SAS/QC® 13.2 User's Guide

The ISHIKAWA Procedure

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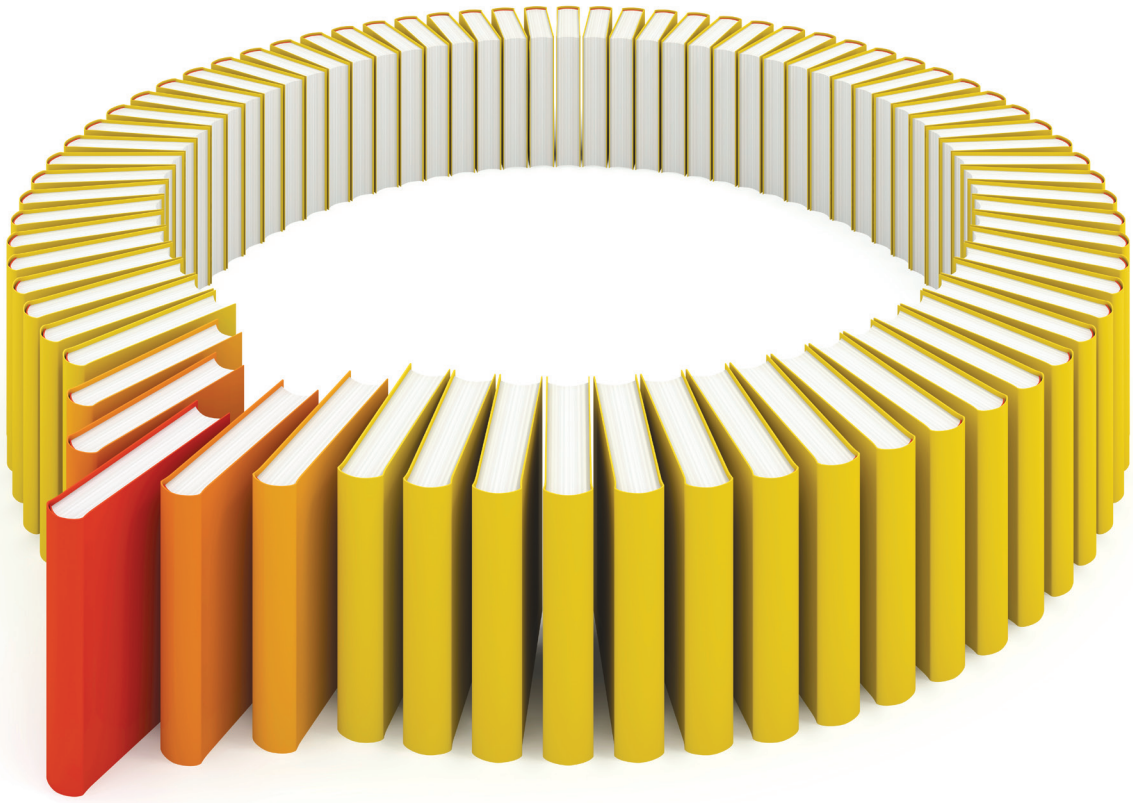

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Chapter 8
The ISHIKAWA Procedure

Contents

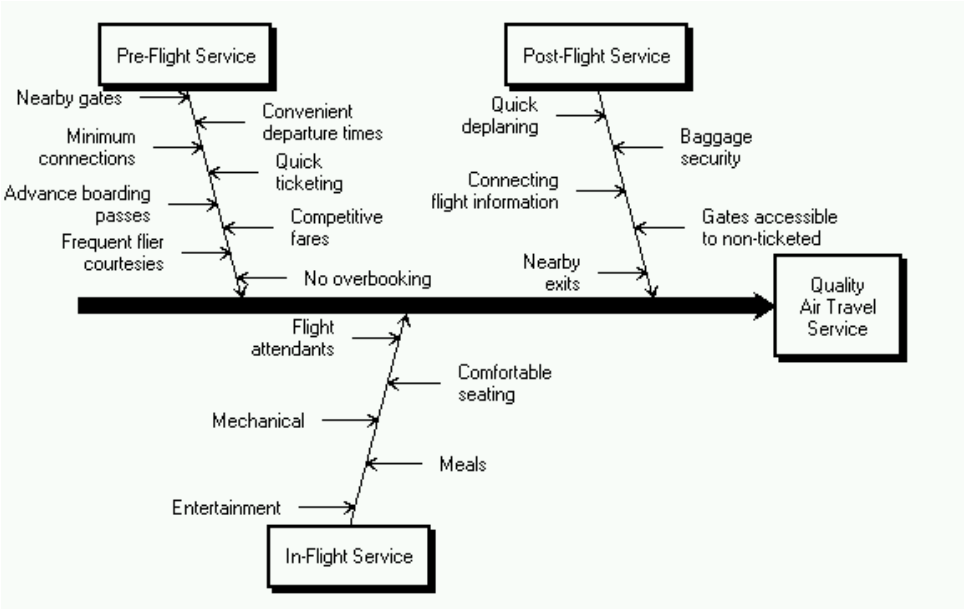
Introduction **696**
Overview 696
Terminology 697
Tutorial 699
Details of the ISHIKAWA Environment **708**
Summary of Operations 708
Operations 711
Adding Arrows 711
Labeling Arrows 715
Moving Arrows 718
Deleting Arrows 724
Resizing Arrows 727
Swapping Arrows 729
Balancing Arrows 732
Notepads 739
Managing Complexity 741
Zooming Arrows 743
Isolating Arrows 744
Merging Diagrams 746
Creating Graphics Output Using SAS/GRAPH Software 749
Creating Bitmap Graphics Output 752
Modifying Fonts 754
Modifying Box Colors 755
Modifying Arrow Colors and Line Styles 755
Modifying Text Colors 763
Modifying Arrow Heads 765
Modifying Environmental Attributes 765
Saving an Ishikawa Diagram for Future Editing 766
Reading an Existing Ishikawa Diagram 767
Displaying Multiple Ishikawa Diagrams 769
Input and Output Data Sets 771
Syntax 773
Examples 774
Example 8.1: Quality of Air Travel Service 774
Example 8.2: Integrated Circuit Failures 775
Example 8.3: Photographic Development Process 776
References **776**

Introduction to the ISHIKAWA Environment

Overview

The Ishikawa diagram,[1] also known as a cause-and-effect diagram or fishbone diagram, is one of the seven basic tools for quality improvement in Japanese industry. It is used to display the factors that affect a particular quality characteristic or problem. For example, the following Ishikawa diagram shows factors affecting the quality of air travel service:

Figure 8.1 Ishikawa Diagram



In this example, the factors are organized into three categories of service (Pre-flight, In-flight, and Post-flight), which are represented as branches. The factors affecting each of these areas are represented as stems.

An Ishikawa diagram is typically the result of a brainstorming session to improve a product, process, or service. The main goal is represented by a main arrow or trunk, and primary factors are represented as sub-arrows or branches. Secondary factors are then added as stems, tertiary factors as leaves, and so on.

Creating the diagram stimulates discussion and often leads to an increased understanding of a complex problem. Japanese QC Circle members often post Ishikawa diagrams in a display area where they will be accessible to managers and other groups; refer to Rodriguez (1991). In the United States, Ishikawa diagrams are often included in presentations by plant personnel to management or customers.

Traditionally, Ishikawa diagrams have been prepared by hand on paper or chalk boards. This limits the amount of detail that can be added and makes it awkward to update the diagram as an understanding of the process evolves. Manual preparation also restricts the collection and display of data on the diagram, as advocated by Ishikawa (1982).

[1] The Ishikawa diagram is named after its developer, Kaoru Ishikawa (1915-1989), a leader in Japanese quality control; refer to Karabatsos (1989), Kume (1985) and Sarazen (1990).

The ISHIKAWA procedure was designed to overcome these limitations by providing a highly interactive graphics environment (referred to in this section as the *ISHIKAWA environment*) for creating and modifying Ishikawa diagrams.

In the ISHIKAWA environment you can

- add and delete arrows with a mouse. You can also swap, copy, and so forth.
- highlight special problems or critical paths with line styles and color
- display additional data for each of the arrows in a popup notepad
- display portions of the diagram in separate windows for increasing or isolating detail. You can also divide sections of the diagram into separate Ishikawa diagrams.
- merge multiple Ishikawa diagrams into a single, master diagram
- display any number of arrows and up to ten levels of detail
- foliate and defoliate diagrams dynamically
- save diagrams for future editing
- save diagrams in graphics catalogs or export them to host clipboards or graphics files
- customize graphical features such as fonts, arrow types, and box styles
- obtain online help at any time

If you are using the ISHIKAWA procedure for the first time, the tutorial at the end of this chapter demonstrates some of the basic operations used in the ISHIKAWA procedure. A summary of these operations (and others) can be found in the section "Summary of Operations" on page 708.

For a detailed discussion of each of the operations, see "Details of the ISHIKAWA Environment" on page 708. This chapter includes many tools not presented in the tutorial.

Terminology

This section introduces basic operations used in the ISHIKAWA environment and defines terms used to describe the ISHIKAWA procedure. Some details depend on your *host*, which is the specific system of computing hardware and software you use. For example, all hosts present the ISHIKAWA environment in a system of *windows* on the host's *display*, but the appearance of your windows may differ from the figures in this book. You can find more information in the SAS companion for your host and in your host system documentation.

Using a Mouse

On most hosts you can use a *mouse* to point to objects on the display. A mouse is a physical device that controls the location of a *cursor*, which is a small, movable symbol on the display. Due to the precision required, you must use a mouse to perform tasks in the ISHIKAWA environment.

Text is placed relative to the *text* cursor and not the *mouse* cursor (↖). The mouse cursor is always visible, while the text cursor is displayed only when text can be entered (for example, when an arrow is being added).

The mouse also has *buttons* that work like keys on the keyboard. On most hosts, you *select* an object by pointing to it with the mouse and clicking the left button on the mouse. To *click*, press the button down and release it quickly without moving the mouse. To *double click*, click *twice* quickly without moving the mouse. To *drag*, move the mouse while holding down the left mouse button.

Popup menus appear to *pop up* on the display when you press a button—usually the right mouse button. Popup menus are convenient to use, since they always appear at the cursor location. Selecting an item from the popup menu, however, is host specific.

For details about using the mouse on your system, consult the SAS companion for your host.

Using Context-Sensitive Operations

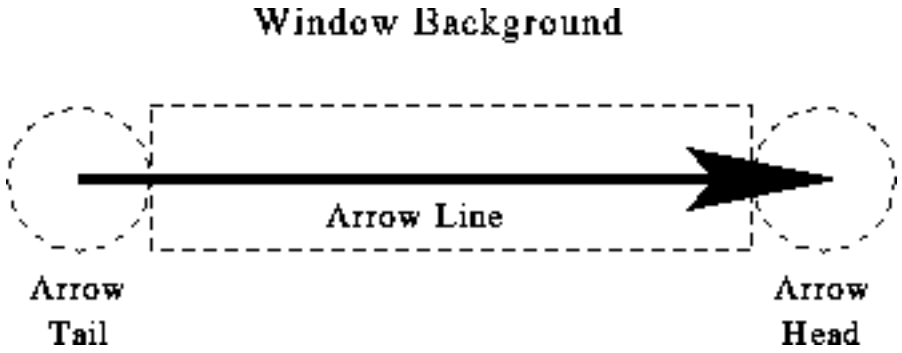
Basic operations such as add, edit, delete, and move are invoked by activating the mouse near various *hotspots* along the arrows rather than selecting tools from a tools palette. The hotspots are the following context-sensitive areas in the Ishikawa diagram:

- arrow heads, tails, lines, and labels
- window background

Given such evident features, and a rigidly defined structure, the hotspots are not highlighted.

The hotspot areas are illustrated in the following figure:

Figure 8.2 Context-Sensitive Locations (Hotspots)



The dotted, circular region at the right end of the arrow is the arrow head hotspot. Arrows attach to other arrows at the head of the arrow. The dotted, circular region at the left end of the arrow is the arrow tail hotspot. The region that encompasses the arrow line is also hot. Every arrow in the diagram has these hotspots.

The window background is any area inside the window and outside the dotted lines. You use the window background to cancel pending operations (such as adds and moves) and to control global or environment-specific operations (such as decreasing detail and tagging arrows).

When you activate the mouse, the ISHIKAWA environment uses the mouse event (click, double click, drag, or popup) and the hotspot type (head, tail, line, label, or background) to infer the intended operation. The ISHIKAWA environment responds differently depending upon which hotspot you select and how you select it. This is often referred to as *context-sensitive* behavior.

Context sensitivity allows the ISHIKAWA environment to operate without modes. In a modeless environment like the ISHIKAWA environment, context-sensitive operations reduce the amount of mouse travel (the time and distance spent moving the cursor from the drawing area to the tools palette and back). For example, you do not go to a tools palette to change from *add mode* to *delete mode*. This allows you to focus on the diagram rather than on the diagramming tool.

In the ISHIKAWA environment, the primary operations such as add, edit, delete, and move are all operations associated with a specific hotspot and the mouse button. Secondary operations such as zoom, copy, highlight, and so forth operate from *context-sensitive* popup menus (typically activated using the right mouse button.) Other, less frequently used operations are available from the command bar.

The relationship between these context-sensitive areas, the mouse actions, and the basic ISHIKAWA tools is introduced in the tutorial that follows. A comprehensive discussion of each operation is given in "Details of the ISHIKAWA Environment" on page 708. In addition, the tables in the section "Summary of Operations" on page 708 provide a good overview of how to function inside the ISHIKAWA environment.

Using the Command Bar

In addition to the editing tools, the ISHIKAWA environment provides a number of file management, printing, and help facilities. These facilities are located on the *pull-down* menu associated with the window. The appearance and location of the command bar are host specific. On most hosts, you choose these operations by *pulling down* a menu from a *menu bar* using the mouse button. For more details about using the command bar on your system, consult the SAS companion for your host.

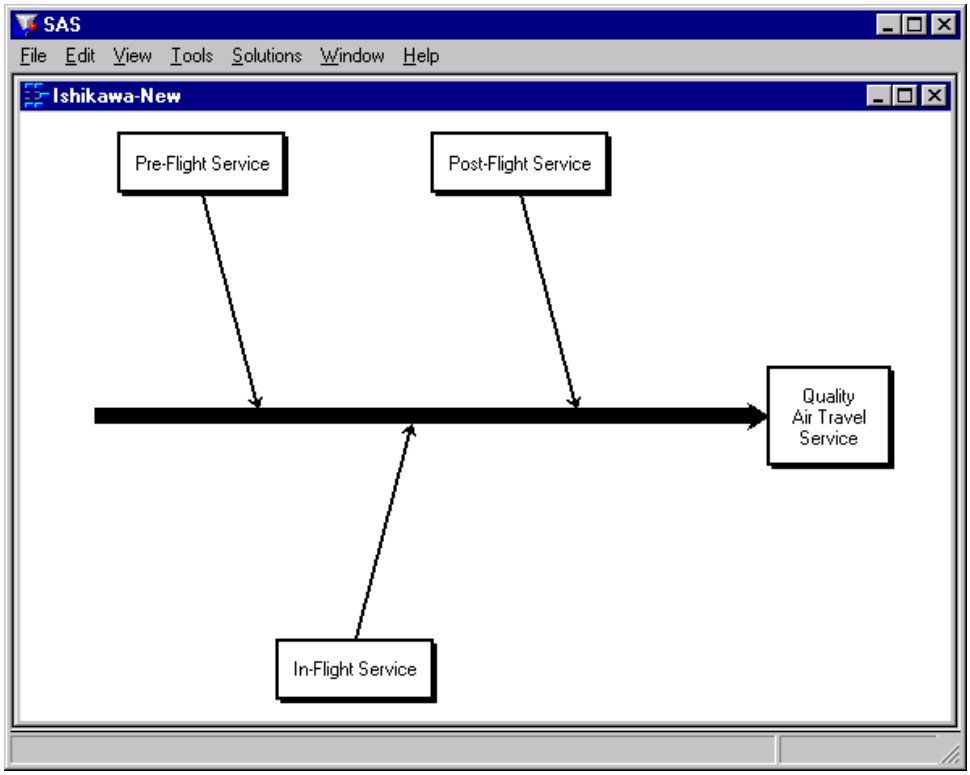
Tutorial

NOTE: See *Airline Data* in the SAS/QC Sample Library.

