Contents

INTRODUCTION

The procedures for executing the INSTED®/Fin & Fin Array program are presented in this section. The input file options, primary tasks, required data, and the output results are discussed, as are the online utilities that are available within the program environment.

INSTED allows a "Detailed Analysis" of fin types where exact heat conduction equations are known. The program also analyzes fins using empirical equations. The latter kind of analysis is termed "Approximate Analysis" in the program.

Using the empirical approach, INSTED®/Fin & Fin Array program supports up to ten distinct fin types. For the detailed analysis, the program calculates fin performance for both cylindrical and rectangular fins using one of four boundary condition types. These boundary conditions are:

- Insulated fin end
- Heat transfer coefficient at fin end
- Specified heat flux at end
- Assumed infinitely long fin

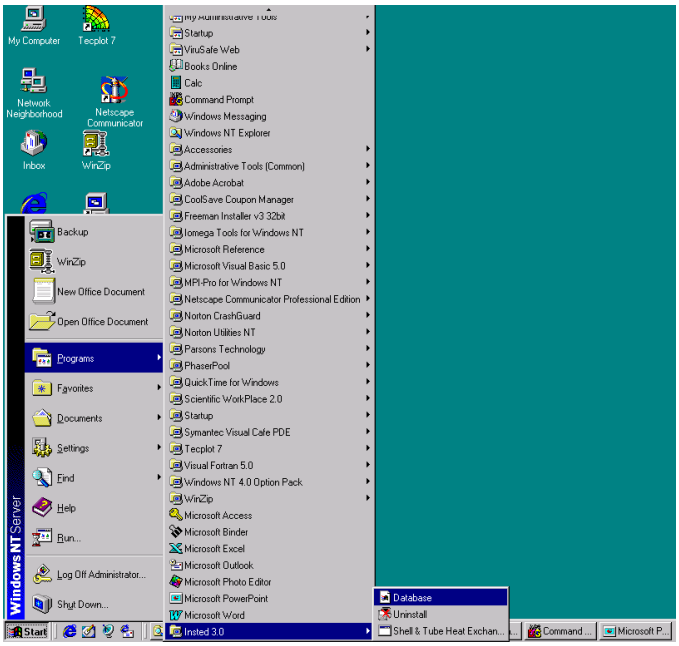
The program supports both single fin analysis and fin arrays.

RUNNING INSTED®/Fin & Fin Array Program

Starting the Program

Follow this procedure to execute INSTED®/Fin Program.

1. Click on the Windows **Start** button.
2. Select **Program**
3. Select **INSTED 3.0**
4. Select the **Fin Analysis** icon.

