide the class into teams and give each team a length of wood ¾" X 1" X 2-3 feet (make them different lengths). Have each team construct a measuring tool that is ruled from 0-1 in half, quarter, eighth and sixteenth increments. These increments will not correspond to a standard scale. For example, a 1/8" increment is not 1/8th. inch: it is 1/8th of the distance from 0-1. Measure various objects in the lab with the new measuring tool. Enable students to transfer this learned measurement concept by trying the following two activities:

1. A worksheet with line segments progressing from inch increments through 1/16" increments.

2. Use tape rules and have students measure various objects in the lab.

DAY 8
Pre-teach model truss bridge construction techniques. Students need to know:

1. A glue gun is **HOT!** Hand out glue gun safety sheets provided with this publication and review with the class.

2. Always glue over wax paper.

3. Truss bridge members must be fitted over the bottom cord of the bridge and under the top cord of the bridge. Students must know this essential concept prior to orthographic drawing in DAY 9.

DAY 9

Instruct the students how to draw a single view orthographic drawing. Students should know how to properly use and care for a T-square, triangle and drawing board. They should know how to approximate the drawing in the center of their paper. The drawing must be true size and shape and have sufficient line weight so the lines can be seen through wax paper.

DAY 10-11

Engineering teams prepare the orthographic drawing. Each team will need a piece of legal size paper to be able to fit their bridge drawing on the paper at full scale.

DAY 12-16

Before your students can construct their bridges, a second copy of the bridge has to be made. Both copies will be used in the construction of the bridge, one by each member. Tape the drawings to individual pieces of cardboard and then cover with wax paper. Since the bridge will be constructed over several days, the cardboard will support the structure until stable enough to remove for overlapping layers. Your students may now construct their bridges' structural sides. When structural sides are completed, the team will attach the side to the road bed and top cord design.

DAY 17

Weigh and record the weight of the bridge. Test the bridge using the Structural Stress Analyzer. Record the results of the test.

After the Structural Stress Analyzer has completed its compression cycle, have the engineering team analyze the structure for design weakness. Help students discover specific design modifications that can be made.

Remove bridge from the Structural Stress Analyzer and have the engineering team prepare modifications.

DAY 18

Finalize design changes.

DAY 19

Weigh and record the weight of the bridge. Note any change in the weight as a + or - amount.

Test the modified bridge in the Structural Stress Analyzer. Compare the performance of the modified bridge design to the original bridge design.

DAY 20
Give the class the Technology test on load bearing structures.

REFERENCES AND RESOURCES

The following texts and reference material are essential to this activity and should be added to a school technology library.

Billings, Henry. Bridges. New York: The Viking Press 1958

Corbett, Scott. Bridges. New York: Four Winds Press 1978

Descriptive Geometry text (truss bridges)

Engineering/Technical Drafting Book (trusses, girders, and long span framing)

Gamet, Charles. Highways Across Waterways-Ferries, Bridges and Tunnels. New York: Abeland-Schuman 1978

High School physics book (vectors, energy and stresses)

Kingston, Jeremy. How Bridges Are Made. New York: Facts on File, 1985

McGregor, Anne and Scott. Bridges-A Project Book. New York: Lothrop Lee & Shepard Books, 1980

Olympics of the Mind Activities-PO Box 27 Glasboro, NJ 02028

Otto, Frei. Tensile Structures: design, structure, and calculations of building of cables, nets and membranes. Mass: MIT Press 1969

Salvadori, Mario. Building:The Fight Against Gravity. New York Atheneum 1979

Salvadori, Mario. and Tempel, Michael. Architecture and Engineering. New York Academy of Science.

Super Structures.New York; The Viking Press, 1980

ENGINEERING VOCABULARY

ANALYZE: To look or examine something very closely and carefully.

BEARING Part of a machine on or in which a shaft turns or slides. A bearing serves to support the moving part and reduces friction. Also means, that which supports or holds up weight.

CONTROLLED TEST: The results of an examination by using a set of scientific or engineering standards of comparison to verify an experiment.

COMPUTER PROGRAM: Instructions entered into the computer memory that makes the computer do what you want.

CORD: When applied to bridge, a cord is a straight connecting member.

CYCLE: Period of time or complete process or action that repeats itself in the same order. *From start to finish and ready to start again.*

DEFLECTION: The amount of bending caused by a force.

DIGITAL ELECTRONICS: Using logic circuits and switches to represent information/data in the form of two step voltage levels- zero and one.

ENGINEERING the application of scientific knowledge to a practical purpose.

ENGINEERING TEAM: A group of two or more engineers working on the same problem.

ELECTRONICS: Branch of physics that deals with the production, activity, and efforts of electrons in motion through vacuum, gases and semiconductors.

ELONGATION: The amount of stretching caused by a force.