The following example is used throughout the ISHIKAWA chapters. Later examples illustrate how to add to and modify this diagram. If you are not familiar with the ISHIKAWA procedure, you may want to complete this tutorial before proceeding to "Details of the ISHIKAWA Environment" on page 708. In this tutorial you will learn to create and save a simple Ishikawa diagram.

A task force is studying ways to improve the quality of passenger service for a major airline. After a preliminary discussion, the team concludes that three major areas should be considered: pre-flight service, in-flight service, and post-flight service. This result is to be displayed with the following preliminary Ishikawa diagram:

Figure 8.3 Preliminary Ishikawa Diagram

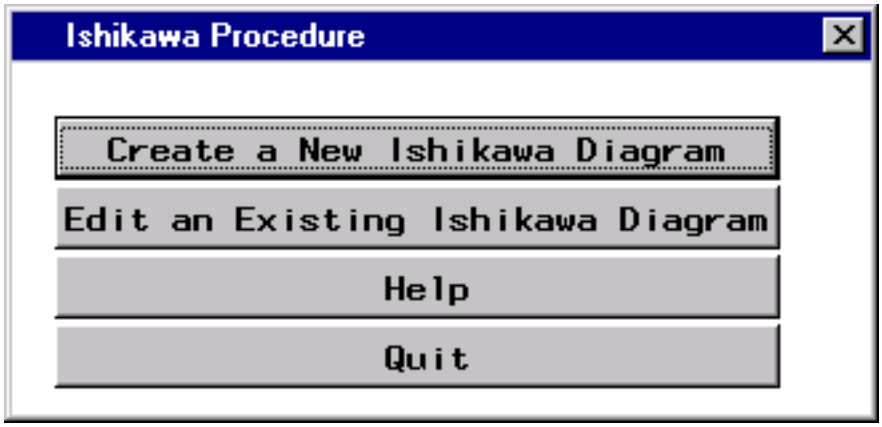


1. To begin using the ISHIKAWA environment, submit the following SAS statements:

```
proc ishikawa;
run;
```

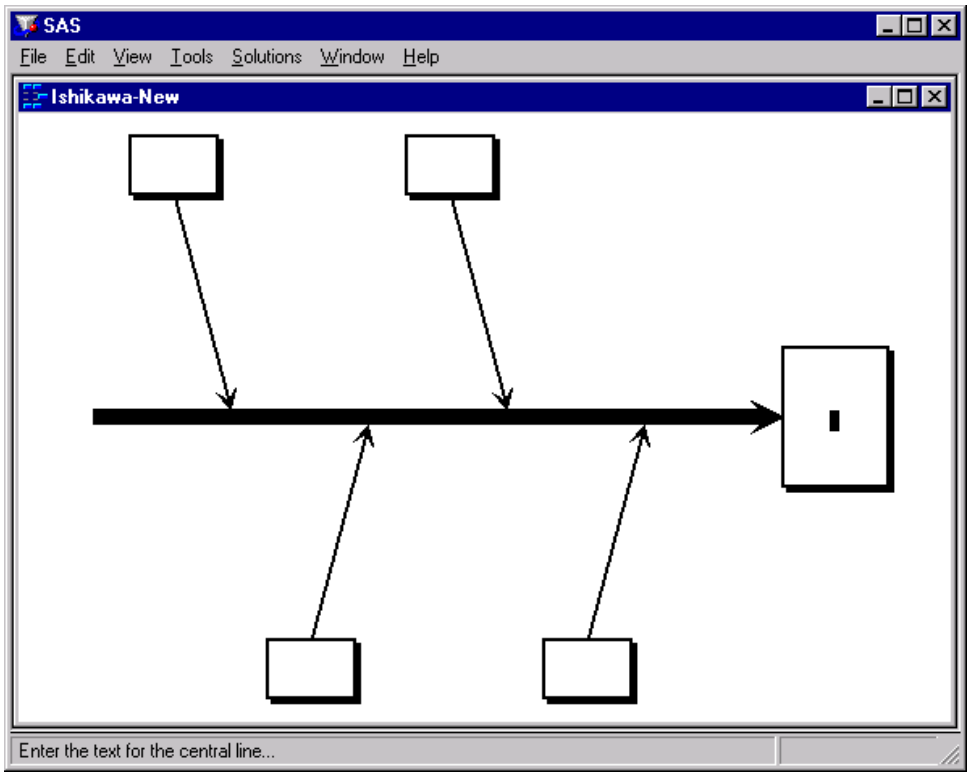
An initial menu appears on your display, as follows:

Figure 8.4 Initial Menu



2. Select **Create a New Ishikawa Diagram** to open a window containing a template for a new Ishikawa diagram.

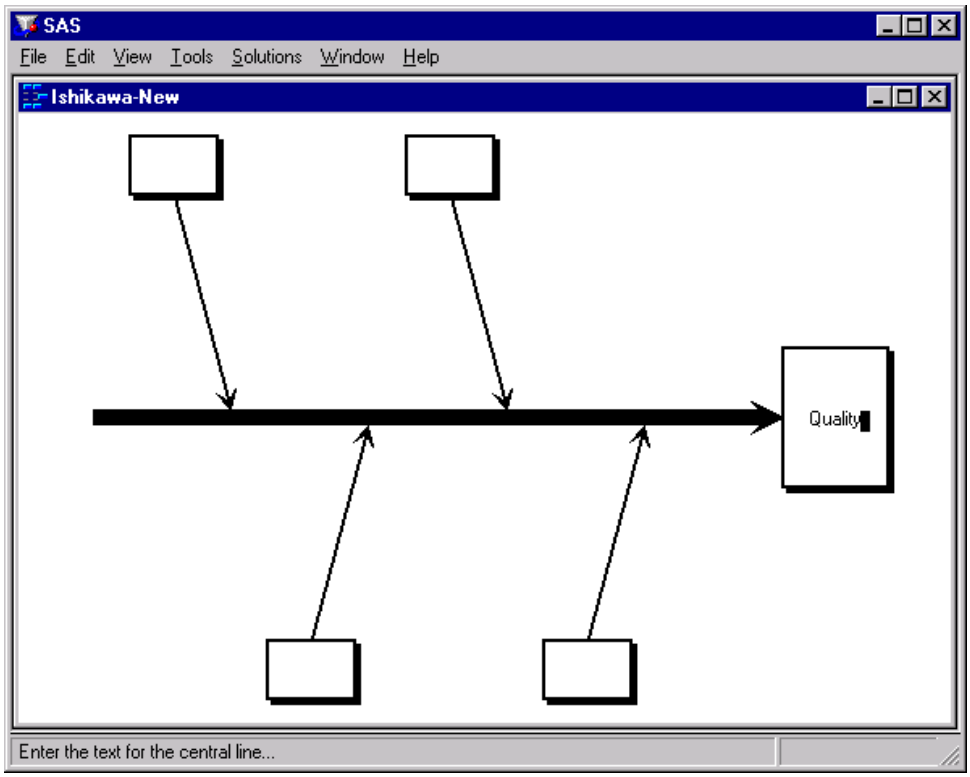
Figure 8.5 Starting a New Ishikawa Diagram



The ISHIKAWA environment guides you through the first steps of the diagramming process by prompting you to enter the text for the central line and then the upper left branch. During each step, a message indicating the action required is displayed in the message area for this window. Once you have completed these preliminary steps, you can proceed in any order you want.

3. Initially, the text cursor is positioned inside the box for the trunk. A message is displayed directing you to enter the first line of text for the trunk. Type the word *Quality*.[2]

Figure 8.6 Labeling the Trunk

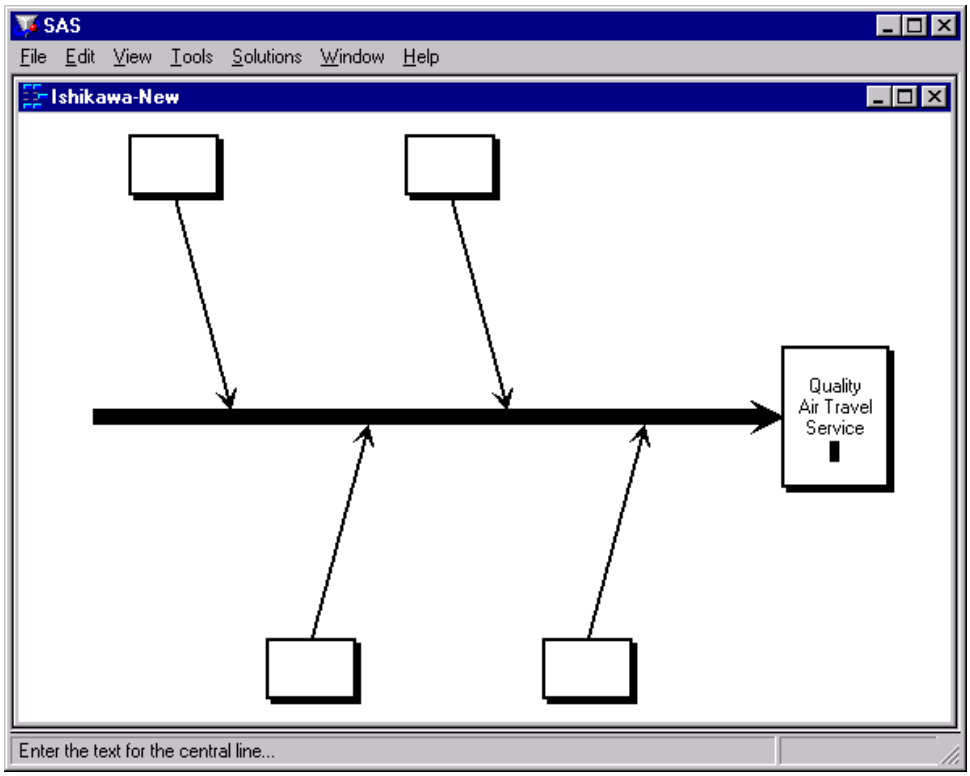


Note that the text is placed relative to the text cursor. You can correct mistakes by using any of the keyboard editing keys or cursor navigation keys (for instance, BACK SPACE and ←).

[2] You can skip this step, in future diagrams, by pressing RETURN before entering any text.

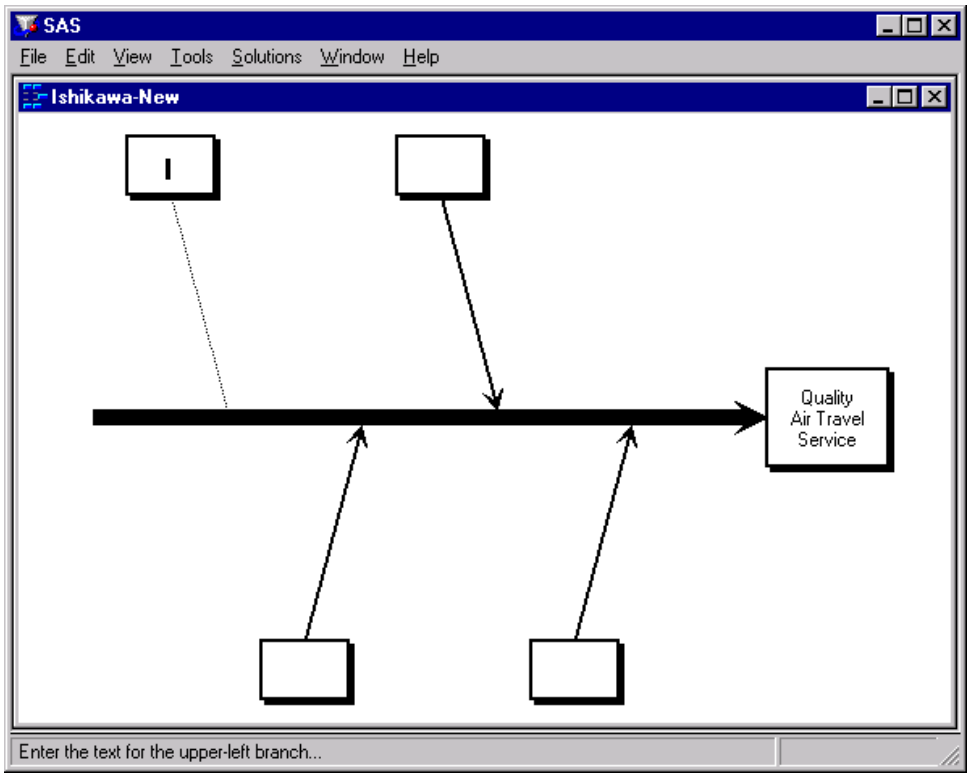
4. Advance to the next line by pressing RETURN. Now complete the label by entering *Air Travel* and *Service* on separate lines.

Figure 8.7 Labeling the Trunk *(continued)*



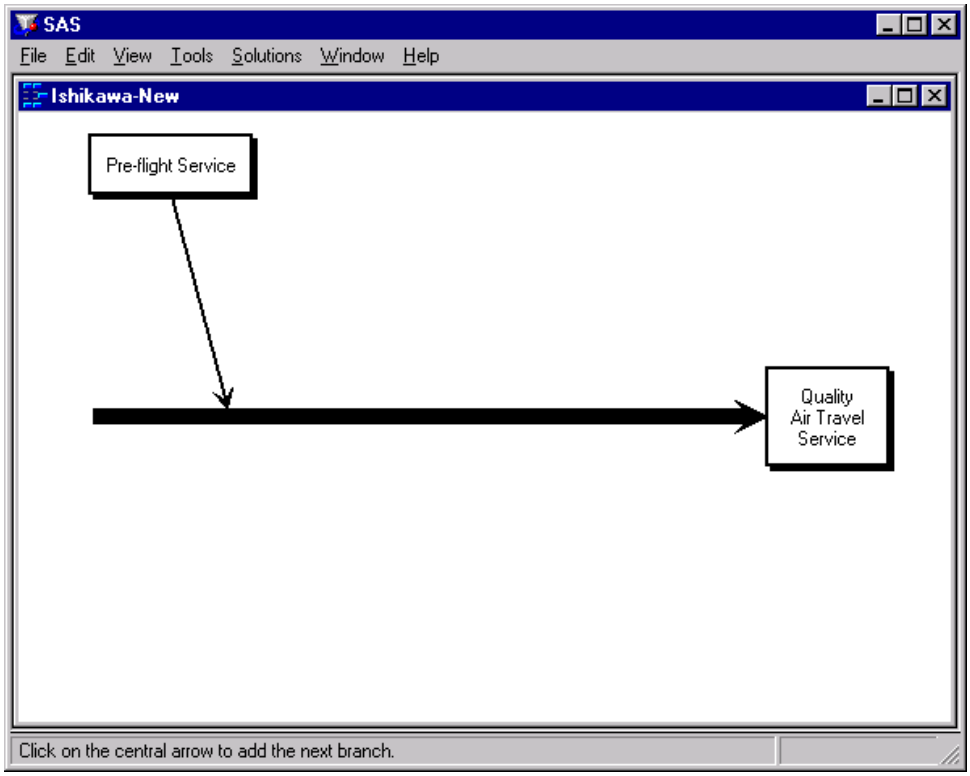
5. To terminate text entry, press RETURN a second time. The ISHIKAWA environment automatically moves the cursor to the upper left branch. If you made a mistake labeling the trunk, continue with the example. You cannot return to the trunk until you have finished the branch.