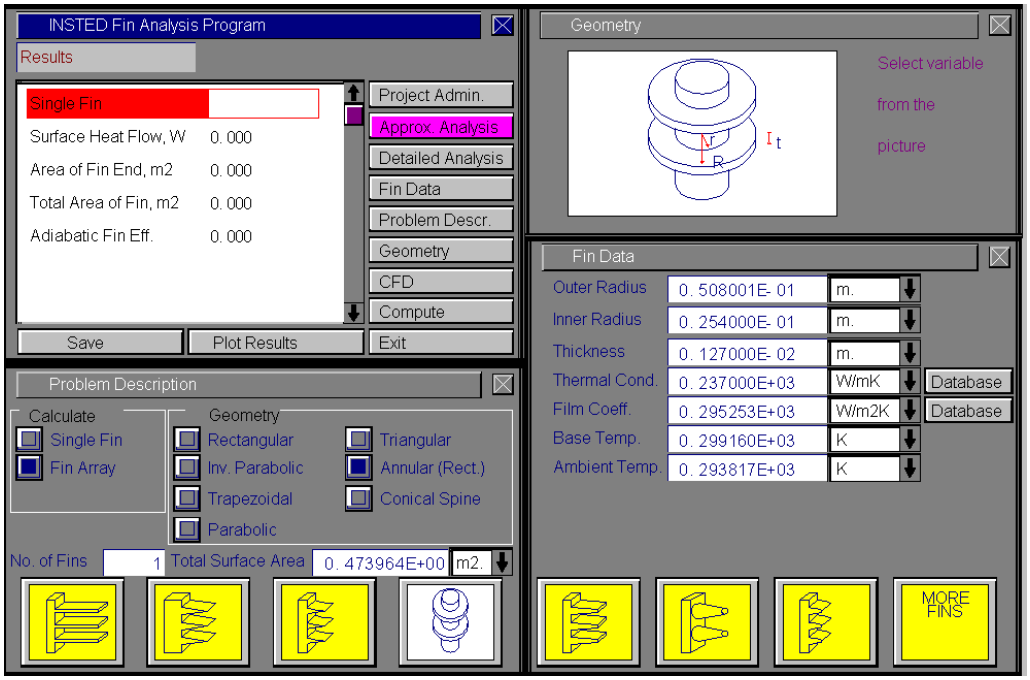


The Restart File

The Fin Analysis program automatically loads the previous analysis if the program was terminated normally in the previous session. This is to allow previous sessions to continue naturally. However, to initialize all input fields, select the “New Project” option discussed later in this manual.

PROGRAM ORGANIZATION

The INSTED®/Fin Analysis Program is organized into five dialog boxes: the Main, Project Administration, Problem Description, Fin Data, and Geometry dialog boxes. The dialog boxes are launched from the Main dialog box. Result presentation is done also via thee Main dialog box. A detailed description of each dialog box is presented later in this manual. The figure below shows the program interface.



Required Data

The minimum data required for analysis are:

- Analysis type (“Detailed” or “Approximate”)
- Model type (single fin or fin array)
- Fin type
- Fin geometry (depending on the fin type, fin geometry implies thickness of fin, length of fin, or inner and outer radius of fin)
- Thermal conductivity of fin material
- Film coefficient
- Base temperature of fin
- Ambient temperature

Other Data

- Boundary condition of fin end for a “Detailed” analysis
- Number of fins and fin pitch or total surface area for fin array analysis

Results

- Heat transfer rate
- Area of fin
- Fin efficiency
- Fin resistance
- Total heat flow rate (for fin array analysis)
- Total fin resistance (for fin array analysis)

Required Input By Fin Type

The figures below show the required geometric input for single fins and fin arrays for the fin types supported in the current version of INSTED/Fin & Fin Array program.

