COMPUTER AIDED LEARNING PACKAGE FOR TEACHING AND ASSESSING STRUCTURAL TIMBER DESIGN

BUAN ANSHARI

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COMPUTER AIDED LEARNING PACKAGE FOR TEACHING AND ASSESSING STRUCTURAL TIMBER DESIGN

by

BUAN ANSHARI

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Department of Civil Engineering
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ABSTRACT

This project aims to develop Computer Aided Learning and Assessment packages for a Higher Education Taught course. The aim of this project is to provide an alternative teaching tool for teaching Timber course, which can be used by students as self-teaching interactively.

The software which has been used to carry out this project, is ***Authorware*** 5.2 from Macromedia Production. Authorware is a powerful and flexible tool for developing all kinds of interactive multimedia but is mainly used for creating Computer-based training programs.

The outcomes of this project, are Computer Aided Learning (CAL) and Computer Aided Assessment (CAA) packages for teaching Timber. The CAL package contains an overview of timber, its properties and structure, the design of timber structure members especially Solid Beams, Glulam Beams, and Nail Joints based on British Standard 5268-2:1996. The CAA contains the assessment test of three topics as mentioned above, which consist of 16, 17, and 13 questions for Solid Beams, Glulam Beams, and Nail Joints respectively.

ACKNOWLEDGMENT

The name of Allah, The most Gracious, The most Merciful

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I would also like to express my gratefulness to my kindest friend, Kendell Johnson, for willing help during carrying out my project report.

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NOTATIONS

τ_a : applied shear parallel to grain stress

τ_g : grade shear parallel to grain stress

τ_{adm} : admissible shear parallel to grain stress

$\sigma_{m,a,par}$: applied bending stress parallel to grain

$\sigma_{m,g,par}$: grade bending stress parallel to grain

$\sigma_{m,adm,par}$: admissible bending stress parallel to grain

$\sigma_{c,a,par}$: applied compression stress parallel to grain

$\sigma_{c,g,par}$: grade compression stress parallel to grain

$\sigma_{c,adm,par}$: admissible compression stress parallel to grain

$\sigma_{c,a,perp}$: applied compression stress perpendicular to grain

$\sigma_{c,g,perp}$: grade compression stress parallel to grain

$\sigma_{c,adm,perp}$: admissible compression stress parallel to grain

δ_t : total deflection

δ_m : bending deflection

δ_v : shear deflection

A : total cross-sectional area

b : breadth of beam

h : depth(width) of beam; greater transverse dimension of a tension or compression member

L **:** span; length

E **:** modulus of elasticity

$\mathbf{E_{adm}}$: admissible value of modulus elasticity

$\mathbf{E_{mean}}$: mean value of modulus elasticity

$\mathbf{E_{min}}$: minimum value of modulus elasticity

G : shear modulus (modulus of rigidity)

$\mathbf{G_{adm}}$: admissible value of shear modulus

$\mathbf{G_{mean}}$: mean value of shear modulus

$\mathbf{G_{min}}$: minimum value of shear modulus

I : second moment of area

$\mathbf{K_{form}}$ **:** form factor

$\mathbf{K_m}$: constant related to shear deflection

$\mathbf{K_v}$: constant related to bending deflection

$\mathbf{K_2}$ **:** moisture factor

$\mathbf{K_3}$: load duration factor

$\mathbf{K_4}$: bearing stress factor

$\mathbf{K_5}$: shear strength factor at notched end of beams

$\mathbf{K_6}$: shape factor

$\mathbf{K_7}$: depth factor for bending

$\mathbf{K_8}$: load sharing factor

$\mathbf{K_{12}}$: axial compression factor

$\mathbf{K_{15}}$: glulam factor for bending member

$\mathbf{K_{18}}$: glulam factor for bearing

$\mathbf{K_{20}}$: glulam factor for stiffness

$\mathbf{K_{19}}$: glulam factor for shear member

K_{48} : moisture factor for nails joint

K_{49} : load duration factor for nail joints

K_{50} : no. of nails each line factor

W **:** total load or total force

Z : section modulus

V : shear force

V_{max} **:** shear force maximum

M : applied bending moment

M_{max} **:** maximum applied bending moment

INTRODUCTION

The uses of computer in education have increased greatly for the past 30 years. There are three main points can be categorised in term of computer role in education:

a. As a 'supercalculator' for performing complicated and time-consuming calculation.
b. As a teaching tool for computer programming.
c. As an aid to the interactive teaching/learning process.

We emphasise the last role, which is contribution of computers in the teaching and learning process. For this point, it can be divided into two modes: Computer Aided Learning (CAL) and Computer Aided Assessment (CAA).

Computer Aided Learning (CAL) is a method of delivering knowledge bases to learners/students. It is expected that the student can understand the knowledge easily. In addition, CAL requires students to give interactive participation in other to gain and augment fundamental knowledge about a particular subject area. Specifically, for engineering knowledge, by using CAL a student can demonstrate the actual behaviour of a structure dynamically, which cannot be obtained during a traditional lecture.

Computer Aided Assessment (CAA) is one of ways to evaluate or examine the knowledge bases, which have been taught to students. Students can conduct this assessment easily and repeatedly anytime. As interactive assessment, CAA will help students to improve their understanding of the particular knowledge by seeing given feedback related to questions.

Recently, there are many Computer Learning Packages, which have been developed to assist student to understand the content of courses thoroughly. In the Civil Engineering Department, Liverpool University, there are several packages, which have been developed and are already in use such as the CAL-Crete Packages, which contains Reinforced Concrete and Pre-stress Concrete design. In addition, the GSA packages for structural and dynamic analysis, Master Series for Concrete Structures design, and EZLP for Linear Programming. Therefore, it is essential to develop others learning package to help student increase their knowledge and understanding about the courses, which will be worthwhile after graduation.

In this project Computer Aided Learning Packages for teaching and assessing Timber is developed, which is one of the main courses in Civil Engineering. The aim of this project is to produce a learning package for Timber, which can be used by students as self-teaching or interactive teaching. This will make it easier for students to understand the Timber course deeply. However, it is not intended to be used a replacement of the regular lecture tutorial given by the lecturer. The software which will be used is Authorware 5.2 from Macromedia Production. Authorware is a software development tool for creating interactive multimedia applications. Authorware also provides a complete solution for creating and distributing robust software applications. One of the reliable functions of Authorware is the ability to track the progress of users and assess their score at the end of running the package.

The reason why I choose this topic, is the significance to my job as a teaching staff of a state University in my country, Indonesia. This is very attractive package and easy to run, which can be used to teach and assess some course in Civil Engineering knowledge bases. I am sure this project will be meaningful when I return home to Indonesia.

Due to time limitations, this project will contain the Computer Aided Learning (CAL) and Computer Aided Learning Assessment (CAA) of three parts of timber design in accordance with British Standard 5268-2:1996. It covers the design and analysis of a simply supported solid beam, glue laminated horizontal beams, and nail joints for a simple truss. In general, this project consists of one CAL and three CAA packages where each CAA comprises 16, 17, and 13 feedback questions for solid beams, glulam horizontal laminated beams and nailed joints in the simple truss respectively.

AUTHORWARE

A. Authorware Fundamentals

Hooper (1998) gives overview that Authorware is the state of the art development tool for designing interactive multimedia. We can use Authorware to develop any combination of presentations, tutorials, simulations, tests, or educational games, as well as programs that interact with the World Wide Web.

Authorware is a software development for creating interactive multimedia applications. It is mainly designed to facilitate the creation of computer-based training programs. However, its rich capabilities enable it to be used for many other computing applications. Authorware provides a unique combination of simplicity and power for producing and publishing interactive information.

The Authorware interface follows many of standard Microsoft Windows conventions and functionality. For instance The Windows Control Bar, Menu Bar, and Toolbar as shown below.

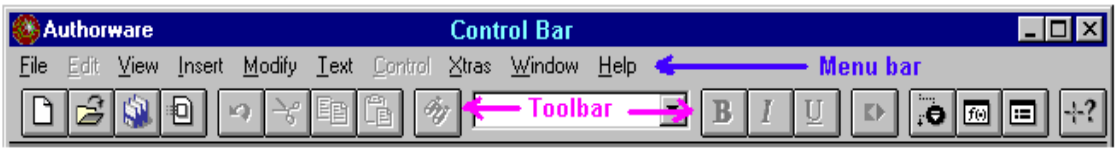

Figure 2.1. The Authorware Control Bar, Menu Bar and Toolbar

1. The Windows control bar

The Windows control bar features standard windows functionality. That is, it gives users the ability to control the author menus, minimise, maximise, and close the Authorware interface windows.

2. The menu bar

The menu bars offers a series of drop-down menus filled with the features that give the multimedia developer control and Authorware its power and flexibility. Many of these menus have standard functionality. The ones specific to Authorware will be covered in detail throughout this chapter.

3. The Toolbar

The toolbar features shortcut buttons make doing common tasks in Authorware easier and faster. The toolbars contain many familiars, and a few unfamiliar icons. The icons that are new include the Control Panel, the run icon, function, and variables.

The unique components of the Authorware interface look simple at first glance, but their powerful capabilities are soon discovered. There are two types of windows: ***Design Windows***, which contain ***flowlines,*** and ***presentation windows***, where images can be imported, objects can be drawn and text can be entered.

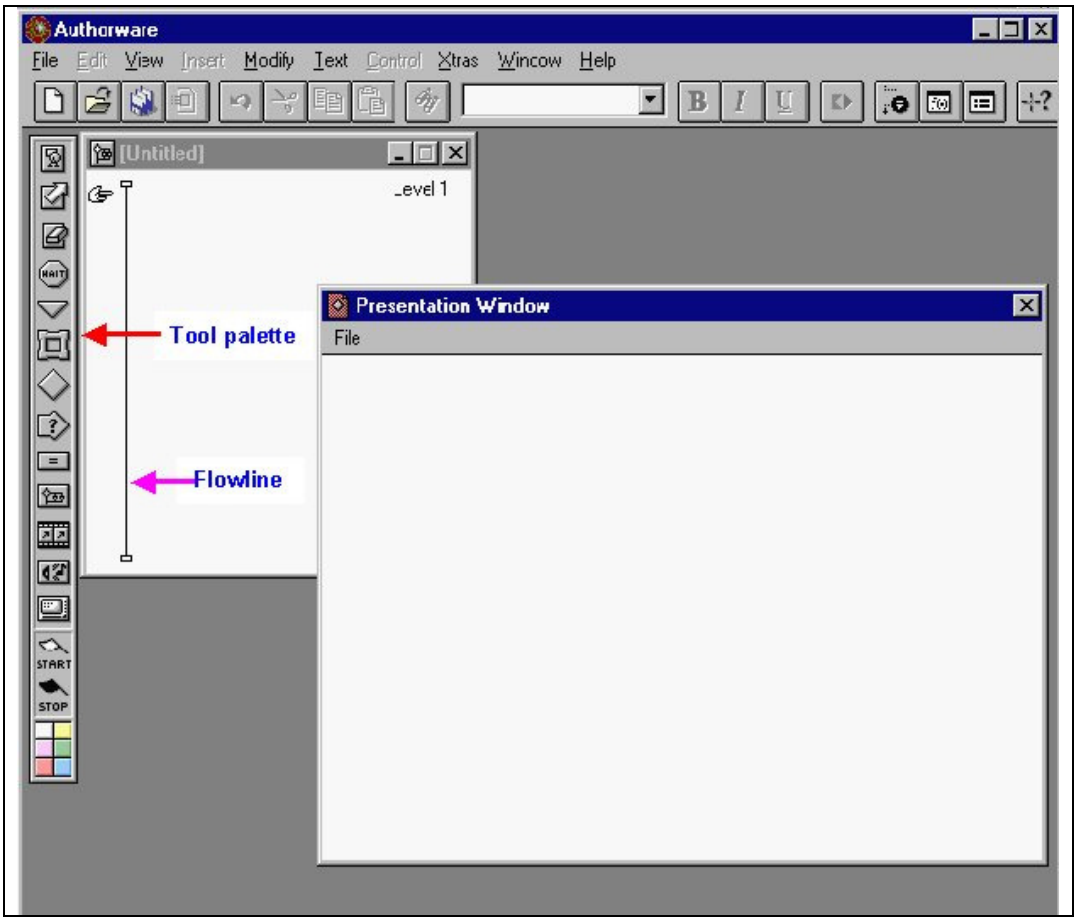

Figure 2.2. The Authorware Design Window together with Flowline, Presentation Window, and Tool Palette

4. The Design Window and the Flowline

The design window is an area where the programming is done and may be called the flowline. Technically, the flowline is within the Design window, but it is usually refer it them both as the flowline. The flowline in Authorware provides an area in which to arrange icons to create a **project** or **piece**. Icons are dragged from the tool palette, which appears to the left of the design window, to the flowline. The physical length of the flowline is limited by the

size of its design window. If the length of flowline exceeds the boundary of design window, some or all icons above can be grouped into map icons. The icons are executed sequentially beginning with the first icons and ending with the last.

5. The Tool Palette

The tool palette provides all the building blocks for creating projects. They control what the user sees and hears. They determine how they interact with a project and how they are managed while interacting with application. Each icon represents a different type of content. For instance, a display icon is used to show graphics and text, while a sound icon can play and control digital audio. Description of each icon can be seen in the Table 2.1. below:

Icon	Purpose
Display	Used to show graphics and text
Motion	Move graphics, text, or digital video along path defined and speed specified
Erase	Deletes an icon's content. A single erase icon can delete content from several previous icon
Wait	Holds the program flow until a mouse is clicked, a key pressed or specified unit of time elapses
Navigation	Specifies where to jump to in hypertext/hypermedia interaction. It is used with framework icon
Framework	Control project navigation, flow and organisation
Decision	Specifies branching based on program-defined specification or conditions
Interaction	Creates displays and control event interactions that respond to the user input. These may take the from of hot spots, hot objects, or buttons
Calculation	Provides a mechanism for Authorware scripting. Calculation icons can stand alone or integrated into other icon types
Map	A grouping of icons. Each maps can be opened to show its own flowline
Movie	Display and controls digital movie such as QuickTime, MPEG files, etc
Sound	Plays and controls audio such as WAV, PCM, or AIFF files
Video	Controls Laser Disc players
Start/Stop Flag	These flags can be placed along a flowline to mark temporary start And stop points
Colours	To make icon coloured to distinguish from the others

Table 2.1. The icons in the Authorware Tool Palette

6. The Presentation Windows

In the Presentation window, the project can be viewed, as the user will finally see it. It provides a visual work area where graphics and text object are assembled. The default size of presentation window is a 640x480-pixel window, which is most commonly supported one of both Macintosh and

Windows computer. However, the size of presentation window can also be changed as desired. In this window, users also create text and simple graphics and manipulate all the visual elements in the pieces. See Figure below to show this window.

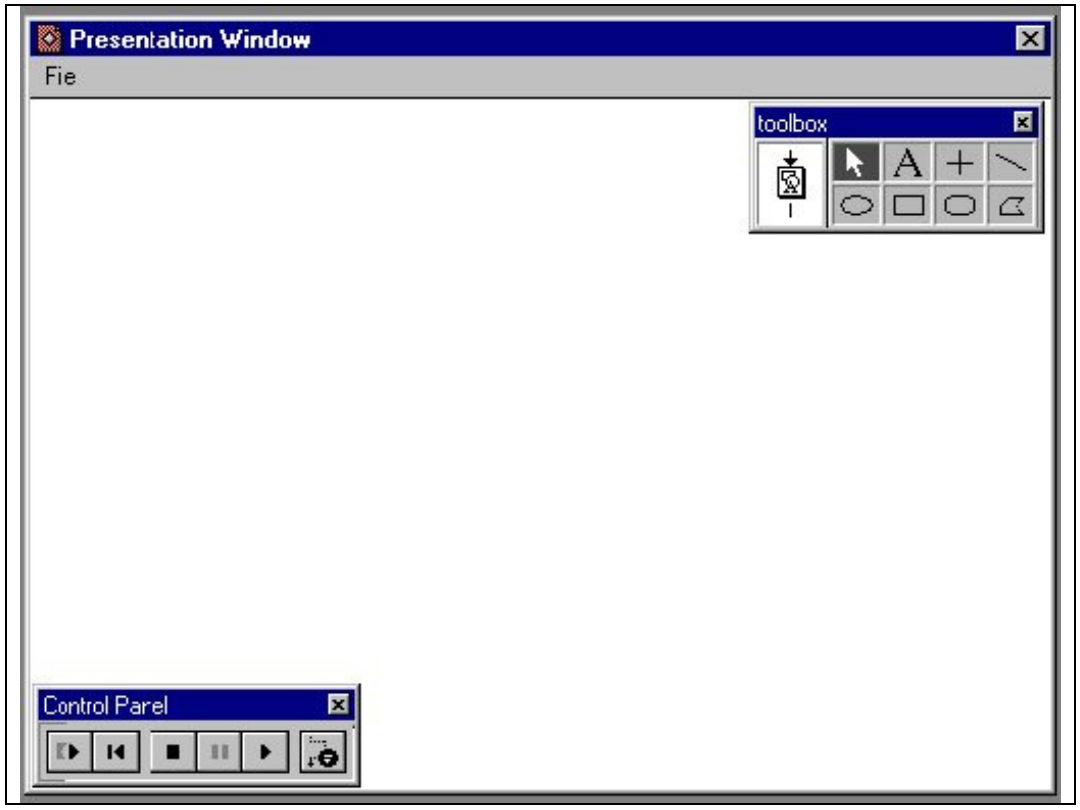

Figure 2.3. The Presentation window, the Toolbox and the Control Panel

7. The Control Panel

The control panel is used mainly as debugging tool. It can also be used to stop, pause, restart, or trace the piece. To activate the control panel, click on the on the control panel button on the tool bar. It will appear as shown on left bottom corner (Figure 2.3). The button represent from left to right hand side:

Restart, Reset, Stop, Pause, Play, Show-Hide Trace and the Expanded Control Panel respectively.

8. The Toolbox

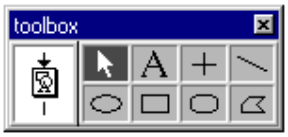

Figure 2.4. The Toolbox of presentation window

This toolbox is part of the presentation window, which have eight different tools and will allow for creation and manipulation of the text and graphics object. A single click over any icon in the toolbox will select that icon as the active one. By default the selection is highlighted as the active tool.

8.1. The pointer (selection) tool

The pointer tool acts as a toggle switch to change objects from selected to unselected. This toggling is accomplished by single clicking repeatedly on the same object or by clicking on different object. The pointer can also be used to move objects. By clicking the object, it will appear several selection handles like small boxes, outline the object, as in Bending Moment diagram below:

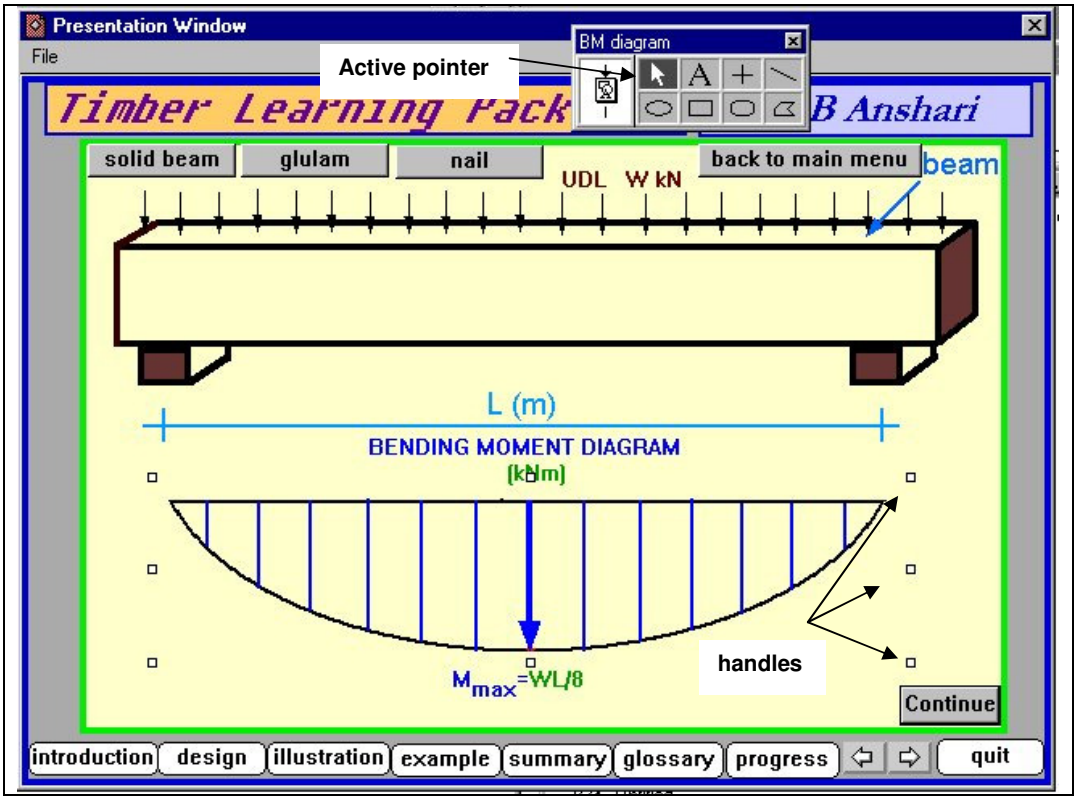

Figure 2.5. Pointer Toolbox Usage

8.2. The Text Tool

This tool is used to create text objects. By clicking anywhere, the text-width line pictured will be visible. We can enter, import, and paste the text inside the text width-line. We can also adjust margin as necessary. This tool has the main role of creating text within the learning package due to contain many texts. In creating texts we can choose font, size, style and alignment as desired. The colours of the text and other objects added to the presentation window have components that can be changed. To add or to change the colour of an object, the object is selected and a colour is chosen from the Colour Palette

(To show: strike Ctrl+K). Authorware provides three components for colouring objects. They are, the Pen, Foreground, and Background as shown in Figure 2.7.

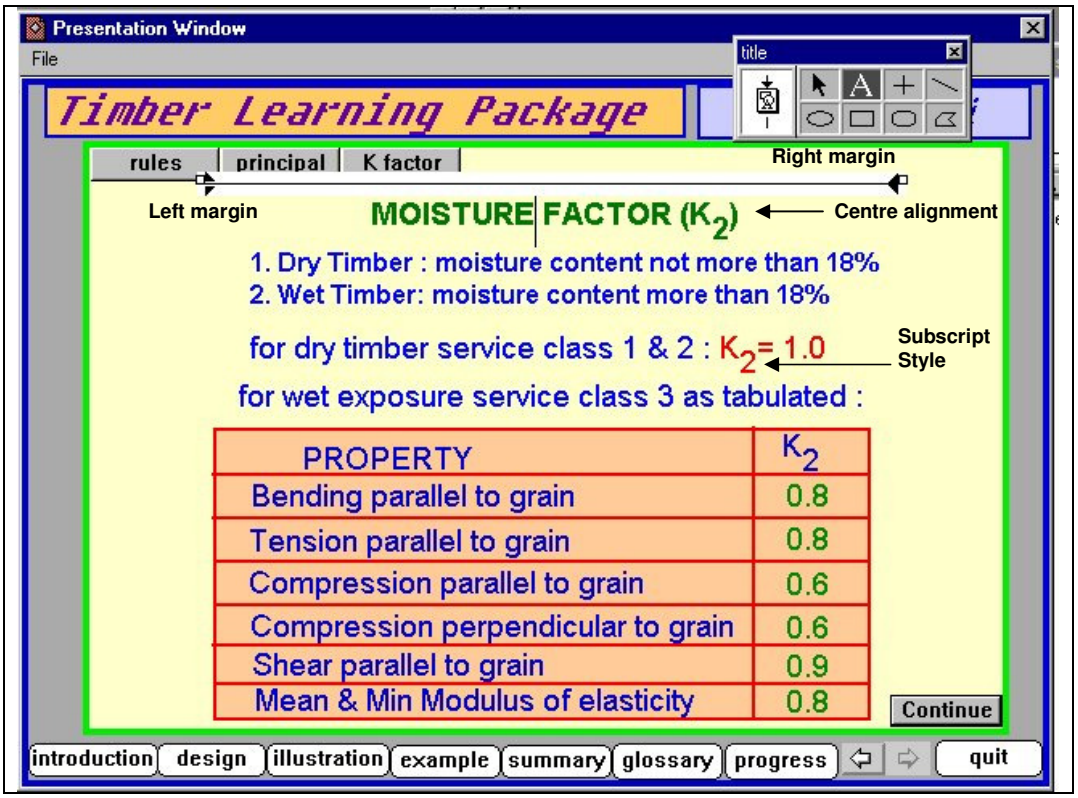

Figure 2.6. Presentation Window with various font, and style

Figure 2.7. The Colour Palette

8.3. The Drawing Tool

The other six tools in the toolbox are all used for creating graphics object. These tools also have additional palettes, such as Line and Fill, which can change object appearance.

1. Straight Line Tool
2. Diagonal Line Tool
3. Oval Tool
4. Rectangle Tool
5. Round Rectangle Tool
6. Polygon Tool

The use of these tools can produce graphics as shown in Figure 2.8. about shape factor in the solid timber.

The general ways to use the first five tools except the polygon tool are as follows:

- Choose the tool
- Place the cursor in the desired starting area of the object
- Hold on the left mouse button and drag to the desired stopping point.

Special for the polygon tool:

- Usually, the last click will be in the same location as the first. When this is the case the shape close with a line around its exterior.
- Double-clicking the mouse instead of single clicking will close the object without an exterior between the last two points.

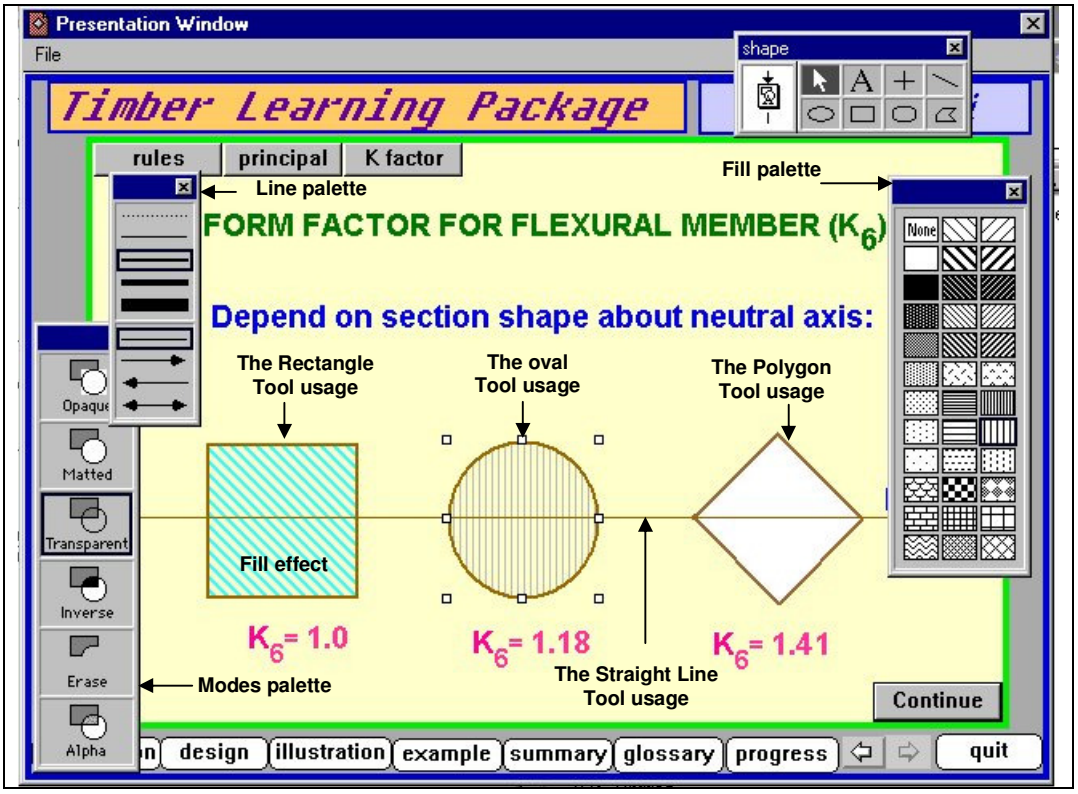

Figure 2.8. Illustration of the use of drawing tool

It is clear that that the function of these tools is very flexible and attractive to show graphics with size, background, colour, and shape as desired. The Modes Palette provides six options that affect the appearance of text and graphics on the screen. The Opaque option makes the image completely cover the background, whereas the Transparent option makes white areas of the image transparent, as in example above. The Line Palette enables the author to choose line thickness or arrow line.

These tools can also be use to draw the simple block in 2 dimension to show the beam section and the bearing area of beam as in the example below.

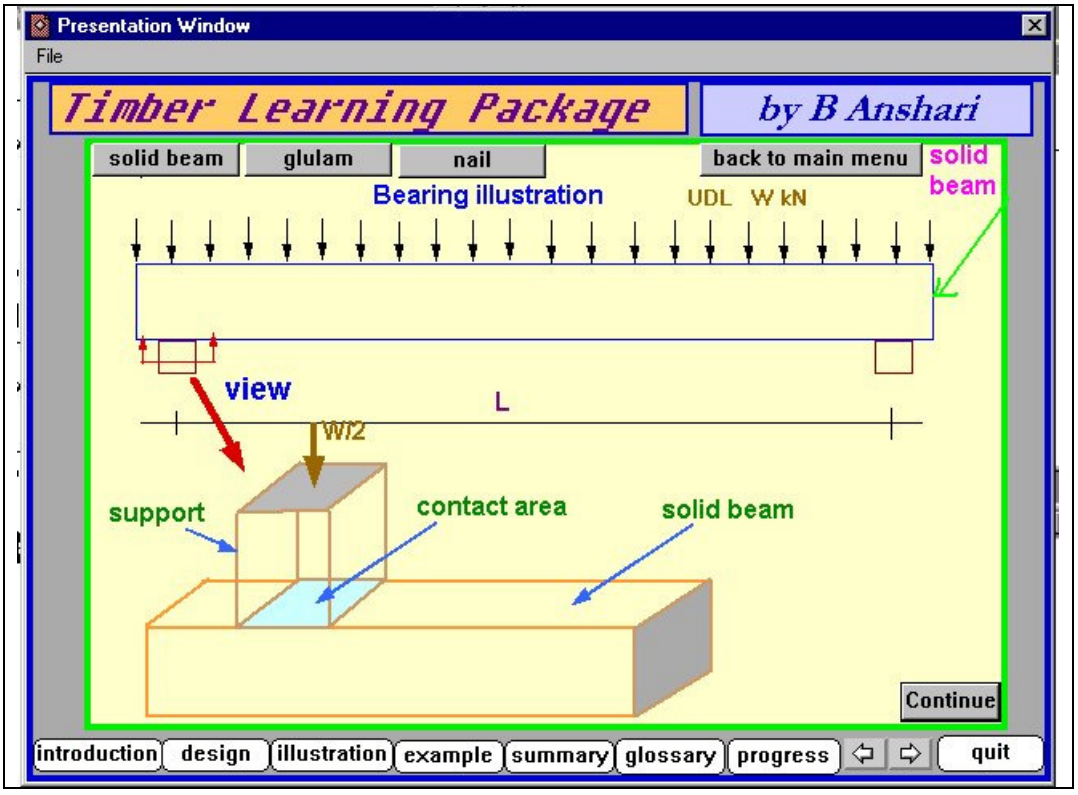

Figure 2.9. Illustration of the use of drawing tool

9. Transition Effect

Screen **transitions** are visual effects that vary the way objects are displayed and erased on the screen. Transitions are created simply by double clicking the text or image, then choosing any type of transition effect in dialog box. For example, it can be seen in Figure 2.10 *Strips on Left Built Up* transition are applied to the beam image. Figure 2.10 also shows the beam on the half way of a transition, whereas in the Figure 2.9 shows the complete image.

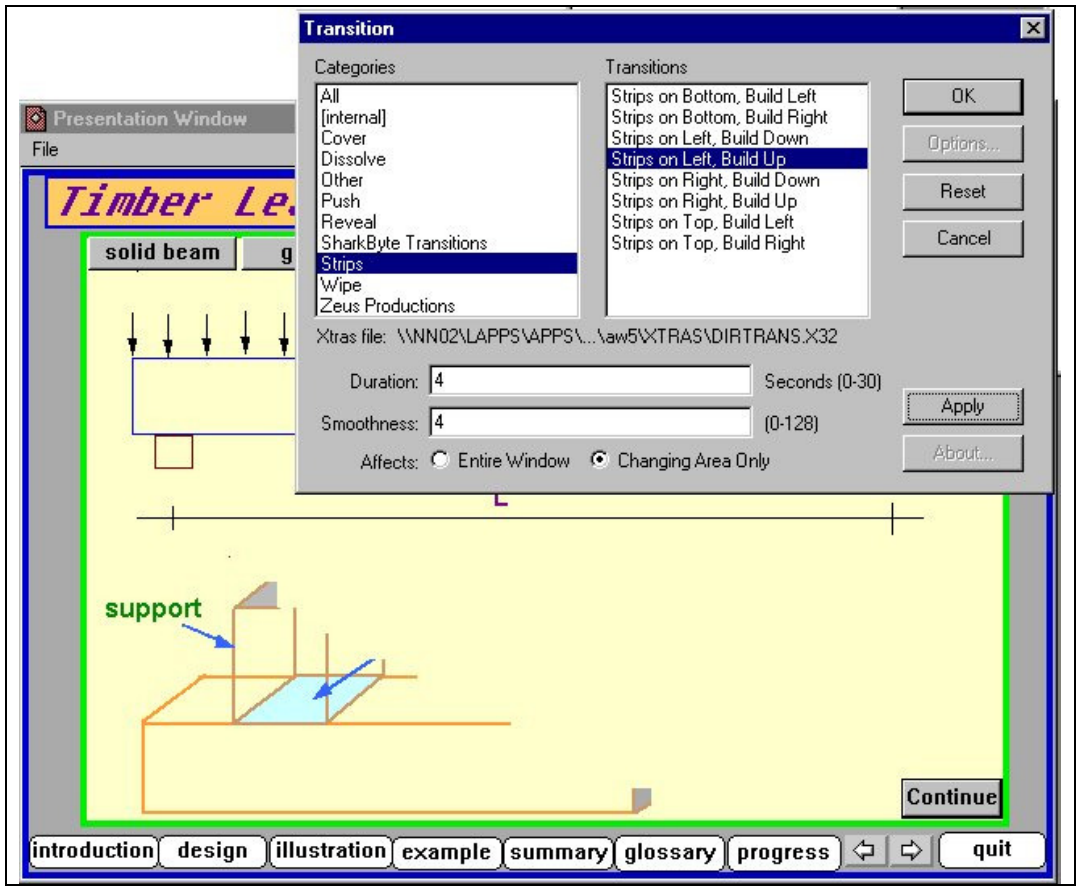

Figure 2.10. Transition effect

B. Managing Text and Graphics

1. Display Icon

Icons which are used in managing text and graphics of a project are the display, erase and wait icons. But, most of the graphics and text content are added to Authorware through the use of display icon. Each display icon can contain one or more graphics object. Object types include text, lines, simple and complex shape. Authorware provides features that allow easy manipulation of alignment and display characteristics of display icon object. Display icon can accommodate content from other application; that is, text and graphics can be imported from other applications when Authorware's limitations have been reach. An example, in this CAL, the notation content, which is originally in Rich Text Format (RTF) by using Microsoft Word. It can be imported into Presentation Window of Authorware in either the standard text or the scrolling text form. The scrolling text is chosen if the imported text is longer than a page in length as shown in Figure 2.11.