Figure 8.8 Labeling the First Branch



6. Enter the label *Pre-Flight Service*. Press RETURN twice to terminate text entry for this branch.[3] Your window should now look like this:

Figure 8.9 Completed Branch Label

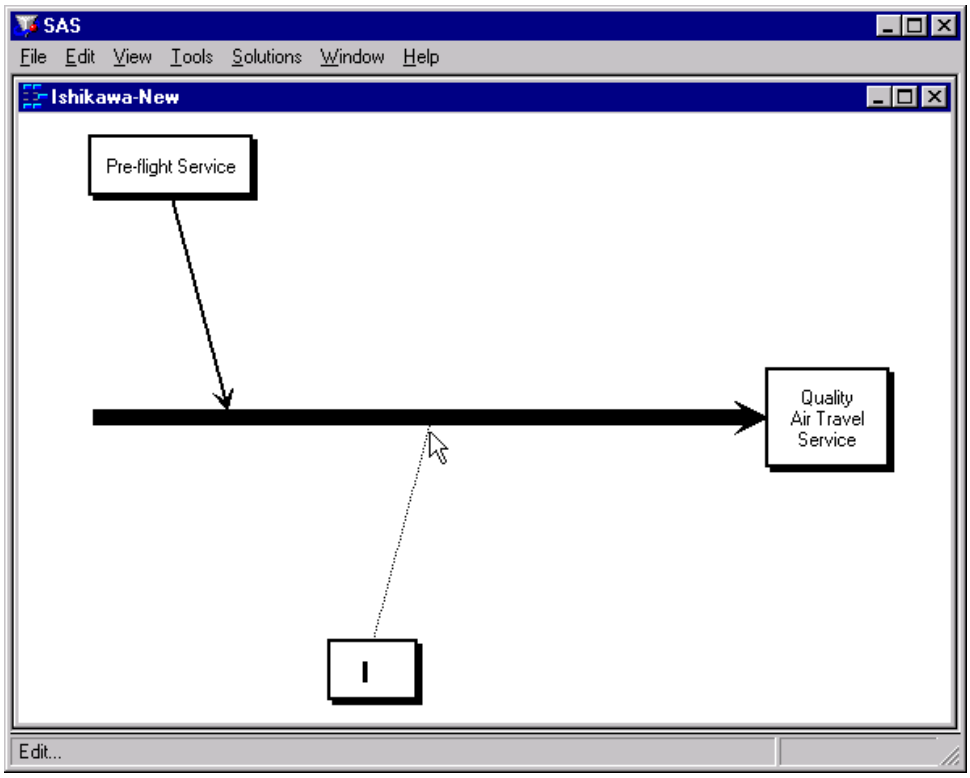


Note that when you finish entering text for the upper left branch, the other branches are deleted. These were temporarily displayed as visual cues, and now it is up to you to decide where to add the remaining branches.

[3] You can skip this step, in future diagrams, by pressing RETURN before entering any text.

7. To add the branch labeled *In-Flight Service* to the lower half of the diagram, position the cursor slightly below the point where you want the branch to attach to the trunk and click the mouse button. The branch appears with the text cursor centered inside the box. Enter the first line of text.

Figure 8.10 Adding a New Branch



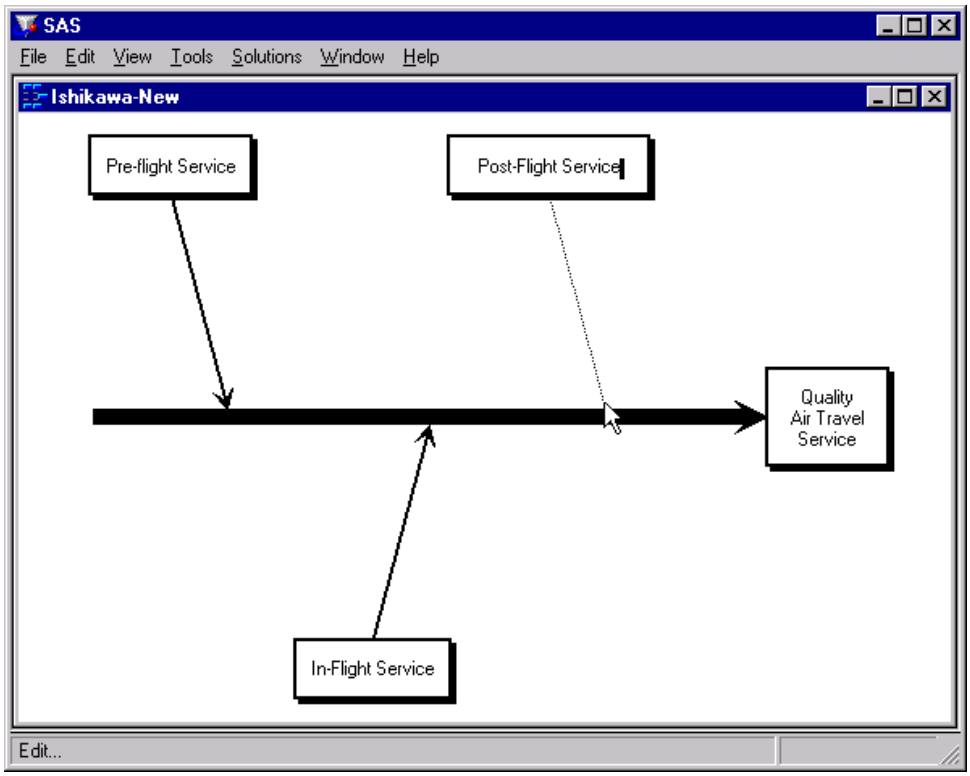
If your branch is not positioned where you want it, move the cursor to the appropriate position along the trunk and click. Each time you click, the branch is moved to the new location.

If, on the other hand, the branch is not drawn at all, the cursor was probably too far away from the trunk to be recognized. Move the cursor closer to the trunk and try again.

Enter the label *In-Flight Service* and press RETURN twice to terminate text entry.

8. Next add the branch *Post-Flight Service* to the upper half of the diagram. Position the cursor so that it is just above the point where you want the branch to attach to the trunk and click.

Figure 8.11 Adding the Last Branch



9. Press RETURN twice to terminate text entry.

Congratulations. You have just completed your first Ishikawa diagram using the ISHIKAWA procedure. In the process you learned to add branches to a diagram using context-sensitive mouse clicks. Future examples will illustrate other context sensitive areas, tools, and popup menus.

The examples that follow will, for the most part, expand on this diagram. To save the diagram, select **File ► Save as ► Data Set** from the command bar. Use SASUSER for the library name and AIRLINE for the data set name. Then select **Save**.

To leave the ISHIKAWA environment and return to the SAS Display Manager, select **File ► Close** from the command bar.

Details of the ISHIKAWA Environment

This chapter presents detailed information about and examples of all the operations available in the ISHIKAWA environment. Some of the examples build upon the diagram created in the tutorial.

Summary of Operations

To invoke the following context-sensitive operations, apply the specified action (mouse event) to the appropriate hotspot, using the left mouse button:

Table 8.1 Primary Operations

Operation	Mouse Event	Hotspot	Section
Add	Click	Near the intended attachment point	"Adding Arrows"
Edit	Click	Arrow tail	"Labeling Arrows"
Move	Click *(to pick)*	Arrow head	
	Click *(to drop)*	Near the intended attachment point	"Moving Arrows"
Delete	Double click	Arrow head	"Deleting Arrows"
Resize	Drag	Arrow tail	"Resizing Arrows"
Notepad	Double click	Arrow tail	"Notepads"

To invoke the following operations, make the specified selection from the appropriate context-sensitive popup menu using the right mouse button:

Table 8.2 Secondary Operations

Operation	Menu	Selection	Section
Swap	Head or tail	**Swap**	"Swapping Arrows"
Balance	Head or tail	**Balance**	"Balancing Arrows"
Hide Detail	Background	**< Detail**	"Managing Complexity"
Show Detail	Background	**> Detail**	"Managing Complexity"
Zoom	Head or tail	**Zoom**	"Zooming Arrows"
Isolate	Head or tail	**Isolate**	"Isolating Arrows"
Print	Pull-down	**File ► Save as ► Graph**	"Creating Graphics Output Using SAS/GRAPH Software"
Save	Pull-down	**File ► Save as ► Data Set**	"Saving an Ishikawa Diagram for Future Editing"
Save	Pull-down	**File ► Save as ► Image**	
Subset	Head or tail	**Subset**	"Modifying Arrow Colors and Line Styles"
Copy	Head or tail	**Copy**	"Merging Diagrams"
Refresh	Background	**Refresh**	
Unsubset	Background	**Unsubset**	"Modifying Arrow Colors and Line Styles"
Unbalance	Background	**Unbalance**	"Balancing Arrows"
Undelete	Background	**Undelete**	"Deleting Arrows"

When applied to the appropriate hotspots, the following actions (mouse events) invoke these context-sensitive operations:

Table 8.3 Context-Sensitive Tools

Hotspot	Mouse Event	Operation	Section
Arrow Head	Click	Begin move	"Moving Arrows"
	Double click	Delete	"Deleting Arrows"
	Drag	Resize	"Resizing Arrows"
	Popup menu	Subset	"Modifying Arrow Colors and Line Styles"
		Balance	"Balancing Arrows"
		Swap	"Swapping Arrows"
		Copy	"Merging Diagrams"
		Zoom	"Zooming Arrows"
		Isolate	"Isolating Arrows"
Arrow Tail	Click	Edit	"Labeling Arrows"
	Double click	Notepad	"Notepads"
	Drag	Resize	"Resizing Arrows"
	Popup menu	Subset	"Modifying Arrow Colors and Line Styles"
		Balance	"Balancing Arrows"
		Swap	"Swapping Arrows"
		Copy	"Merging Diagrams"
Arrow	Click	Add new arrow or	"Adding Arrows"
		complete move operation	"Moving Arrows"
Window	Click	Drop (finish) pending action	
Background	Drag	Drop (finish) pending action	
	Popup menu	Undelete	"Deleting Arrows"
		Unsubset	"Modifying Arrow Colors and Line Styles"
		Unbalance	"Balancing Arrows"
		Show Detail	"Managing Complexity"
		Hide Detail	"Managing Complexity"
		Refresh	

The File menu on the command bar can be used to control the following operations:

Table 8.4 File Menu

File ►	Description	Section
New…	Start a new diagram	"Tutorial"
Open…	Open an existing diagram	"Reading an Existing Ishikawa Diagram"
Close	Close the current window	
Merge	Merge in an existing diagram	"Merging Diagrams"
Save as ►		
Data Set	Save as a SAS data set	"Saving an Ishikawa Diagram for Future Editing"
Graph	Print using SAS/GRAPH software	"Creating Graphics Output Using SAS/GRAPH Software"
Image	Save as an IMAGE, catalog entry	"Save as an IMAGE"
Export as Bitmap ►		
File…	Copy to a bitmap file	"Creating Bitmap Graphics Output"
Customize…	Export options	"Export as Bitmap"

The Edit menu on the command bar can be used to control the following operations:

Table 8.5 Edit Menu

Edit ►	Description	Section
Copy	Copy the diagram to host clipboard	"Creating Bitmap Graphics Output"
Clear…	Clear the window	

The View menu on the command bar can be used to control the following operations:

Table 8.6 View Menu

View ►	Description	Section
Ishikawa Settings ►		
Palettes	Line and color palettes	"Modifying Arrow Colors and Line Styles"
Background Color	Change window background color	
Save Attributes	Save window attributes: size, fonts and background color	
Balance Method ►	Select a balancing style	"Balancing Arrows"
Resize Method ►	Select a resizing method	"Resizing Arrows"
Primary Fonts...	Font dialog for first 3 levels	"Modifying Fonts"
Secondary Fonts...	Font dialog for levels 4-10	"Modifying Fonts"
Colors...	Color dialog	"Modifying Box Colors"
Arrows...	Arrow style dialog	"Modifying Arrow Heads"
Other...	Style dialog	"Modifying Environmental Attributes"
Refresh	Refresh the window	

The Help menu on the command bar can be used to control the following operations:

Table 8.7 Help Menu

Help ►	Description
SAS System Help	SAS help system
Using This Window	Ishikawa specific help

Operations

This section provides details concerning the operations available in the ISHIKAWA environment. The order in which the topics appear is the order in which the operations are typically encountered. Some of the examples in this section build upon the diagram created in the tutorial.

Adding Arrows

You add an arrow by pointing with the mouse to the intended attachment point along an existing arrow and clicking the mouse. You control the direction of the new arrow by offsetting the mouse cursor a small distance away from the parent arrow on the side where the new arrow is to appear.

For example, to add upper branches, you offset the cursor slightly above the trunk. To add lower branches, you offset the cursor slightly below the trunk. Likewise, you offset the cursor to the right of the branch to add a right-hand stem and slightly left for a left-hand stem.

If a new arrow is not drawn as you intended (either positionally or directionally), you can easily move or delete it. To delete a new arrow before you have entered any text, click in the background. To move a new arrow before you have entered any text, move the cursor to a new attachment point and click.

Once an arrow is drawn, you are immediately prompted for its label (note the hint, *Edit...*, displayed on the message line and the appearance of the text cursor at the end of the arrow). See "Labeling Arrows" on page 715, for details on the text editing features of the ISHIKAWA environment.

A diagram can contain up to ten levels of detail, but the number of arrows is limited only by the resolution and size of your graphics display.

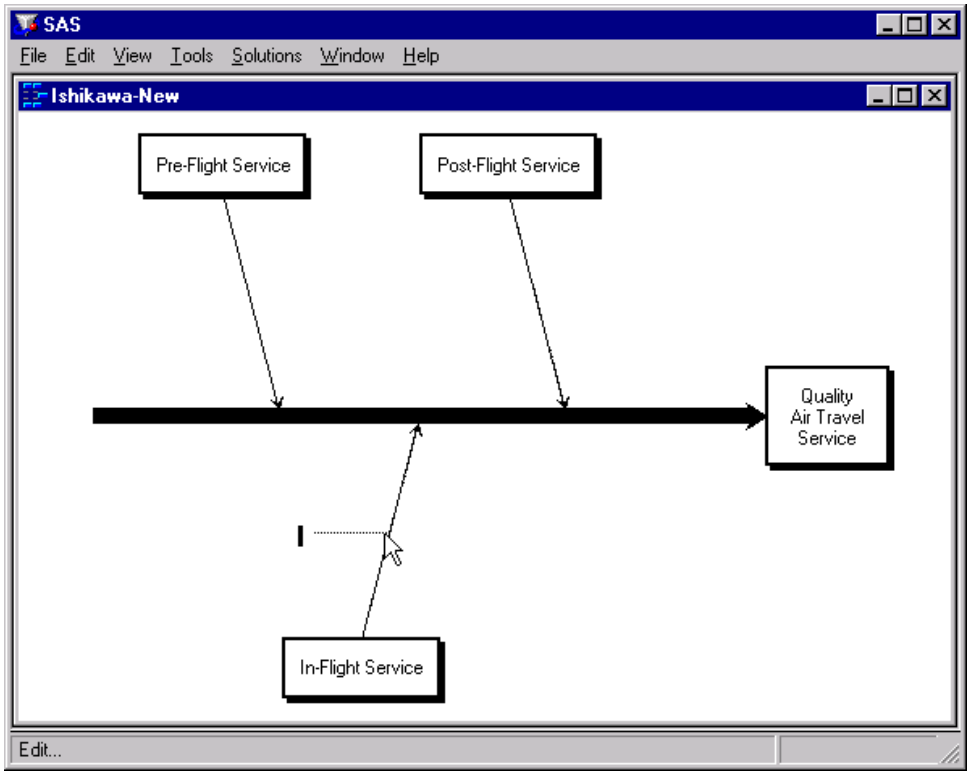
Example

Continuing with the tutorial example from "Tutorial" on page 699, suppose that you have obtained detailed information for each of the three major service areas, which you want to display by adding stems to the branches of the diagram you previously created. If you closed the ISHIKAWA environment after saving the data set, SASUSER.AIRLINE, you can easily restore the diagram by submitting:

```
proc ishikawa data=sasuser.airline;
run;
```

To add a stem to the left side of the branch labeled *In-Flight Service*, position the cursor so that it is just to the left of the point where you want the stem to attach. Click the mouse. The new arrow (pending text) appears as follows:

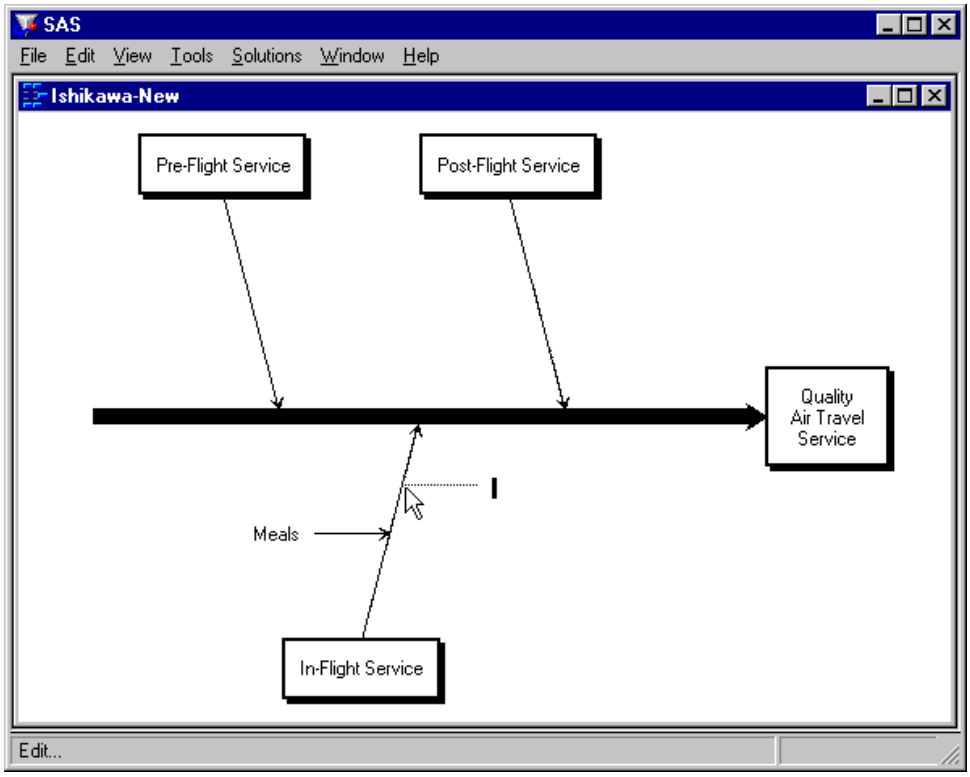
Figure 8.12 Adding the Left Stem



Type the label *Meals* and press RETURN twice.

To add a stem to the right side of the same branch, position the cursor so that it is just to the right of the attachment point. When you click the mouse, your window will appear as follows:

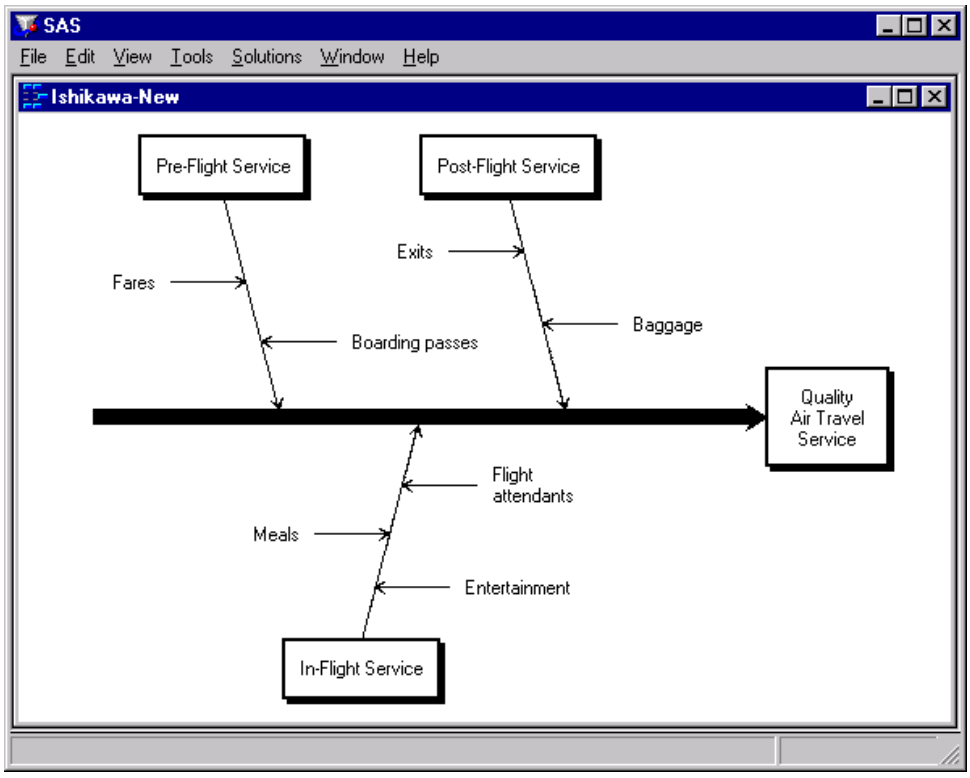
Figure 8.13 Adding the Right Stem



Type the label *Flight attendants* on two lines and press RETURN to terminate text entry.

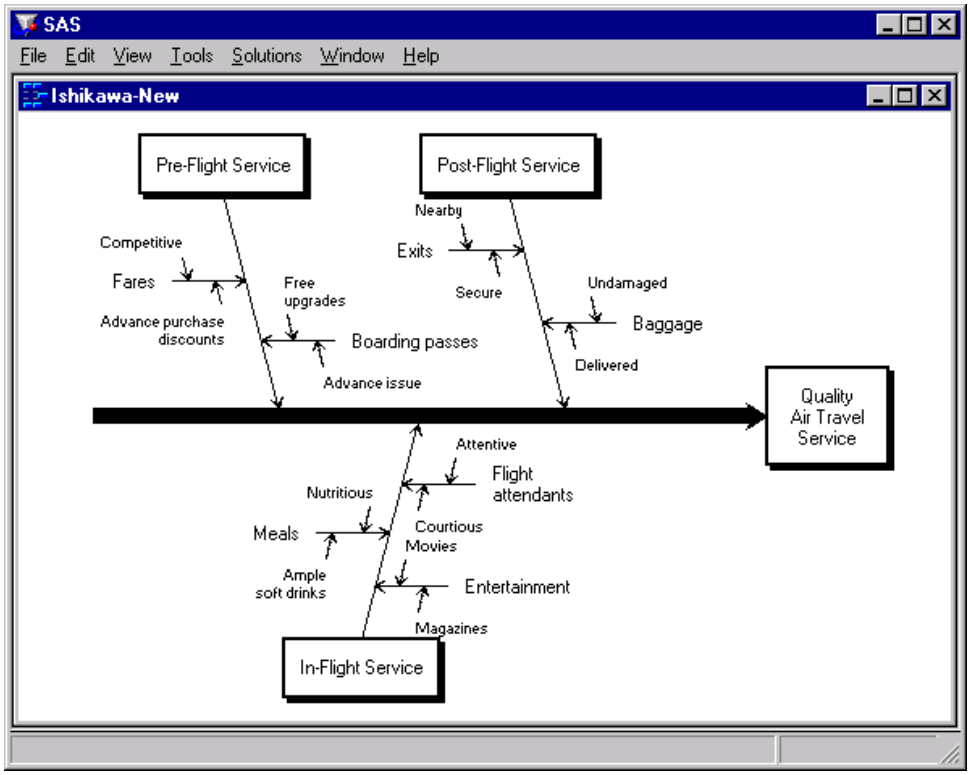
Complete the diagram by adding the remaining stems shown in the following window:

Figure 8.14 Stem-Level Diagram



Experiment further by adding several of the leaves shown in the following window. Don't be concerned if some of the labels collide with each other. Later, you will learn how to move and resize arrows.

Figure 8.15 Leaf-Level Diagram



Labeling Arrows

To edit the label of an existing arrow, click on one of the following areas:

- the label
- the arrow tail (if the arrow does not have a label)
- inside the box for trunk and branch labels

Use your keyboard to enter the text.

On hosts that support direct graphical text entry,[4] the following functions are supported:

- edit keys such as BACK SPACE, DELETE CHAR, DELETE LINE, and RETURN
- cursor navigation keys such as ↑, ↓, → and ←
- the INSERT key to toggle between insert and overstrike modes
- buffers to copy, cut, or paste text into and from external sources

Text entry is terminated whenever you press RETURN on an empty line or exceed the maximum line limit for a label. Text entry is also terminated whenever you click the mouse. This shifts focus away from the editing operation and to the new location.

Labels are restricted to 40 characters per line. The trunk label can have up to five lines, and labels for other levels are limited to two lines.

You can split a line of text into two lines by pressing the RETURN key anywhere inside the line. Likewise, flow a line with the previous line of text by pressing the BACK SPACE key at the beginning of the line.

You can copy the contents of the paste buffer into a label using the PASTE command. This can be helpful when the information for your diagram is available from another source (a flat file, for example). Use the paste buffer to copy the information from that source to your Ishikawa diagram.

Some hosts designate the right mouse button for pasting, some use control keys (like ctrl-p), while others use a designated function key. For more details about using paste buffers with the SAS System, consult the SAS companion for your host.

To paste text into a label, you must first select the label. For existing arrows, select the arrow, position the cursor where you want the text to appear, and then issue the PASTE command. For new arrows pending text entry, simply issue the PASTE command. Any text in the paste buffer that causes the label to exceed its limits is truncated.

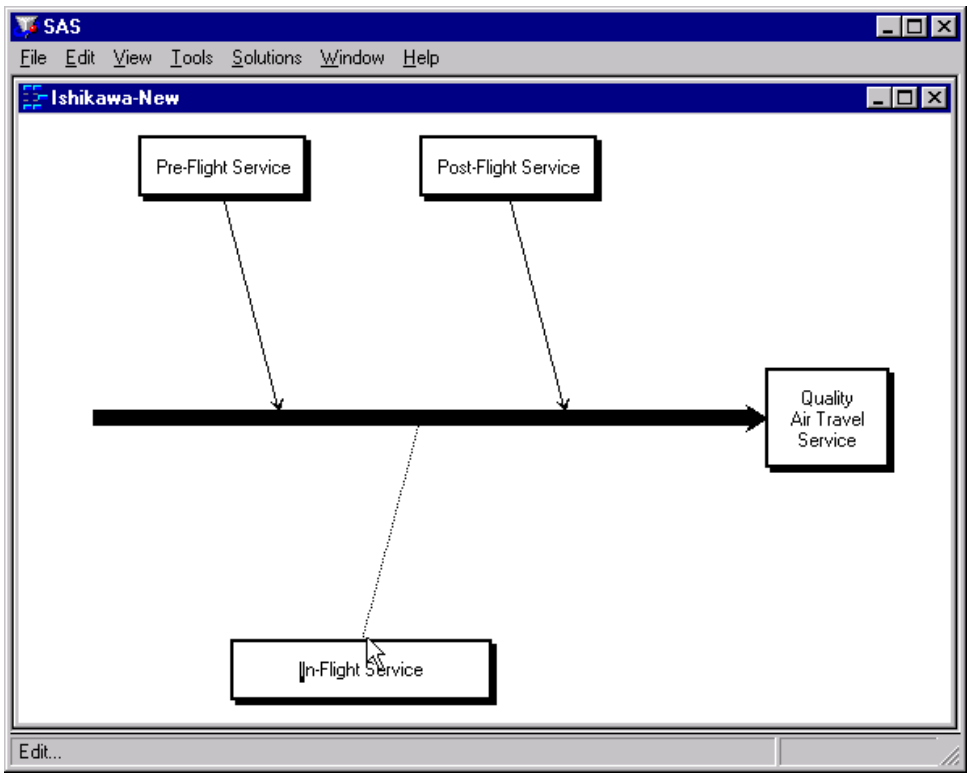
When your mouse has a paste key defined, instead of adding an arrow and pasting the text in two operations, use the *right* mouse button to add the arrow. This action adds a new arrow, automatically copies the label from the paste buffer, and terminates text entry, in a single operation.

Example

In the following diagram, the branch labeled *In-Flight Service* has been selected by clicking on the arrow tail. The arrow is highlighted with a narrow dotted line, and the text cursor is positioned over the first character in the label.

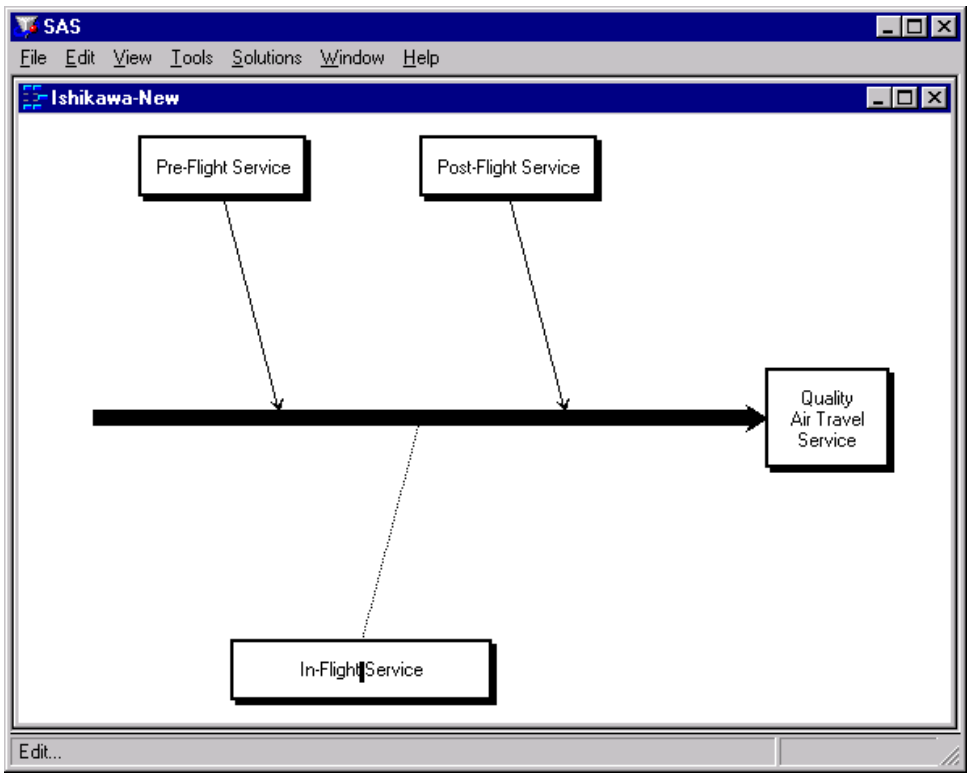
[4] Devices such as the IBM3179 do not support the direct graphical text entry mechanism described in these examples. Instead, a text entry window pops up whenever you select an arrow for editing. You must edit the text for the arrow from the dialog box and close the text entry window before the diagram is updated.