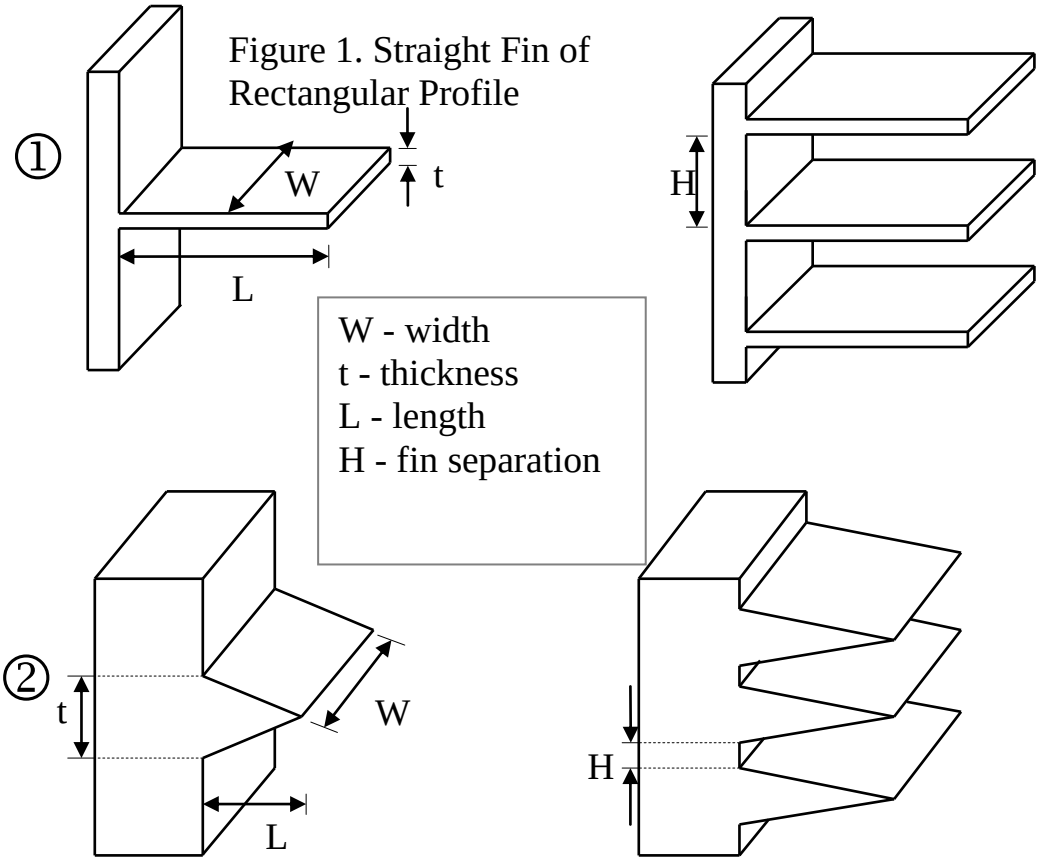


Figure 1. Straight Fin of Rectangular Profile

Figure 2. Straight Fin of Triangular Profile

Figure 3. Straight Fin of Inverse Parabolic Profile

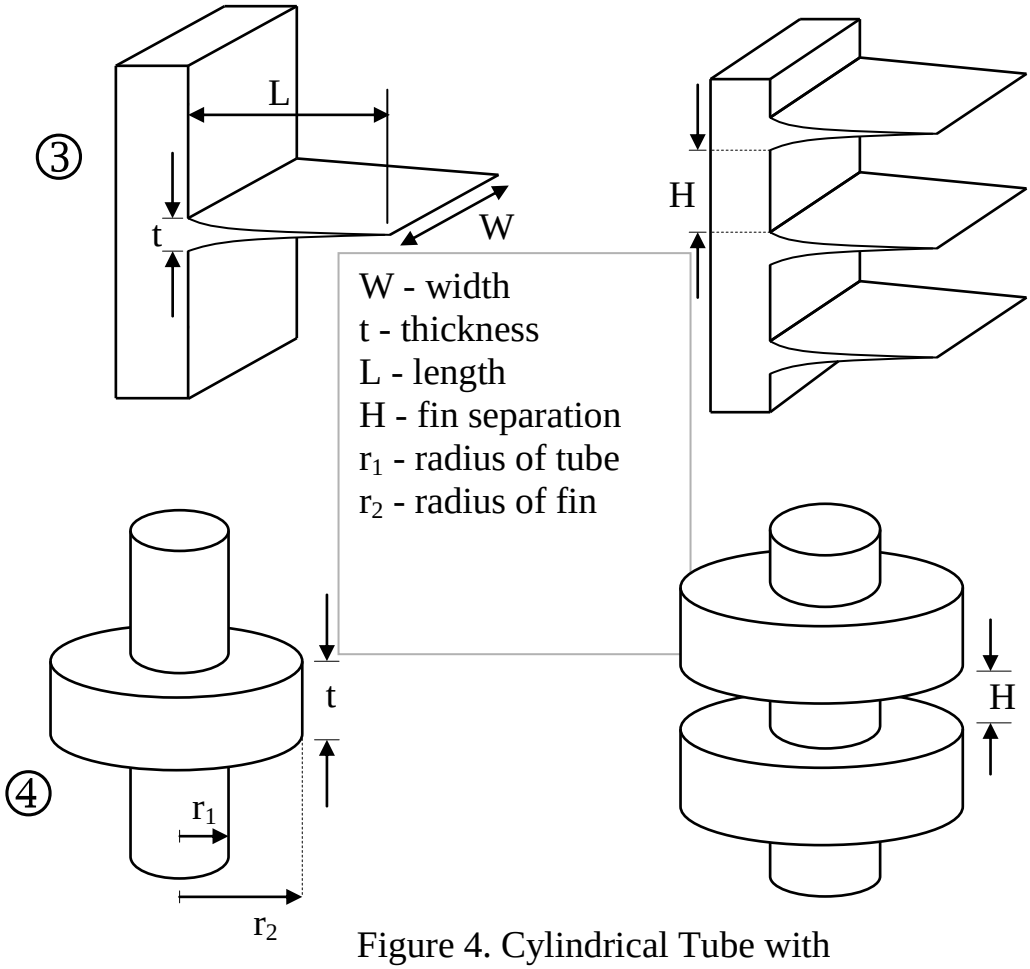
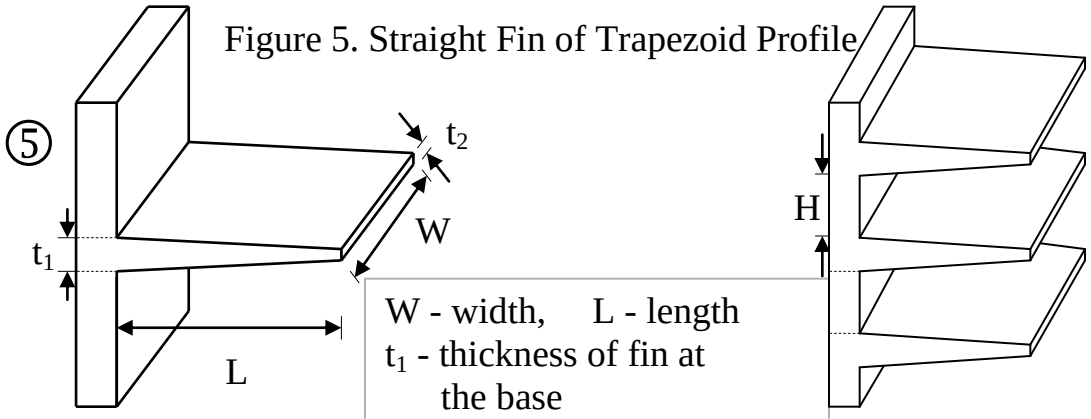