FORCE: Cause that produces, changes, or stops the motion of a body.

FRICTION: A rubbing of one object against another.

INCREMENT: Amount or portion of a given volume, distance, force, etc.

MAXIMUM: The largest of highest amount permitted. *The maximum score on this test will be 100.*

MICROCOMPUTER COMPATIBLE: One CPU in Machine "A" being able to talk to another CPU in machine “B” because both CPU's speak the same computer language and are connected by cables.

MICROPROCESSOR CONTROLLED: A machine that is controlled by a central processing unit (CPU) in a computer.

ORTHOGRAPHIC DRAWING: A two-dimensional drawing drawn true size and shape. The drawing may be scaled because of its size to fit on a piece of paper.

PARALLEL: Two lines that are always the same distance from each other. *The top of the bridge is parallel to the bottom of the bridge.*

PEAK: The greatest of largest amount, as in peak force.

PRESSURE: The continued action of a force.

PROBLEM SOLVING METHOD: A systematic process applied to reaching a solution to a problem.

RESEARCH: The careful study of a topic, subject or field.

ROAD BED: The structural part of a bridge against which force is applied.

RS 232: A cable plug often used to connect computer equipment together.

SCREW: An incline plane wrapped around a center shaft.

STRESS: A pressure of force that tends to change the shape of something.

STRUCTURAL: Something that is constructed to support or carry weight such as a bridge or building.

SYNTHESIZE: to combine or apply test data to a new design.

TECHNOLOGY: The application of use of scientific knowledge to control physical objects and force.

TEFLON: A product, invented by a chemist, that lowers friction.

TEST DATA: The information or records from a controlled test.

ULTIMATE: The greatest amount as in ultimate yield. *The ultimate score on this test will be 100 plus 20 bonus points.*

UNPARELLEL: Opposite of parallel. *The top of the bridge is not parallel to the bottom of the bridge.*

YIELD the point during stress when failure or breaking occurs.

.001 in: An engineer's notation for one thousandth of an inch. E.g. .125 in. is one hundred twenty-five thousandths on an inch. Also .125in. =1/8".

Appendix 'D'

Name_____ Date_____
Teacher_____ Period_____

TRUSS BRIDGE DESIGN ACTIVITY

PROBLEM:

Each Engineering Team is to design and construct a bridge which may be chosen to replace an existing bridge in you county. As engineering teams, you have the challenge of designing and constructing a model bridge. A record of your results is to be submitted to state officials for final selection of the best bridges. Following the selection, a contract will be awarded.

The selection will be based on a design which adheres most closely to the specifications listed in this document. Limitations and constraints have been place on the structure to ensure uniform characteristics that the state will accept.

SPECIFICATIONS:

1. The design must be of a truss bridge form.
2. The bridge must have external measurements of 4" in width, 5" in height, and 12" in length.
3. The design must be symmetrical in all dimensions.
4. The roadway floor beams must have sufficient strength to support and transmit downwards forces.
5. The design of the top lateral bracing must leave 2-1/2" wife opening centered in the length of the bridge.
6. No structural members can extend past the bottom cord of the bridge.
7. An orthographic view, drawn at full scale, of the side structural members and a sketch of the floor beams and top lateral bracing must accompany your design.
8. The bridge will be constructed of a maximum 175 wooden beams which will be supplied to each engineering team. The beams measure approximately 1/16" X 3/16"X 5" long. No other beam material may be used without penalties. The beams may be cut in any manor.
9. The bridge beams will be adhered only by hot glue melt.
10. The Structure under load may not deflect more than .500 of an inch.
11. Additional beams can be purchased in groups of ten. Grade? to be set by the instructor.

JUDGING OF STRUCTURES:

1. The structure will be pre-weighed and results will be recorded.
2. The structure will be placed in the Structural Stress Analyzer and a test of the structure will occur and tests results recorded in pounds of force applied and deflection in thousandths of an inch.
3. The structural integrity of the bridge will be determined by dividing the weight of the structure (in grams) by the force (converted to grams) in held maximum yield.
4. Deflection of .50 inch will disqualify a bridge.

TECHNLOLGY TEST – LOAD BEARING STRUCTURES

ANSWER KEY

True & False		Multiple Choice		Matching	
1. T	6. F	1. E	6. A	1. D	5. H
2. T	7. F	2. B	7. E	2. C	6. A
3. T	8. T	3. D	8. C	3. F	7. B
4. F	9. T	4. C	9. D	4. G	8. E
5. F	10. T	5. E			

1. To study or examine something very closely and carefully.

2. To combine or apply test data into a new design.

3. An engineering team uses combined brain power and also may divide the work among engineers. This team approach increases efficiency and shortens time needed to complete the job.