Figure 8.16 Selecting an Arrow for Editing



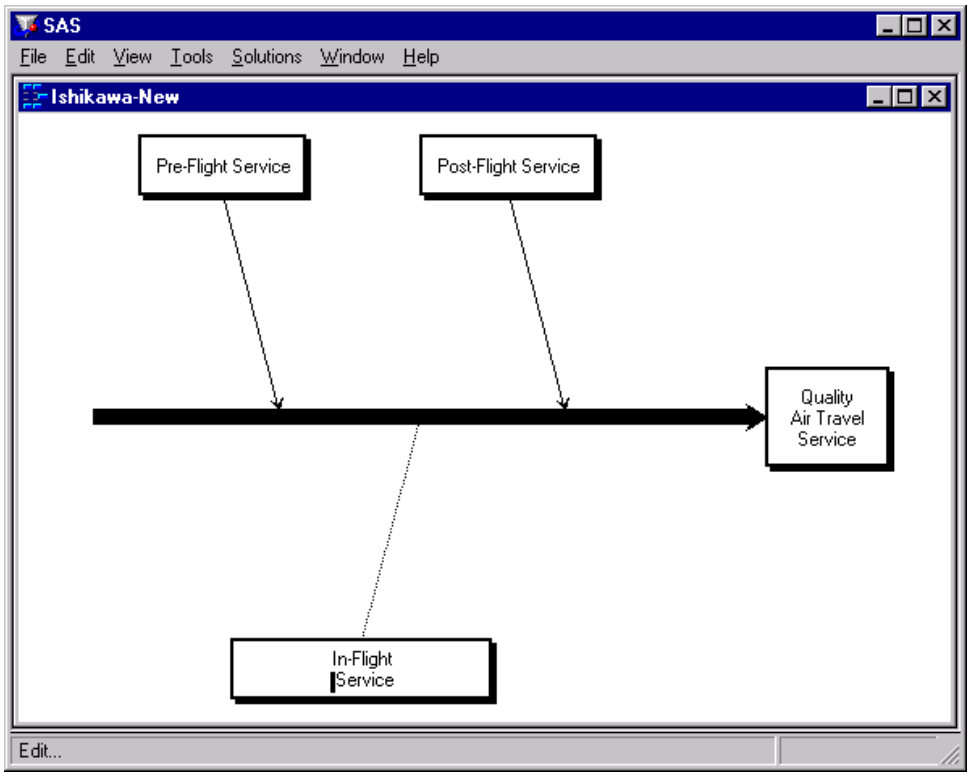
To change the label so that the word *Service* appears on a separate line, use the → or ← key to move the cursor to the space before the word *Service*, as shown in the following:

Figure 8.17 Using Cursor Keys



Now press RETURN to split the text into two lines.

Figure 8.18 Splitting Text



Remember to delete the space preceding *Service* before pressing RETURN to terminate text entry.

Moving Arrows

You move an arrow by picking up the arrow and dropping it at a new location:

- To *pick up* an arrow, position the cursor over the arrow head and click the mouse. The arrow you selected will be highlighted with a narrow dotted line. If the arrow is not highlighted, move the cursor closer to the arrow head and repeat the click.
- To *drop* an arrow, move the cursor slightly to one side of the new attachment point and click (just as though you are adding a new arrow).

When you move an arrow, all its descendants move with it.

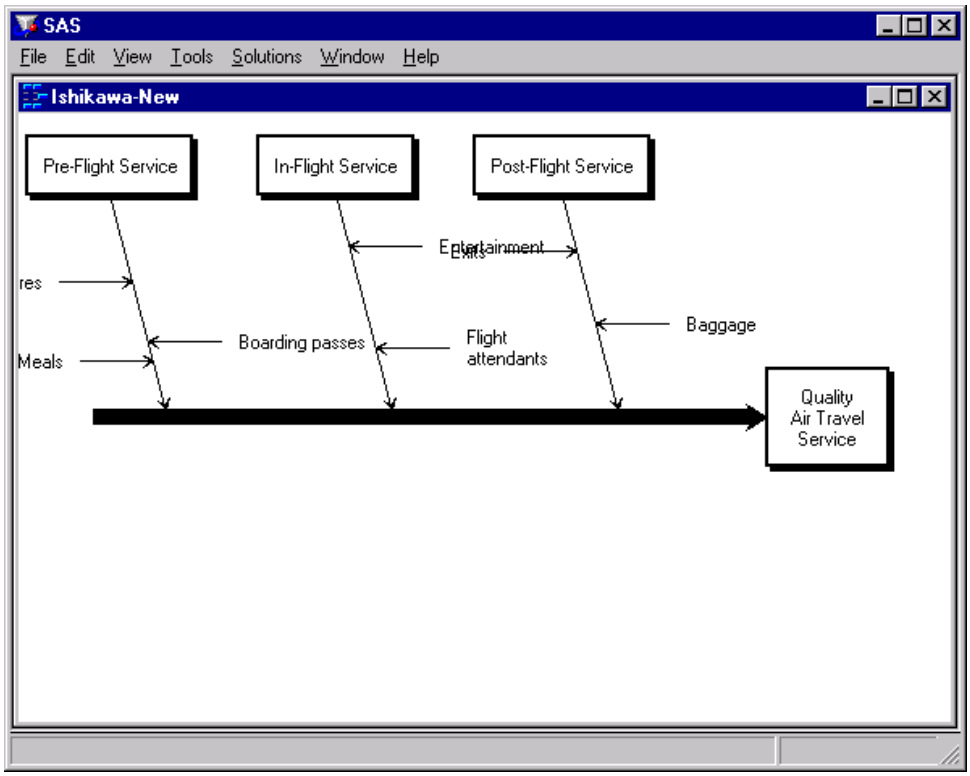
To cancel a move after picking up an arrow, click in the background area of the ISHIKAWA window.

Do not try to drop the arrow back into place by clicking on the arrow head a second time. A double click on (or near) the arrow head deletes the arrow. To move an arrow a short distance, move the cursor away from the arrow head before clicking to drop the arrow. On some systems the cursor will change shape when you have moved outside the context-sensitive area.

Example

As your diagrams develop, you will want to reposition arrows, either because of errors or for aesthetic reasons. The following is an example of an Ishikawa diagram that needs to be modified:

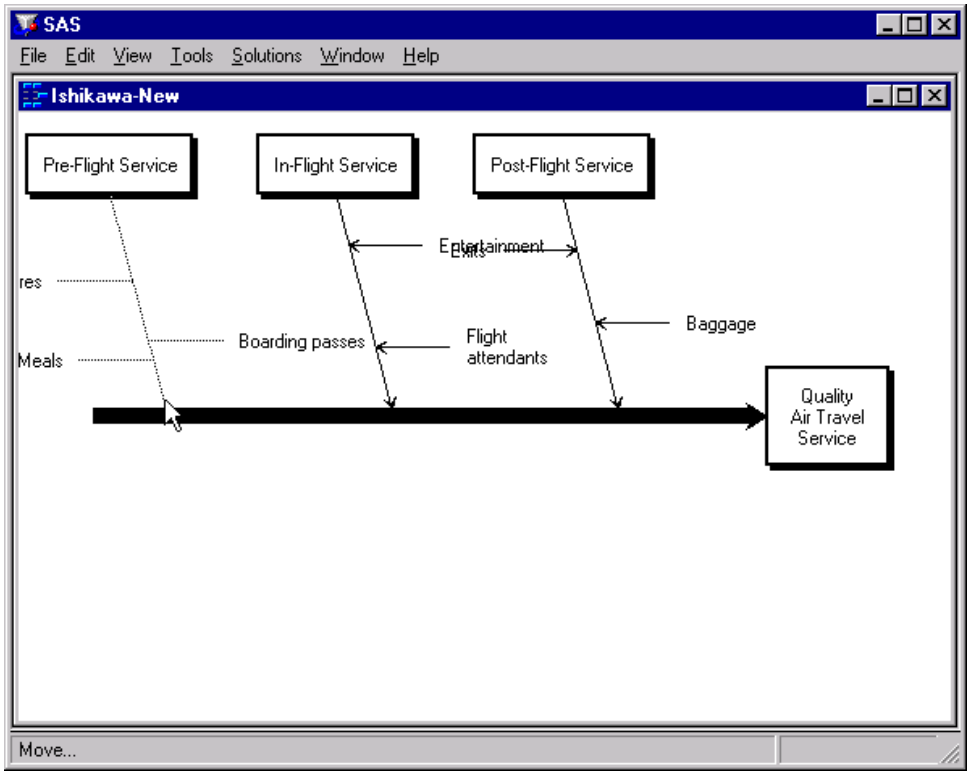
Figure 8.19 An Inelegantly Arranged Ishikawa Diagram



The diagram lacks balance, and some of the branches are too close, resulting in collisions and clipping.

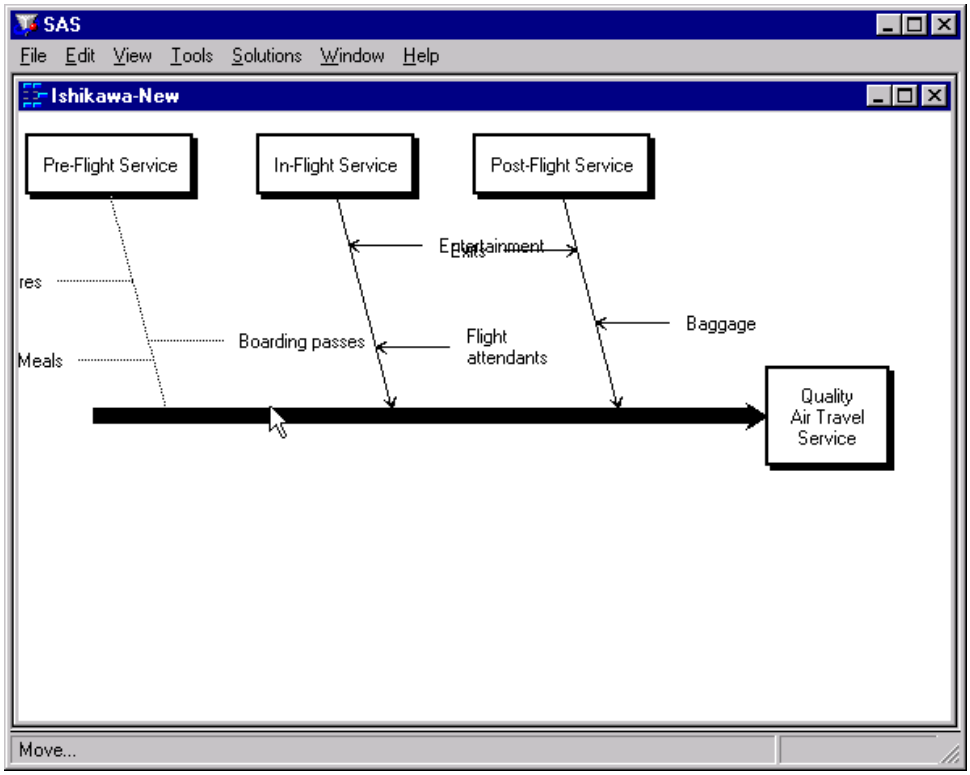
One way to improve the diagram is to move the branch for *Pre-Flight Service* toward the center of the trunk. First select the arrow head for this branch.

Figure 8.20 Selecting an Arrow to Move



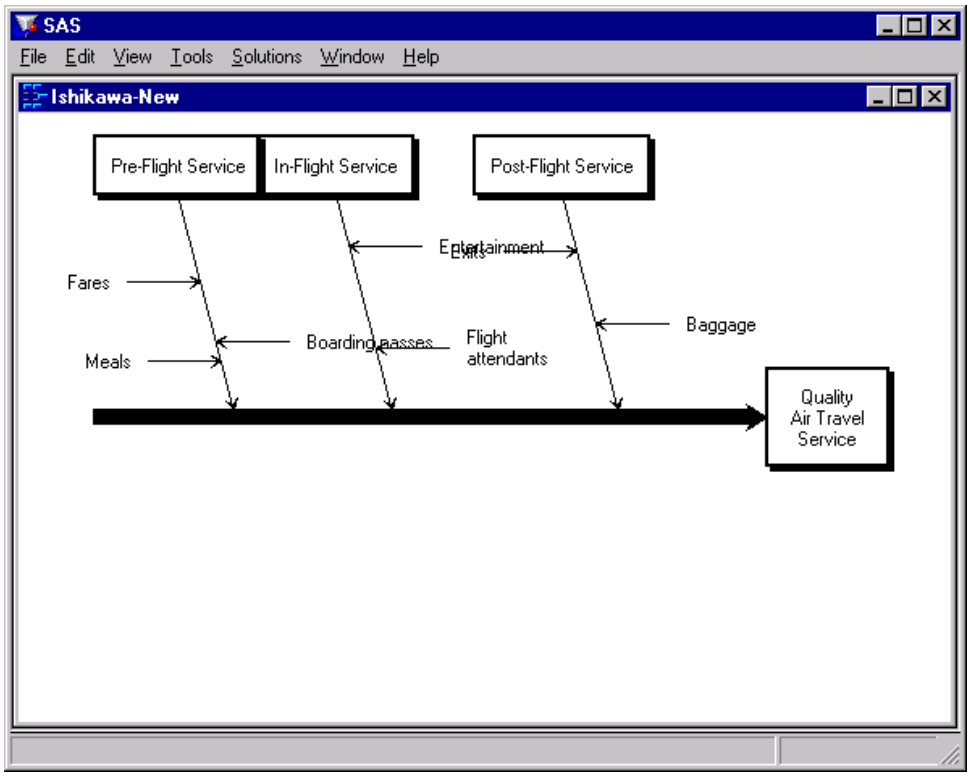
Then move the cursor to a point just slightly above the trunk near the desired new attachment point.

Figure 8.21 Locating the New Attachment Point



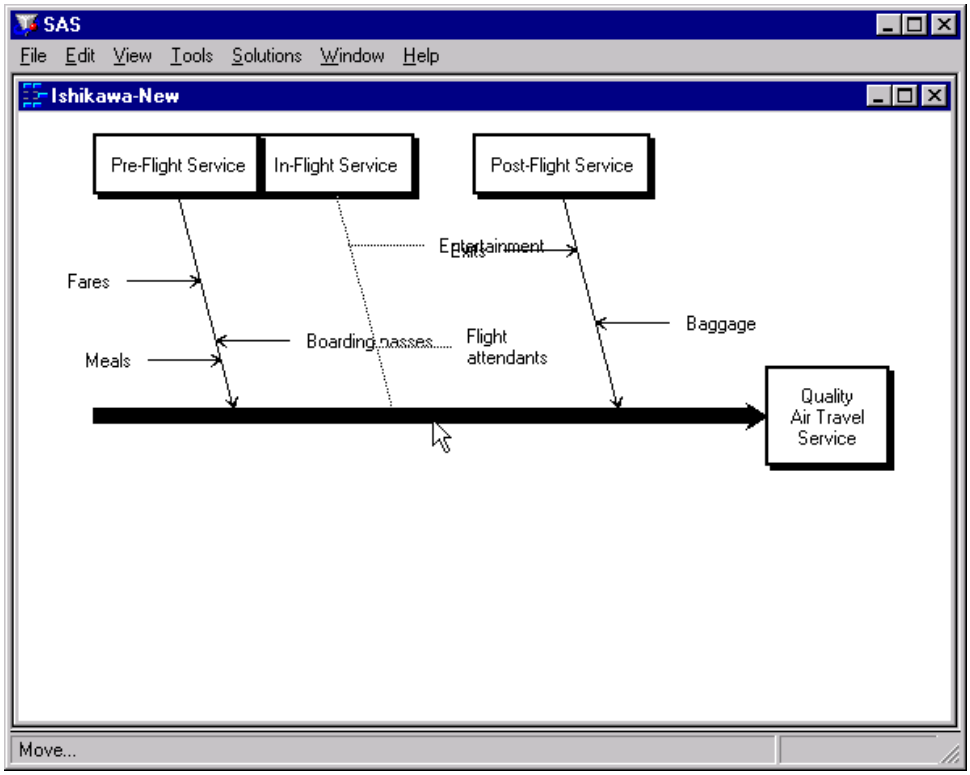
Drop the arrow in place by clicking the mouse.