Figure 4. Cylindrical Tube with
Radial Fin of Rectangular Profile

Figure 5. Straight Fin of Trapezoid Profile



W - width, L - length
t_1 - thickness of fin at the base
t_2 - thickness of fin at the tip
H - fin separation
r_1 - radius of fin at the base
r_2 - radius of fin at the tip

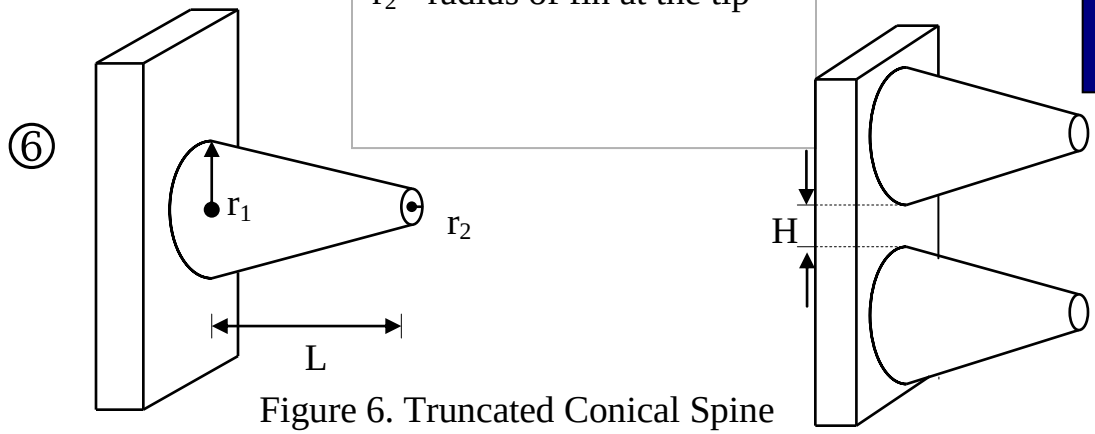


Figure 6. Truncated Conical Spine