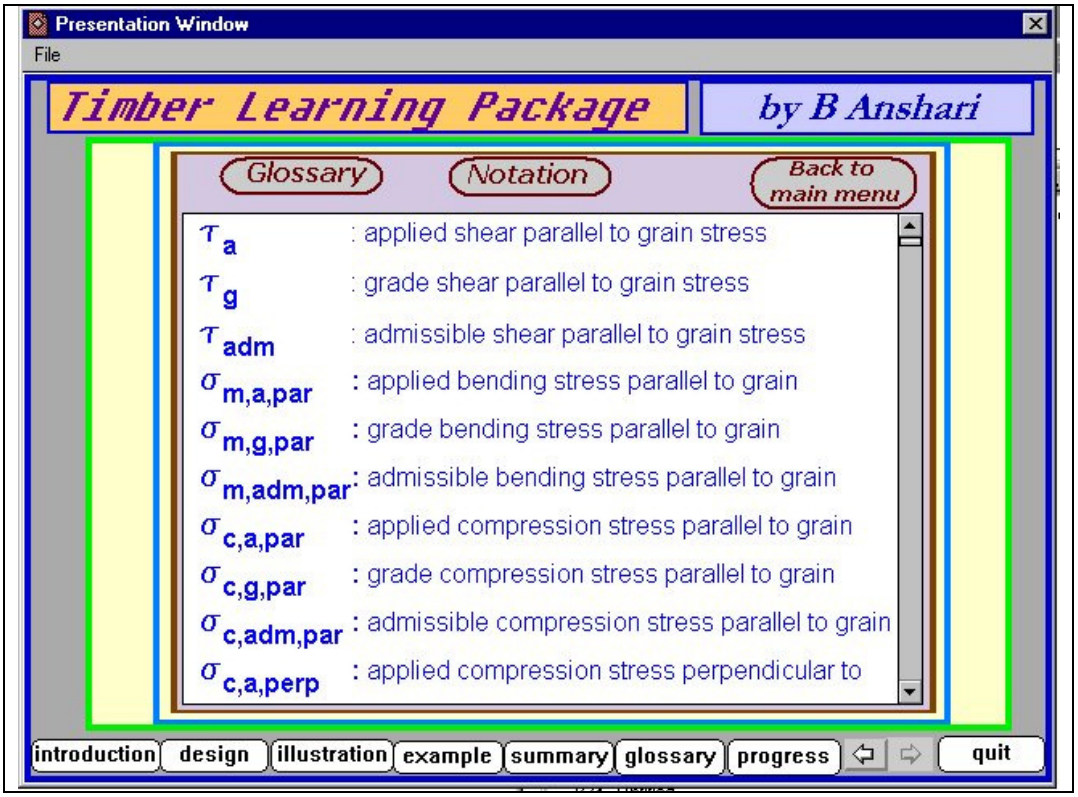

Figure 2.11. Imported Text

2. Erase Icon

Once presented, content can be removed using the erase icon. The erase icon is usually used to remove the content of display icons, but can also be used to remove all other icon types. There are times when we want to delay or erase an object. The erase icon works as follow:

- Insert an erase icon on the flowline, where you want one or more icons to be erased.
- Title the Erase icon with a name that hints at the name(s) of the icon(s) to be erased.

Double click the erase icon.

- You can select the transition to show special effects when displaying or erasing Display icons by clicking Icons button first.
- Select the Display icon that you want to erase by using the mouse to click an object from its display. All selected icons will appear in the Erase icon option box. If the wrong icon is selected, highlight and remove the icon from the list of icons to be erased.

An example in this CAL can be seen in the Figures 2.12 and 2.13

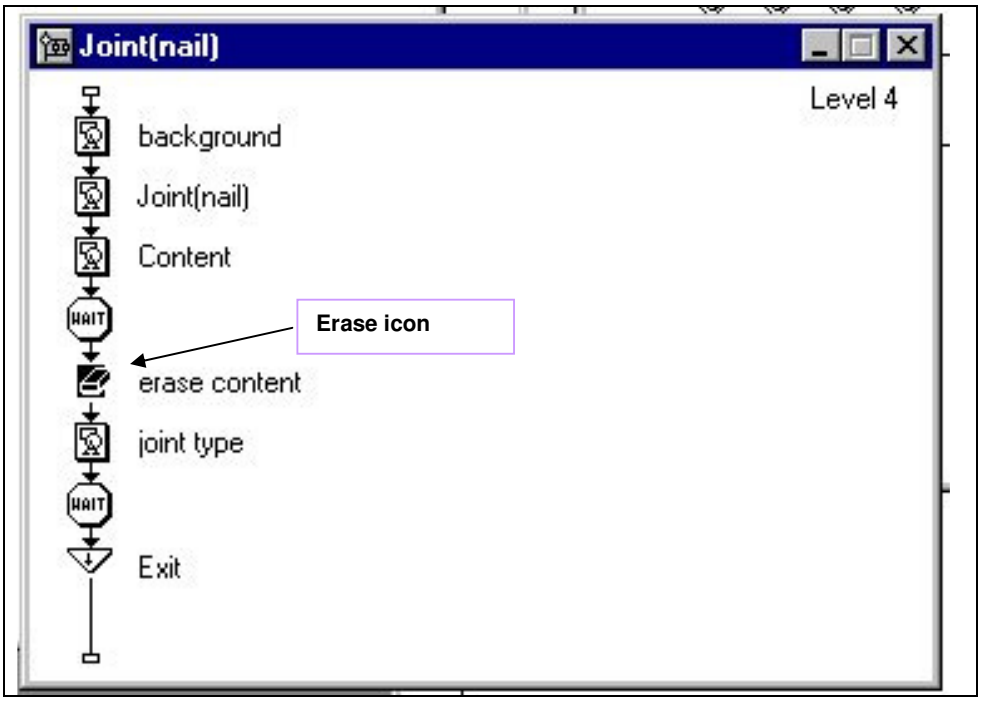

Figure 2.12. The flowline with erase icon

The erase icon above will erase the Content text in other that the joint type text is not overlapped in the next Display Icon. The procedure is initially to double click the Display (Content) Icon, then double click the erase icon result

in a dialog box will display and select the content icon to be erased. See the dialog box below.

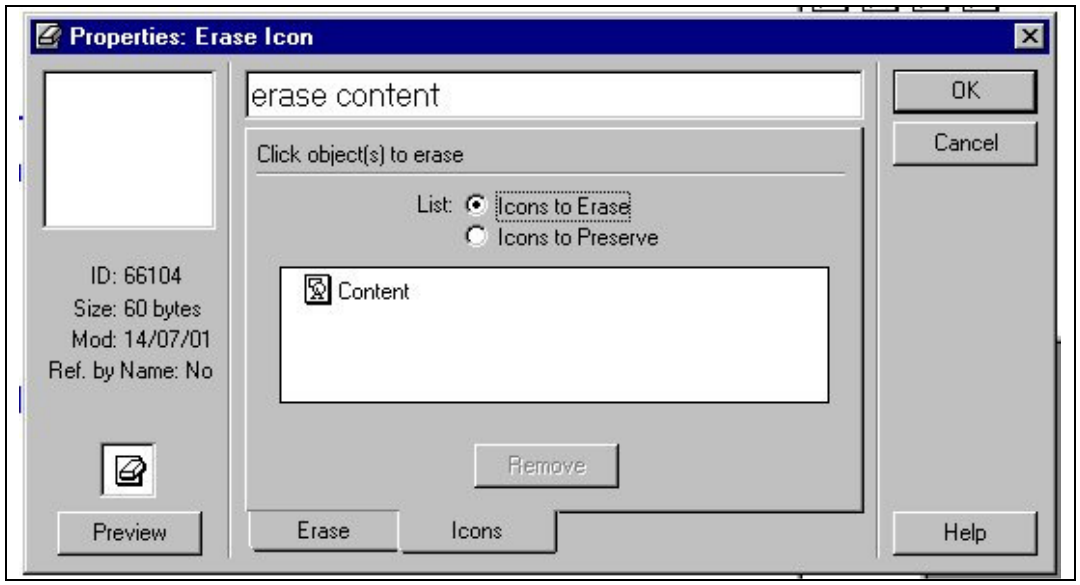

Figure 2.13. Erase Icon properties.

3. Wait Icon

The wait icon can give pauses into the project which may be either for a set time period or until the users acts by pressing a key or clicking the mouse button. The procedure of the wait icon works as follow:

- Place a Wait icon on the flowline at the point where you want the program pause
- Double click the icon. The wait icon properties will be displayed.

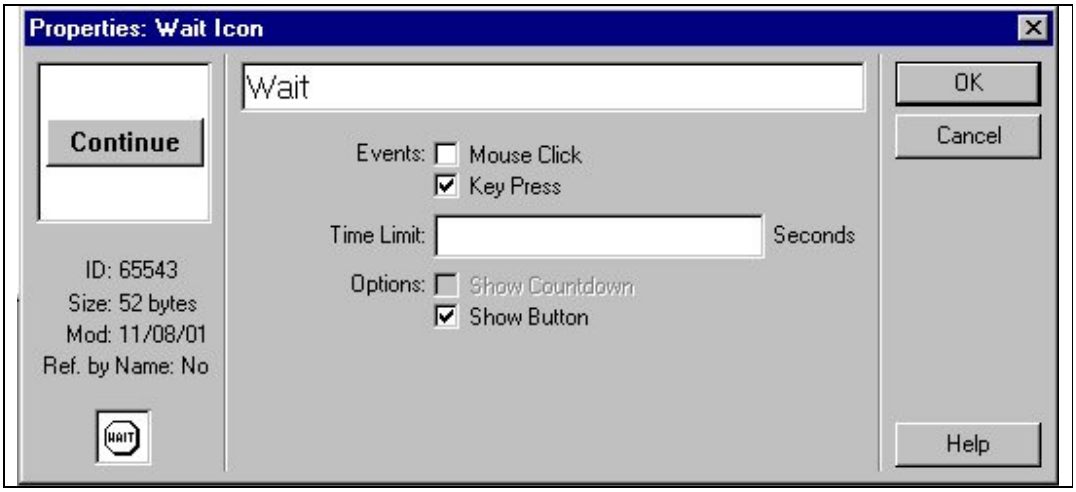

Figure 2.14. Dialog Box Wait Icon

- Use the mouse to select the options that are appropriate for you needs. The meanings of the options are generally clear from the title:
  - Mouse Click waits for the user to click the mouse once.
  - Key Press waits for the user to press any key on the keyboard
  - Time Limit waits for the given time to expire before proceeding.
  - Show Button places the default “Continue” button on screen.
  - Click OK when you are done.

An example of wait icon usage in this CAL can be seen in the flowline and presentation window below:

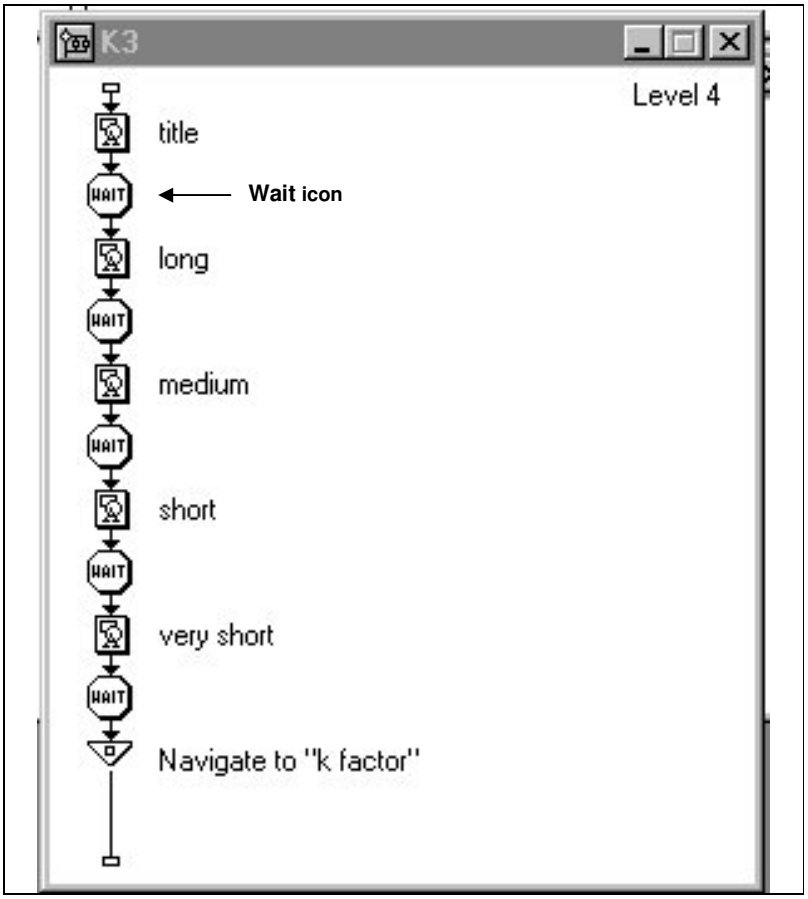

Figure 2.15. The Flowline which contain wait icons

The appointed wait icon causes the duration load factor for long term loading to appear after the user click the continue button (see Figure 2.16). So, the next point will be displayed after the user click the continue button. It is useful for the students to read content line by line rather than displaying whole content suddenly.

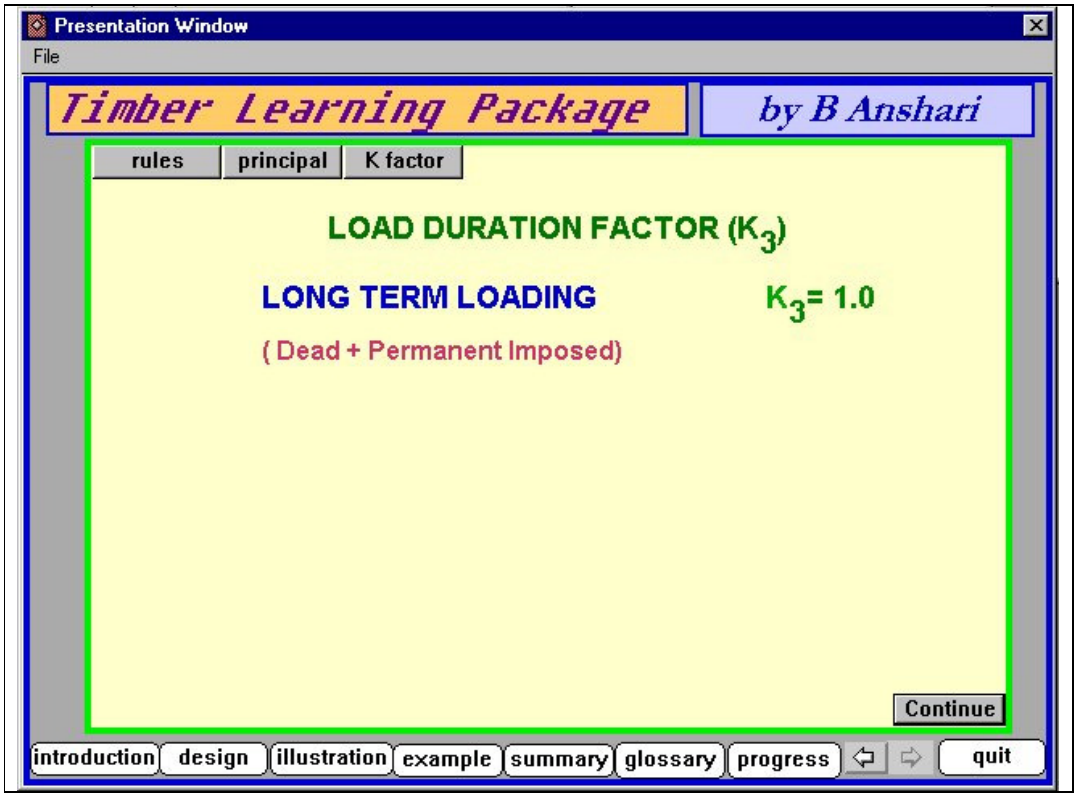

Figure 2.16. Illustration of wait icon

C. Motion/animation

Authorware provides a variety of animation options within the motion icons. In its simplest form, animation or movement is accomplished by dragging an object while author mode. Authorware tracks the movement and records it automatically. All objects within the selected icon being moved are animated, so if you want to move a single object, then place it in its own icon. The three main steps to use the motion icon:

- Add a display object icon with the item(s) to be moved.
- Add a motion icon
- Specify the motion parameters.

An example in this CAL can be seen in the illustration of single shear nail joint. Firstly, in the display icon I create the beam section as headside on the left of the presentation window and this of as pointside on the right of presentation window. Secondly, add the motion icon after the display icon as shown in Figure 2.17.

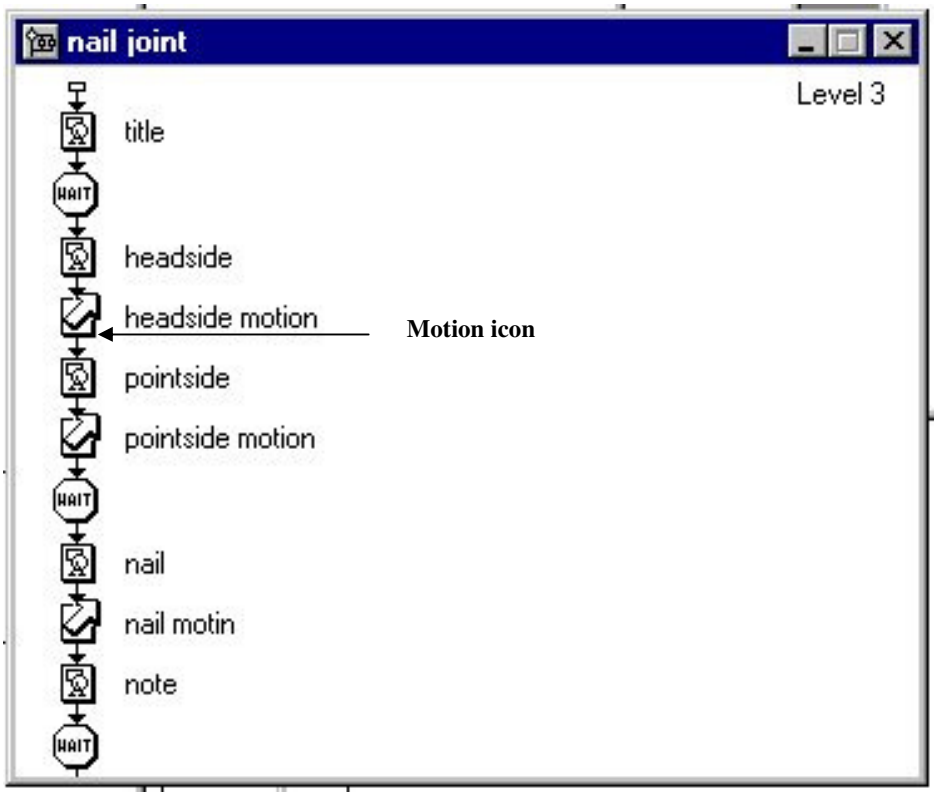

Figure 2.17. The Flowline contain motion icons

Thirdly, double click the motion icon to determine the type of movement which is desired. It will appear in the dialog box as shown. Finally, drag image from the starting point to the desired point, for instance, at the centre of Presentation Window.

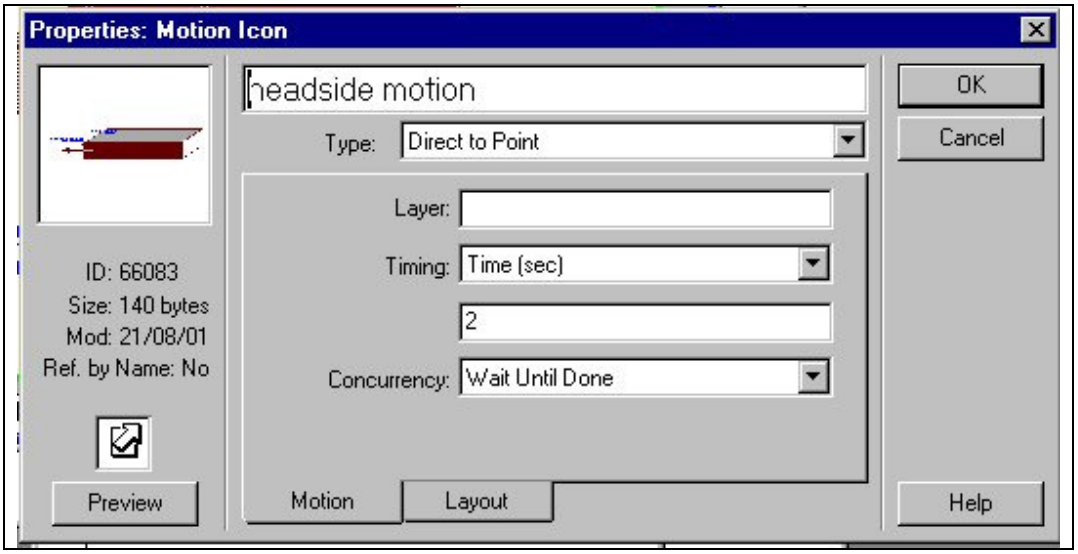

Figure 2.18. Dialog Box Motion Icon

1. Type

Choosing an option from this menu cause Authorware to move the selected object(s) along the straight line from its starting point to its end point in the specified amount of time.

2. Timing

This option means that the animation should take **2 seconds**

3. Concurrency

Wait Until Done is the first option (default), which means the animation, must finish before the next icon is run.

4. Preview

To replay and review the motion as defined by the current parameters.

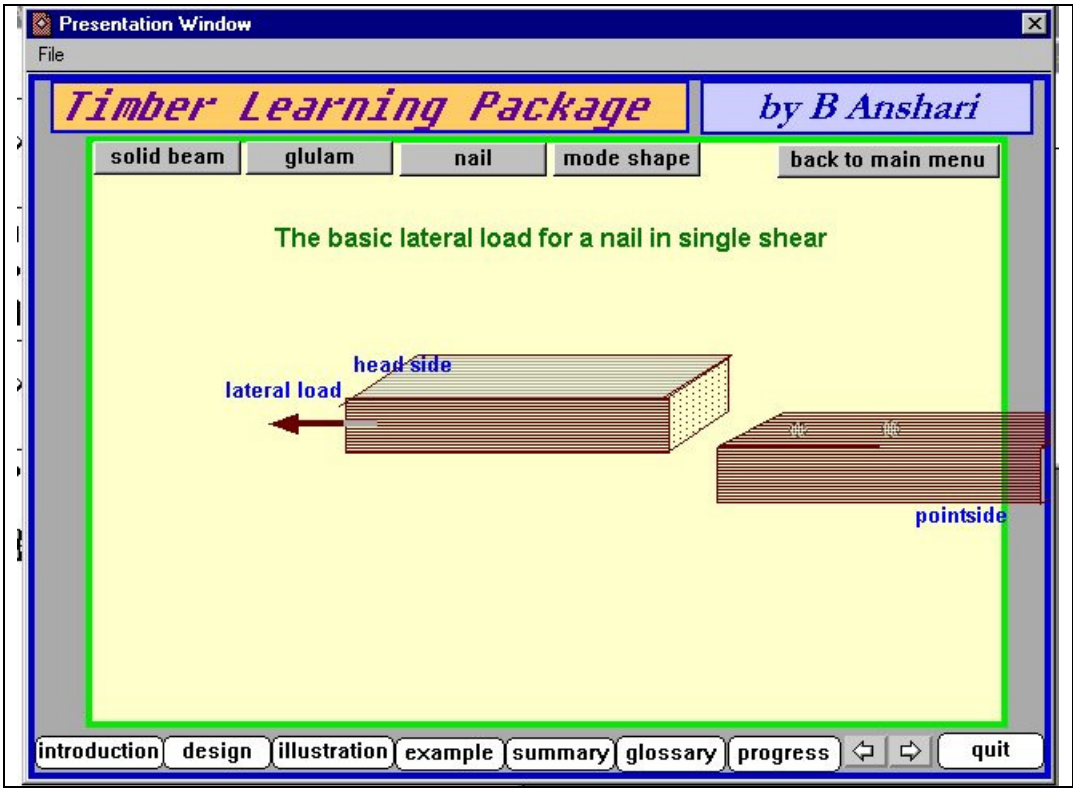

Figure 2.19. Image animation

The Figure above shows that the pointside image is moving to the centre to coincide with beneath of the headside image. Afterwards, two nails from the top of screen will go down to connect two pieces of timber. At the same time, additional information will appear with Dissolve transition type below the image. Finally, it will be shown as Figure 2.20.

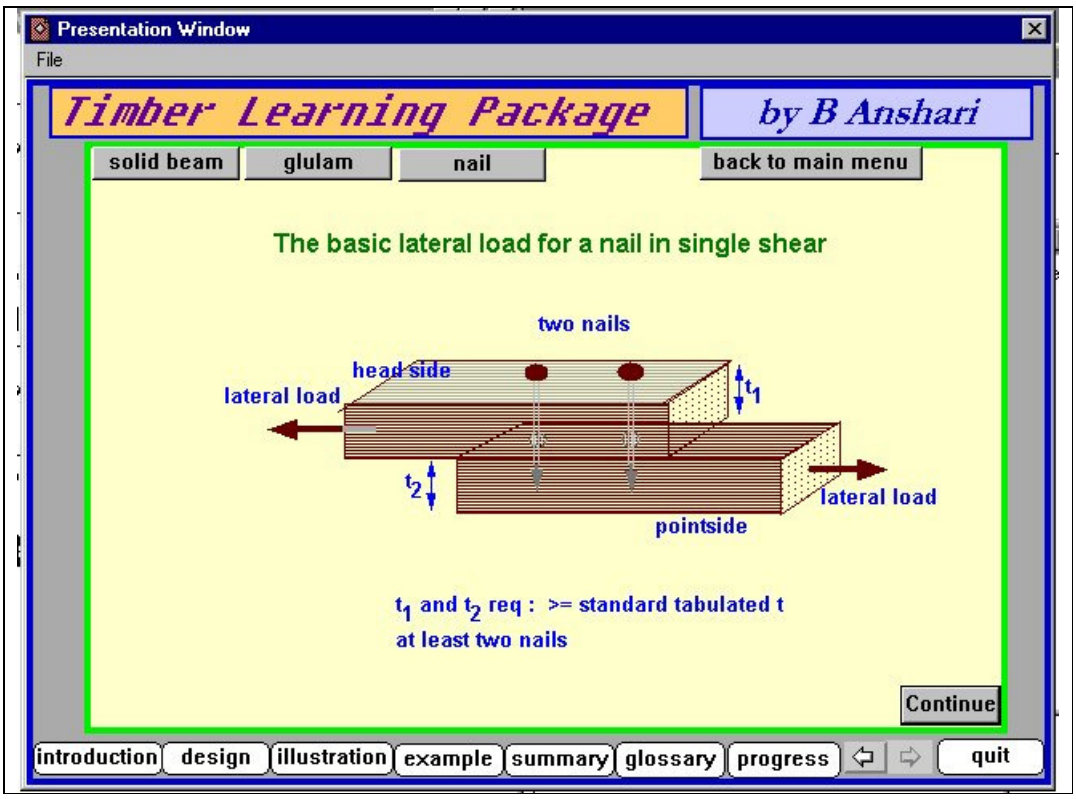

Figure 2.20. Final result Motion

D. Interactivity

The heart of Authorware is the interactive capability of the application created, which responds according to what a user clicks on the screen or what keys the users presses. The core tool for create interactivity in Authorware is the Interaction icons. This icon can branch to different paths, like a decision icon, and also it can pause an activity until a user responds, somewhat like a wait icon. Also, it can remove object from the screen, like an erase icon. The anatomy of interaction icon can be described as shown:

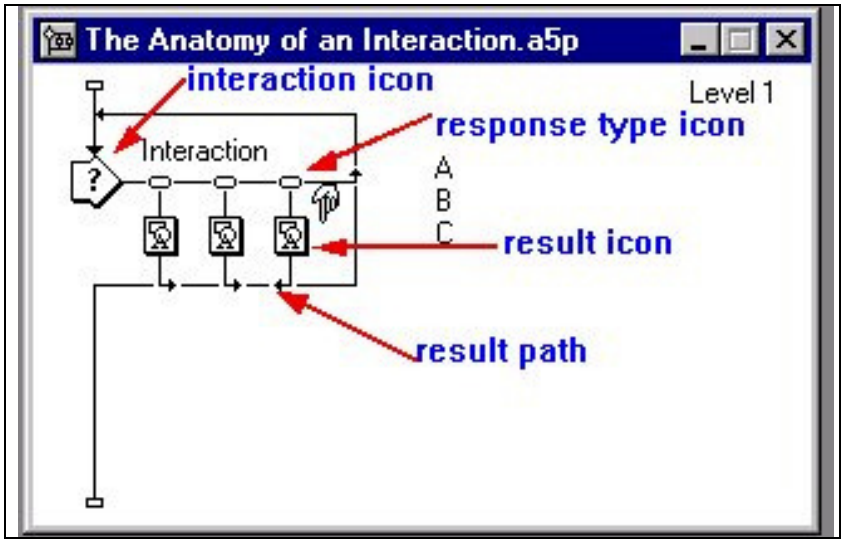

Figure 2.21. A Typical Interaction.

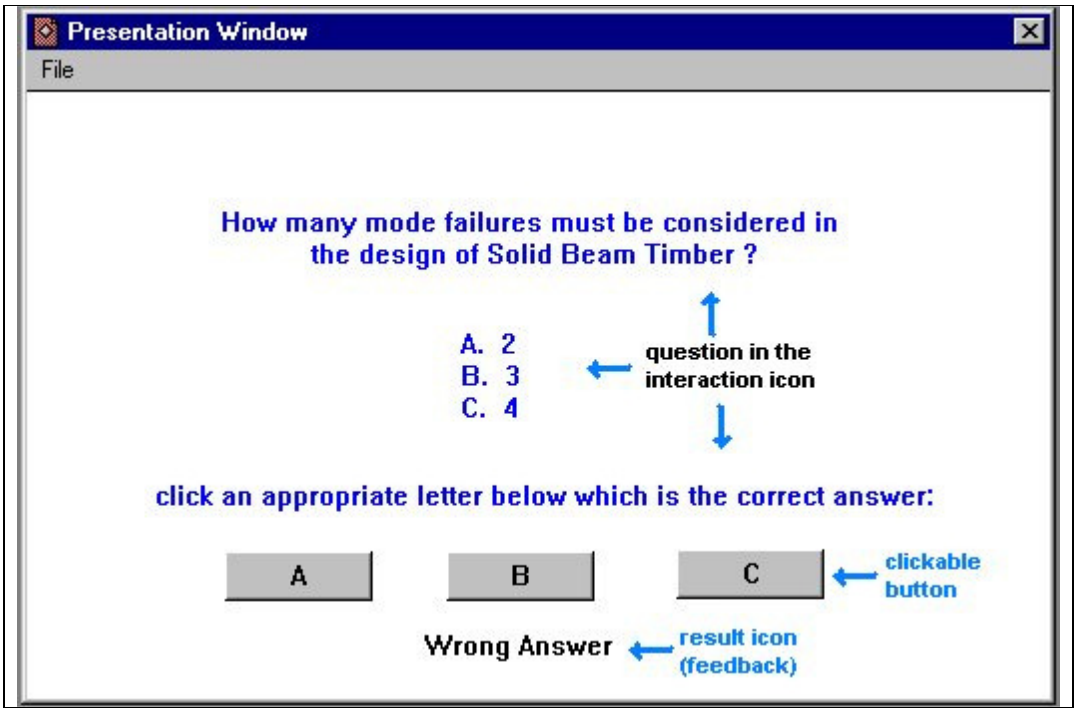

Figure 2.22. Interaction Content

1. ***Response Types***

There are eleven sorts of Response Type that are attached with interaction icon as shown in the following dialog box.

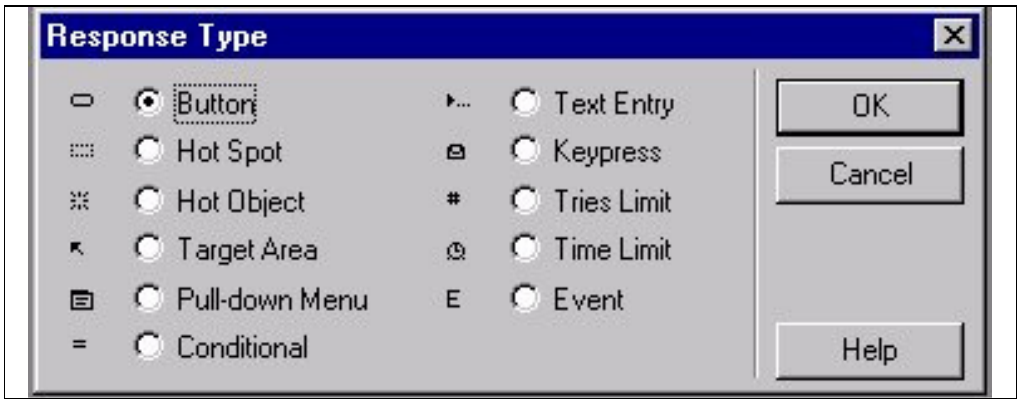

Figure 2.23. Eleven Response Types

In this report, I just describe several Response Types which I have used in CAL-Timber.

a. Buttons

Buttons are commonly used to transfer control of offer a series of choice. When pushed, button causes Authorware to branch to the result icon attach to that button. The result might be a dialog box, a sound, a digital video, or even a jump to a completely new sub topic. It's the use of responses like buttons that enable you to create pieces that are truly interactive. An example of button interaction, which is used in this project, is Main Menu of CAL, which is always displayed on the bottom of screen (see Figure 2.25.). If the user clicks the button, for instance **design**, it will navigate the user to a sub-menu which

contains several topics which are related to main topic e.g. general rules to design.