4. To test something under control using accepted scientific or engineering standards to verify an experiment.

5. Maximum means the largest. Ultimate means beyond to the greatest amount.

ESSAY:

Encourage students to be creative and futuristic. Tell them not to copy TV such as the “transporter” on Star Trek. An example might be a computerized auto pilot system for a car. This system would keep the car on the road controlling speed and direction. It would also take you to your destination via the best route. Satellite communications would provide timely traffic and weather conditions enabling continual adjustments in route plans.

Evaluate the essay subjectively looking for two elements: originality/creativity and plausibility of technological applications.

TECHNOLOGY TEST – LOAD BEARINGS STRUCTURES

Directions: Circle (T) for true or (F) for false.

1. T F Safety glasses must be worn at all times, when any work is being done, in a Technology laboratory.

2. T F A glue gun tip and liquid from an electric glue gun is very hot and should be treated with caution.

3. T F T-squares, triangles and drawing boards are used to prepare orthographic drawings.

4. T F The first step in the program solving method is “select the best solution”.

5. T F A truss bridge and a suspension bridge are the same.

6. T F Bearings are machined parts that set direction.

7. T F Friction is not harmful to machine operation.

8. T F Yield is the point during stress when failure of breaking occurs.

9. T F A cycle can be described as “From start to finish and ready to start again”.

10. T F The cause that produces, changes, or stops the motion of a body is force.

Directions: Place the proper letter to the correct answer on the line provided with each question.

1._____ A career title related to bridge design and construction is _____.

a. civil engineer
b. surveyor
c. iron worker
d. heavy equipment operator

2._____ To examine something very closely and carefully means to _____.

a. synthesize
b. analyze
c. rectify
d. justify
e. all of the above

3._____ A cause that produces, changes, or stops the motion of a body is _____.

a. pressure
b. deflection
c. elongation
d. none of the above

TECHNOLOGY TEST – LOAD BEARING STRUCTURES
CONTINUED

4._____ The best way to solve a problem is to _____.

a. attacked the problem
b. get help from an expert
c. use the problem solving method
d. use a computer
e. all of the above.

5._____ Which of the following is a bridge type?

a. piers and spans
b. truss
c. arch
d. suspension
e. all of the above

6._____ A common term for a group of people solving a technical problem is a (n)_____.

a. engineering team
b. problem solving group
c. partnership group
d. common research group
e. none of the above

7._____ A glue gun must be used safely by doing which of the following?

a. always wear safety glasses
b. never touch the hot glue tip or the melted glue
c. disconnect glue gun from power source when not in use
d. observe all precautions that you would with any electric appliance.
e. All of the above

8._____ The results of an examination by using a standard of comparison to verify an experiment is a (n) _____.

a. experiment
b. controlled test
c. pilot program
d. computer program

9._____ The Structural part of a bridge against which force is applied is ____.

a. concrete
b. asphalt
c. cord
d. road bed
e. connecting members

Match the following into a systematic method for problem solving.

Step #1___	a. apply the solution
Step #2___	b. evaluate the results
Step #3___	c. identify any limitations and constraints
Step #4___	d. define the problem
Step #5___	e. adjust the solution as needed and apply
Step #6___	f. survey sources of information
Step #7___	g. identify alternative solutions to the problem
Step #8___	h. select the best solution

Write a brief description for each of the following:

1. Define the word “analyze” in your own words.

_____
_____

2. Define the word “synthesize” in your own words.

_____
_____

3. Explain the advantage of an engineering team over individual effort.

_____
_____

4. Describe a controlled test.

_____
_____

5. Explain the difference between maximum and ultimate.

_____
_____

Essay:

Fifteen years ago, the personal computer was a new consumer product. Very few people knew anything about it at the time. Today the personal computer is a common place.

Think about the technology of today and project fifteen years ahead of time. Describe in your own words one new technological application that will be a common place fifteen years from now. Be specific as to how people’s lives will be affected by it.

_____
_____
_____
_____
_____
_____

GLUE GUN SAFETY

The operation of the glue gun is very basic, but because of the simplistic nature of the tool it is misused FREQUENTLY. The following instructions may prove helpful in introducing the tool to the students.

- **DO NOT** operate a glue gun without reading or having been taught the instructions of operation.
- Always use proper eye protection
- The use of cotton type gloves may prevent burns from the hot glue
- **DO NOT TOUCH** the glue gun or glue of the trigger are during use, because of the danger of burns
- Glue extruded from a glue gun looks cool but is **VERY HOT… DO NOT TOUCH IT!!!!**
- A hot glue gun tip can damage many surfaces, always stand the gun up on a non-flammable stand. Some glue guns come with a built-in stand that should be used.
- Always disconnect a glue gun from its power source when not in use.
- Glue guns sometimes drip glue, Place the gun on a surface such as masonite (which cleans up) to avoid glue mess.
- Use proper nozzle size for this type of gluing operation
- Observe all precautions as with any other electric appliances