Figure 7. Straight Fin of Parabolic Profile

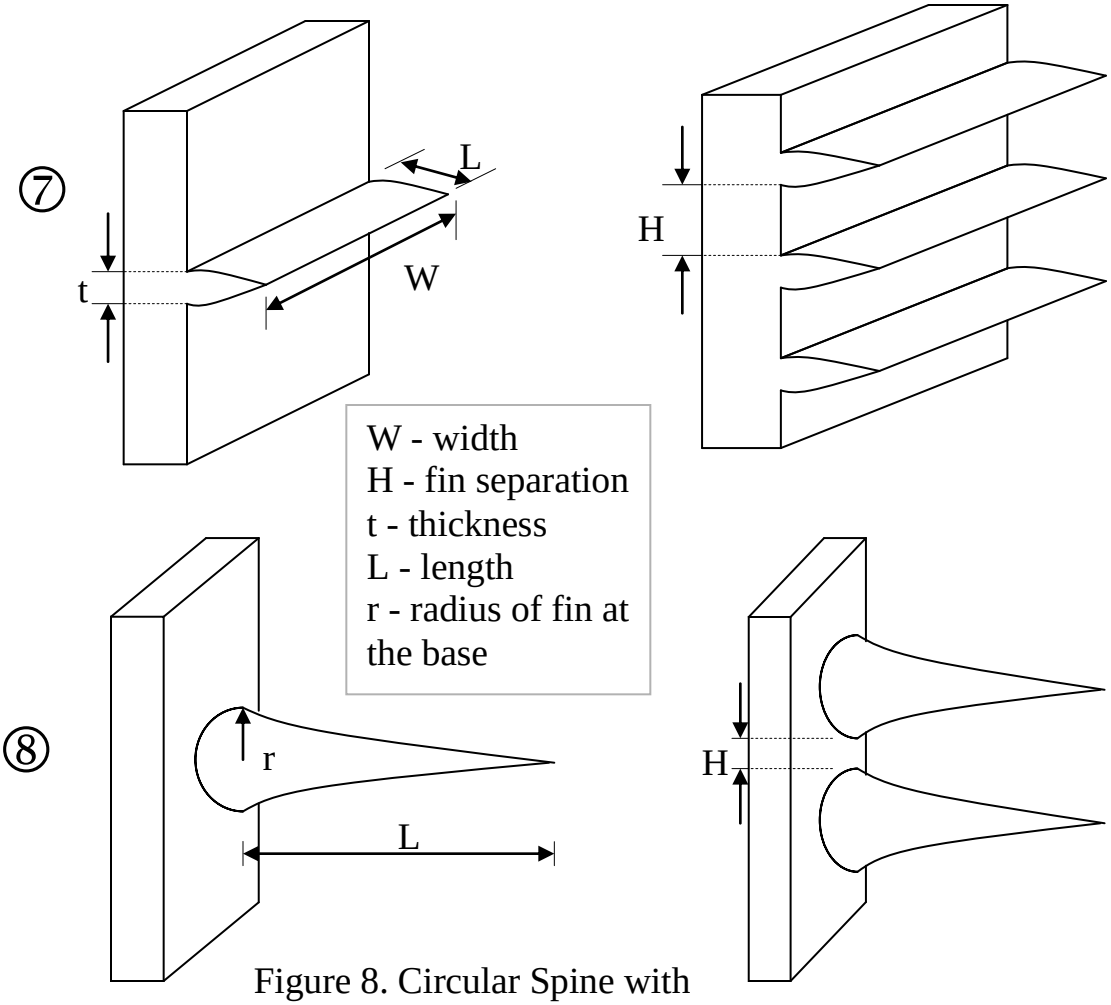


Figure 8. Circular Spine with Parabolic Profile

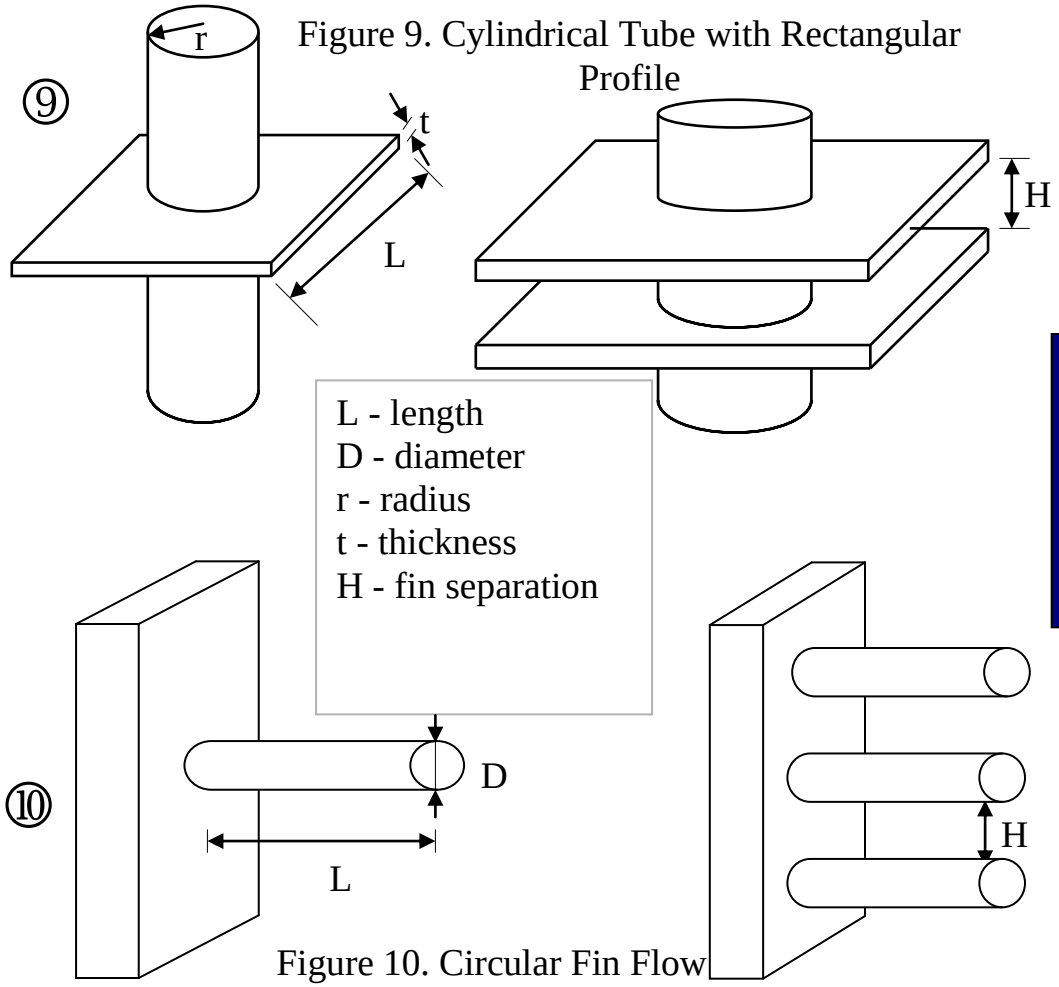


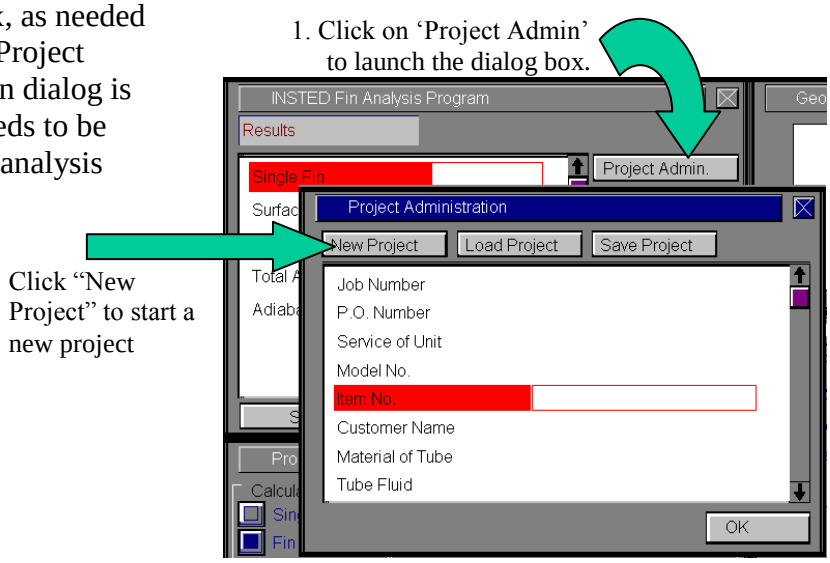
Figure 9. Cylindrical Tube with Rectangular Profile

Figure 10. Circular Fin Flow

Starting a New Project

To start a new project:
1. Click the “Project Admin.” button on the Main dialog box
2. Click “New Project” button on the ‘Project Administration’ dialog box
3. Fill in the administrative data for the editbox in the Project Administration dialog box, as needed

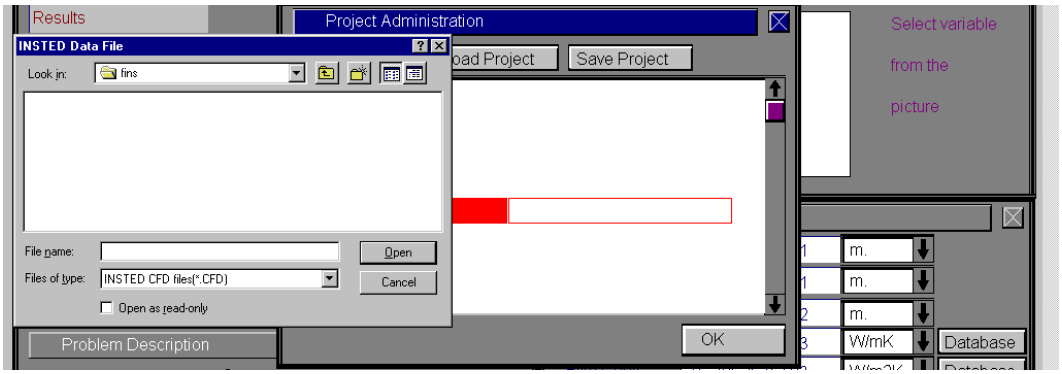
Note that the Project Administration dialog is modal and needs to be closed before analysis can continue.