Figure 8.22 Dropping an Arrow into Position



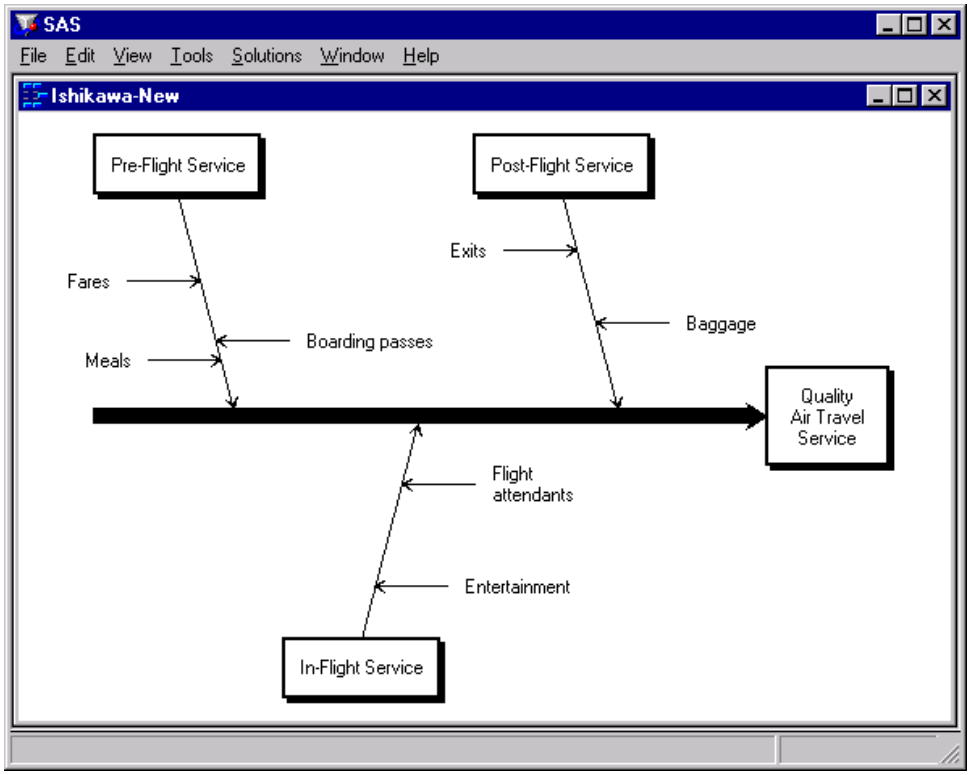
Next, you should reflect the middle branch to the lower half of the diagram to balance the diagram and eliminate the remaining collisions. Once you have selected the branch, position the cursor slightly below the trunk near the desired new attachment point.

Figure 8.23 Selecting an Arrow for Reflecting



Click the mouse to complete the reflection.

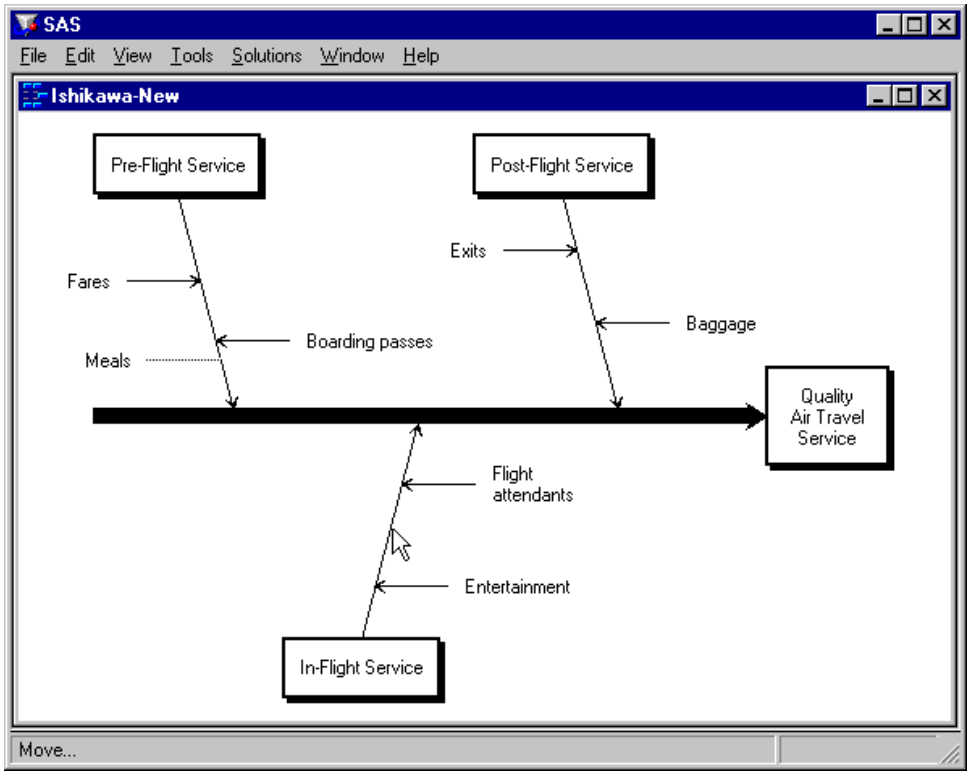
Figure 8.24 Reflecting an Arrow



Note that the stems are reflected with the branch and that their positions (relative to the trunk) are preserved.

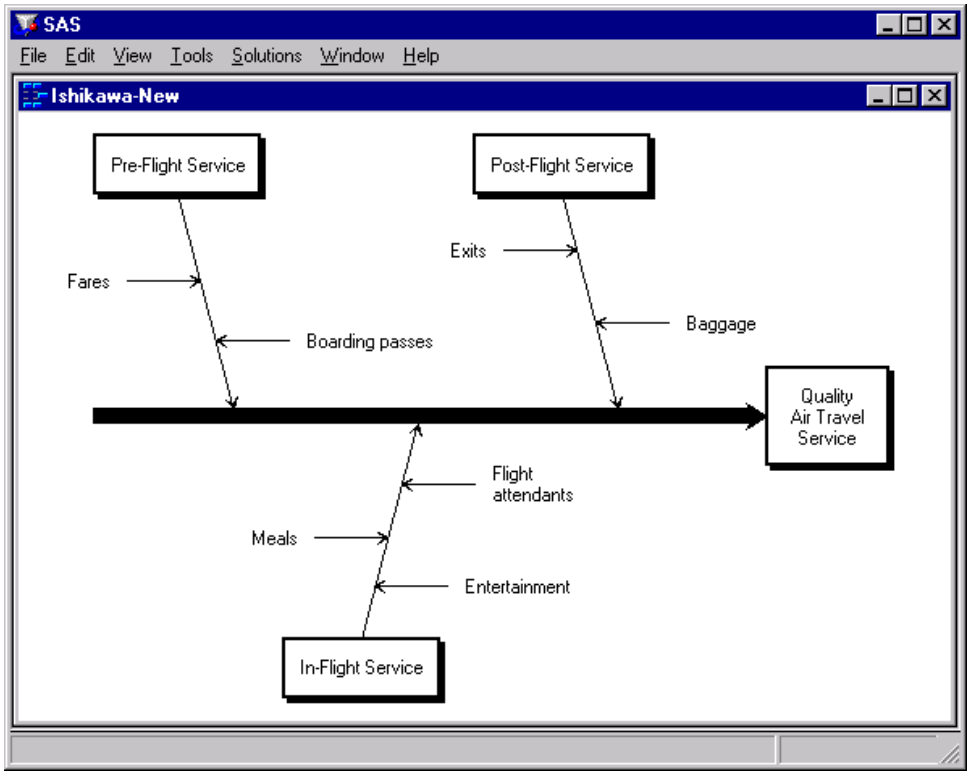
Finally, the stem labeled *Meals* is incorrectly attached to the branch labeled *Pre-Flight Service* and should be moved to the branch labeled *In-Flight Service*. Once you have selected the stem, move the cursor slightly left of the new attachment point.

Figure 8.25 Locating the New Attachment Point



To complete the move, click the mouse.

Figure 8.26 Moving a Stem



Apply the same principles when moving an arrow to a new level (for example, to elevate a stem to a branch) or a new diagram (when you have multiple ISHIKAWA windows open).

Deleting Arrows

You can delete an arrow (with all its descendants) by moving the cursor over the arrow head (attachment point) and double clicking. If you accidentally move the cursor while double clicking, it is possible that the arrow will be moved instead of being deleted. In that case, double click on the arrow head again.

You can undo a deletion by moving the cursor to a background area of the window and using the right mouse button to select **Undelete** from the background popup menu. Repeat the operation when you want to undo several deletions.

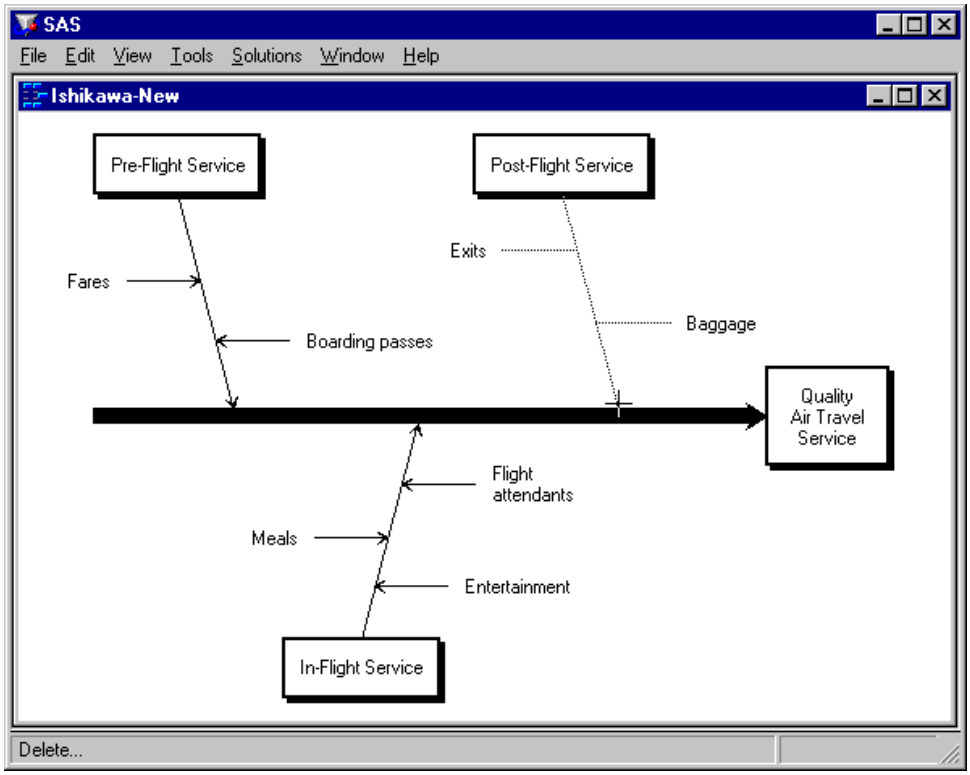
Once an arrow has been selected for deletion, you can cancel the pending operation by moving the cursor to a background area of the diagram and clicking the mouse.

The ISHIKAWA environment does not allow you to delete the trunk. To clear the window, select **Edit ► Clear...** from the command bar. Then start a new diagram by selecting **File ► New...** or **File ► Open...**.

Example

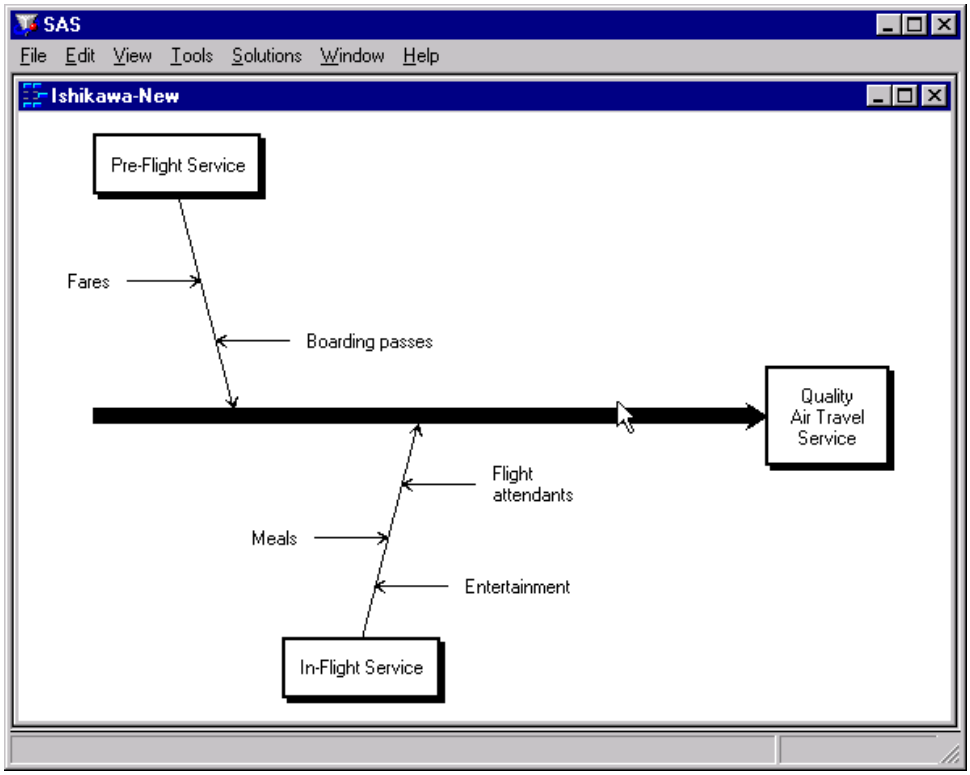
In the following diagram, the branch labeled *Post-Flight Service* has been selected for deletion (note that the branch is highlighted):

Figure 8.27 Selecting a Branch for Deletion



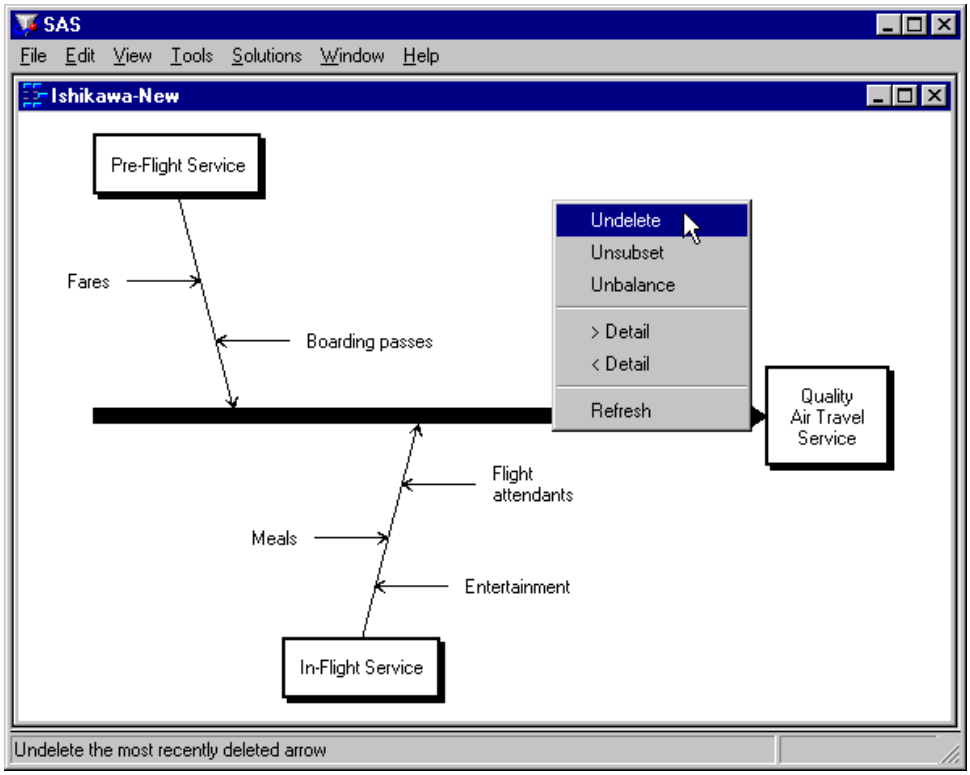
Without moving the cursor, click on the arrow head a second time to delete the branch.

Figure 8.28 Deleting a Branch



To undelete the previous deletion, move the cursor to a background area of the window and use the right mouse button to select **Undelete** from the background popup menu.

Figure 8.29 Undeleting a Branch



Resizing Arrows

You can resize an arrow by holding the mouse button down over the tail end of the arrow and dragging the mouse.[5] As you move the mouse, the arrow is represented by a rubberband line, and a plus sign (+) is drawn to indicate the original position of the arrow tail. The new length is determined by the position of the cursor when you release the mouse.

To cancel a resize operation once you have depressed the mouse button, release the button outside the ISHIKAWA window.