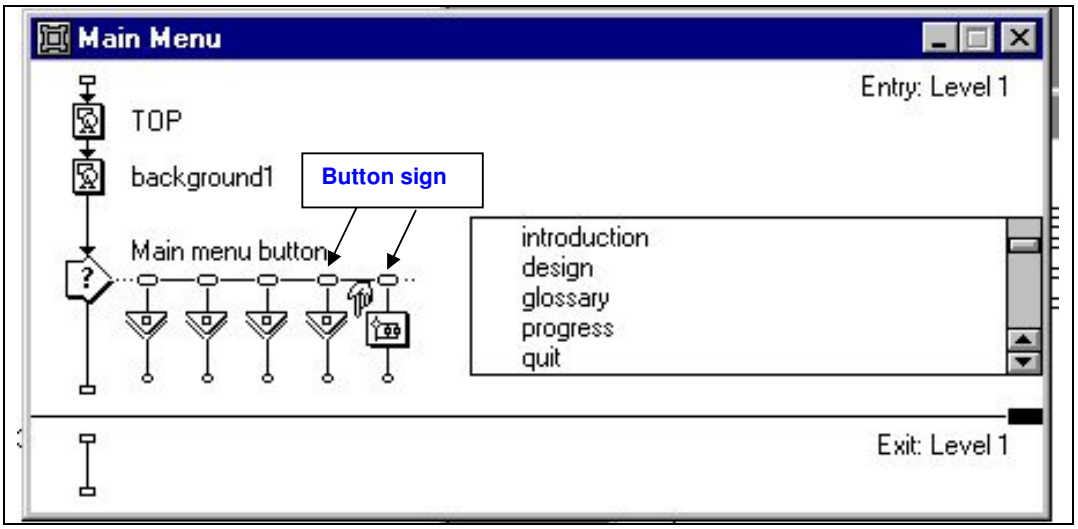

Figure 2.24. The Flowline of Button Interaction

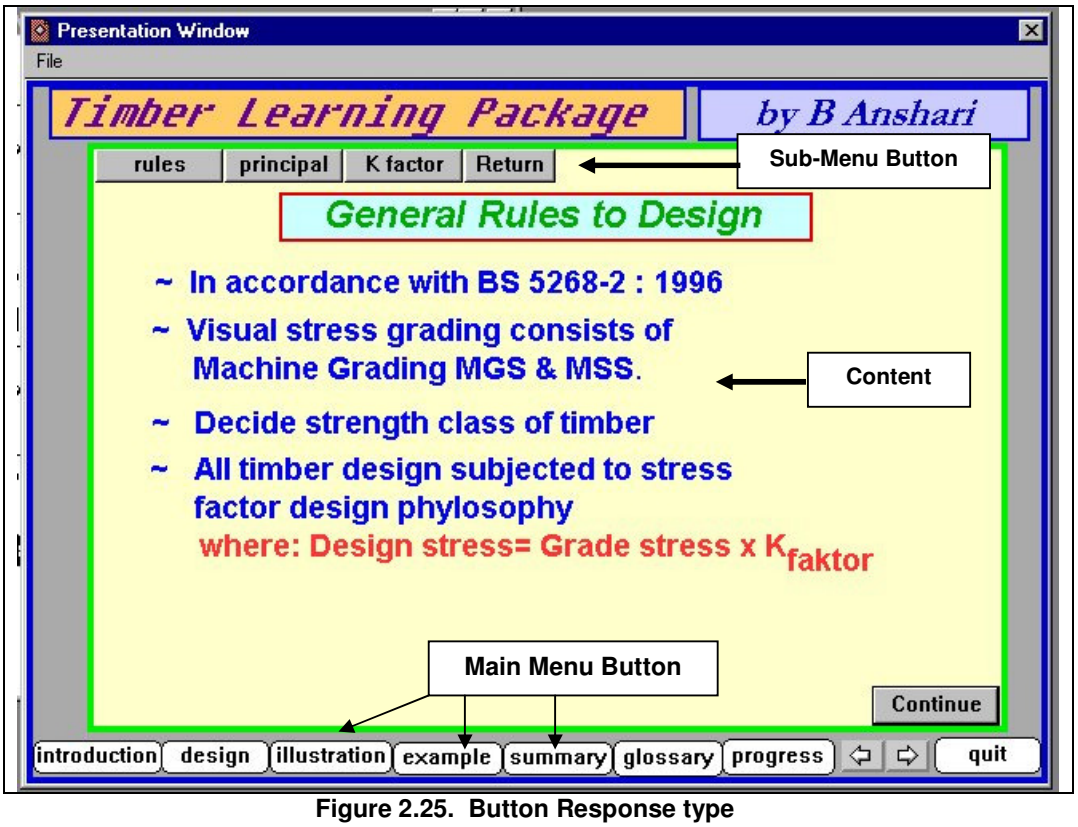

Figure 2.25. Button Response type

b. Hot Spots

Hot spots are rectangular portions of a display associated with corresponding sets of actions to be taken. The actions can be triggered by clicking, double clicking or by simply moving the cursor over the hot spot. The cursor shape can be altered while over the hot spots. An example of hot spot interaction would be Menu Description in this CAL. If the cursor moves over the bottom menu on the screen will appear the description of each menu.

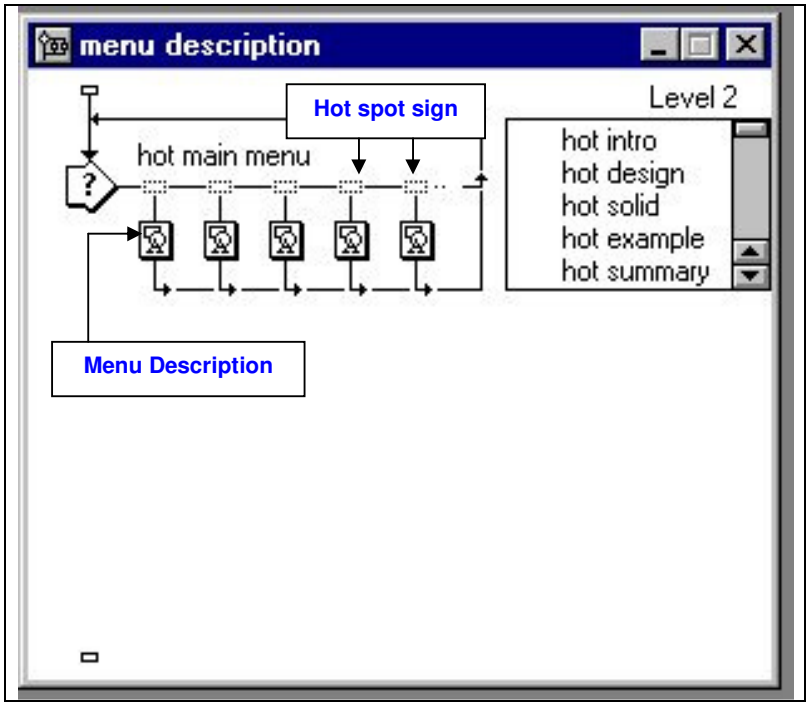

Figure 2.26. The Flowline of Hot Spot Interaction

It can be seen in Figure below that when the cursor (hand shape) moves over illustration button, the content description of illustration will appear.

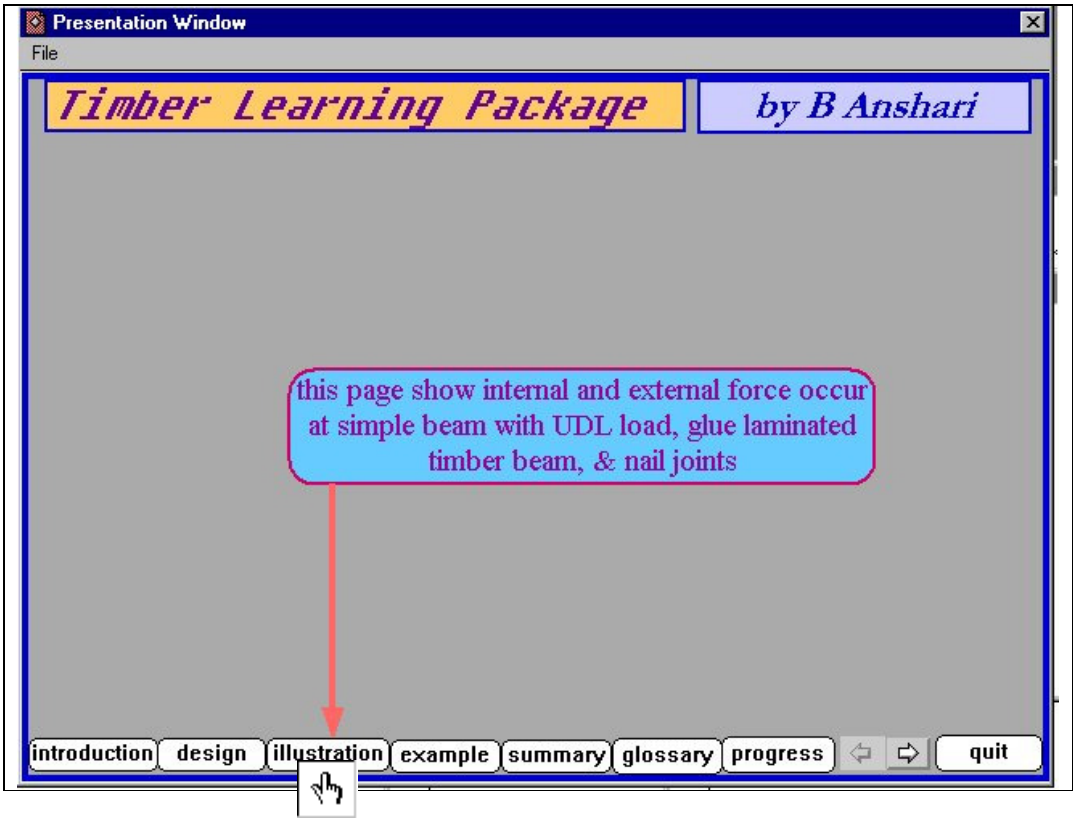

Figure 2. 27. Hot Spot Response type

c. Target Areas

Use a target area if you want a user to drag an object to a specified area. Target Area responses are particularly useful whenever users need to practice or demonstrate their understanding of the order in which a sequence of events is to be completed. A target area is always rectangular, and while author mode, Authorware shows an X inside it. An example of Target Areas spot interaction would be a feedback question in this CAL as shown in Figure 2.28 and 2.29. This question requires the user to drag two appropriate K factors to the defined target area to complete the equation. If the users drag

the correct K factor and put in the defined area, it will occupy the area permanently.

In contrast, if the user drags the wrong K factor and puts in the defined area it will be rejected, and K factor will be back at the starting point.

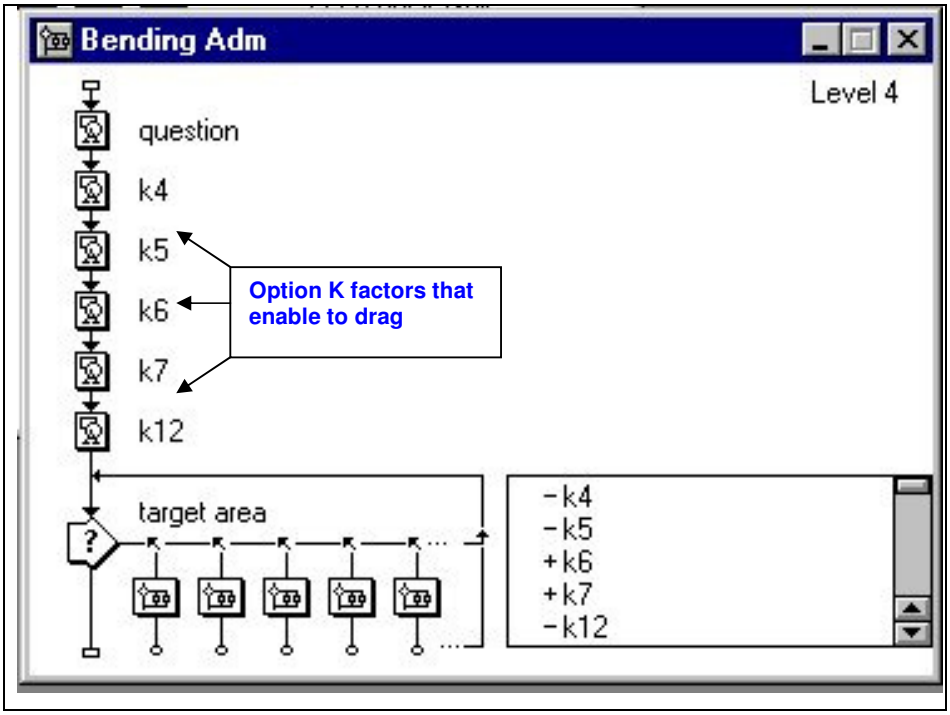

Figure 2.28. The Flowline of Target Areas Interaction

In this example, if the user drags either K6 or K7 in the target area, it will occupy this area permanently. Contrary, if the user drags K4, K5, and K12, these K factors will return to the initial point.

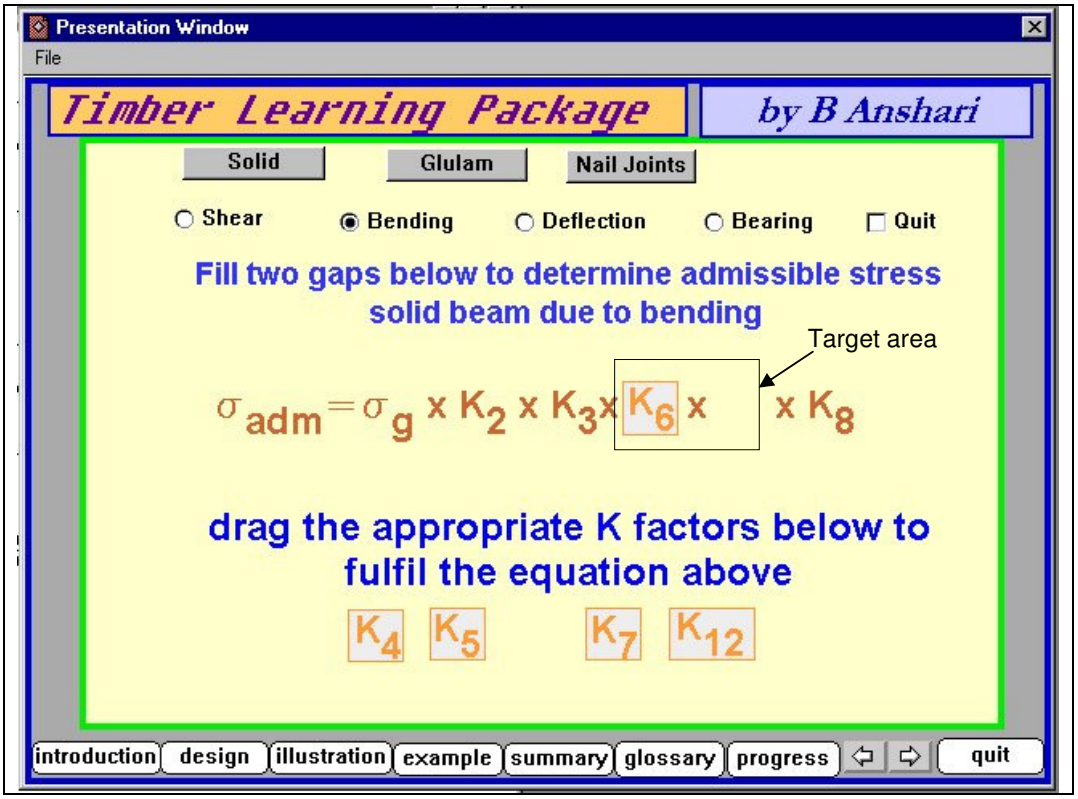

Figure 2.29. Target Areas Interaction

d. Text Entries

Text entry response can range from the simple to the complex. These might be used to ask user's name, or to ask the author of 'Books'. We need to anticipate incorrect spellings and different methods of capitalisation. Authorware also provides the ability to use wildcard, to match *n* words, to ignored punctuation and extra words, and to specify a particular answer sequence.

An example about Text Entries interaction in this project can be seen in the beginning of CAL when the user sign in the CAL.

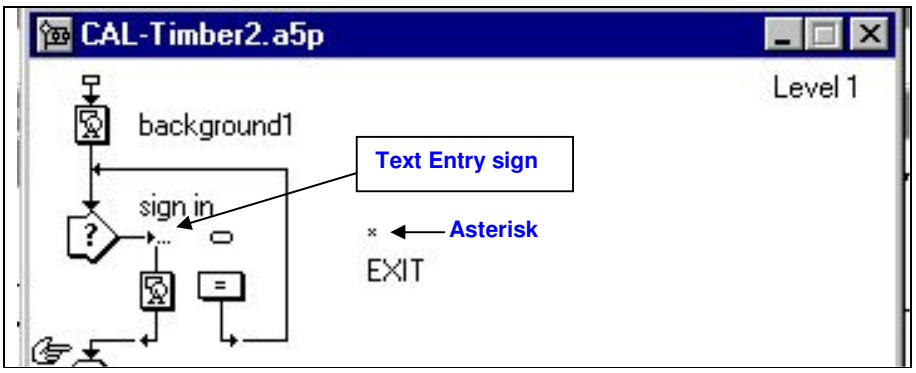

Figure 2.30. The Flowline of Text Entry Interaction

The use of asterisk for the title of the response icon designates * as the text pattern that will be accepted as a match. The asterisk is a wildcard character that indicates that any text a user enters will be accepted. In this example, Authorware requires the users to type their name in the provided box and to sign in the package.

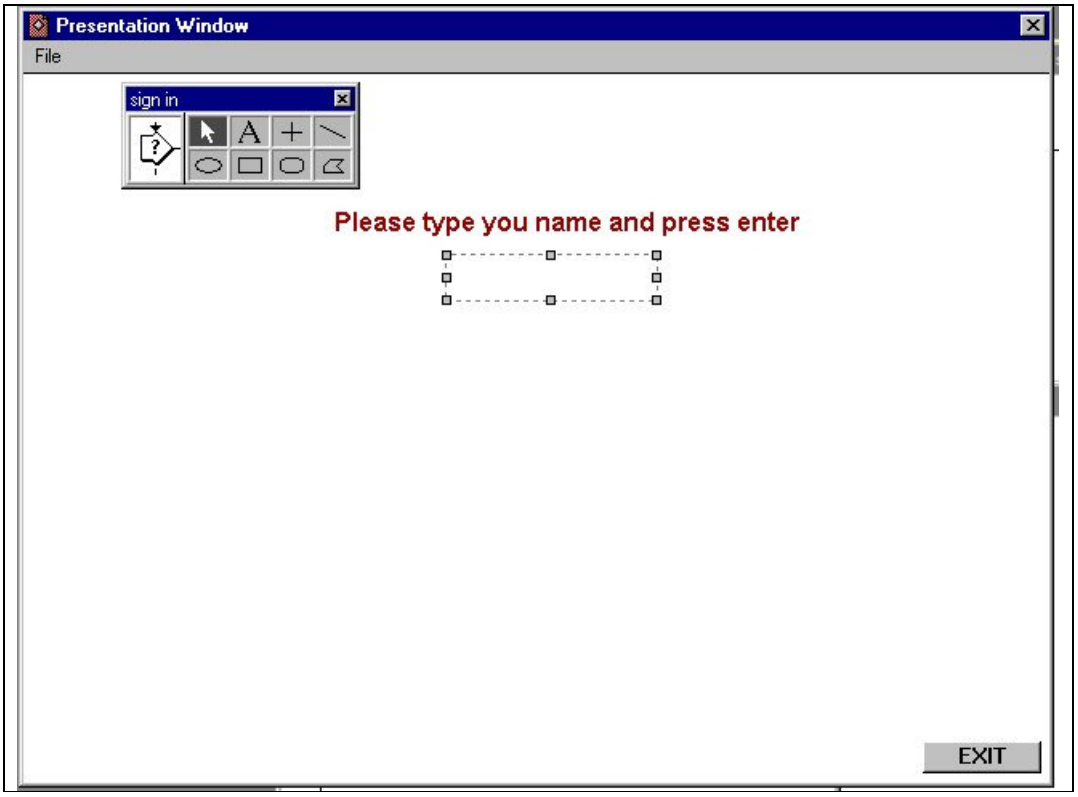

Figure 2.31. The Text Entry Interaction content

2. Typical Interaction Options

If a new response type is added, or an existing one opened, a dialog box will be displayed presenting options that apply to the response type. See the dialog box below.

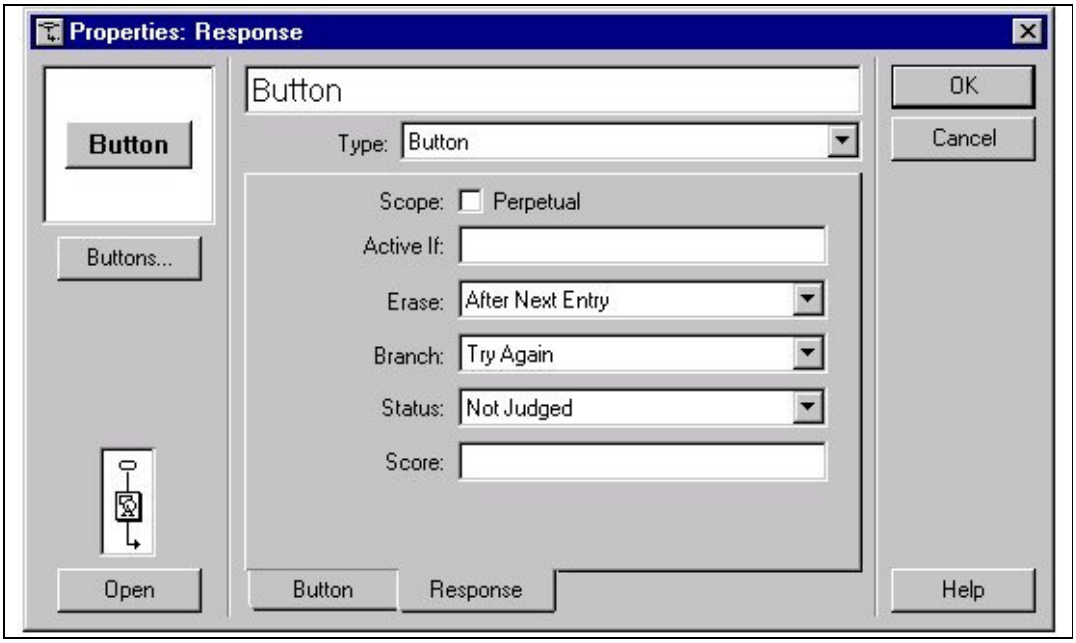

Figure 2.32. Dialog Box of Response Types

Among the common component are:

a. Type

Use the Type drop-down list to select a different response type as described previously

b. Scope

Check the perpetual box to make the interaction. A typical use for this is with button type, where button would stay active and ready for the user to push.

c. Active if

Enter an expression or variable in the box that determine when the interaction is active. For example, the next button would be active if Page Number was less than total Page Number.

d. Erase(feedback)

This specifies what to erase after displaying the content of the result, or feedback, icon. There are four options:

- Before Next Entry: erase the result icon's display before redisplaying the interaction display, which prompts the user for another response.
- After Next Entry: erase the result icon's content after the user makes another response (a mouse click, keypress, etc.)
- On Exit: Authorware leaves the result icon's display on the screen until the interaction icon is exited.
- Don't Erase: to leave responses on the screen until an erase icon removes them.

e. Status (response tracking)

When we want to judge each interaction and compute performance statistics, there are three options:

- **Correct Response**: to assign the correct answer to the path that constitutes the correct answer or response
- **Wrong Response**: to assign the incorrect answer to the path that constitutes the wrong answer or response
- **Not Judged**: is used when we do not need to track right and wrong answers or responses

f. Branching(Exit)

This specifies what Authorware should do after getting a correct or incorrect response. There are four choices:

- **Try Again**: Authorware will loop back to the interaction icon and wait
- **Continue:** Authorware will continue to check icons to the right for possible additional matches
- **Exit Interaction:** to make Authorware move to the next icon on the main flowline (not the next icon within the interaction)
- **Return:** this option is only available with the "Perpetual" option, which is associated with Hot Spot, Button, Target Area, Pull-down menu and conditional Interaction.

E. Calculating and Branching

1. Calculation Icon

Calculation icons are used to assign values to variables. These variables can be Authorware variables, or ones you create. A variable is an object whose value can be change. The general syntax for assigning a variable value is: `VariableName:=expression.` The expression can include references to other variables or built-in functions. You can insert calculation icon at any point on the flowline. To add content to a calculation icon, double click on it to open its calculation window where you can enter expressions, comments, scripts for If-Then statement, repeat loop and much more.

The functions of calculation icon among are:

- Perform mathematical calculation
- Use arrays to store and retrieve data
- Control presentation window

- Set up and use branching icon

The calculation icons have main role in my project mainly in the Computer Aided Assessment Package. One of the functions is to assign random data so that the user will get a different data anytime doing the assessment. The use of calculation icon in this project can be shown in an example as follow.

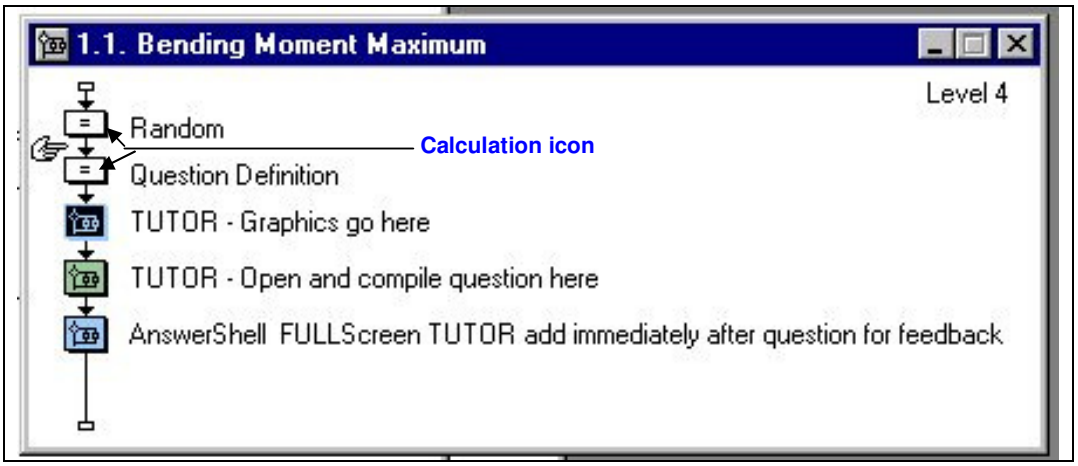

Figure 2.33. The flowline with calculation icon

If the Random icon is double clicked, it will appear the calculation window. In this window we can assign **Random** function to generate random data as desired. For example beam depth is random between 200 mm and 600 mm by steps of 50 mm, as show in Figure 3.35. Whereas, on the screen or presentation window, it will appear as a particular value in the defined range as shown in Figure 3.36.

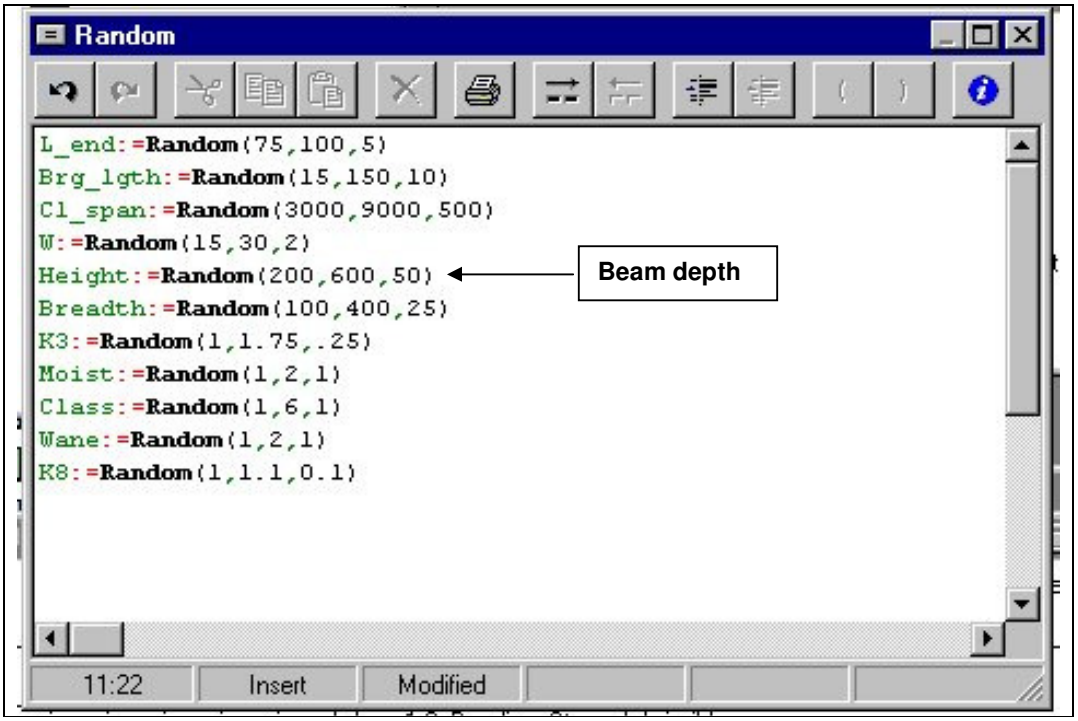

Figure 3.34. Calculation Icon Window

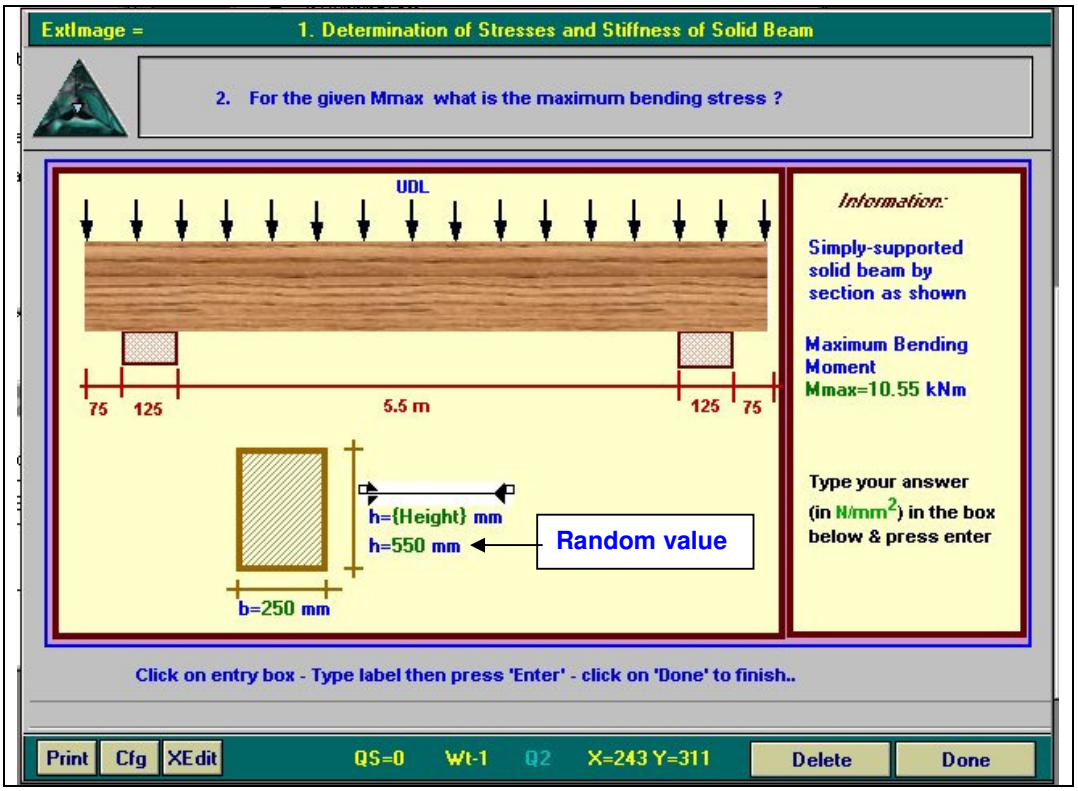

Figure 3.35. Presentation Random Value

2. Decision Icon

Decision icons establish structures called **paths.** When a decision icon is encountered, Authorware takes one of the branches to the right of the decision icon. A branch or path is an attached icon. You can assign as many paths as you want. Authorware can branch to the path *sequentially, randomly, randomly to only untraveled paths, or base on calculation.* Figure 2.18 shows the decision icon properties.

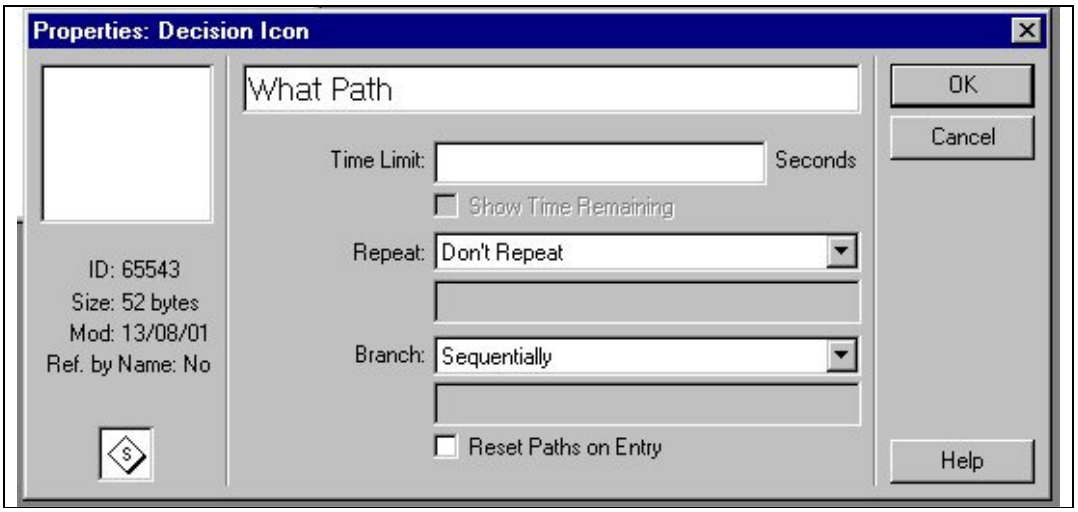

Figure 2.36. Decision Icon Properties

There are three main sections in the Decision Icon Properties box: Branch, Repeat, and Timing.