Loading an Old Project

To load an old project:
1. Click the “Project Admin.” button on the Main dialog box
2. Click on the “Load Project” button
3. Type *.* in the file name text box on the Windows file menu which comes up.
4. Press the Enter key.

5. Select the file you wish to open by locating it on the Windows file open dialog box. This dialog box is shown below.



Saving a New Project

To save a new project:

1. Click on the “Project Admin.” button in the Main dialog box
2. Click on the “Save Project” button

⇒ A Windows ‘File Save’ dialog will appear

3. Select the path in which you wish to save the file
4. Type a name for the new project file

DESCRIPTION OF THE DIALOG BOXES

The following section describes the functions of each dialog box in INSTED®/Fin & Fin Array program.

The Main Dialog Box

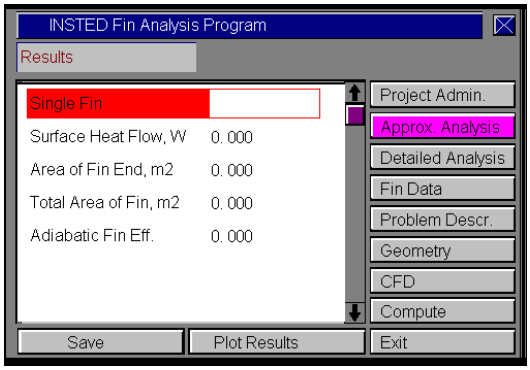
This dialog box contains eleven buttons. The functions of the buttons are described below.

Project Admin

This button opens the Project Administration dialog box. The dialog box performs administrative functions, including loading and saving the session data and initiating a new project.

Approx. Analysis

Pressing the "Approx. Analysis" button indicates that you intend to perform analysis using empirical equations. The effects of boundary conditions are not required for this kind of analysis.



Fin Data

This button opens the 'Fin Data' dialog box, which contains input such as the geometry and material properties of the fin.

Problem Description

This button opens the Problem Description dialog box. In this dialog box, for example, you specify whether you wish to analyze a single fin or an array of fins. You also select the fin type in this environment, as well as the number of fins and the total surface area.

Geometry

This button opens the 'Geometry' dialog box, which displays a schematic of the currently selected fin type and the data fields required for analysis. Clicking on the labels in the picture will navigate you to the corresponding data entry area.

Compute

The Compute button tells INSTED to compute the results. This assumes that all required input data for the task have been specified. If this is not the case, the computation may be unsuccessful and the missing input is indicated, via a (warning) message box.

To Save

Click on the "Save" button, which is conveniently situated on the Main dialog box. To safeguard work done in the session, it is advisable to intermittently perform a save operation. Note that an error occurs if no project has been loaded and previously saved using the "Save Project" button in the 'Project Administration' dialog box. The procedure for saving a new project has been described in a previous section of this manual.

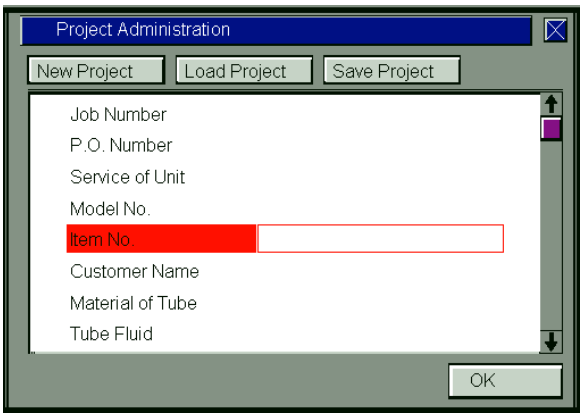
Plot Results

The "Plot Results" button displays a plot of the temperature distribution along the fin section. The plot may be printed from the File/Print menu at the top of the page. Clicking on any part of the page dismisses the plot and returns you to the main program interface. Plotting can be done only for the "Detailed" fin analysis option.

Exit

Press this button to close the program and end the current session. All session data are stored and can be automatically retrieved on restarting the program.

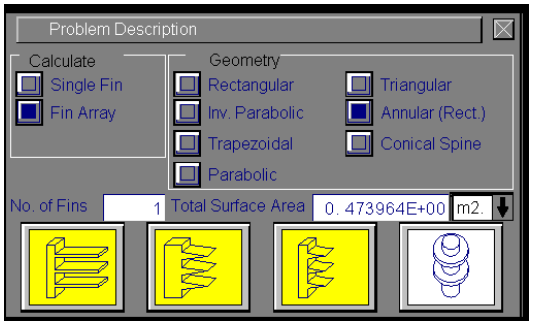
The Project Administration Dialog Box



The functions of the 'Project Administration' dialog box have been covered in previous sections, including loading an existing project, saving a new project, and starting a new project.