All non-horizontal arrows are constrained to have the same angle. You control the angle by resizing a branch. That is to say, when you resize a leaf, its angle does not change.

Use **View ► Ishikawa Settings ► Resize Method ►**to control the scope of the resizing operation.

- **Local** resizes only the arrow being dragged.
- **Global** resizes all the arrows at that level to lengths that are proportional to the arrow being dragged. This is the default.
- **Uniform** resizes all arrows at that level to the length of the arrow being dragged.

When you resize an arrow, you also update the default size for all new arrows at that level.

By default, global and uniform resizing applies to all the arrows at the level of the arrow being resized. To restrict resizing to a specific subset of arrows, you can subset them as follows:

- Move the cursor over the arrow head of an arrow to subset that arrow and all its descendants.
- Move the cursor over the arrow tail of an arrow to subset only that arrow (and not its descendants).
- Use the right mouse button to activate the popup menu.
- Select **Subset**.

On some hosts, shift-clicking on the arrow head or tail also subsets an arrow.

Subsetted arrows are indicated by underlined labels. Subsetting is a toggle operation, so to *unsubset* an arrow, repeat the preceding steps.

To unsubset all the arrows in the diagram, do the following:

- Move the cursor to a background area of the window.
- Use the right mouse button to activate the background popup menu.
- Select **Unsubset**.

Be sure to remove all subsets after you have finished modifying the diagram, since remaining subsets can alter the focus of other operations.

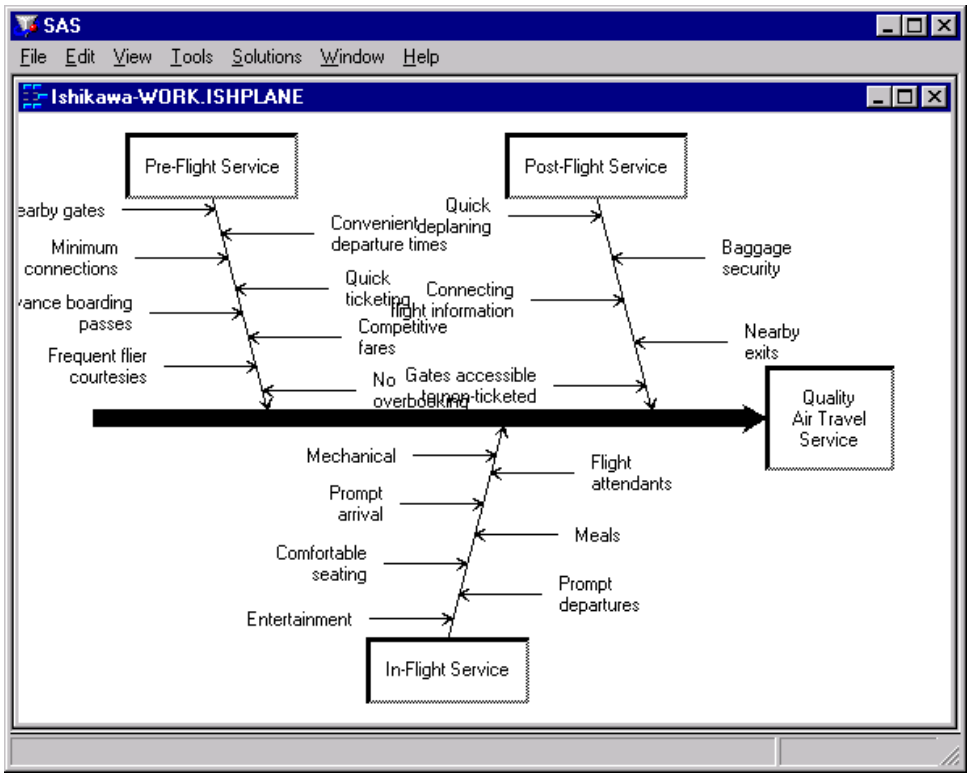
See “Modifying Arrow Colors and Line Styles” on page 755, for more examples of how subsets are used.

[5] Some devices (such as the IBM3179) require you to define a drag key. For more details about dragging on your system, consult the SAS companion for your host.

Example

Arrows that are too long can cause clipping and collisions, as illustrated in the following diagram:

Figure 8.30 Before Resizing the Diagram

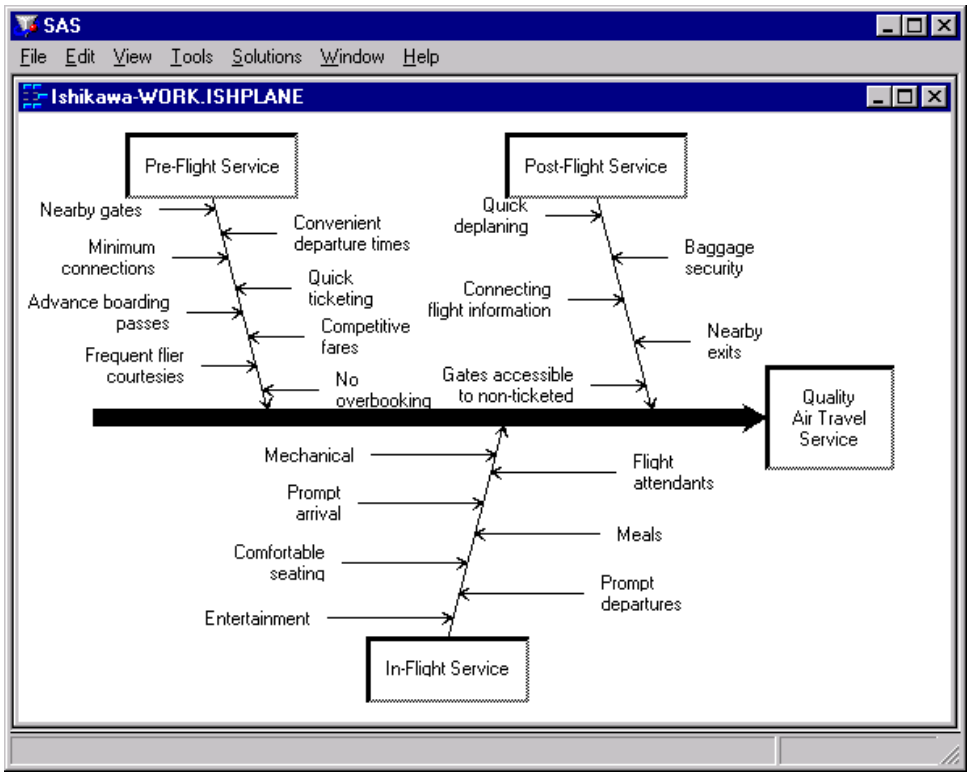


To resize the stems in the upper half of the diagram, proceed as follows:

- Subset the branch for *Pre-Flight Service* by moving the cursor over its arrow head and selecting **Subset**.
- Do the same to *Post-Flight Service*.
- Shorten one of the subsetted stems by dragging its tail to the desired length.
- Remove all subsets by selecting **Unsubset**.

The results are as follows:

Figure 8.31 After Resizing the Diagram



Swapping Arrows

Use the swap operation to interchange two arrows in a single operation instead of using two move operations. Swapping has all the flexibility of the move operation; you can swap arrows that have different parents, different levels, or arrows from different diagrams.

Like moving, the results depend upon whether you select the arrow from the arrow head or the arrow tail. When you select the arrow head, the arrow and all its descendants are moved. When you select the arrow tail, only the labels of the selected arrows are interchanged.

Swapping is a two step operation.

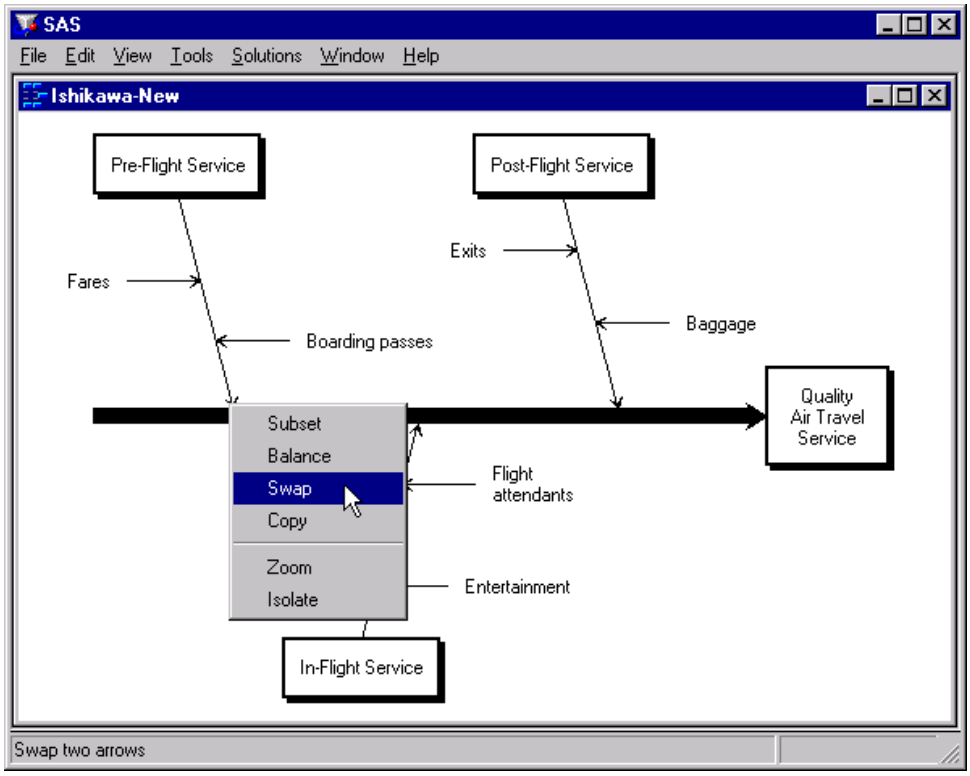
- Move the cursor over the arrow head (tail) of one of the arrows to be swapped and select **Swap** from the context-sensitive popup menu.
- Complete the swap by using the mouse to select the comparable end (head or tail) of the second arrow.

To cancel a swap after you have selected the first arrow, click in a background area of the diagram.

Example

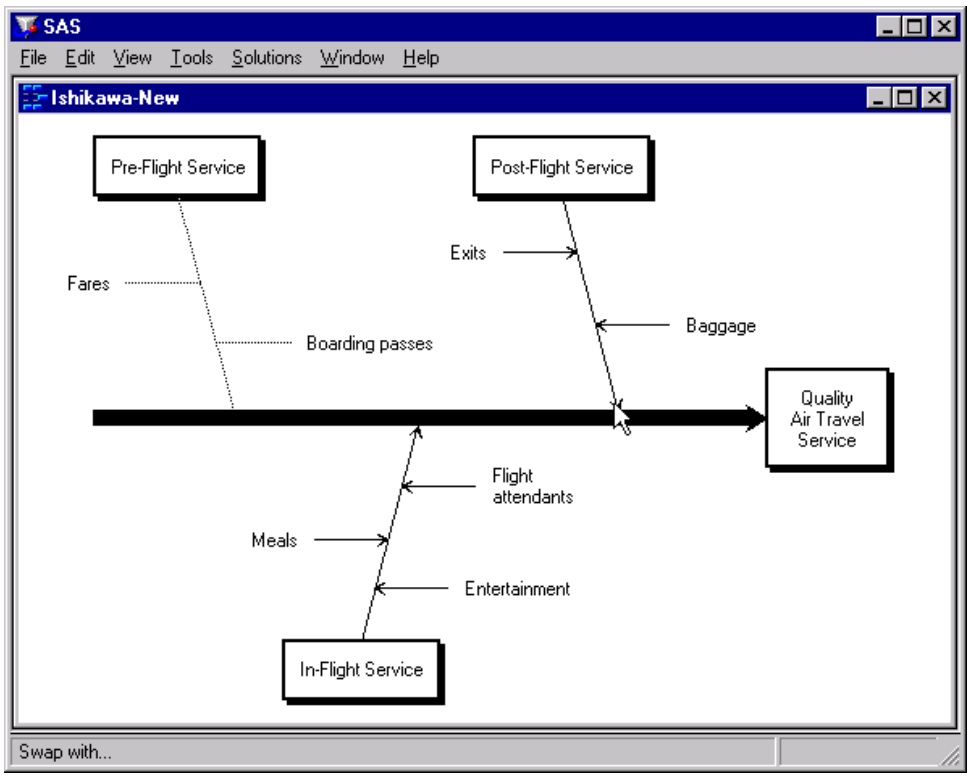
To swap the branch labeled *Pre-Flight Service* (and all its descendants) with the branch labeled *Post-Flight Service* in the following diagram, move your cursor over the arrow head of the *Pre-Flight Service* branch and activate the popup menu using the right mouse button. Select **Swap** to begin the operation.

Figure 8.32 Swapping Two Arrows



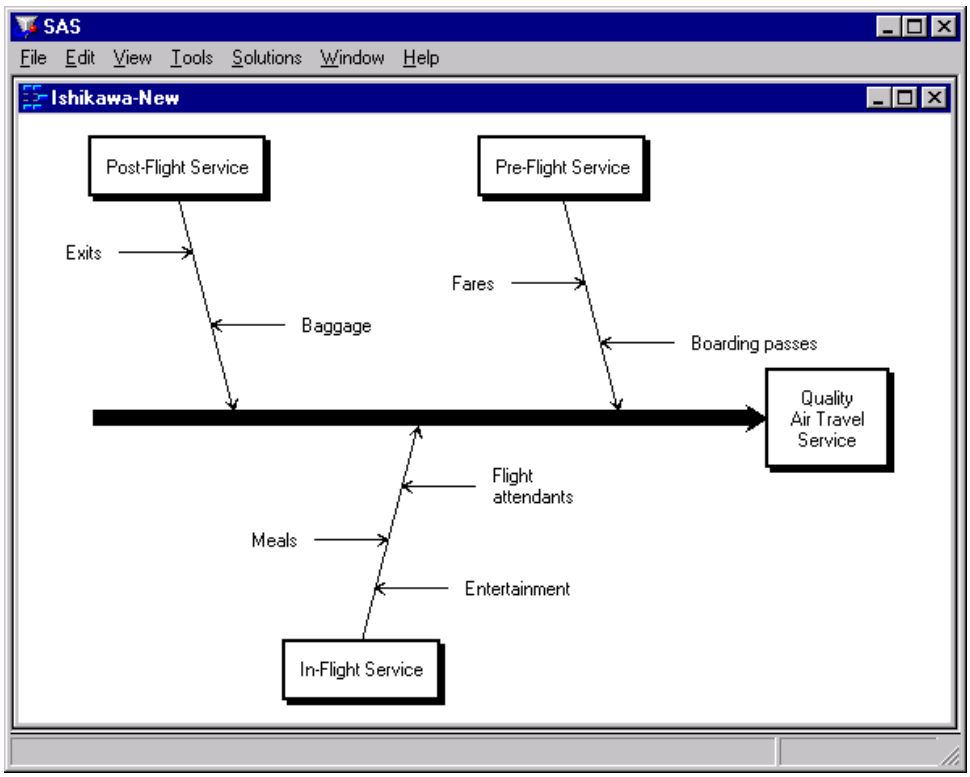
To complete the swap, select the arrow head of the *Post-Flight Service* branch.

Figure 8.33 Swapping Two Arrows *(continued)*



The completed diagram illustrates how the swap operation simplifies interchanging two arrows.

Figure 8.34 Completing a Swap



An alternative to swapping the arrows is to move them. However, moving arrows in this situation requires more steps and tends to be more cumbersome than swapping.

Balancing Arrows

An Ishikawa diagram is said to be *balanced* if the sub-arrows attached to each arrow are equally spaced.

To balance the immediate descendants of an arrow *and all its descendants*, proceed as follows:

- Move the cursor over the arrow head.
- Activate the popup menu using the right mouse button.
- Select **Balance**.

To balance only the immediate descendants of an arrow, select **Balance** from the popup menu for the arrow tail.