F. Variables & Functions

1. Variable

Variables and functions are the language program of Authorware to build even more powerful interactive applications instead of dragging icons to the

flowline. Authorware provides more than 220 system variables, which can keep track of all activities while a piece is running e.g. time of day, session hours. In the variables window (see Figure 3.38), all system variables are listed and any custom variables are created. Variables may be used in three locations: Display Icon, Calculation Icon and In Field within dialog Boxes.

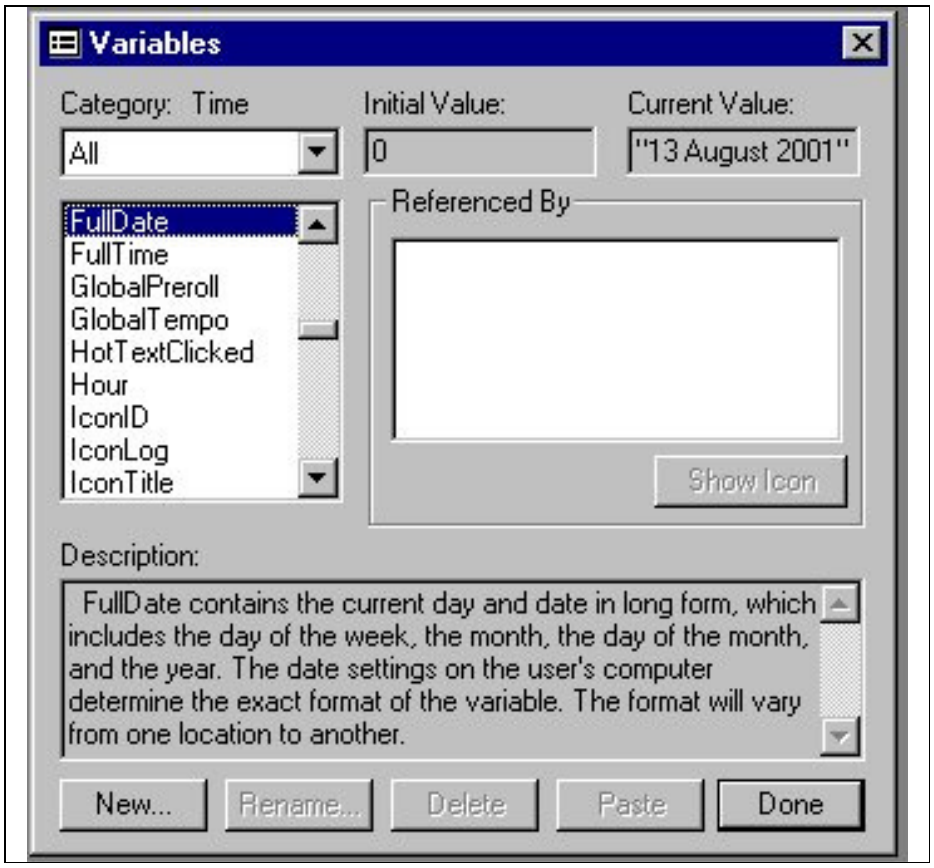

Figure 2.37. The list of variables window

As mentioned before, we can create as many variables as needed for the project. In this project, many customised variables in the Timber Course assessment, such as beam span, bearing length, timber moisture, K factors, etc.

2. Function

Functions are like tools. These tools perform a variety of operations that accelerate lesson development and allow designer to perform tasks that are not normally possible. To use a function, either type the function name or access the dialog box by selecting Functions from window from the Window pull-down menu (or Ctrl+Shif+F) as show in Figure 2.19. Functions are usually entered in Calculation icons, but they can also be used in fields in dialog boxes or in expressions entered within curly brackets in display.

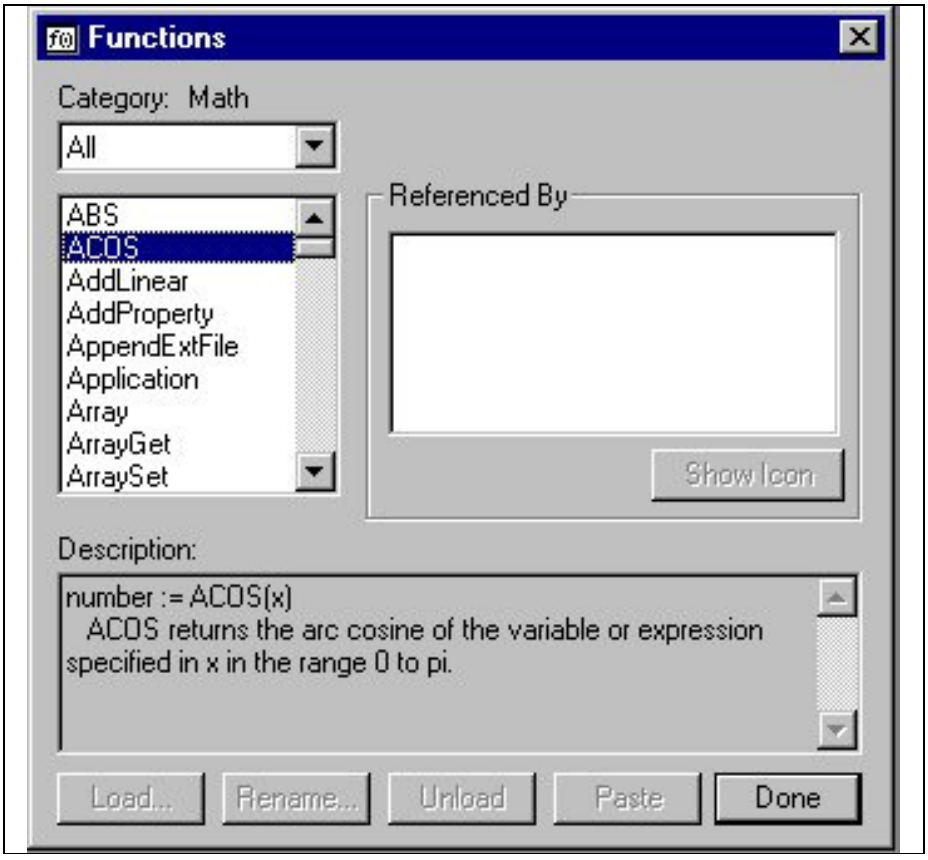

Figure 2.38. The Listed Function Window

The tasks, which are related to the use of variables and functions, are dominantly in the CAA Package. An example in this package such as question about determination of admissible bending stress of solid beam.

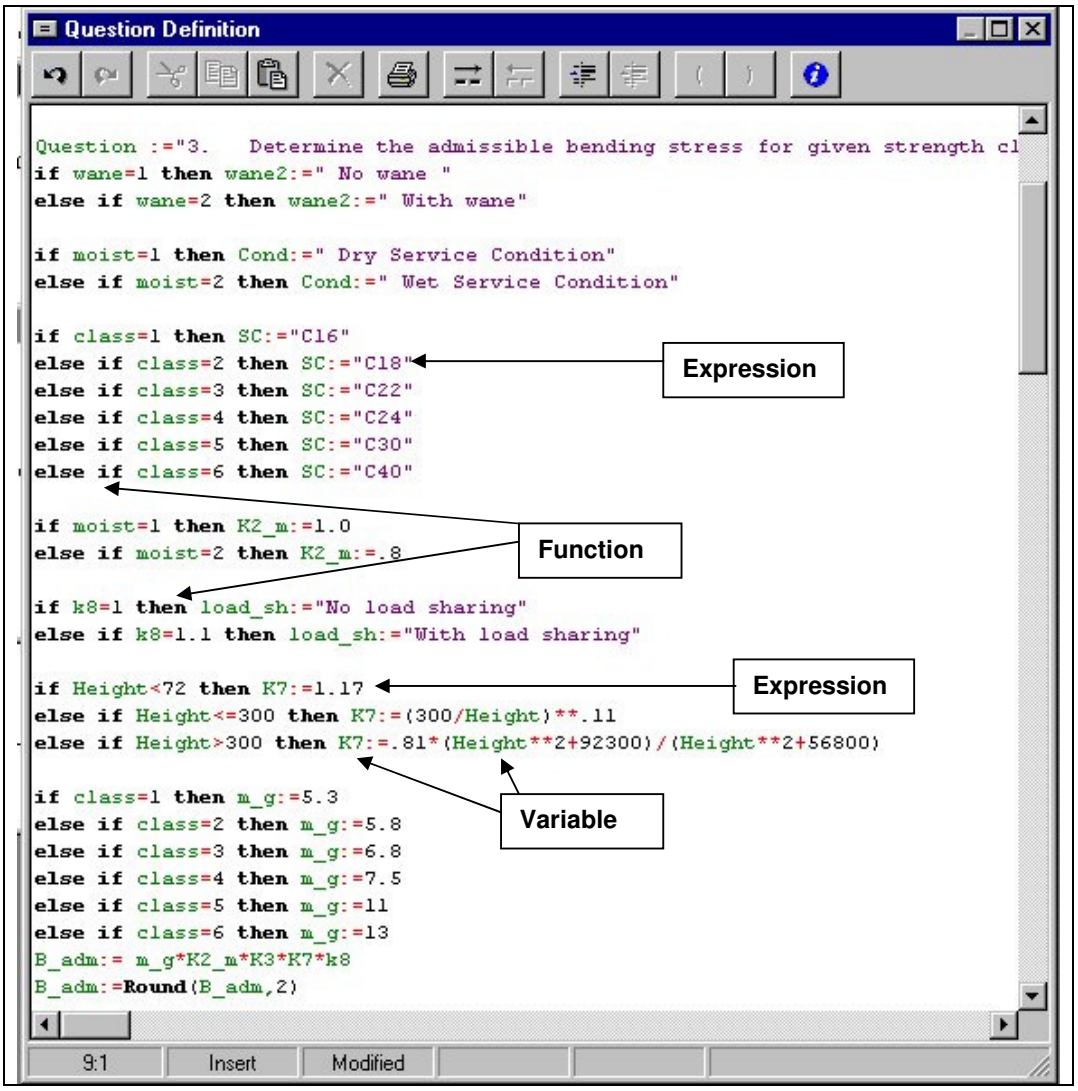

Figure 2.39. An example of Variables and Functions Window

Based on Figure 2.39, it can be summarised:

- The characters that are shown in green colour are variables
- The characters that are shown in bold black colour are function
- The characters that are shown in black or brown colour are expression
- The characters that are shown in red colour are mathematics operators.

In the presentation window after the project is running, it will appear the variable values or expression as show in Figures 2.41 and 2.42 below.

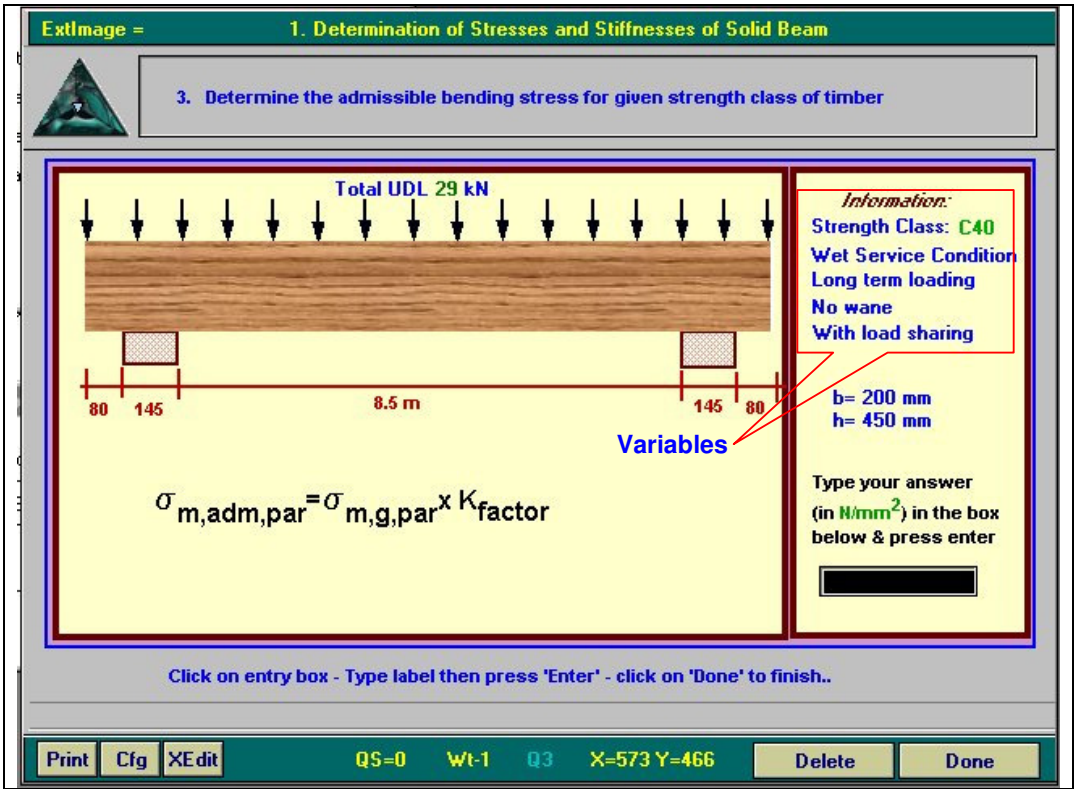

Figure 2.40. Variable result displaying

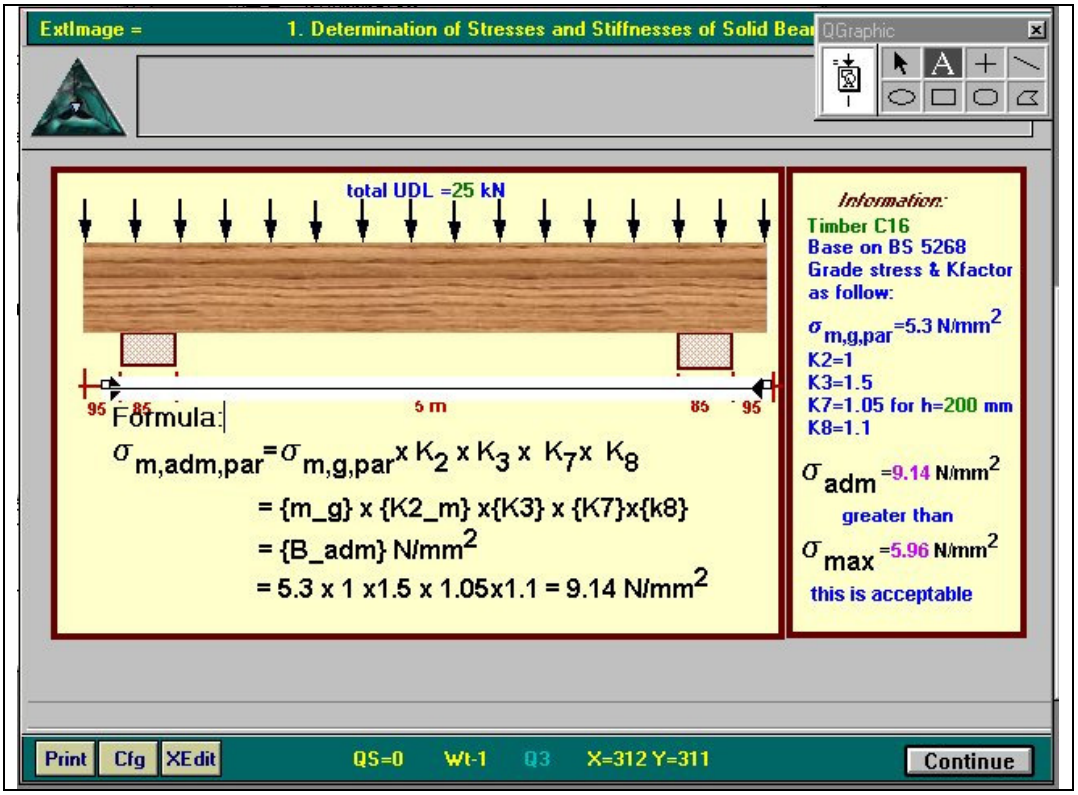

Figure 2.41. Calculation Result Displaying

G. Framework and navigation icon

The Framework icon, together with navigation icon, allow user to move forward and backward non-sequential among a series of screen information. This is more flexible other than the software, which can only move sequentially or linearly. An example of the use of these icons in this CAL, is the main menu, which always appears a long running package.

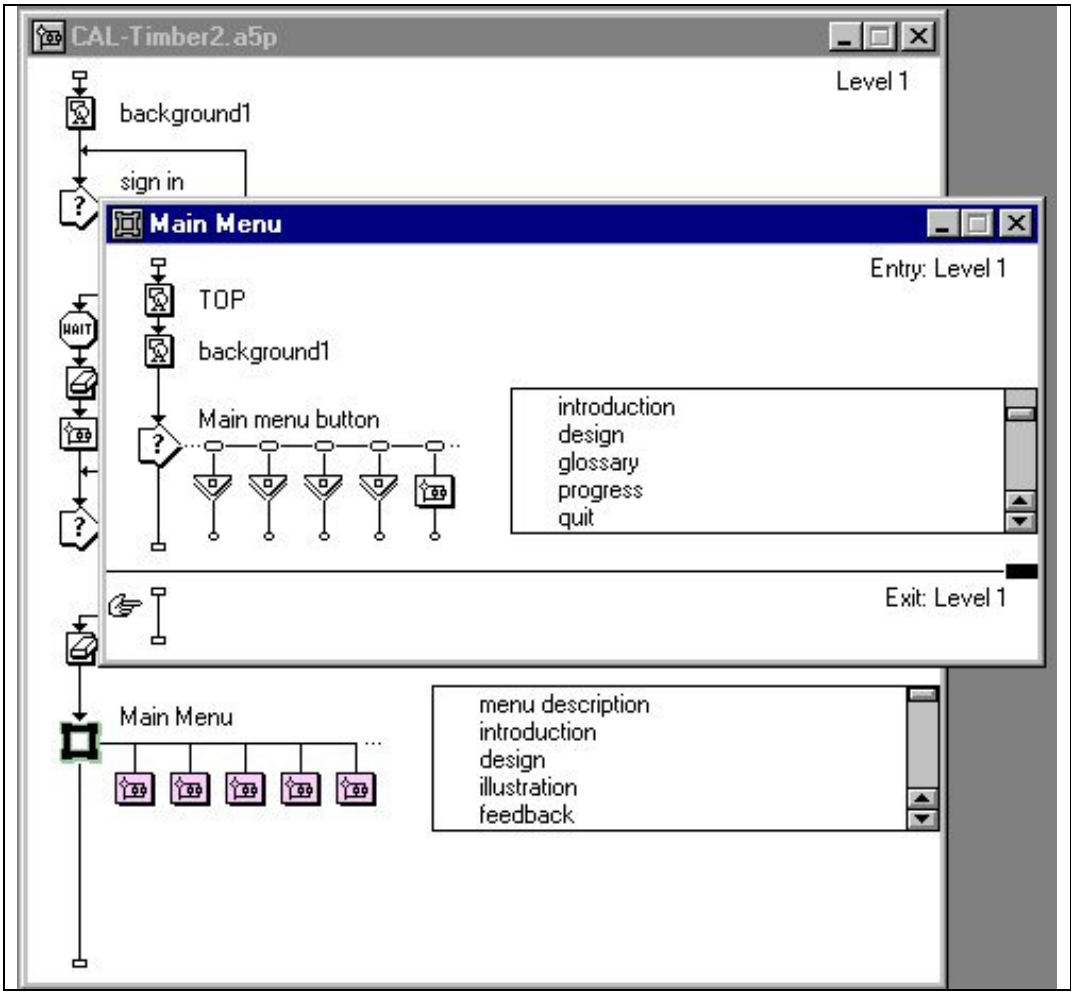

Figure 2.42. Framework icon together with attached icons

A navigation icon enables us to jump to another icon as long as that destination is attached to a framework. The most common choice in the navigation icon is *Nearby* and *Anywhere*. The *Nearby* option allows the user only able to navigate among pages of currently active framework. There are five page options namely Previous, Next, First, Last, and Exit Interaction. Another common option in this project is *Anywhere* option, where under Destination permits linking to any page within the file, provided that the page

is attached to a framework icon. The typical dialog box of navigation icon is shown as follows.

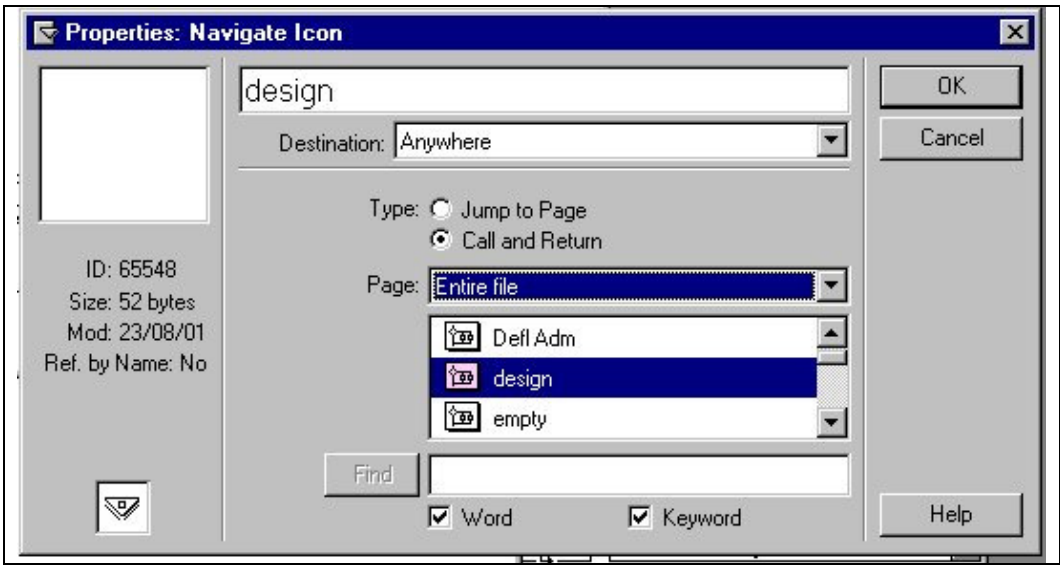

Figure 2.43. Navigation Dialog Box

This option means that the Design menu can be called whenever by pressing The Design button. So, it will navigate to the content on Design map. If in the Design map there is a framework icon as well, it will behave the same pattern as before.

COMPUTER AIDED LEARNING TIMBER (CAL-TIMBER)

As mentioned in the first chapter that this CAL contains three parts of Timber Course bases. They are design Simple Solid Beam, Glulam Horizontal Laminated Beam, and Nailed Joints in Simple Truss in accordance with British Standard 5268:2-1996. In general, the structure of the CAL-Timber can be shown in the flowchart as follows:

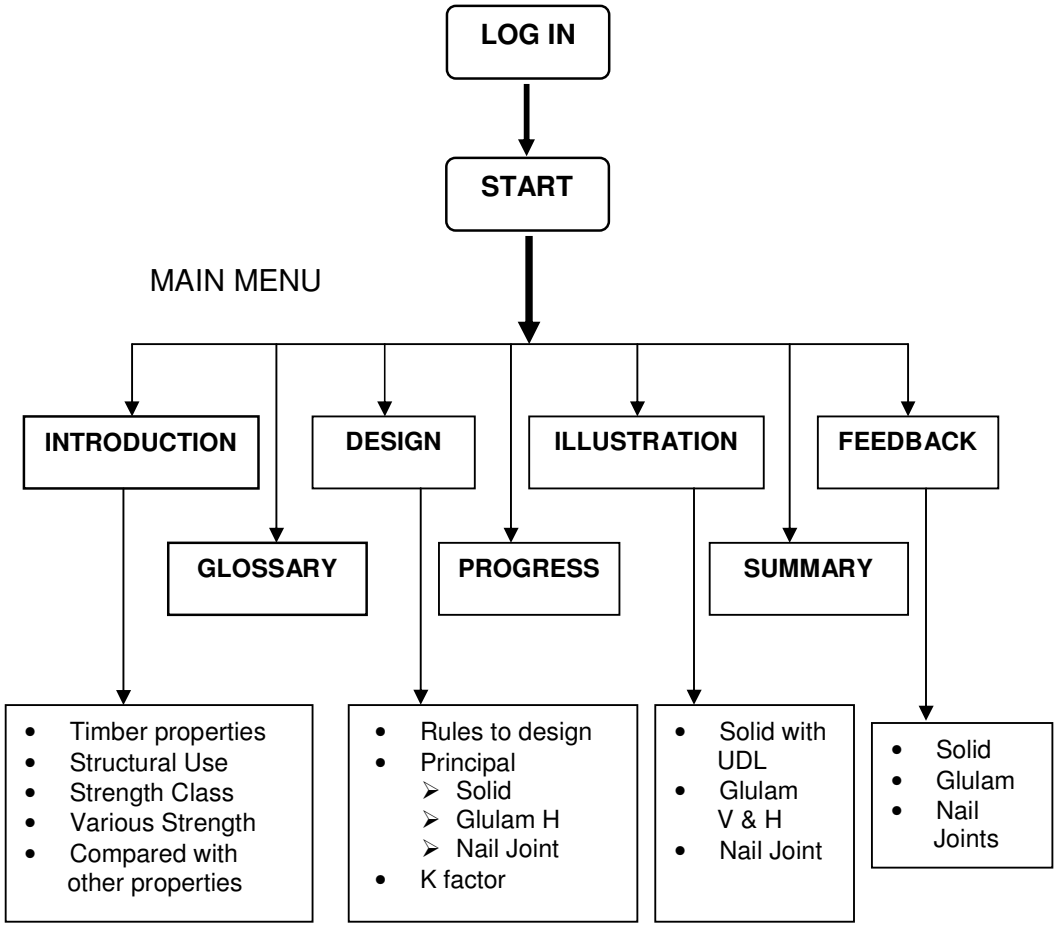

Figure 3.1. Flowchart CAL-Timber

In the Authorware, the main flowline of this CAL-Timber can be seen in Figure 3.2:

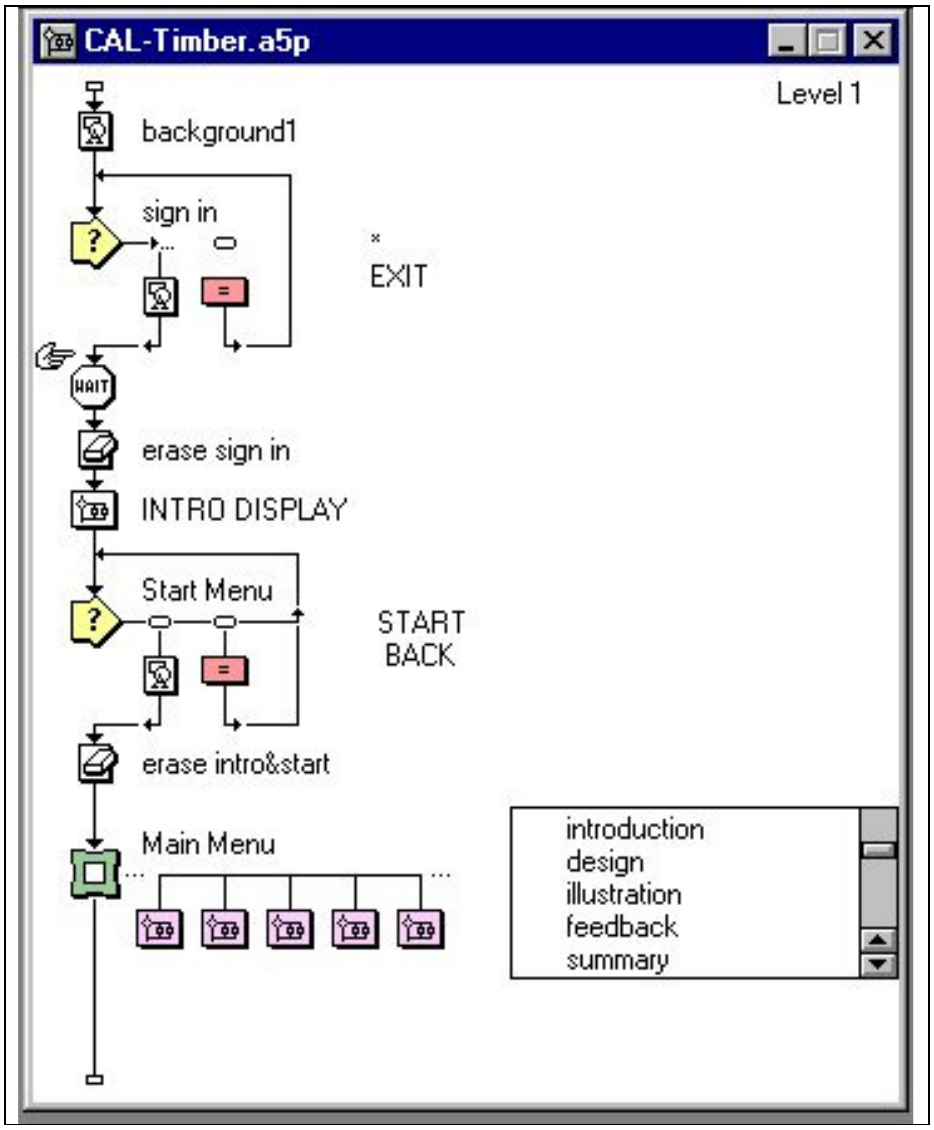

Figure 3.2. The main flowline of CAL

This project tries to perform as an attractive package, which will cover the intended core of Timber course such as timber properties, illustration of timber member and how to design timber members. This package contains all the information briefly so that user can understand quickly and run easily.

A. Introduction

The content of the **Introduction** menu gives the general overview about timber properties, strength class, the unique strength of timber, and comparison with other materials. The summary of the content can be described as follows.

There are two main groups in timber species referring to level of hardness of timber, namely, Hardwoods and Softwoods. Hardwoods have an average density of 700 kg/m^3 and frequently grown in tropic countries. Whereas, Softwoods have a mean density about 500kg/m^3 and grown mainly in non-tropical countries.

BS 5268 has divided these two groups into several classes where softwood consist of 10 classes (C14, C16, C18, C22, C24, C27, C30, C35, C40) and hardwood consist of classes (D30, D35, D40, D50, D60, D70)

The benefits and weaknesses of Timber in comparison with others materials such as steel, concrete and masonry can be described as follow

Timber properties:

- The total cost needed can be categorised *medium cost*
- The self weight of Timber structures is small
- Duration time to undertake Timber construction is quicker
- The resistance to fire is good due to the hardness of core

- It is available with various shapes as desired.
- The appearance of final structure is aesthetic.

Timber has the variety of strength which is influenced by any circumstances of timber itself as described in **Various strength** menu. See Figure 3.3.

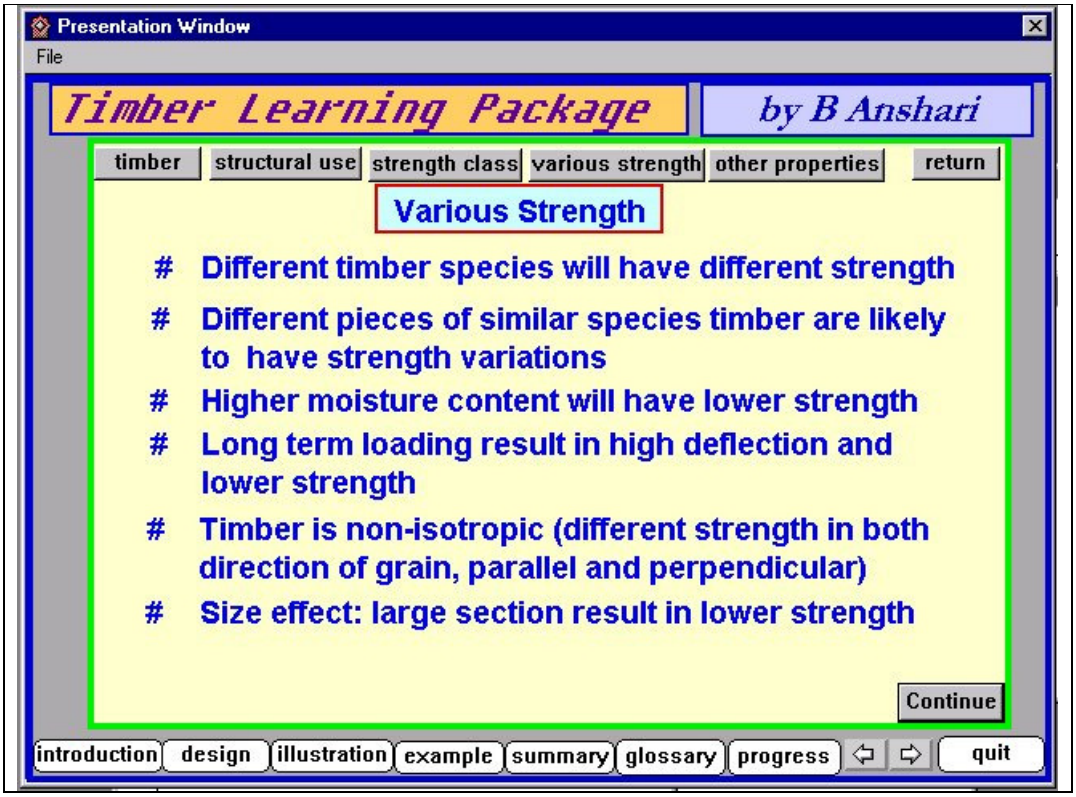

Figure 3.3. Various strength of Timber

The comparison with other materials is located in **other properties** sub-menu. In this menu there are three kinds of material which is compared with such as concrete, steel, and masonry. As an example in this menu, is **steel** property as illustrated in Figure 3.4.