The Project Administration dialog box contains a description of the project including job number, customer names etc. This dialog box is the same in all the INSTED programs and data from it is shared during an integrated session with several programs of the INSTED suite of engineering programs.

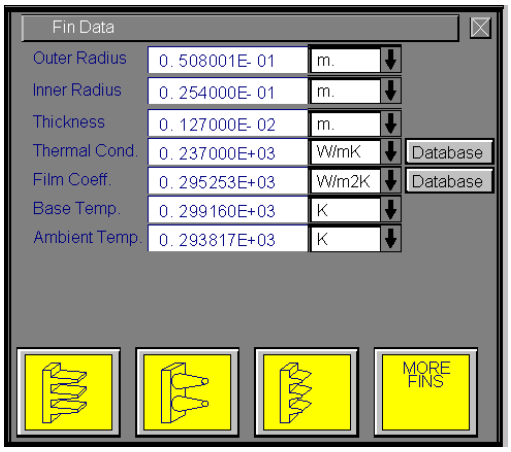
The Problem Description Dialog Box



This dialog box contains a description of the problem. You indicate in this dialog box whether you wish to analyze single fins or fin arrays.

Enter the number of fins and total system area for a fin array problem. You can select the fin type in this dialog box or click on the fin icon in this dialog box or in the 'Fin Data' dialog box.

Fin Data Dialog Box



This dialog box contains input for the fin geometry. The required input depends on the type of fin selected. For instance, for a rectangular fin, the required input is the fin width, length and thickness.

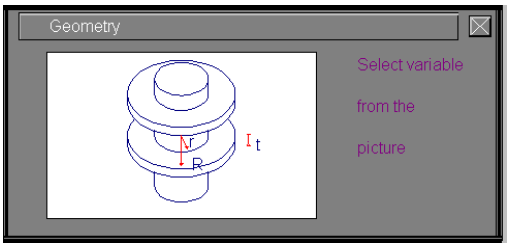
For "Detailed" fin analysis, the conditions at the fin end should also be specified in this dialog box.

Enter the ambient and base temperatures of the fin and the thermal conductivity of the fin material in this dialog box. The thermal conductivity may be obtained from INSTED/Database, which contains the thermophysical properties of hundreds of materials. Materials not included in INSTED/Database may be entered as Custom Data for future access. A description of how to enter custom data in INSTED/Database is provided in the Database sections of this manual.

Enter the temperature and film coefficient at the surfaces in this dialog box. You may obtain the film coefficient from the INSTED/Database by pressing the "Database" button.

Geometry Dialog Box

This dialog box contains a schematic of the fins. Clicking on the labels of the picture transfers you to the input box for the variable that corresponds to the label.



RUNNING A SAMPLE PROBLEM

This section illustrates the use of INSTED/Fin and Fin Array program. A sample problem best illustrates the procedures.

Problem Statement

To increase the heat dissipation from a 2.5 cm outer diameter tube, circumferential fins made of Aluminum (k = 200 W/mK) are soldered to the outer surface. The fins are 0.1 cm thick and have an outer diameter of 5.5 cm. If the tube temperature is 100°C, the environmental temperature is 25°C, and the heat transfer coefficient between the fin and environment is 65 W/m^{2}K, calculate the rate of heat loss from the fin.

Source:

Frank Kreith & Mark S. Bohn, 1993. 5th Edition. Principles of Heat Transfer. West Educational Publishing, Boston, Page 107.

Comments:

- In INSTED, choose "Approximate Analysis" from the Main dialog box.

Name of Data File

The input data for this sample problem are contained in the file "Krbohn.107", which can be found in the 'Samples' subdirectory of the INSTED/Fins directory.

Instructions for running a sample file

Sample problem files for INSTED/Fin & Fin Array are located in of the installation drive. To run the sample file 'janna.275', follow these procedures:

1. From the 'Project Admin' dialog box, click on the "Load Project" button
2. Locate the directory \insted30\fins\samples\ on the installation drive

3. Type " *.* " in the filename position and press Enter
   → A list of the files present is displayed in the directory
4. Select the file ‘Krbohn.107’ and click on the 'Ok' button
5. Click "Compute" on the Main dialog box