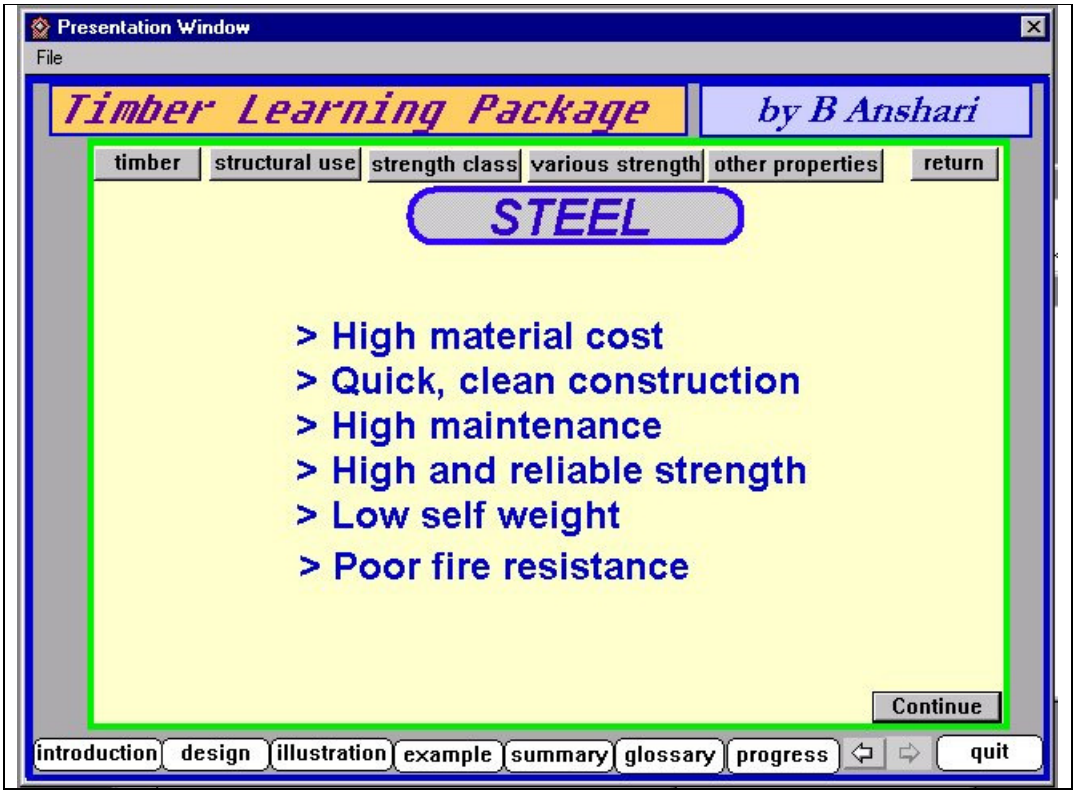

Figure 3.4. Steel Properties displaying

B. Design

In the **Design** menu the package is divided into three parts i.e. rules, principal, and K factor. It can be seen in the flowline as shown in Figure 3.37. The icons, which are frequently used are as map icon, framework icon, and navigate icon. The degree of flowline can be represented by the Level number which written at the top right corner of flowline or design window. So, Design flowline lies on level 2, whereas the principal design, which is a branch of Design flowline, lies on level 3, and so on.

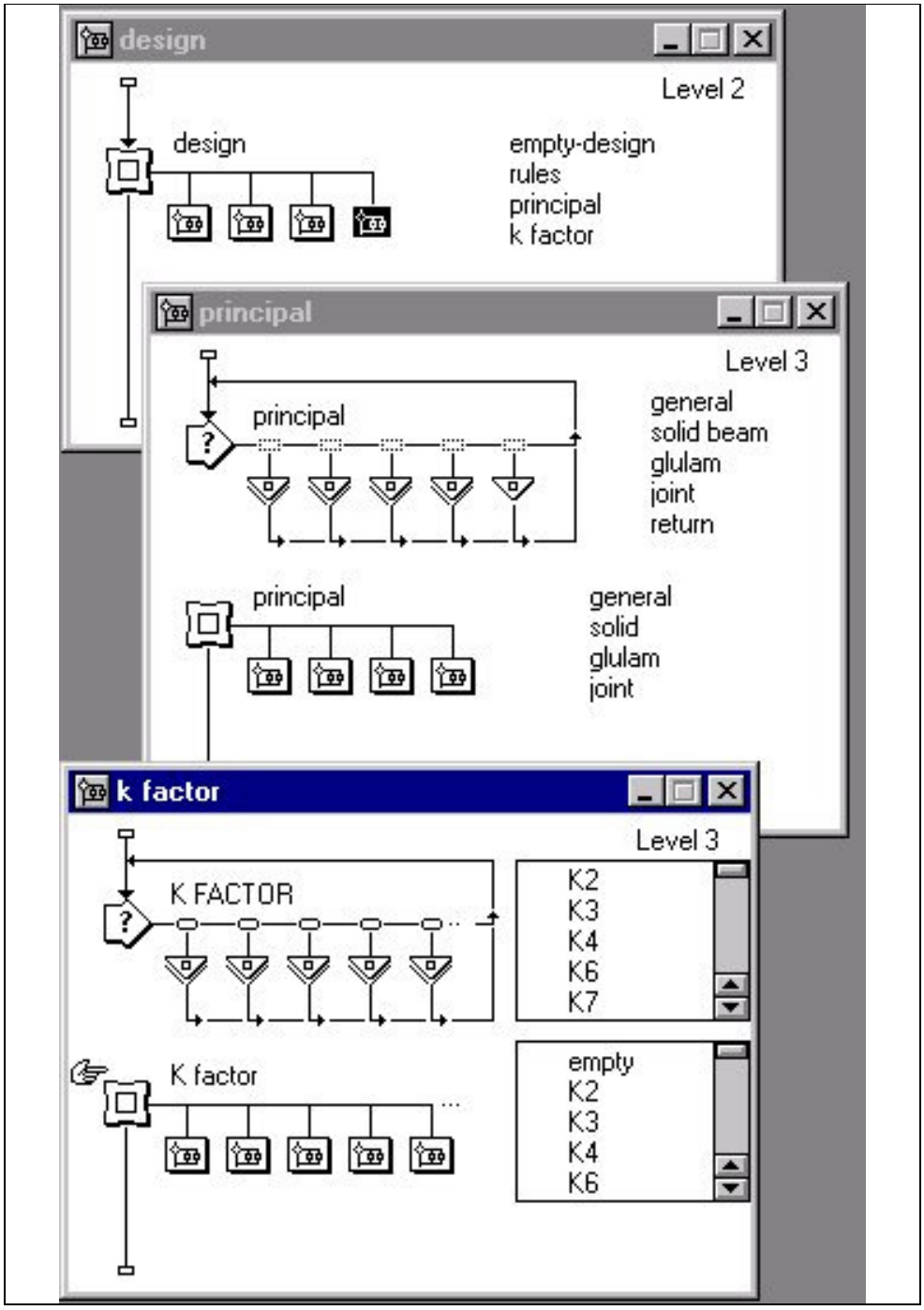

Figure 3.5. The Design flowline

The summary of this Menu content can be described as follows.

General rules to design in accordance with BS 5268 1996:

- Consider the strength class of timber for the design
- Consider other factors such as moisture, load duration, if wane permitted or not, and load sharing.
- The philosophy of design stress:

  Design stress = Grade Stress x K factors.
- Beam members should fulfil four mode failures. These are shear, bending, deflection, and bearing mode failure.
- Nailed Joint strength should strong enough about either member failure or joint failure.

1. Design of Solid Beam

To design beam as mentioned above, the beam must enable to resist shear, bending, deflection and bearing due to applied load.

The admissible stresses of these mode failures can be formulated as shown in Figure 3.6. In addition, the admissible stress of tension and compression members can be formulated as shown in Figure 3.7.

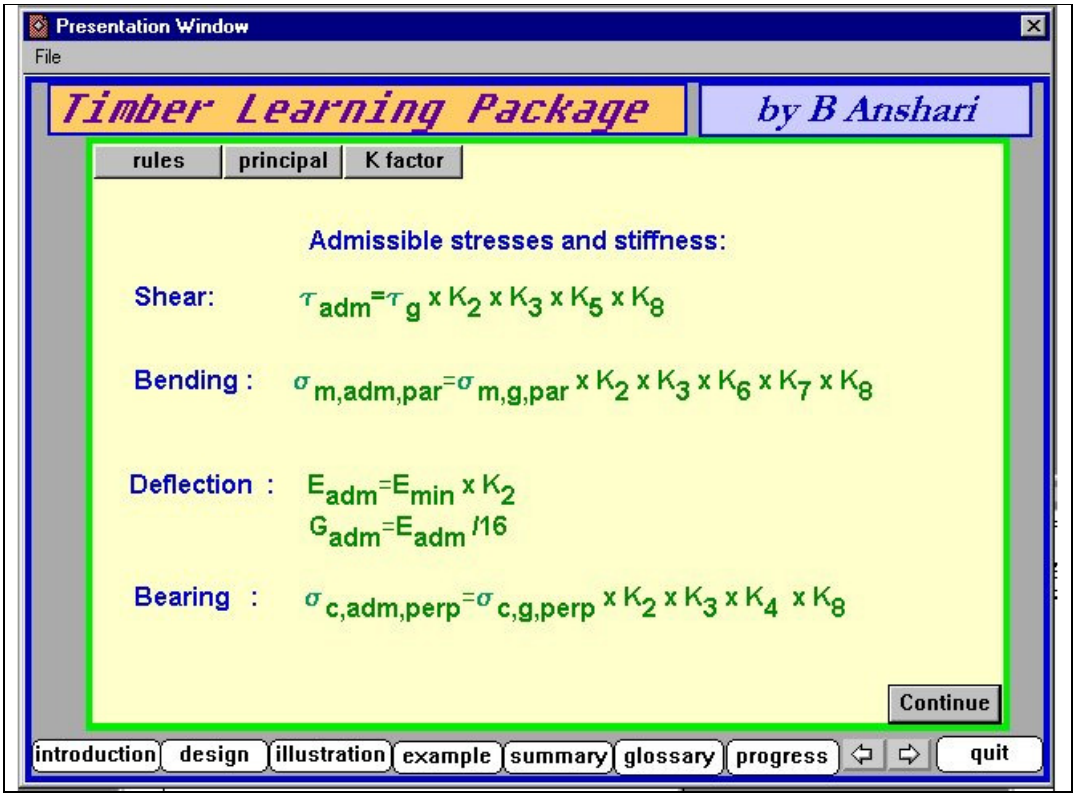

Figure 3.6. Admissible stresses and stiffness based on mode failures

Figure 3.7. Admissible stresses for tension and compression members.

2. Design of Glulam Beam

The thickness of timber laminates normally varies between 25-50 mm. There are two kinds of Glue Laminated Beam based on the direction of in respect to laminates load.

These are Glulam Horizontal Beam and Glulam Vertical Beam, which have the number of laminates at least 4 pieces and 2 pieces respectively.

The formula that will be used to determine the admissible stress of these Glulam Beam is shown below.

a. Glue Laminated Horizontal Beam

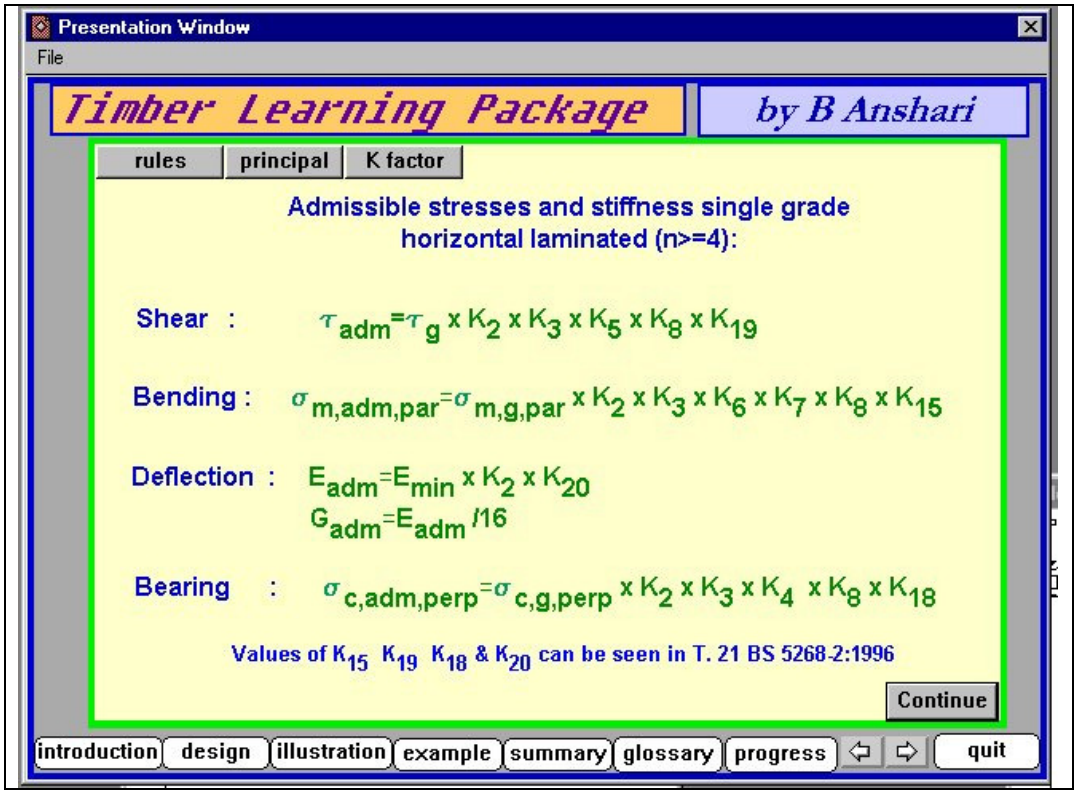

Figure 3.8. The admissible stresses & stiffness single grade Glulam H.

It can be seen that the formulas are the same as solid beam formulas except additional K factors must be applied such as K15, K18, K19 and K20.

b. Glue Laminated Vertical Beam

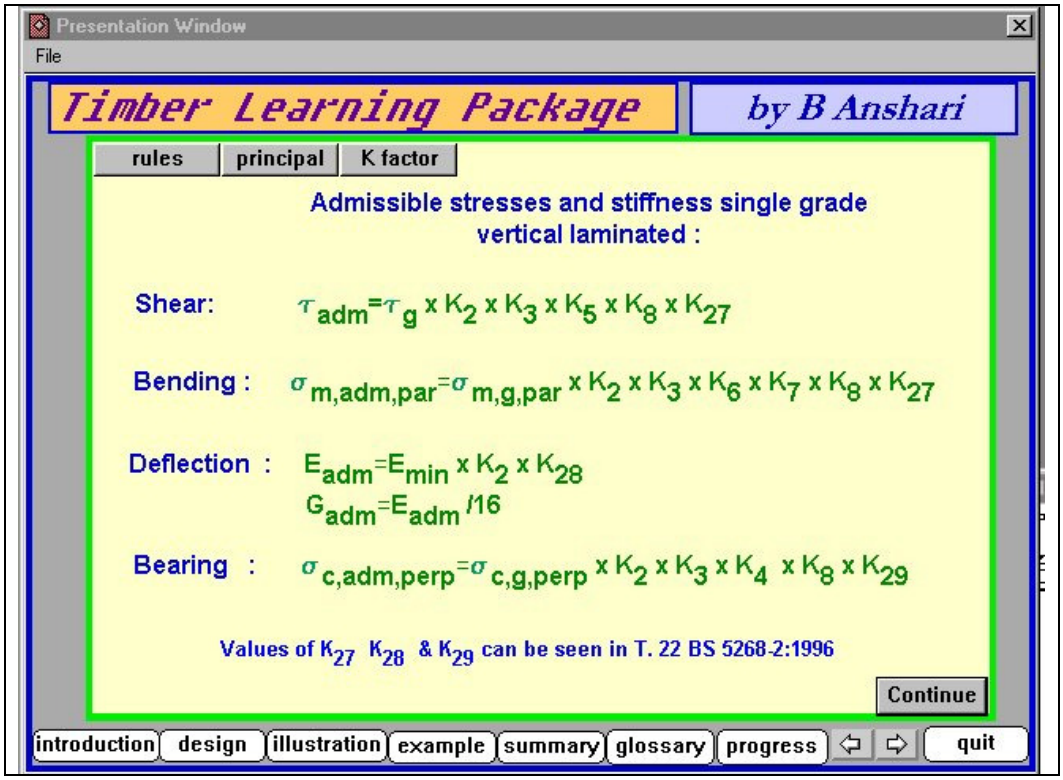

Figure 3.9. The admissible stresses and stiffness single grade Glulam V.

The formulas are still similar to the solid beam formulas, but it should be multiplied by additional glulam factor such as K27, K28, and K29.

3. Design of Nail Joints

In this sub menu, I tried to show the general requirement to connect timber member by nails, especially for timber to timber joints. It also shows the formula to determine the permissible load per nail which can be carried. Look at the two figures in Figure 3.10.

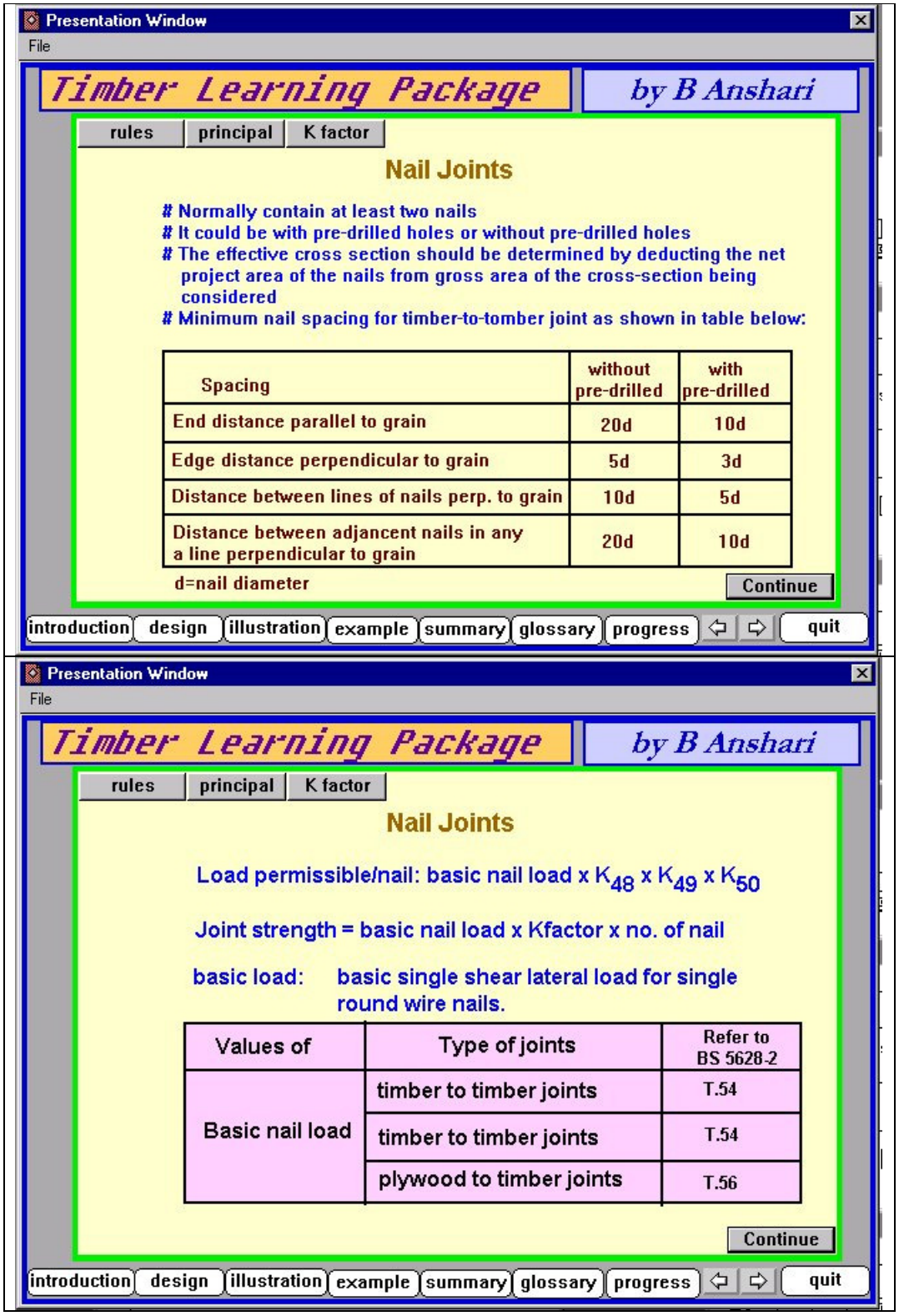

Figure 3.10. Nail Joints

4. K factor

There are many K factors, which have been use in this project, but I will just show some main K factors such as K2, K3, K4, K6, K7 and K8. These pages want to show to students the value of K factors in relation to the particular conditions for a design. An example of these pages can be shown in Figure 3.11 below concerning the Load Duration factor (K3).

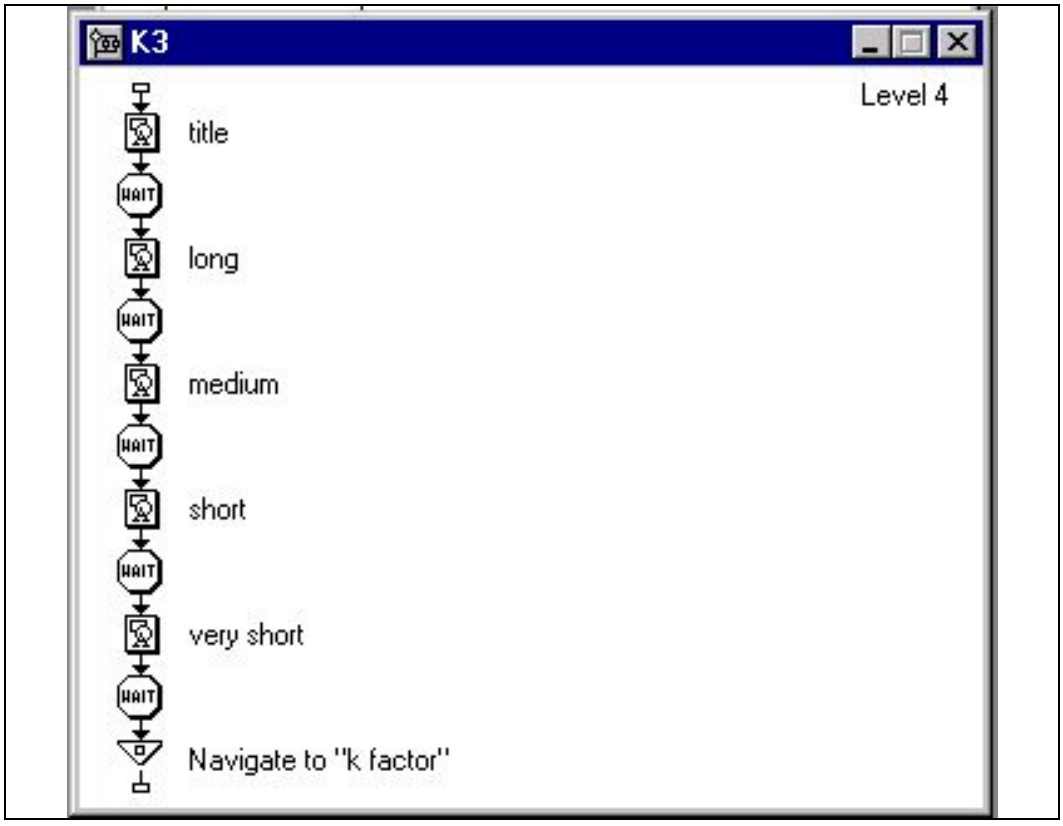

Figure 3.11. The flowline of K3

This figure above shows that a wait icon is lying between two display icons with a navigation icon at the end. It means the content in the next display icon will appear until user clicks continue or presses any key. It is intended that the user has time to read the text line per line.

Finally, at the end of this piece, the project will navigate to upper level K factors to allow the user to see another K factor.

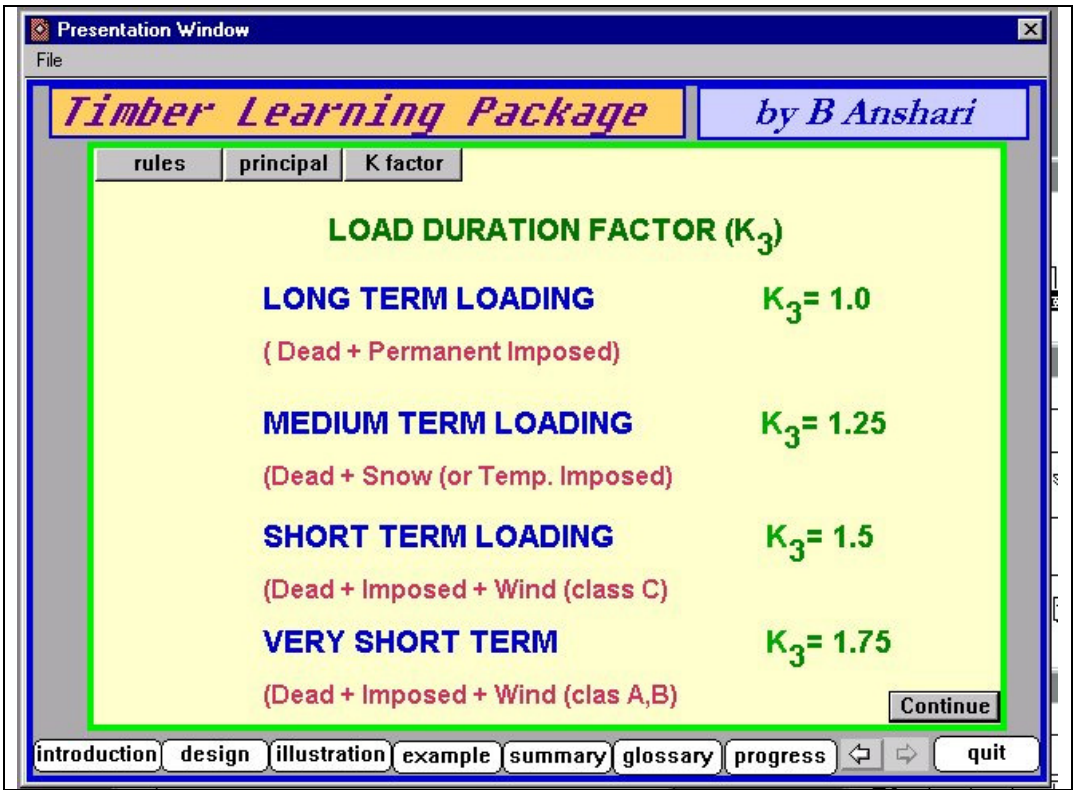

Figure 3.12. Load Duration Factor

C. Illustration

In this **Illustration** menu, I want to show the ability of Authorware as a dynamics and flexible software, which is related to the Timber course. Firstly, an illustration of a solid beam comprises shear force diagram, shear stress diagram, and bending moment diagram as well as bearing illustration of a simply supported solid beam. These diagrams appear with various movements, transitions, and even special sounds.

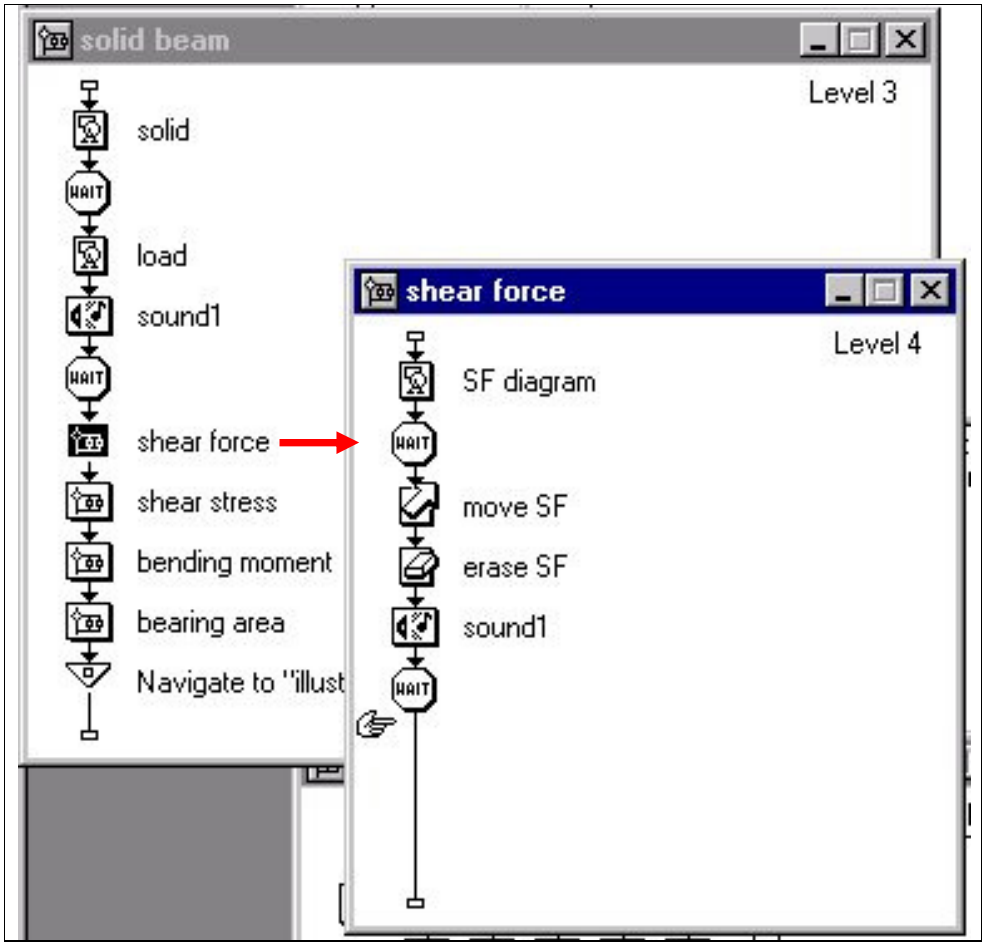

Figure 3.13. The flowline of solid beam illustration

As can be seen in the above flowline, by combination of the appropriate icons the project will appear lively and attractive. An example of illustration, is the shear force diagram. Firstly, a simply supported solid beam appears and is followed by the applied uniform load appearing with a dissolving transition after clicking Continue or pressing any key. The Shear Force diagram then becomes visible with an “Iris Out” transition. If the user clicks Continue or presses any key, the SF diagram will move to the top left corner and is erased automatically.

The displayed shear force diagram can be shown in Figure 3.14.

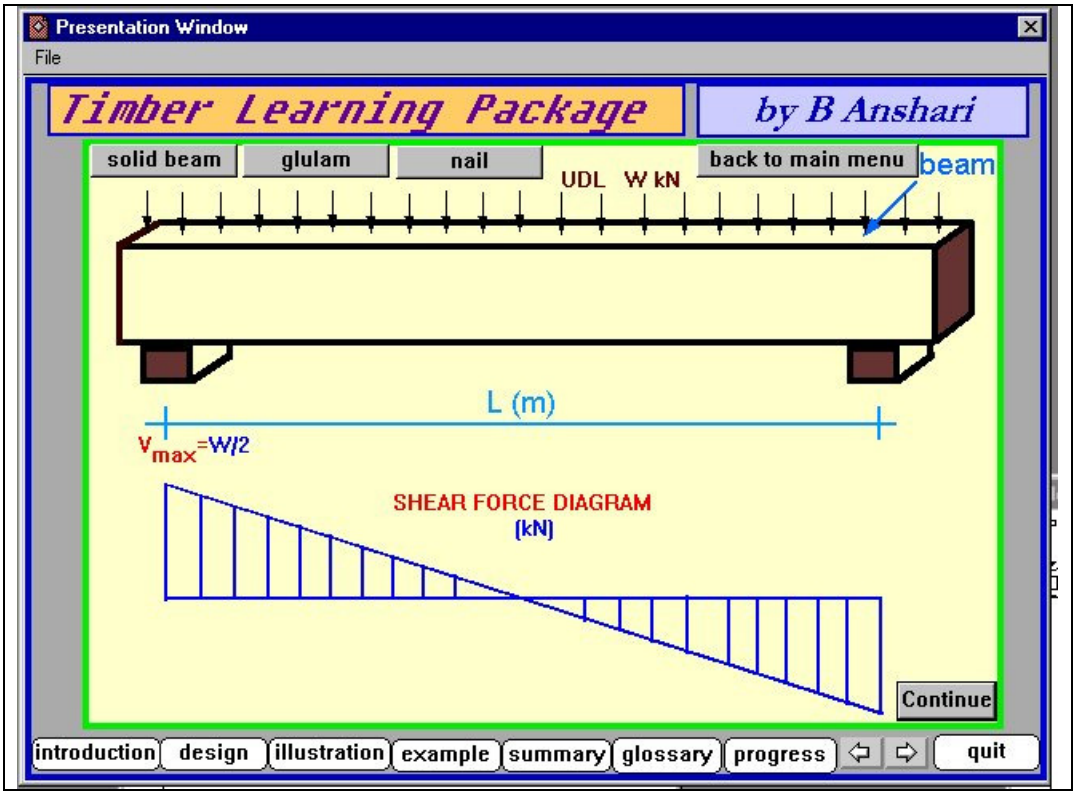

Figure 3.14. Shear Force Diagram Illustration

A second illustration of Glulam beams showing two sorts of glulam i.e. glulam horizontal and glulam vertical beam. In the first illustration, it can be shown how each piece of timber moves horizontally (Push Left and Right transition) to form a glulam beam. It ends up with the lowest piece together with the beam support and cross section of the beam. The second illustration of glulam vertical beams commences by showing a 2D beam and this is followed by a motion from the top screen three times which is represented as if it were three pieces of timber. Eventually, it comes outs the beam section and additional information.

The structure of the flowline and final motion result is as shown in Figures 3.15 and 3.16.

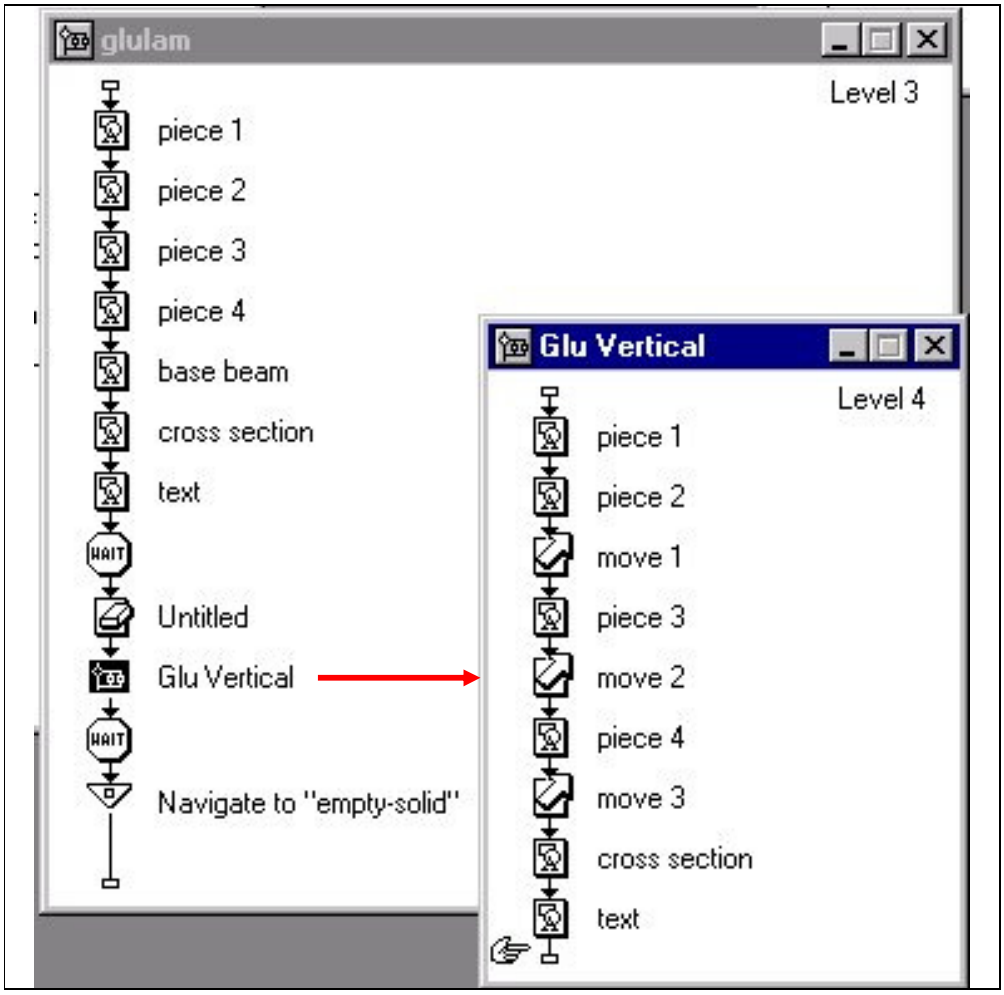

Figure 3.15. The flowline of Glulam illustration

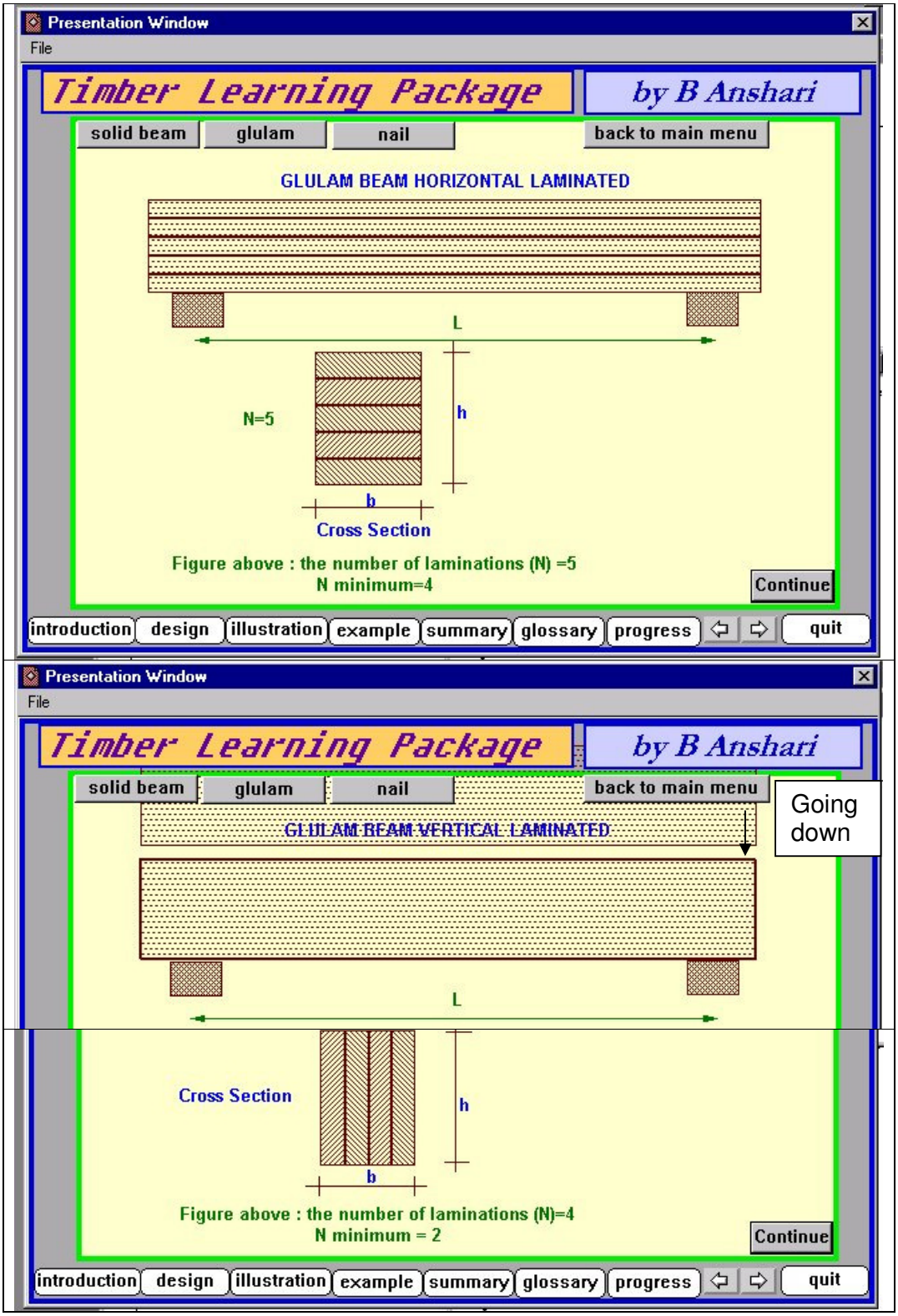

Figure 3.16. Glulam Beam Illustration

A third illustration of Nail Joints shows the movement of two pieces of beam opposite to each other to form single shear nailed joint. This illustration has been described in Chapter II about wait icons. Another illustration in this pages are shows students the minimum nail spacing requirement by showing a block diagram as illustrated in Figure 3.17 and 3.18..

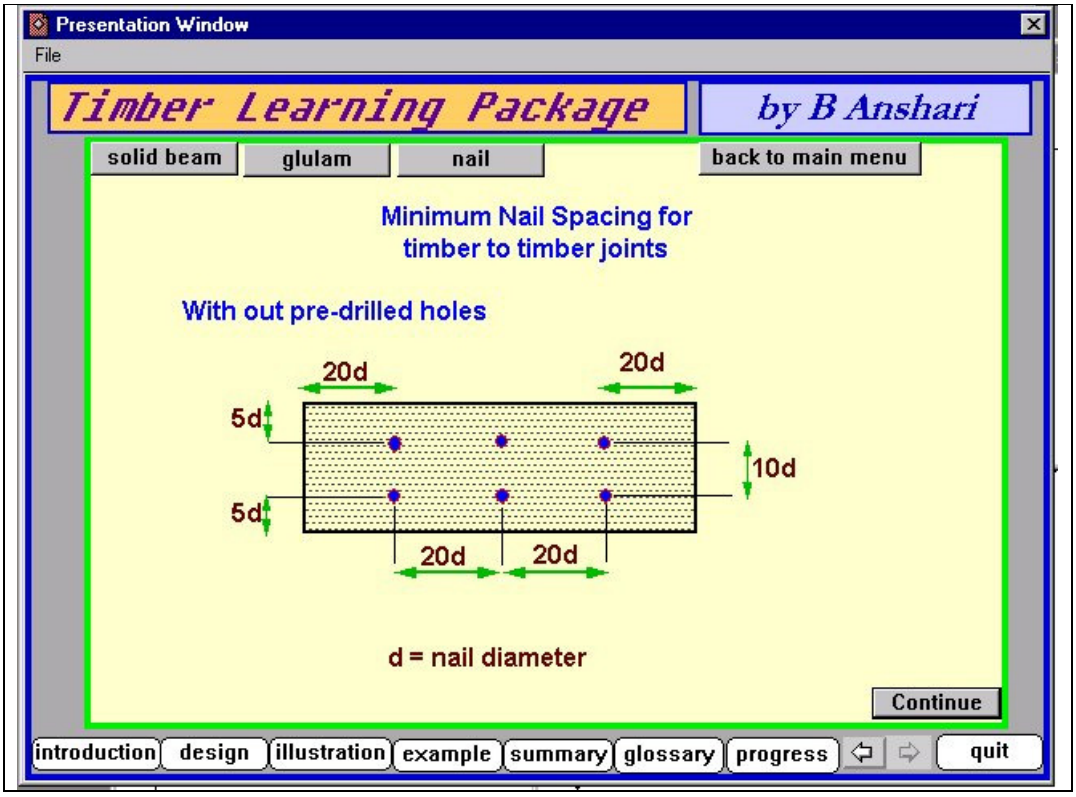

Figure 3.17. Minimum nail spacing without pre-drilling

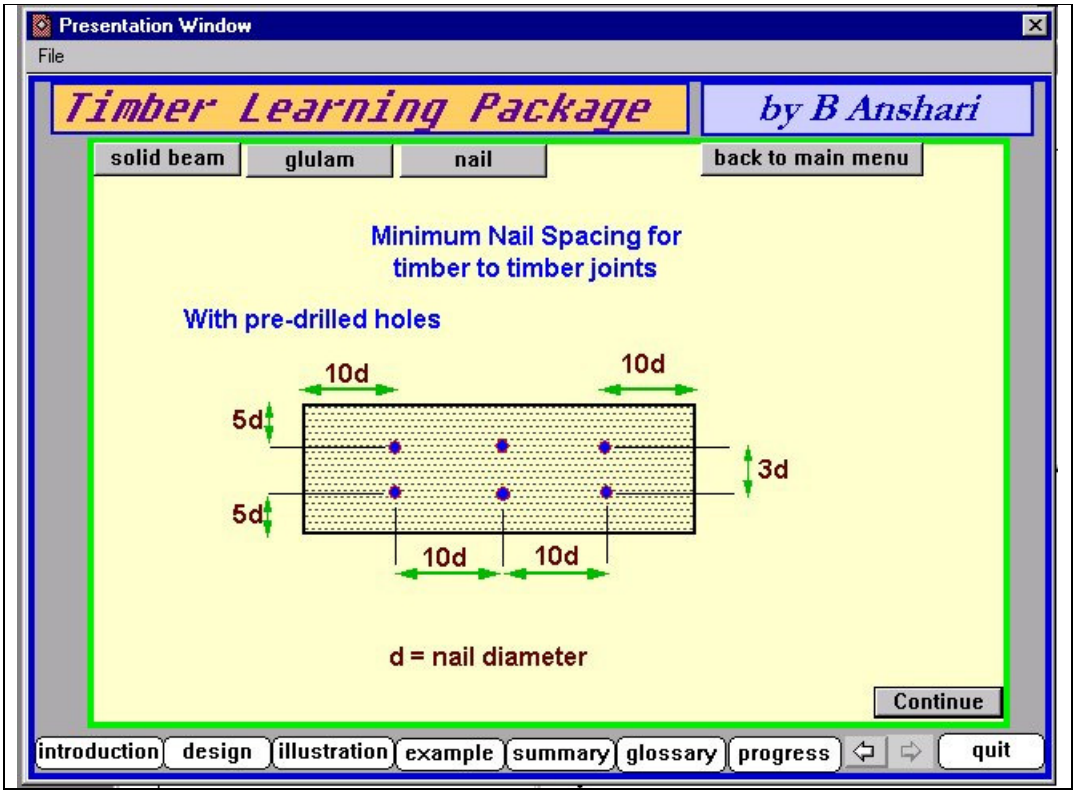

Figure 3.18. Minimum nail spacing with pre-drilling

D. Example/Feedback

In this **Example** menu, several questions are asked, which will cover three topics about Solid Beams, Glulam Beams, and Nail Joints. The types of questions are mostly of multiple choice questions, which is easy to conduct. Interaction icons together with Response type play the main role in this menu such as button, and target area. Each response from users will be given feedback on whether their response is correct or wrong. When a user finds the right answer, the package will navigate to the next question. However, if the user chooses the wrong answer the package will give a chance for the user to try again.

For more detail, see Figure 3.19.

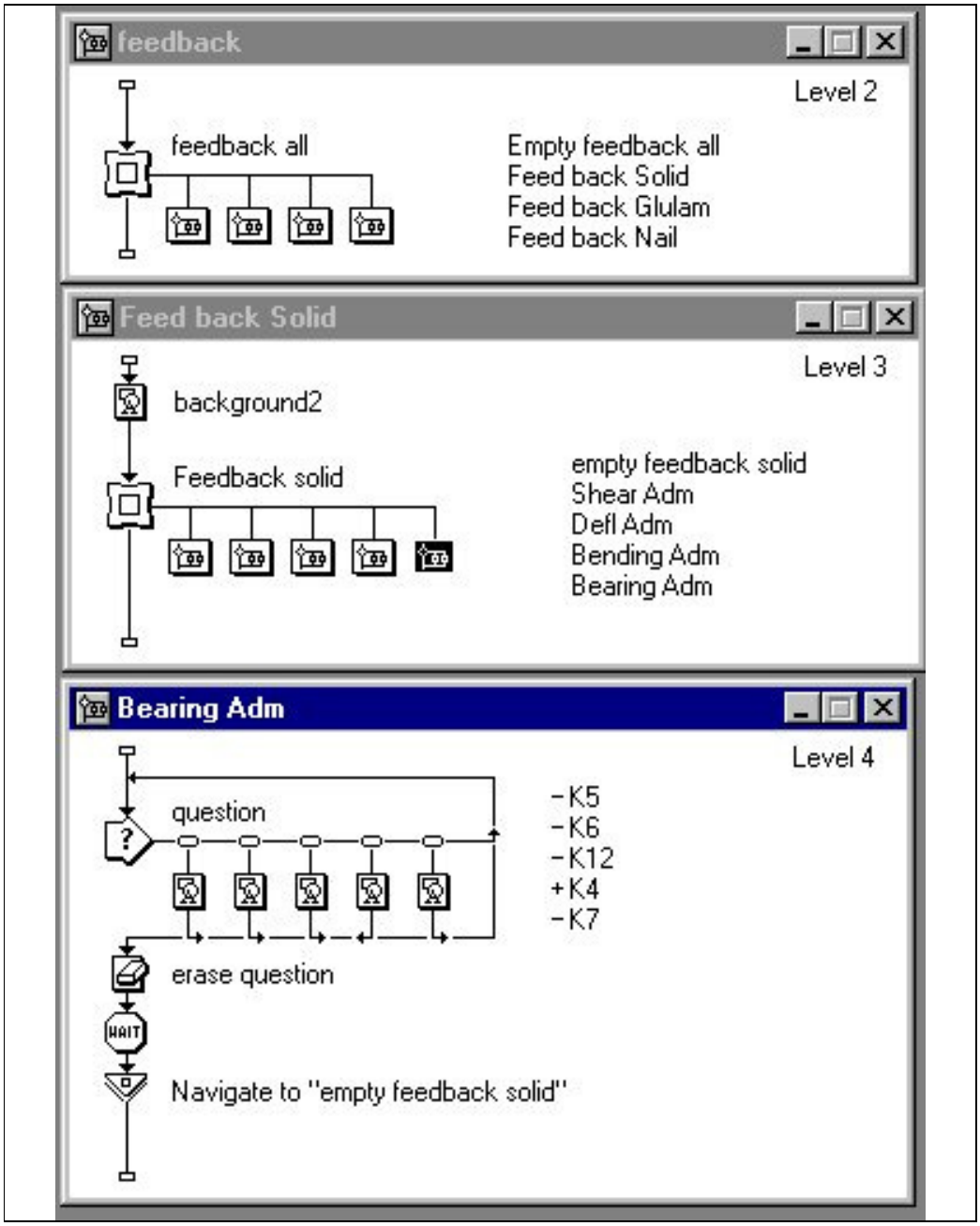

Figure 3.19. The Flowline of feedback and branches

It can be seen that the feedback question is grouped into 3 main groups. For the Solid group this is divided into 4 questions in associated with 4 modes of failure. For example, a question is shown about the admissible bearing stress

formula. The question asks, "What an appropriate K factor to fulfil the formula". The sign '+' and '-' represent the correct and incorrect response which will be recorded by Authorware automatically to assess the user's progress. Look at Figure 3.20 below to show the complete question when a user chooses K6 as the response (wrong answer).

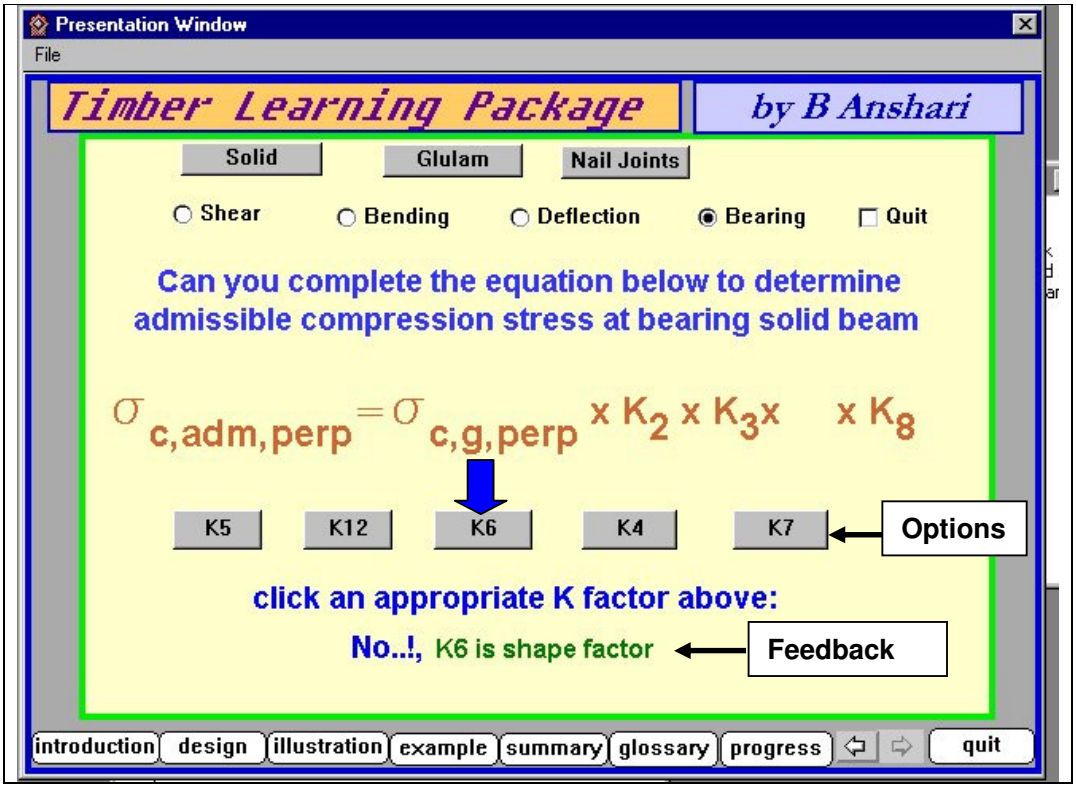

Figure 3.20. Admissible bearing question

There are three questions in the Glulam group feedback about minimum laminations and K factors. As an example, I will show one of the questions i.e. question 2 as shown in Figure 3.21.

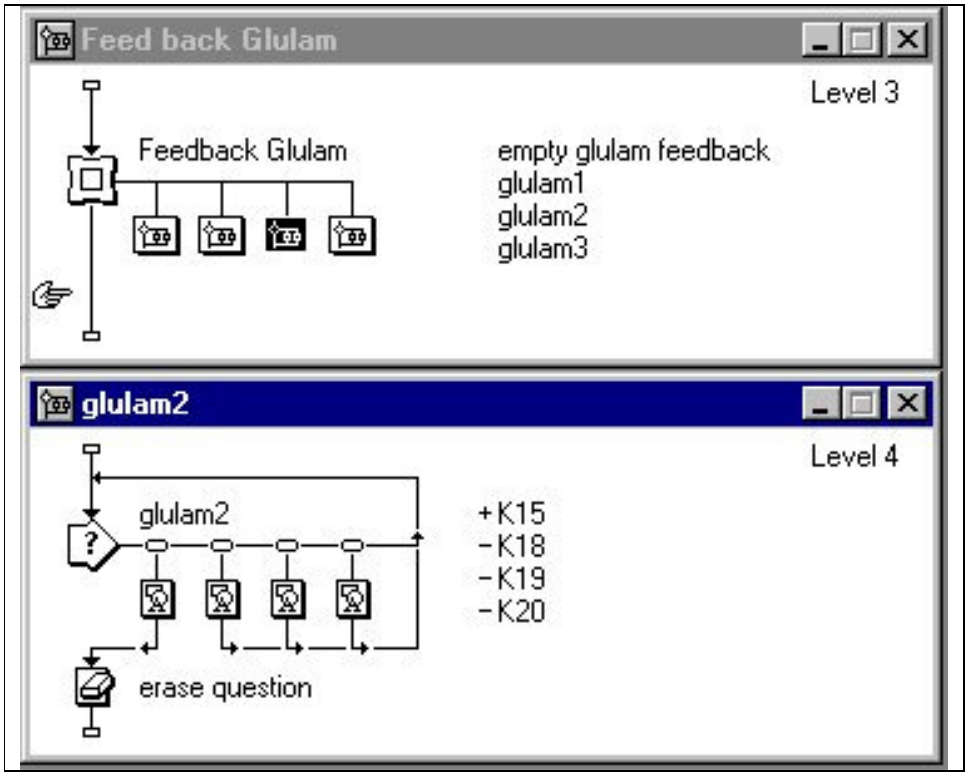

Figure 3.21. The flowline of Glulam feedback

It is seen in Figure 3.21 that K15 is the right response of the question. Therefore, after a user chooses K15, the project will exit interaction. But, if user clicks the other K factors, the branch will return to interaction again.

Figure 3.22 shows that the user has chosen K18 as the response, it will appear as feedback if that is not the answer.

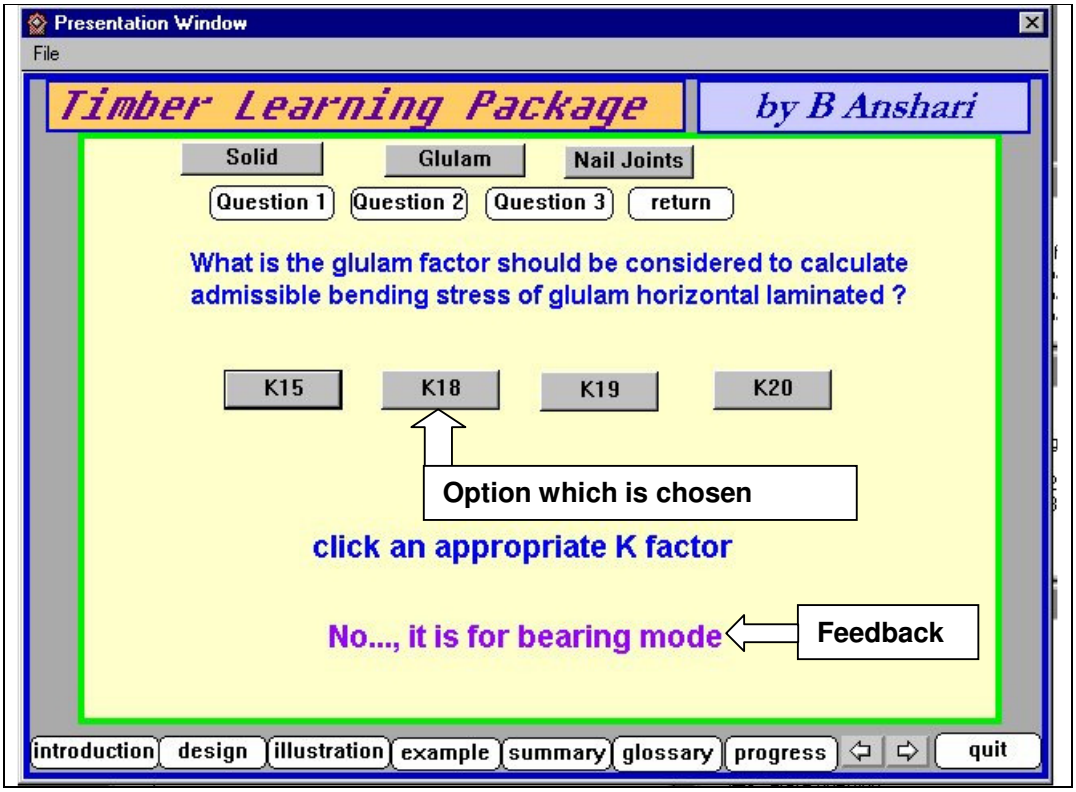

Figure 3.22. An Example of Glulam question

For Nail Joints, I also created 3 questions about K factors for compression and tension members, and the additional percentage of basic nail load for pre-drilled holes. As an example, Question 3 asks, " How many percent may be increased to determine the modified basic nail load". In this case, the user responds correctly (15%), so that the feedback said, "You are right!" As consequence, Authorware will record to judge as the correct response, which will be seen later on in the progress. Subsequently, the user can move to another question by pressing continue.

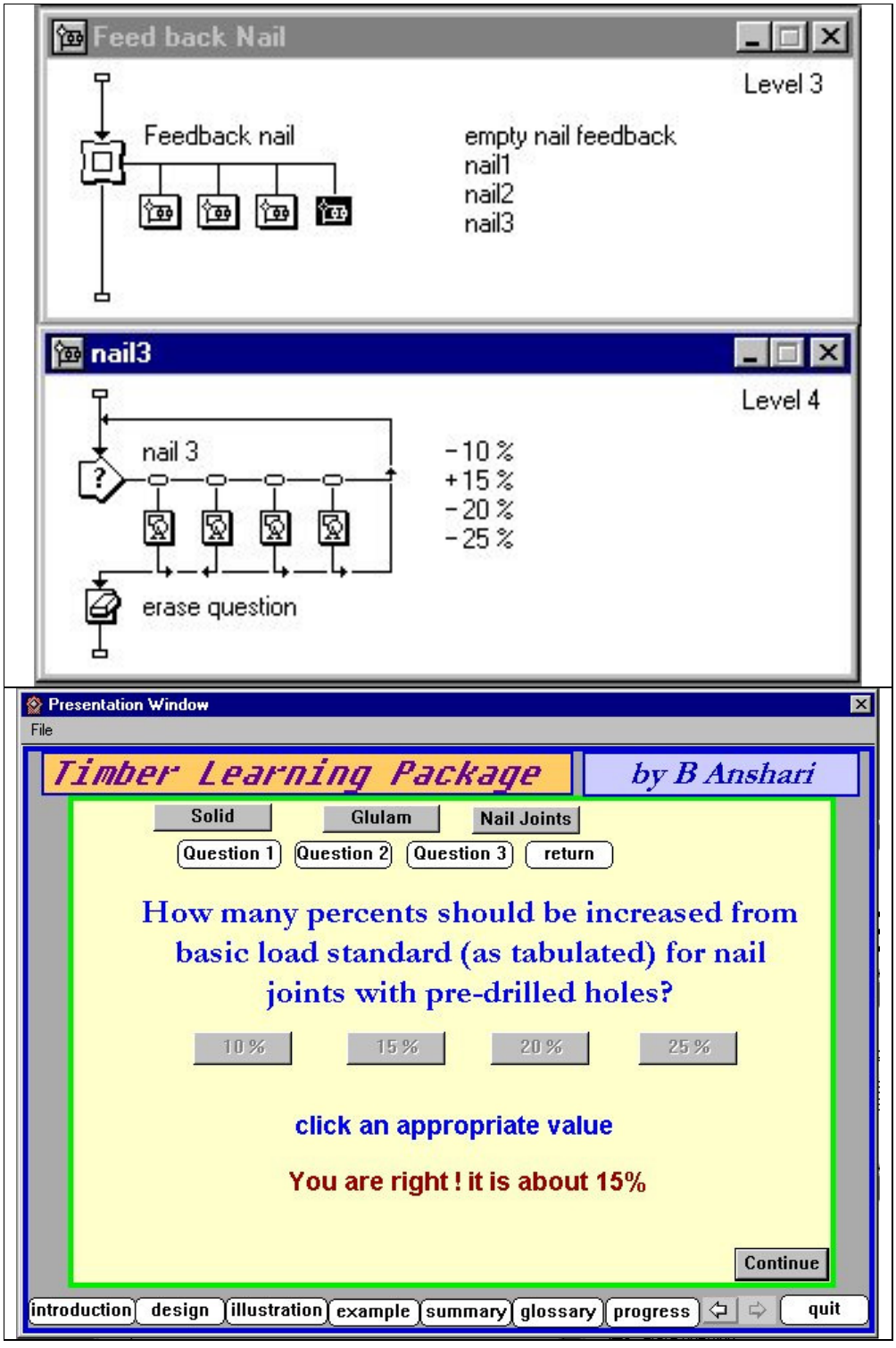

Figure 3.23. The flowline and an example of Nail Joint Question

E. Summary

This menu will cover the extract of whole package in relation to designing of a simply supported beam, glulam horizontal laminate beams, and nail joints. The summary is only consisting of one page as shown below.

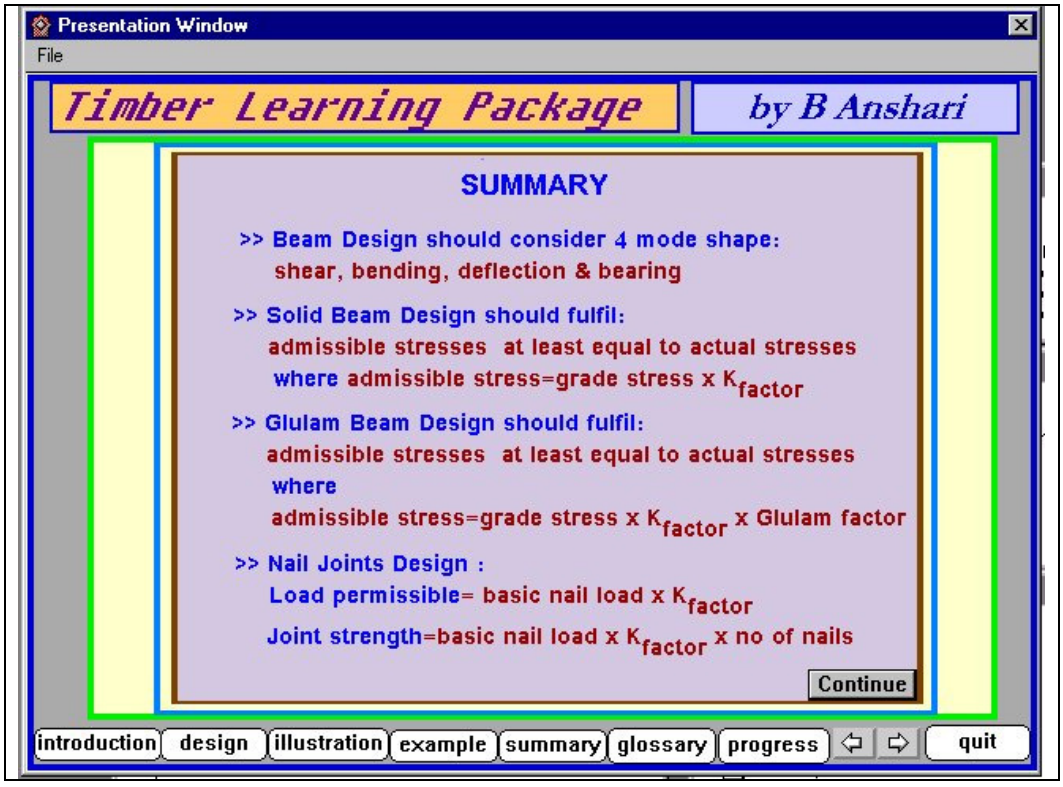

Figure 3.24. The summary of CAL

F. Glossary

As we usually see in the textbook, there is additional information to help readers to become familiar with the book content. In this CAL, I have just shown several terms and notations, which have been used in the package. One of the flexibility of Authorware is, the ability to show text, which is long enough with scrolling text.

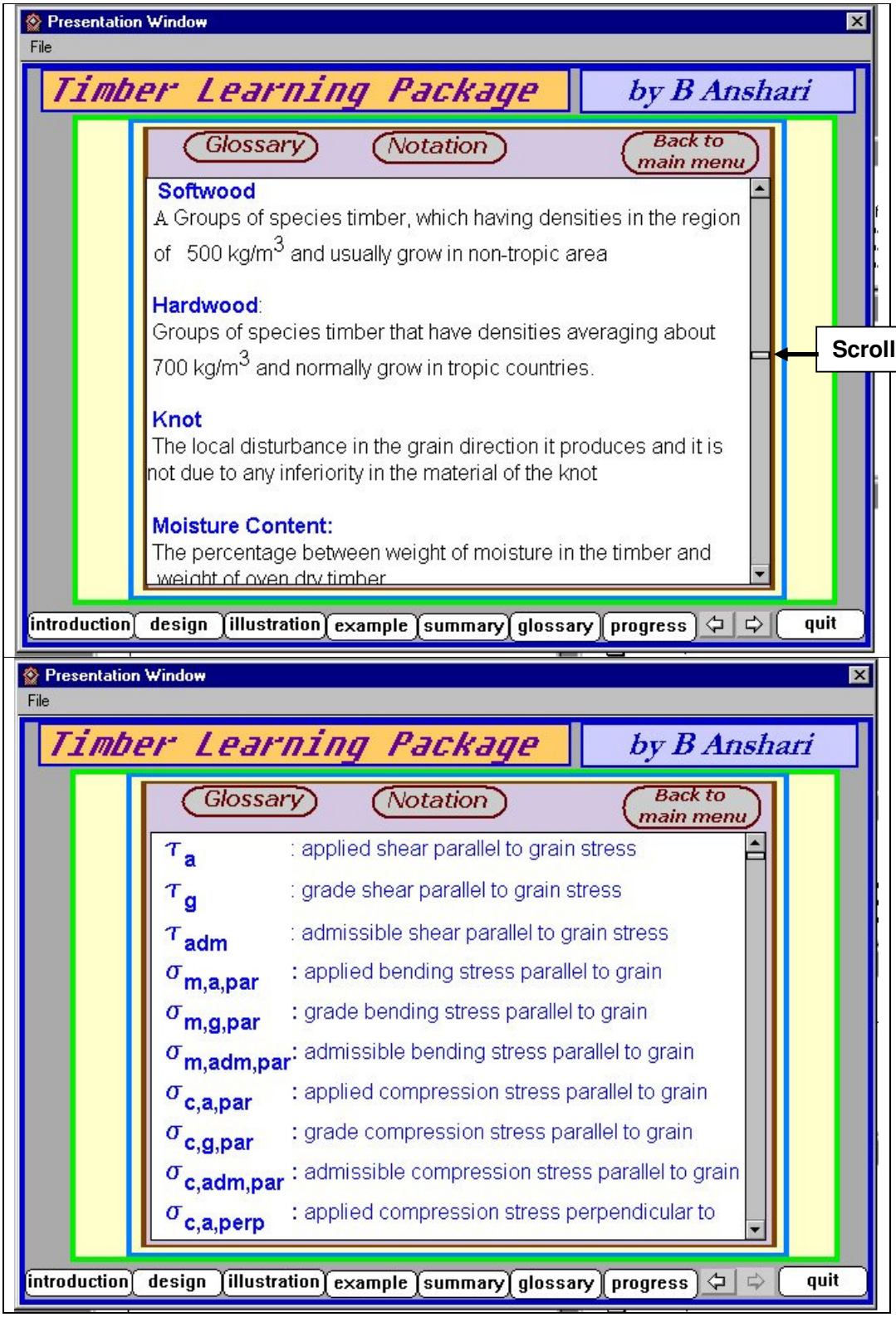

Figure 3.25. Glossary and Notations

G. Progress

As mentioned before Authorware enables a track the progress of users and assesses their score at the end of running the package to be made. There are several variables which are provided in Variables Window such as PercentCorrect, JudgedInteractions, JudgedResponses and TotalWrong, which are dealing with this matter. An example in this CAL can be shown in Figure 3.26.

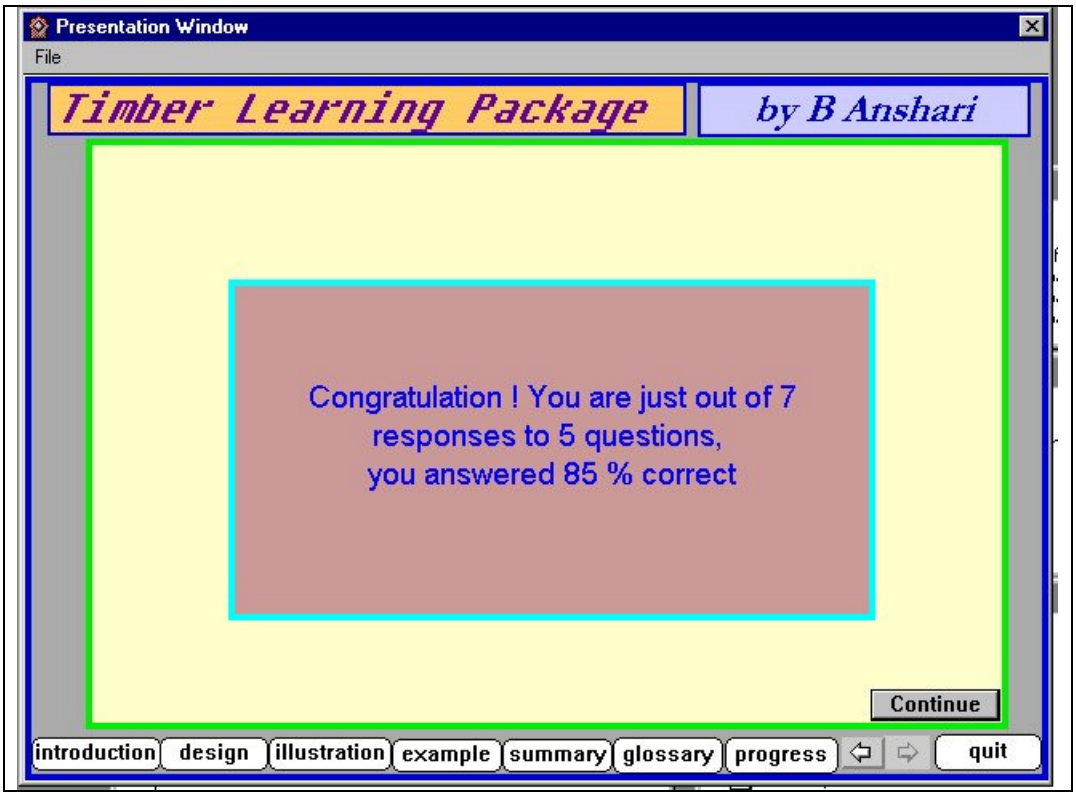

Figure 3.26. Progress of Feedback Interaction

The value of 5 represents the number of Interaction that has been passed by user ("JudgedInteractions" variable). Whereas, the value of 7 mean that the user have done 7 responses ("JudgedResponses" variable) and the value 85% correct is came from PercentCorrect command.

COMPUTER AIDED ASSESSMENT TIMBER (CAA-TIMBER)

To create the CAA-Timber, I used the provided assessment system, which is called TRIADS. The TRIADS assessment system is produced as part of the Assessment of Learning Outcomes Project. This project is devised by the University of Liverpool in collaboration with the University of Derby, and The Open University, U.K. The TRIADS system also uses Authorware for all applications in this project. In this system, the tutor can create the sequence of questions as desired. For my project, I created a three part Timber test in associated with my topics i.e. Solid Beams, Glulam Beams, and, Nail Joints. The questions that I presented in this project consisted of the design and the analysis of timber members.

The main flowline of The TRIADS System can be shown in the Figure 4.1.

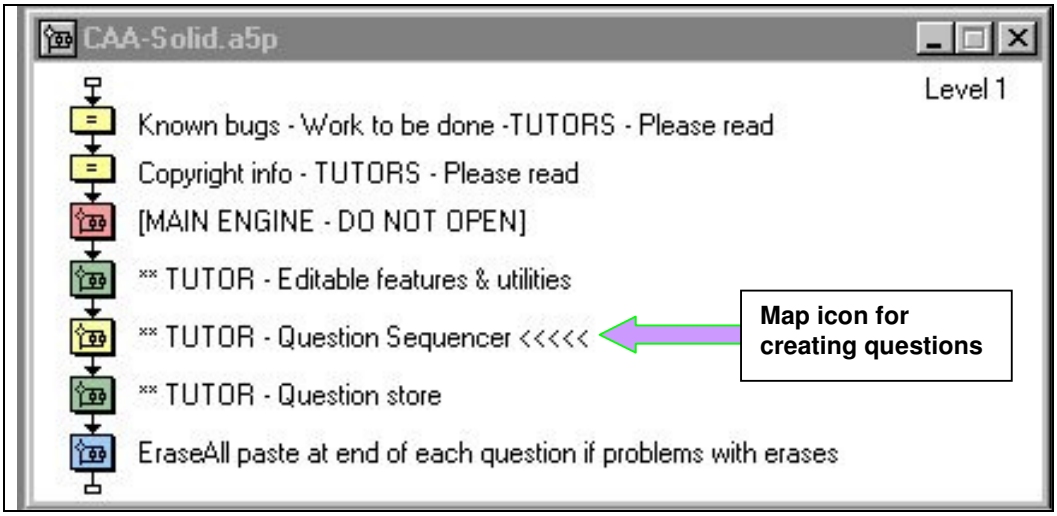

Figure 4.1. The main flowline of TRIADS System

A. Timber Test 1 : Solid Beam

In this part, the test comprises 16 questions, which cover structural analysis, determination of stresses and stiffness of a simply supported solid beam. I created a lot of variables in associated with solid beam design. To randomise these variables, Authorware has the ability to allocate different values within a particular range every time a user runs the project. Therefore, the learners/students can obtain different assessment to be done. In addition, Authorware can record the score the user to assess their progress during running the assessment.

As an example, I will show one question (Question 6) which is how to determine the admissible shear stresses for a simply supported solid beam. The procedure to create this question can be described as follows.

1. Identify the variables which will be involved in this question:
   - Bearing length, which is named *brg_lgth*
   - Depth of beam, section which is named *height*
   - Width of beam, section which is named *breadth*
   - The applied total UDL, which is named *W*
   - Clear span of beam, which is named *Cl_span*
   - Load sharing factor, which is named *K8*
   - Etc.

   All variables above are assigned in the Calculation icon Window by using **Random** function with specified range and step as shown in Figure 4.2.

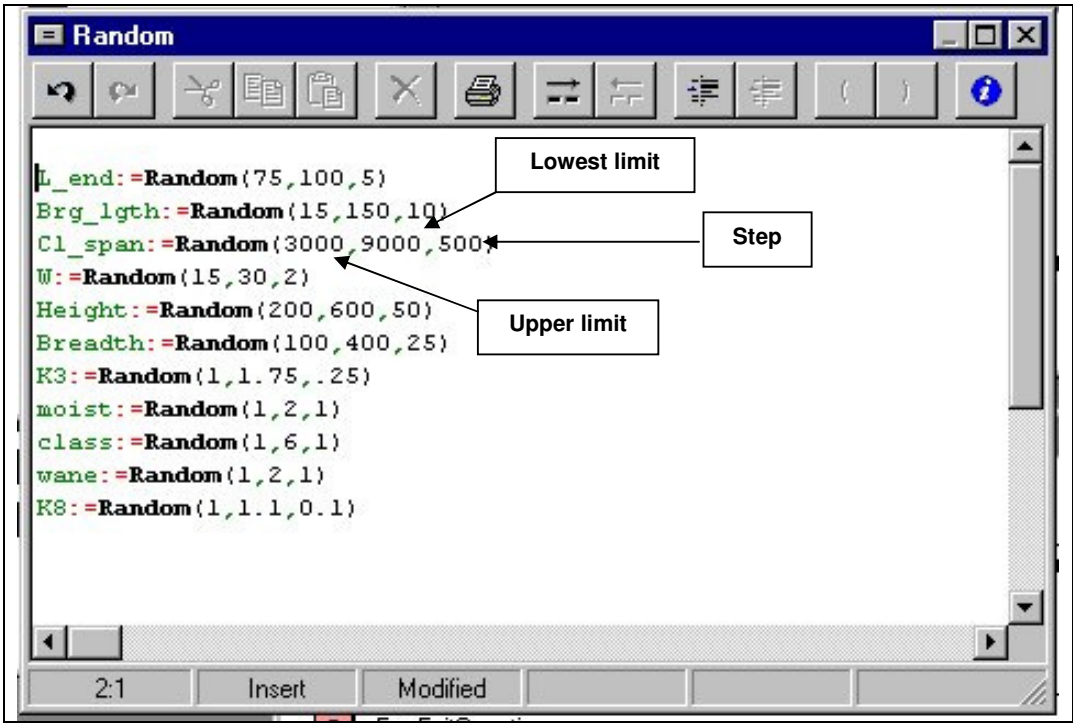

Figure 4.2. Random Variables

2. Define the question by using label expression, which is written between quotation marks.
3. Add some information, which is necessary to complete the question such as the grade stress for a specified strength class, value of moisture factor for shear properties.
4. Formulate the equation to answer the question by using the provided variables.
5. Create the question in the Display icon by using defined variables and add some graphics to illustrate the question.
6. Create the brief feedback to give the right answer to the users.

An example, how to define question can be seen in Figure 4.3 below.

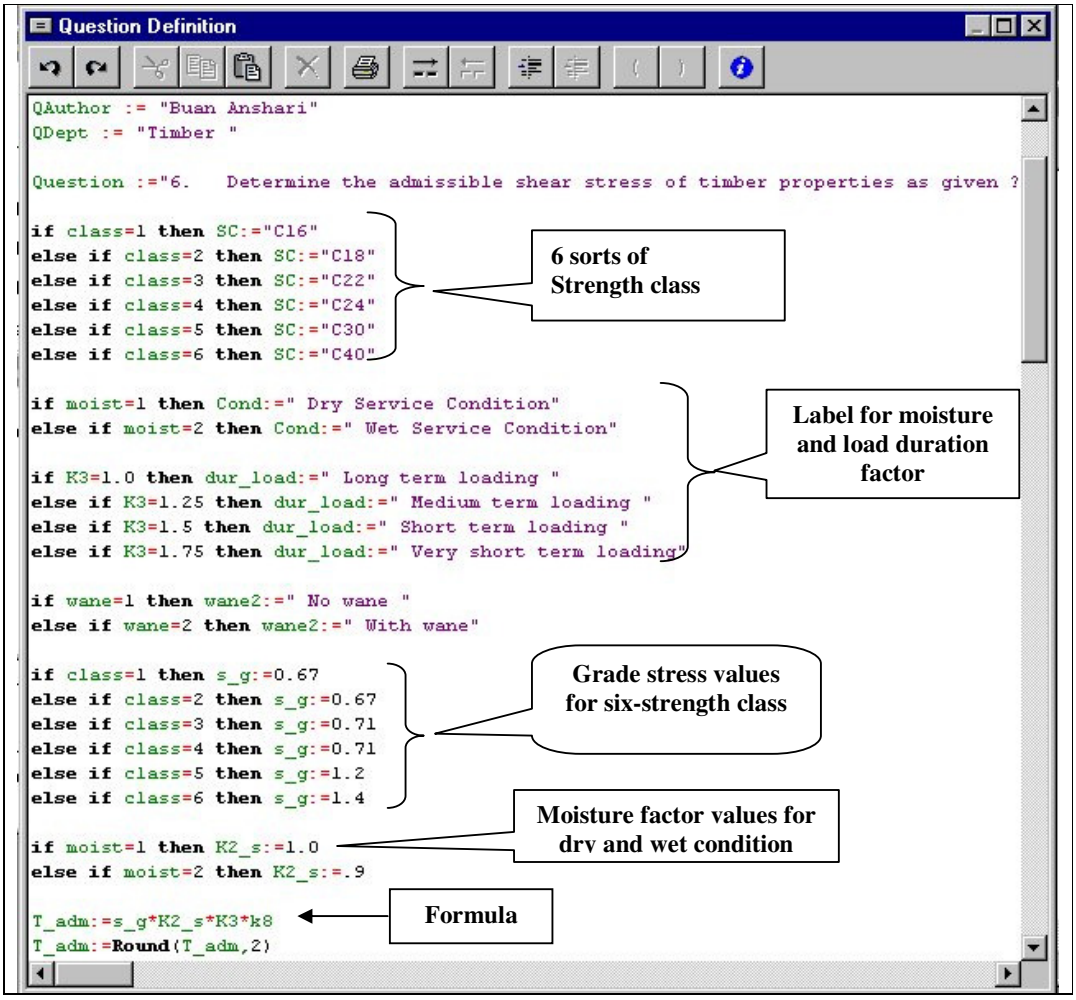

Figure 4.3. Question Definition

In this example, six sorts of Softwoods are shown as a sample. It can be seen that **If** or **else if - Then f**unctions have a main role to assign either values or labels the expression as desired. The **Round** function is used to limit how many decimals are assigned to the results of the variables.

The typical question which is asked as illustrated in Figure 4.4.

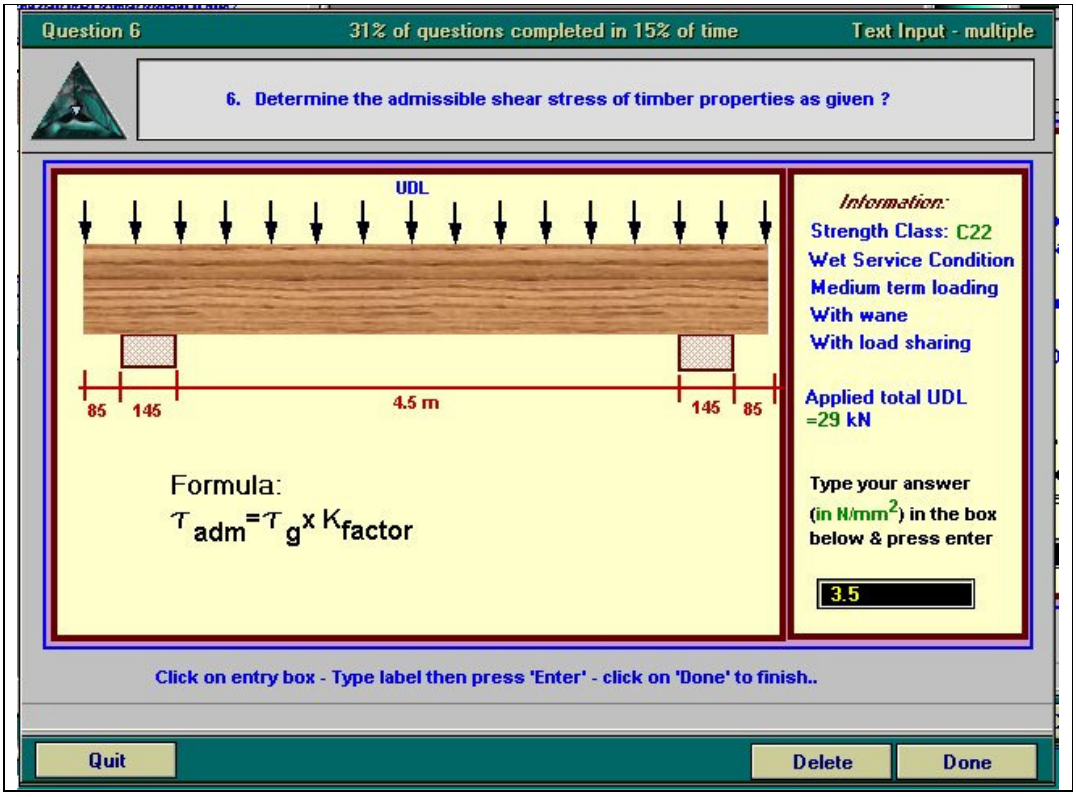

Figure 4.4. Typical Question 6

This Presentation window shows all relevant variables which are needed to solve the given question. The variables which have text expression are Timber C22, Wet Service Condition, Medium term loading, Load Sharing, etc. Whereas the variables which have a value expression are applied total UDL, bearing length, clear span, etc. A Text Entry and Buttons facility are also provided to guide the user interactively through the package.

In other to convince the users/learners about the answer for the question, it is sensible to give some feedback about the answer. As in the example in Figure 4.5 below, the answer of 0.88 N/mm^2 came from multiplying the grade shear stress by the appropriate K factors. K factor variables are based on the condition which has been shown in the Question Window, for example, K2=0.9 is due to a Wet Service Condition, K3=1.25 is due to Medium Term Loading, and K8=1.1 for a load sharing member.

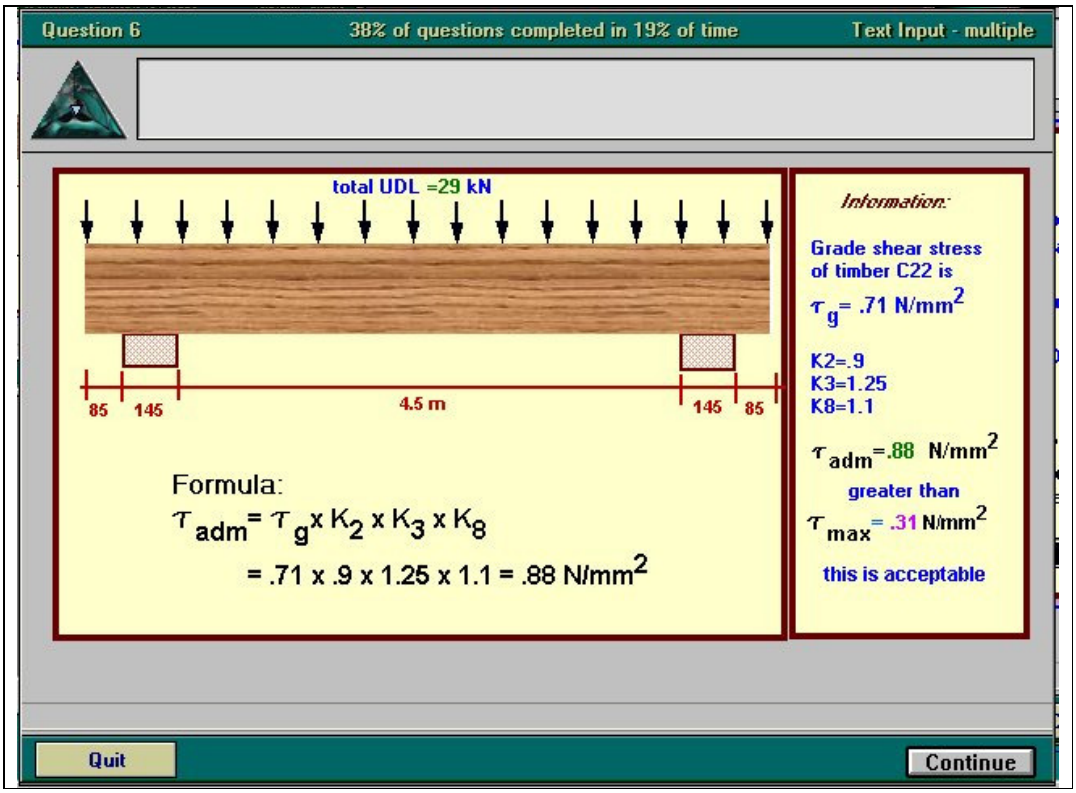

Figure 4.5. Typical Feedback Question 6

B. Timber Test 2 : Glulam Beam

In this part, the test has the same pattern as previous part, but there is a change to suit to the new topic about the design of Glulam beam, especially the horizontal laminated beam. This test consist of 17 questions which covers two main parts; the design of beams of 13 questions and the analysis of beams of 4 questions. As an example, I will show the last 4 questions (Question 14,15,16 and 17) as shown in Figure 4.6.

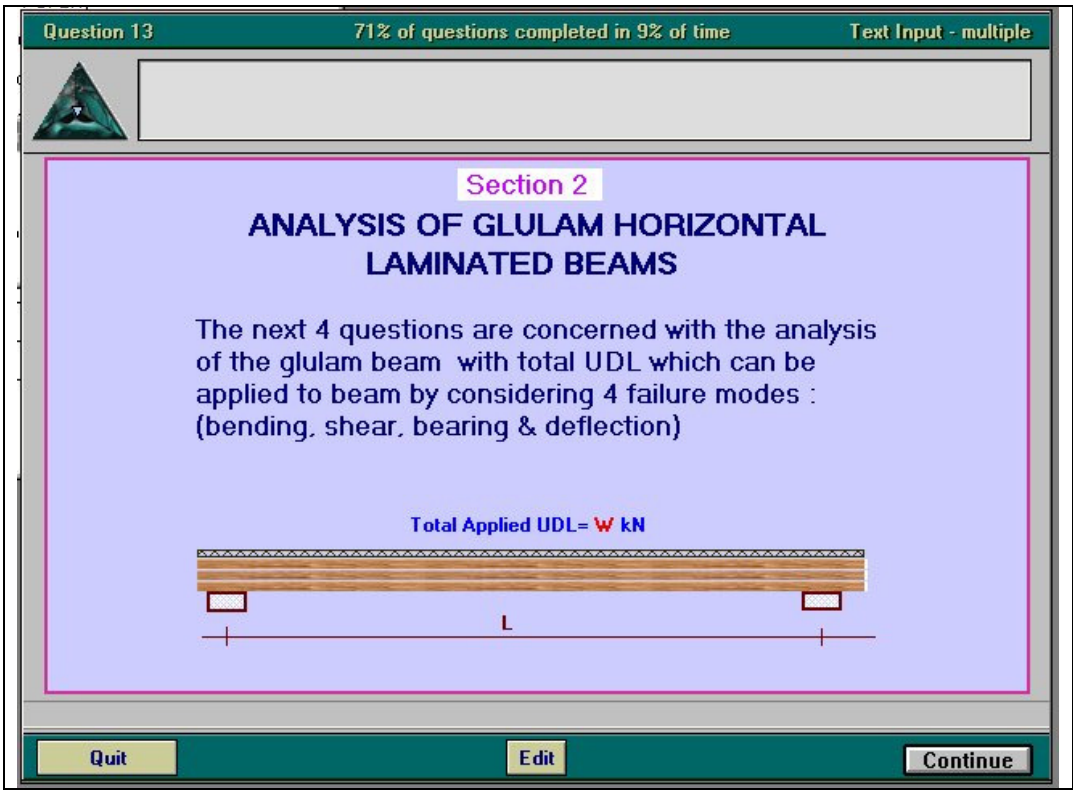

Figure 4.6. Typical information of question

The structure of flowline comprises several levels which represent a branch of the upper map icon. As an example, I present the flowline structure for question 25 on the next page.

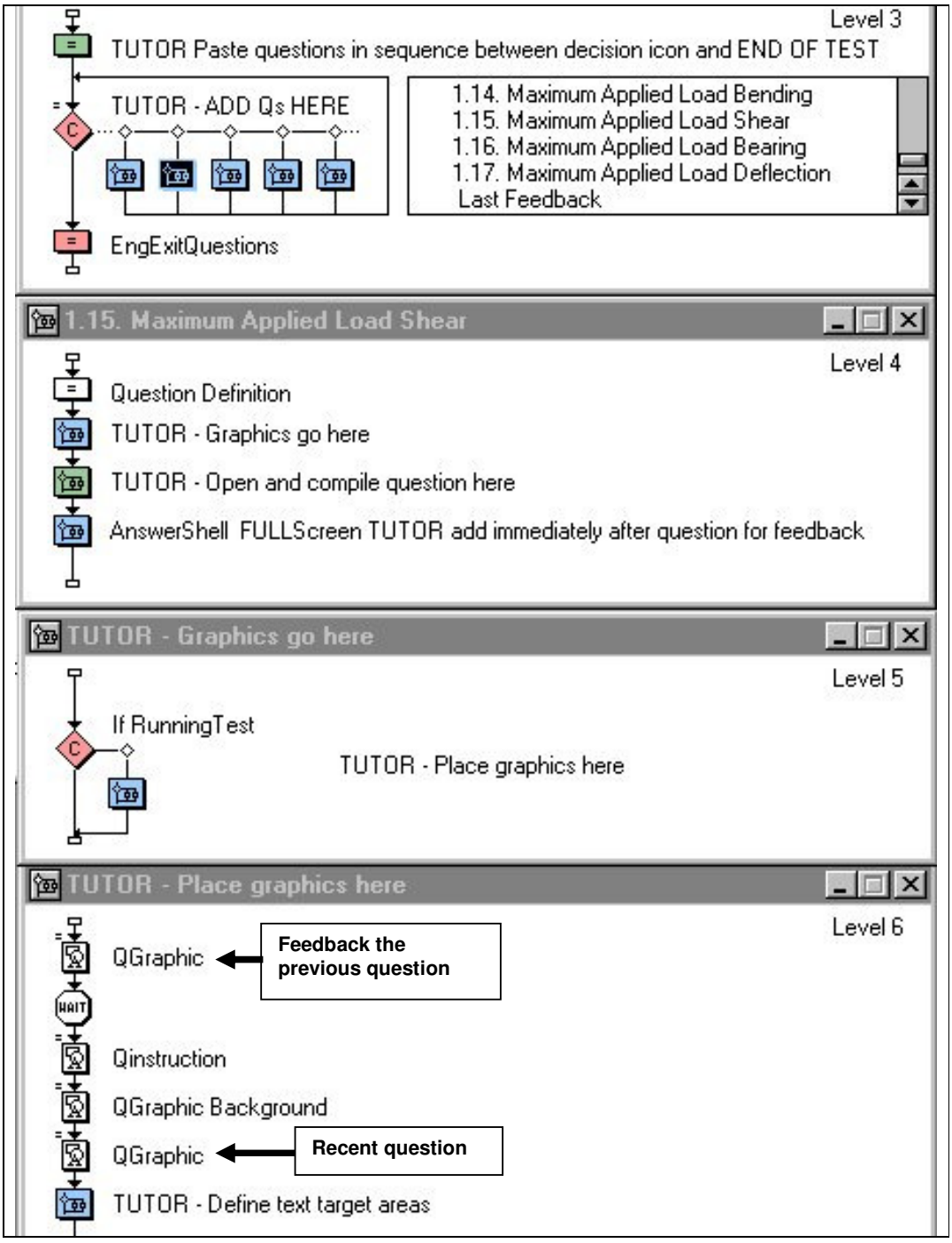

Figure 4.7. Typical Flowline of Question

An example of the question definition in the calculation icon can be seen in Figure 4.8 below, the formulation of Question 17 together with analysis of the permissible load from 4 mode failures.

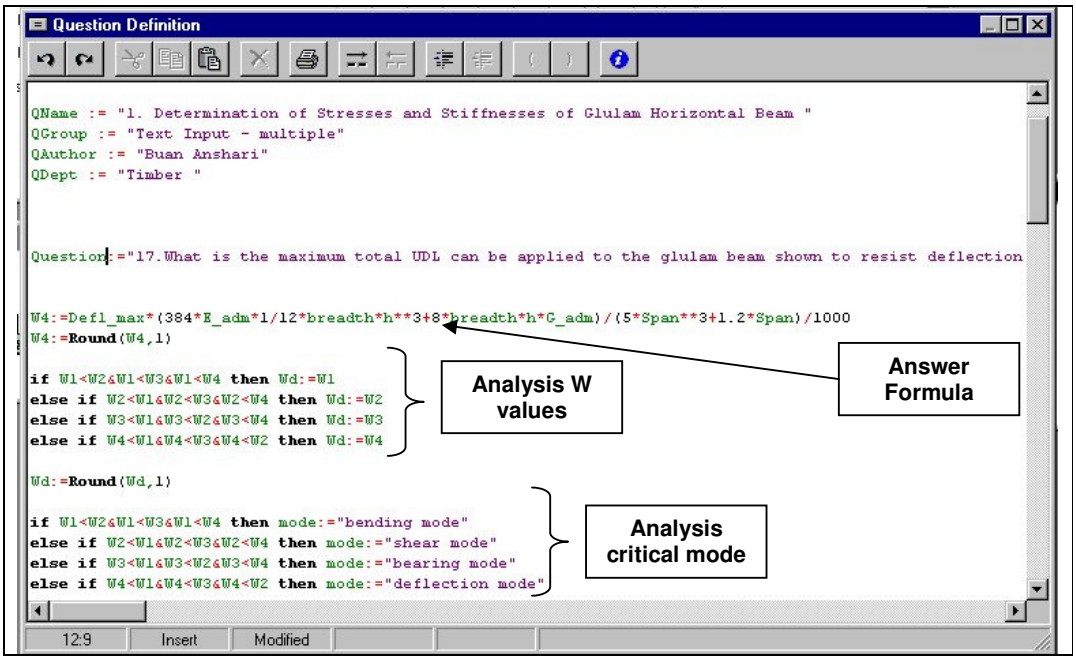

Figure 4.8. Question definition in the Calculation Icon Window

The instructions of Questions 14,15,16, and 17 is to determine the maximum total UDL (**W**) can be applied to the glulam beam shown to resist bending, shear, bearing and deflection respectively, given the admissible stress and stiffness. Each question will establish the different result of the value of **W** and eventually, by "If Then" function, will analyse which W is the minimum value to use in the design. The appearance of Question Presentation Window and feedback of each question can be seen in Figure 4.9 to 4.11. I just showed Question 14 and feedback all four questions. The last figure also shows the feedback analysis necessary to decide the critical mode failure.

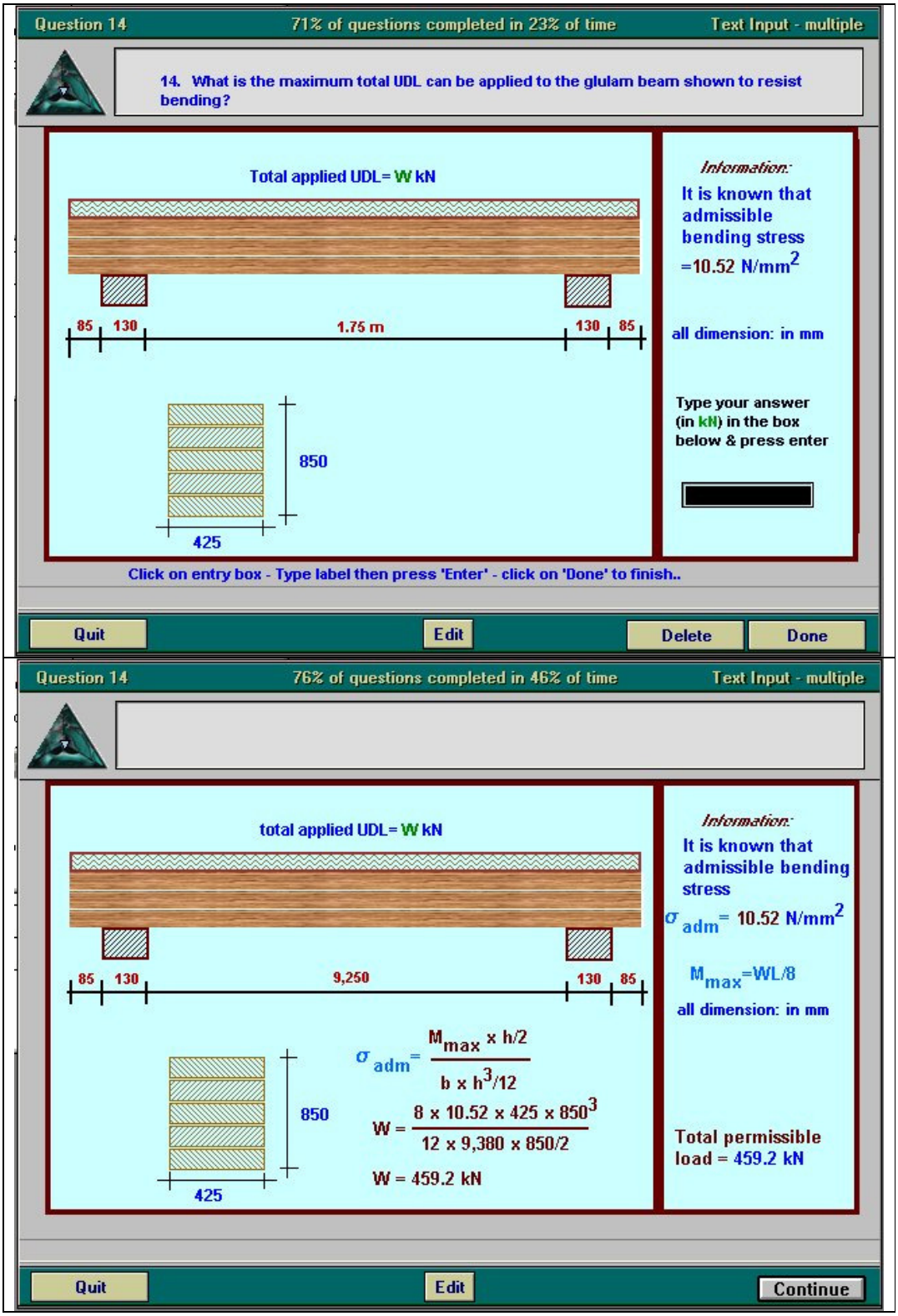

Figure 4.9. Question and Feedback Question 14

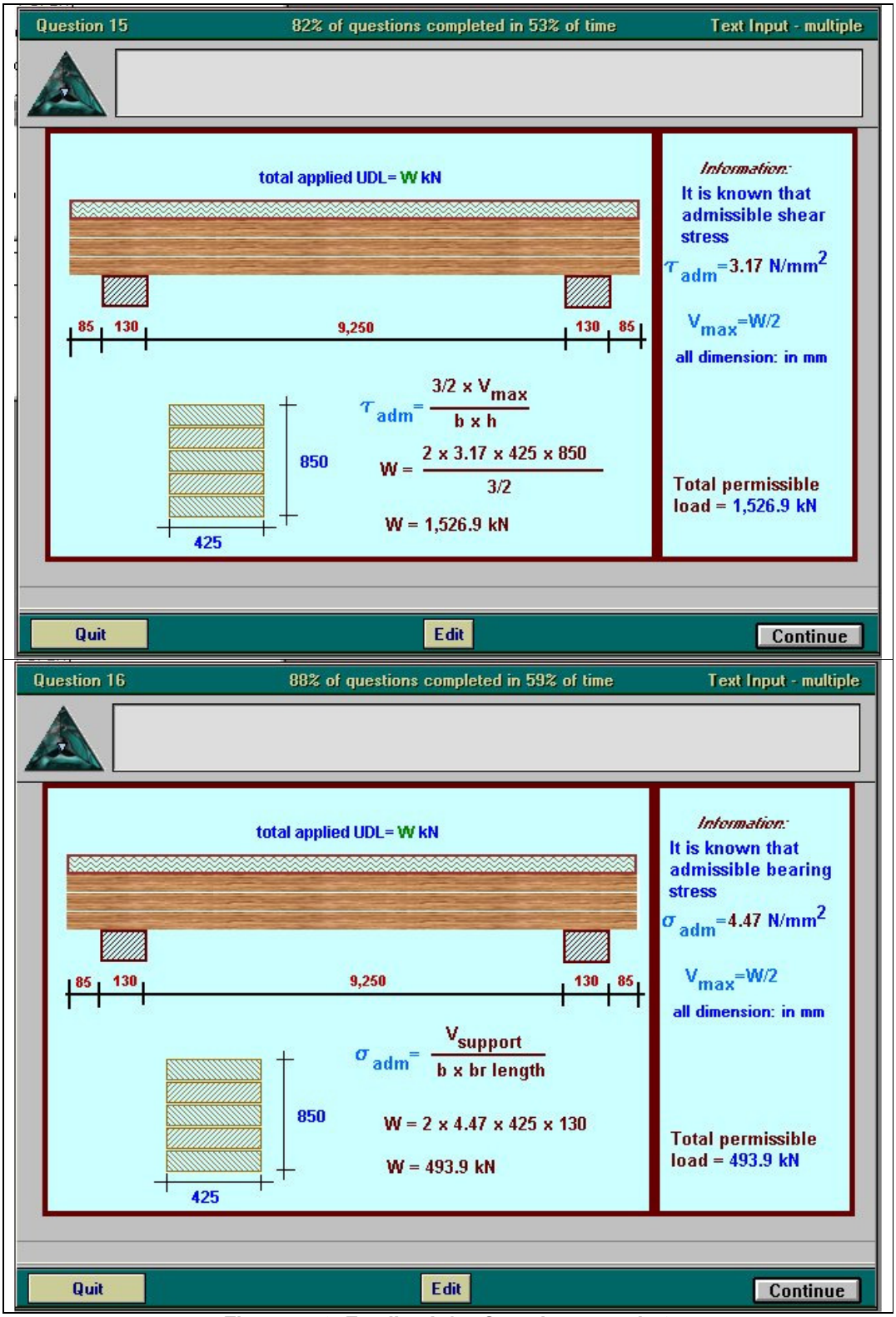

Figure 4.10. Feedback for Question 15 and 16

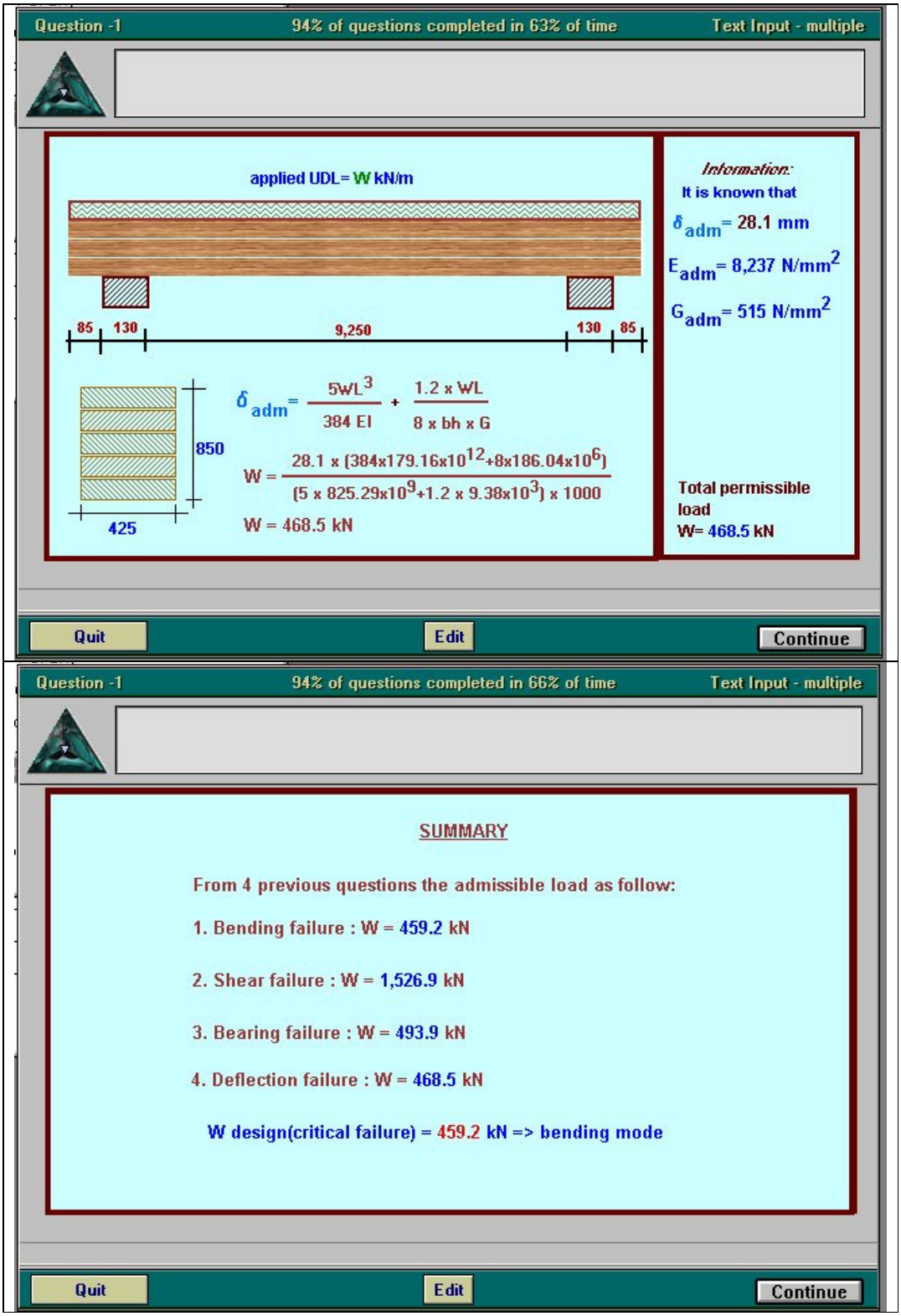

Figure 4.11. Question 17 feedback and Feedback Summary

3. Timber Test 3: Nail Joint.

In the last part of this CAA, I created 13 question about nail joints in a simple truss. This test is also divided into two main parts; the first section covers the structural analysis of a simple truss, the admissible stresses of tension and compression member, the admissible load per nail which can be carried due to a particular applied load, etc. The second section contain the analysis of the maximum admissible load that can be carried by a simple truss for the nail specification and stress admissible given, by considering member and joint failures.

The typical flowline at Level 3 and 4 of this part can be shown in Figure 4.12.

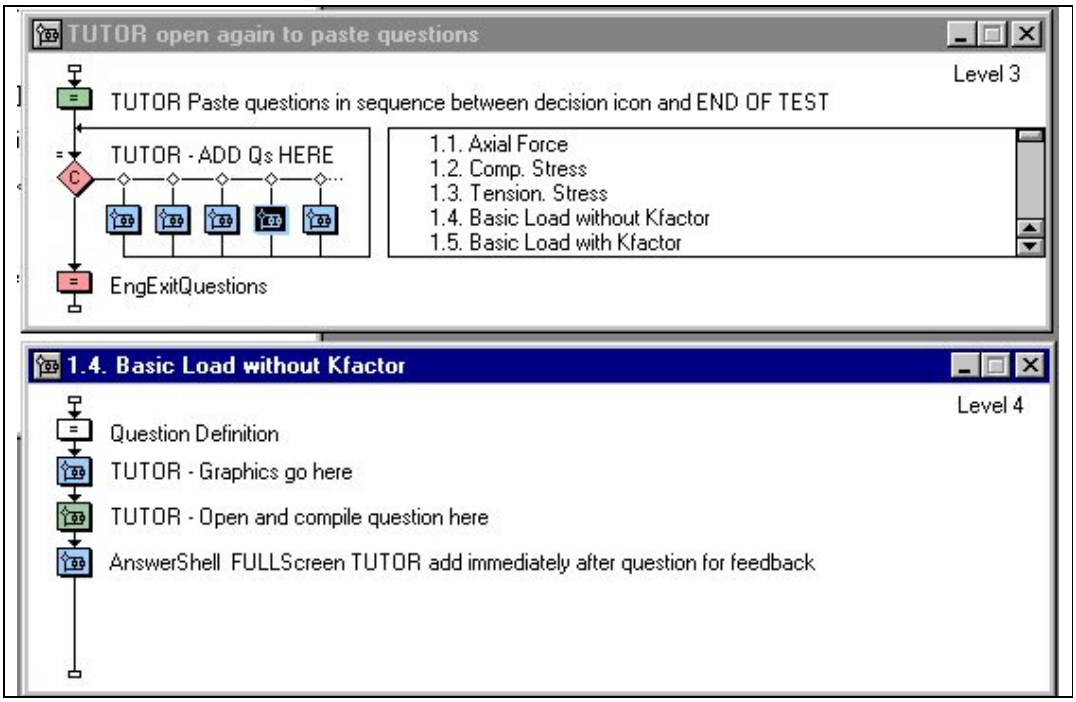

Figure 4.12. The flowline of sequence questions

As an example, I will show the typical Displayed Question and Feedback which is related the flowline in Figure 4.12 that is Question 4. The Question asks, "What is the basic nail force design for the nail specification given". All relevant information to deal with this question should be provided, such as strength class, nails diameter, standard penetration, and basic shear load standard as tabulated in BS 5268. This information must be assigned in Calculation icon by using the appropriate variables and functions. See Figure 4.13.

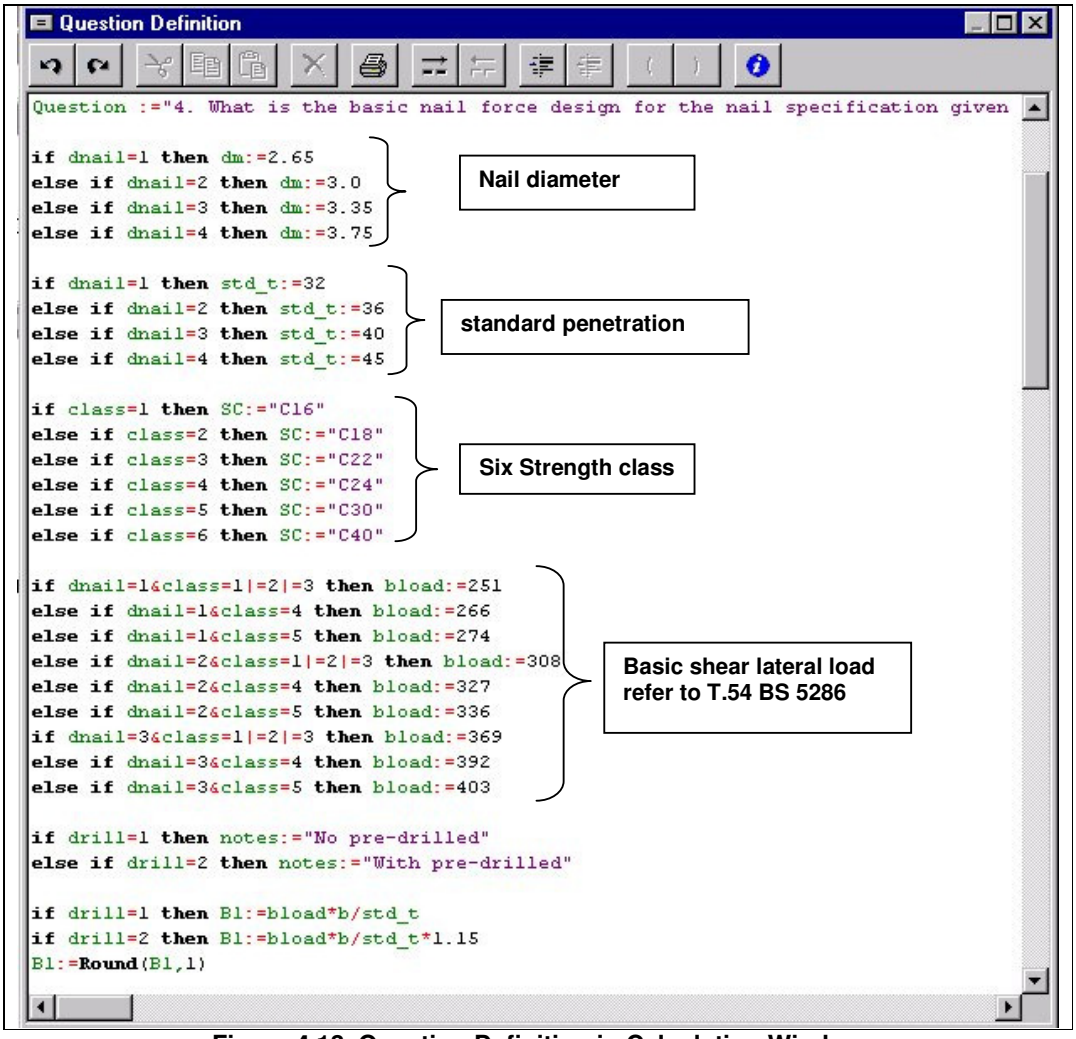

Figure 4.13. Question Definition in Calculation Window

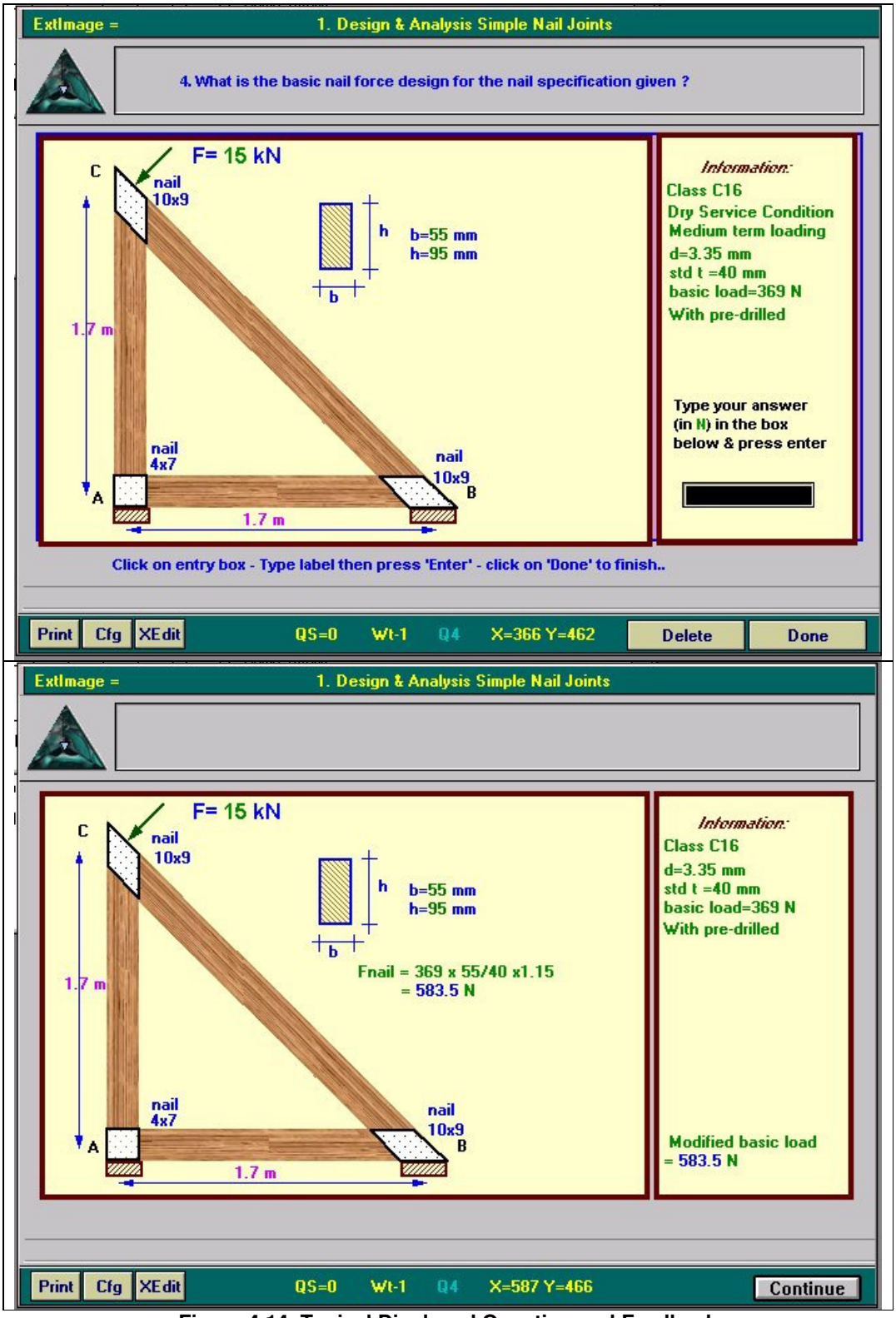

Figure 4.14. Typical Displayed Question and Feedback

As mentioned before Authorware enables a track of the progress of users and assesses their score. This assessment can be recorded after each question or after all the questions as cumulative score at the end of running the package. As an example, in this CAA, a typical assessment after each question i.e. Question 11 in Timber Test 3 can be seen in Figure 4.15,

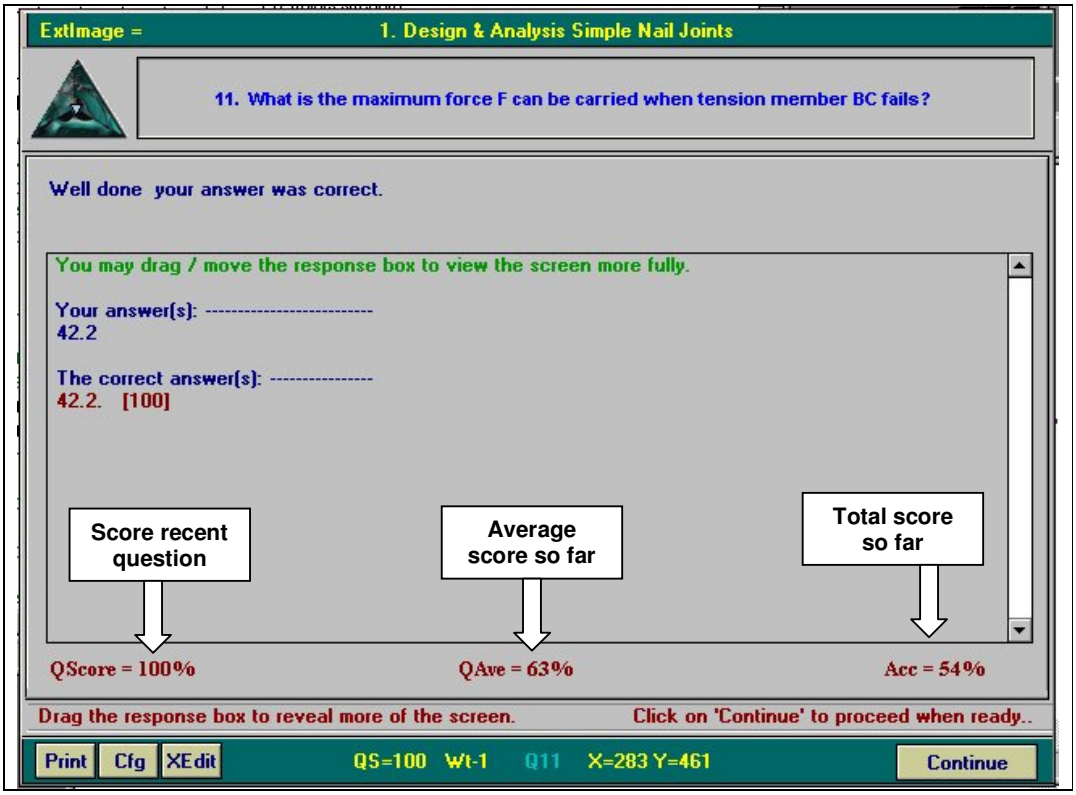

Figure 4.15. Typical Assessment

The assessment of whole questions (13 questions) can be seen at the end, after running the package. Also shown the summary of all the questions and the final score of the user during interacting with this assessment package. For more details, see Figure 4.16 on the next page.

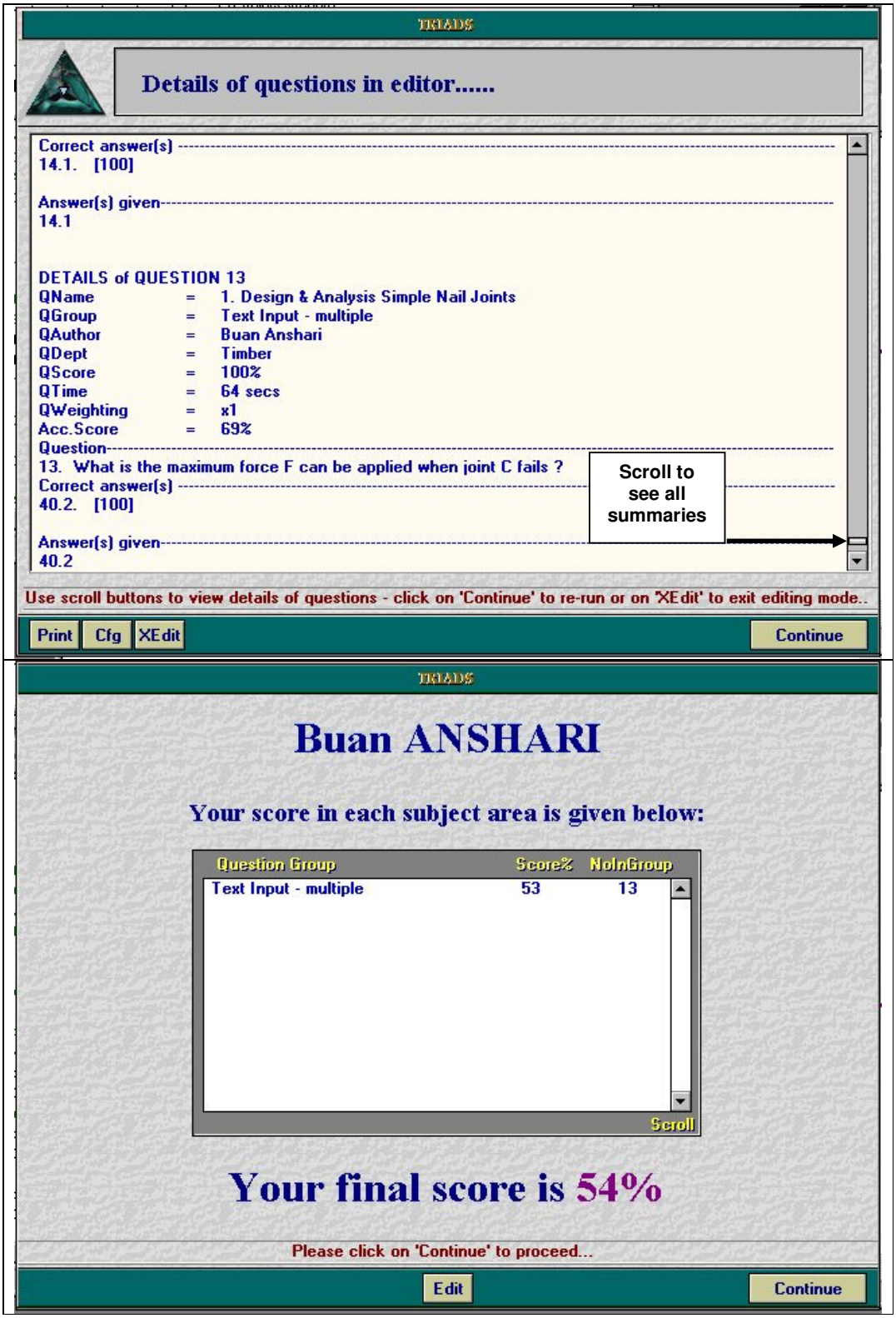

Figure 4.15. Typical Assessment Result

DISCUSSION

The design of this package has concentrated upon the delivery of Timber course as part of a Civil Engineering-base taught course. It is intended that the students have to gain experience in an artificial situation, and the often time-consuming discussion with the lecturer to understand particular points. This project presents an alternative approach; the expert knowledge of the lecturer is captured within the module, which is then made accessible to the students.

This learning and assessment package is designed not to replace the lecturer, but rather to augment his/her work in delivering material course. It is tutorial in nature, providing theory, questions, answers and feedback. However, it has been noticed in use some students interacting with it may not be able to refer to the previous question, since the format is unlike that of text book or scanned information.

Although every attempt was made to make the package as user-friendly as possible, there was no time to make the package user-seductive as well. Its presentation could be improved through the use of 'multimedia' software, and adapted for Internet and Intranet for education and training. The package described contains Timber design-bases, over 46 questions encapsulated in three Timber tests, to cover three parts of Timber course in the Civil Engineering Department, Liverpool University. The degree of difficulty of the questions increases gradually from the beginning to the last question. It is expected that the students may not think hard at the beginning of the test.

As far as I am aware, this is the first project in this Department about creating Computer Aided Learning and Assessing Timber course. It is likely that some mistakes will be made due to my limited ability. Therefore, it is necessary to undertake further development to be better and more attractive. Furthermore, there are a couple of facilities of Authorware which have not been used or shown, for example showing relevant pictures, using movie and video icons.

This package will be beneficial to students and lecturers. It will be used by course students, and will reduce student demand on the lecturers' time. It has been found to encourage reading by having to up-to-date references available and stimulating further questions. Further development with this package is being considered, such as the variety of questions, expanding the content, and improvement of the user interface.

Due to time limitation, it is has been impossible to present the Timber Course in its entirely in this project dissertation. Therefore, I strongly recommend for the next taught Course Students studying Structural Engineering can develop the topics which have not been performed in this project, such as Plyweb, Plywood, Bolted Joints, etc. Moreover, the Computer Aided Learning and Assessment Package can be extended to other courses such as Masonry, Steelwork, Foundation, etc. Another recommendation which may be considered for further development of this package, is to appraise how effective the CAL and CAA Timber packages perform as teaching tool for students who are taking Timber course. Whether this package significantly improves the understanding of the Timber courses may be indicated by the mark obtained in using the package.

Whatever software is used, it definitely has the strengths and weaknesses. The strengths of Authorware are an intuitive development environment, sophisticated interaction capabilities, and a vast array of system functions and variables that allow developers to customise applications. Contrary, Authorware has weaknesses such as limited animation capabilities, the lack of a true-built in programming language, and limited facilities for creating complex shape images. However, the ability of Authorware as an educational multimedia development tool outweighs other software or systems.

Benefits to the learner:

- Ready access to course content and knowledge (including during evening and weekends);
- Identification of weak/strong area of subject knowledge
- Improved understanding of weak areas through repeated interaction;
- Assessment of individual subject;
- Preparation for forthcoming lectures and catching up on any missed lectures;
- Guidance/references for further reading;
- Support for traditional lecture material
- Familiarisation with course requirement

Benefits for the teacher.

- Reduction in tutorial and advice time
- Support for conventional lecture material;
- Consolidation of course material
- Ready definition of course content and provision of reference base

CONCLUSIONS

This project has shown the creation of a Computer Aided Learning Package for Teaching Timber course by using authoring software: Authorware. The package comprises Computer Aided Learning (CAL) and Computer Aided Assessment (CAA). Timber packages are expected to be used by the student to augment the knowledge-base of Timber as a structural material in Civil Engineering. This package is very attractive due to the use of animation, a variety of colourful texts, special sound and flexible interaction. In addition, it is accessible to the students as self-teaching module to support the process of transferring knowledge from the lecturers.

This project also showed how to use Authorware in relation to computer-based training, where the icons play a major role to produce an attractive and interactive project. Basically, it is not difficult to use this software when compared with other programming languages. The icons provided have been pre-programmed with built-in functionality. Therefore, the developer just needs to learn the role of each icon, as well as when each icon should be used and the options that can be employed. The strength of Authorware is the simplicity of developers to customise many applications due to the availability of a system variables and functions in this software.

The results of this project, are Computer Aided Learning (CAL) and Computer Aided Assessment (CAA) packages for teaching Timber design. The CAL package contains an overview of timber, its properties and structure, the design of timber structure members especially Solid Beams, Glulam Beams, and Nail Joints based on British Standard 5268-2:1996. The CAA also contains the assessment test of 46 questions encapsulated in three parts of the Timber test, to cover three parts of Timber course as mentioned above.

Because this project only contains a small part of the total Timber course content, it is reasonable for it to be extended to other topics which have not been covered in this project. Therefore, the development of those topics by MSc. students in Structural Engineering in the next academic year is strongly encouraged. In addition, the investigation of the effectiveness of the package to increase the understanding of the course content is also recommended.

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APPENDIX A
SYSTEM VARIABLES

Variable	Description
AllSelected	Indicates if every icon attached to a decision icon has been selected
SelectedEver	Indicates if the current path decision icon has ever been selected
TimesExpired	Indicates if an icon is stopped because its time limit is exceeded
PathCount	Specifies the number of icons are attached to the decision icon
FileLocation	Path to the folder/directory containing the current file
FileName	Name of current file/title
RecordsLocation	Directory containing user data
CurrentPageNum	The relative number of current page
PageCount	Number of pages attached to the current framework
FirstName	The current user's first name
Sessions	The number of times the current user has used this file
UserName	User's complete name
Version	Authorware version
CharCount	The number of characters the user typed
EntryText	The last type entered
NumEntry	First number typed in response to text interaction
AllCorrectMatched	Indicates whether user has matched all responses for current interaction
CorrectChoice	Relative number of first response icon marked as correct
CorrectChoice-Matched	Number of response icons with correct status user matched in an interaction

Variable	Description
WrongChoice-Matched	Number of response icons with wrong status user matched in an interaction
JudgedInteractions	Number of judged interaction encountered by user in the file.
JudgedResponses	Number of responses given by user to judged interaction encountered by user in the file.
PercentCorrect	Percentage of correctly answered judged responses
PercentWrong	Percentage of incorrectly answered judged responses
TotalCorrect	Number of correct responses to all judged interactions
TotalWrong	Number of incorrect responses to all judged interactions
FullDate	Today's day and date
FullTime	Current time
SessionHours	Time since user began the session, in hours
SessionTime	Time since user began this session , in hours and minutes
Time	Current time in hours and seconds
TotalTime	Time user has spent in all session, expressed in hours and minutes
Year	Current year

APPENDIX B
SYSTEM FUNCTIONS

Function	Description
Capitalize	Capitalize the first letter of every word
GetLIne	Retrieve specific line in specific string
GetNumber	Get n-th number in specific string
GetWord	Retrieve n-th word in specific string
LowerCase	Set all characters specified string to lowercase
NumCount	Return number of numbers in specified string
String	Converts data into string data
Strip	Remove a specified set of characters from a string
WordCount	Returns the number of words in specified string
AppendExFile	Add data to existing file
FileType	Returns the file for specified file
ReadExFile	Return a string containing contents of specified text file
WriteExFile	Add specified string to a new file
GoTo	Jump to specified icon
JumpFile	Continue presentation by jumping to specified file
JumpFileReturn	Same as JumpFile but return when the destination file is finished
ResumeFile	Return to file that was active when Authorware was exited
ResumeFileName	Return name of active file when Authorware was last exited
Exit Repeat	Exit a repeat loop
Next Repeat	Skip to end of loop structure
Repeat With	Repeat loop specified number of times
Repeat While	Repeat loop until specified condition is true
ACOS	Returns arc cosine
COS	Returns cosine

Function	Description
ArraySet	Store item in n-th position
ArrayGet	Retrieve n-th item from array
Average	Returns the average of a list of values
EXP/EXP10	Returns value of **e** (x) or 10x
INT	Returns the integer portion of a number
LN/LOG10	Return natural log or log base 10
MAX	Returns the largest value in a list
MIN	Returns the smallest value in a list
Number	Converts value into numbers
Random	Returns a random number
Round	Round a number to specified number of decimal places
SQRT	Returns the square root
Sum	Returns the sum of values in a list
Beep	Make the system “beep”
Initialize	Reset all variables to their initial values
PressKey	Simulate user striking given key
Test	Compare two expression and take one of two paths based on result of comparison
PrintScreen	Print current screen content
Quit/QuitRestart	Exit current file; Restart ensures always restarting at beginning
Restart	Start file at beginning
Save Records	Save user data to disk
Date	Number of days since base date, converted to short data format
FullDate	Full-date format for specified date for number of days since data base
DayName	Name of day of the week for specified date as number of days since data base

MonthName	Month name for specified date specified as number of days since base data
Year	Year for date specified as number of days since data base