You can restore the arrows to their original positions by doing the following:

- Activate the background popup menu using the right mouse button.
- Select **Unbalance**.

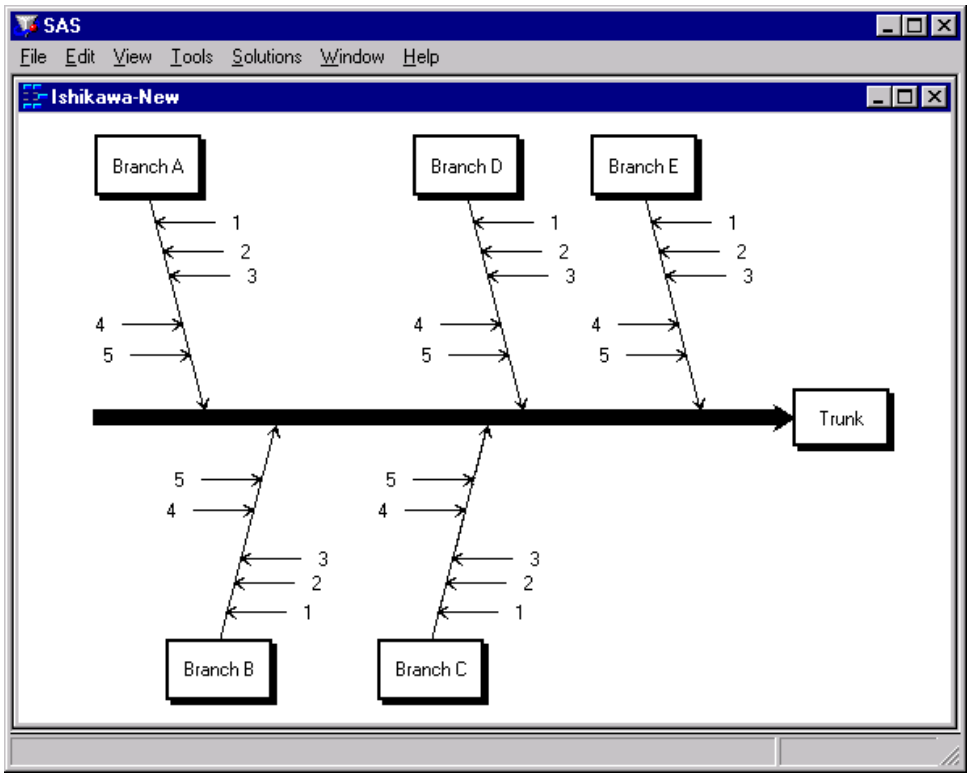
The ISHIKAWA environment provides three alternative methods for balancing arrows. Select one of the following choices from the **View ► Ishikawa Setting ► Balance Method ►**menu:

- **Preserve order/sides** maintains the order and directions of the sub-arrows but repositions them so they are evenly spaced.
- **Preserve order/alternate sides** maintains the ordering of the arrows but repositions adjacent arrows so that they appear on opposite sides. This is the default.
- **Preserve sides** maintains the side on which the sub-arrows are attached then spaces each side of the arrow independently.

Example

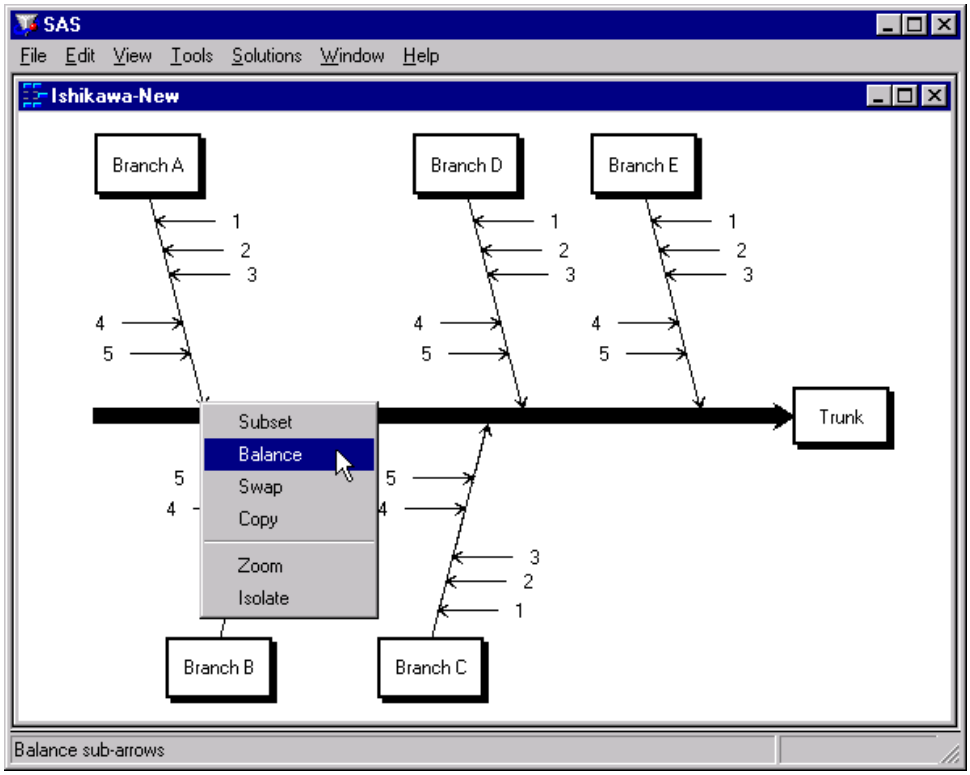
Consider the following unbalanced diagram:

Figure 8.35 An Unbalanced Ishikawa Diagram



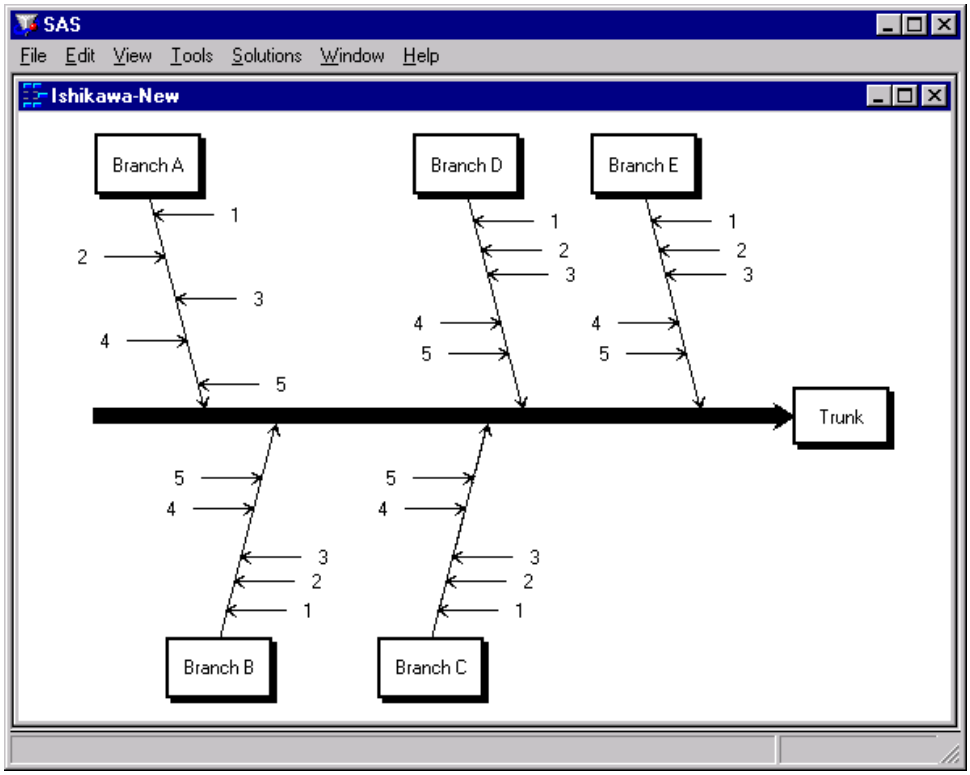
To balance only the stems of the branch labeled *Branch A*, move the cursor over the arrow head and press the right mouse button.

Figure 8.36 Balancing a Branch



Select **Balance** from the arrow head popup menu.

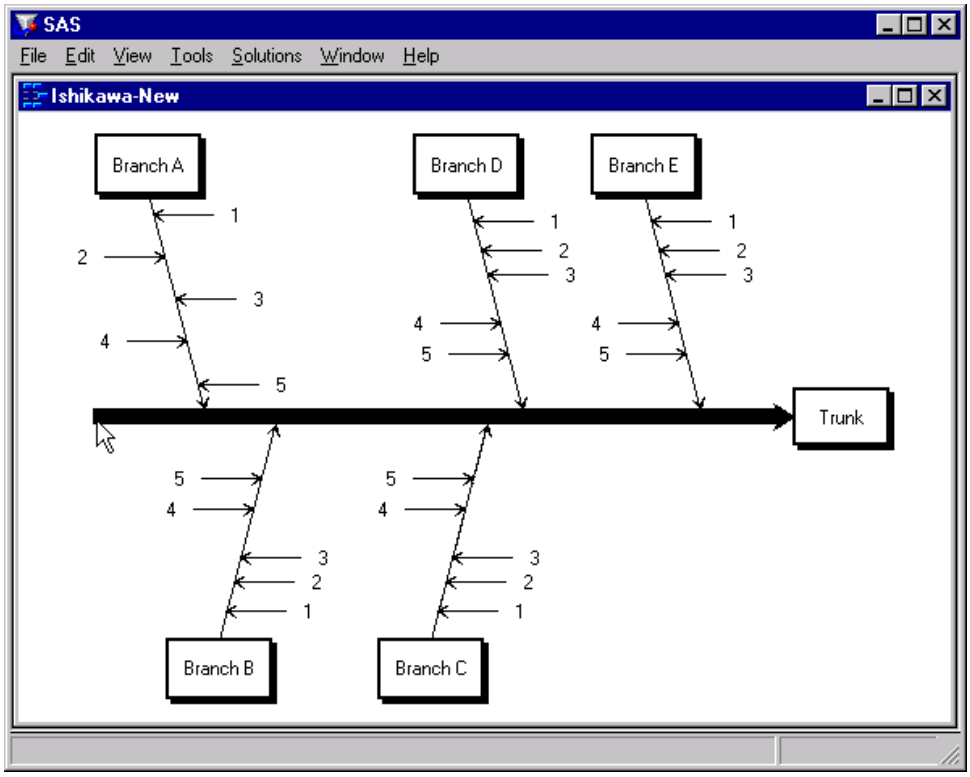
Figure 8.37 A Balanced Branch



Note that since the stems are without leaves, selecting either the head or the tail has the same result.

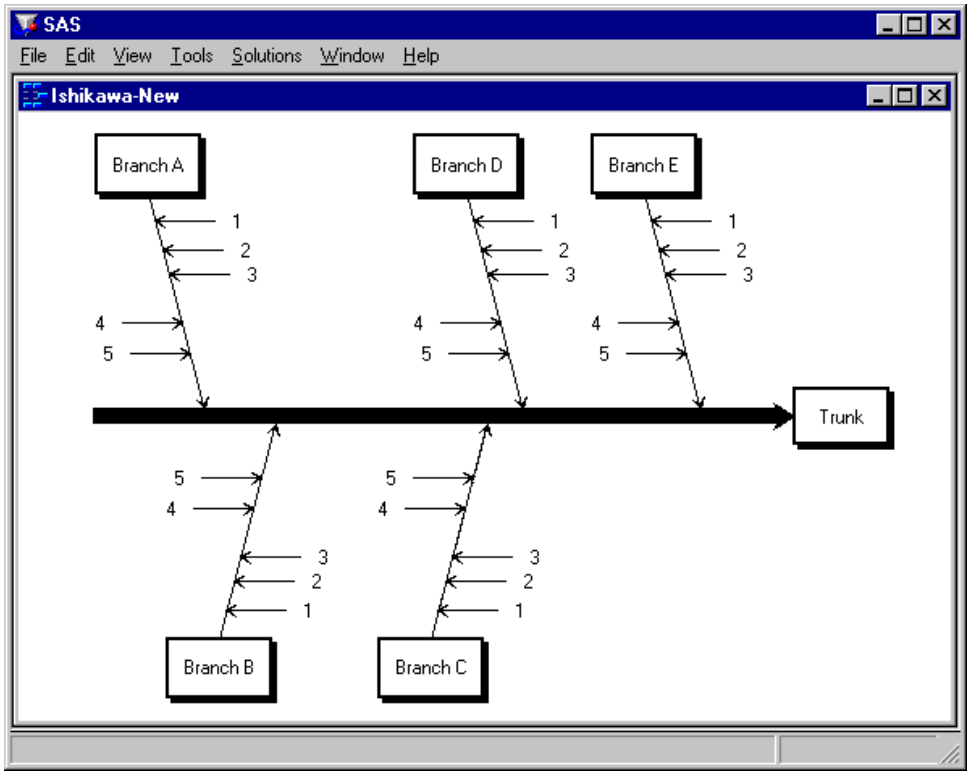
To balance only the five major branches in the preceding diagram without affecting their stems, move the cursor to the tail end of the trunk and select **Balance** from the popup menu.

Figure 8.38 Balancing Only the Branches



To balance the entire diagram (from head to tail, so to speak), move the cursor to the head of the trunk and select **Balance** from the popup menu.

Figure 8.39 Balancing the Entire Diagram

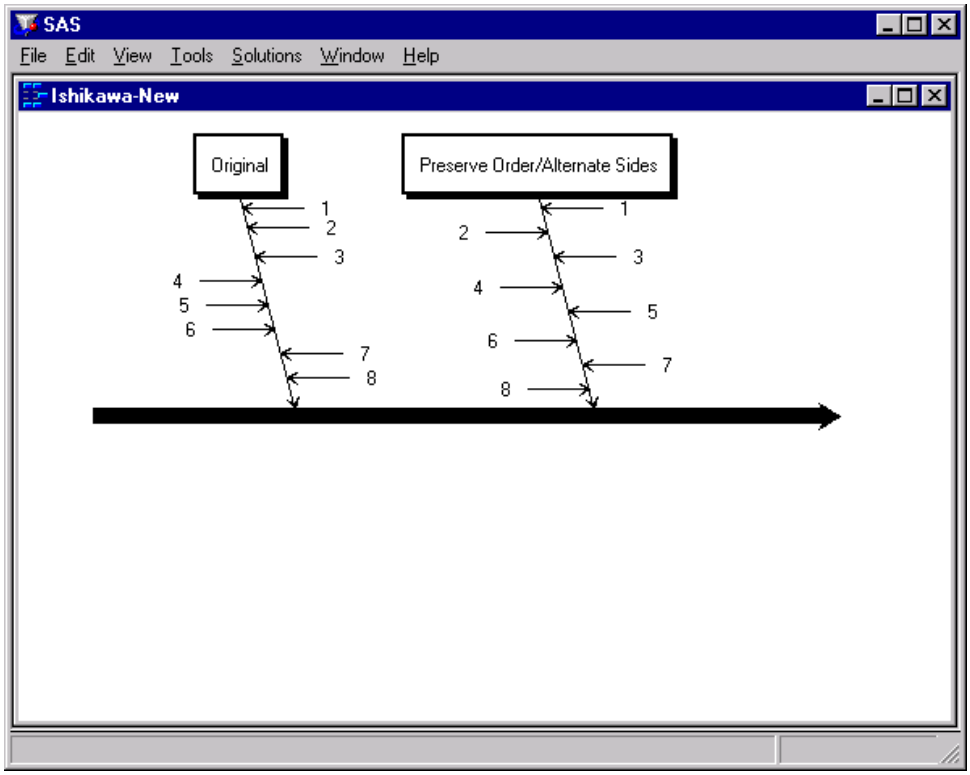


Note that the balancing method used here not only changes the spacing of the stems but reflects them as needed to achieve a balanced appearance. You can control this by specifying a balancing method, as illustrated by the next example.

Example

The following diagram displays an unbalanced branch and a copy of that branch after it was balanced using the **Preserve order/alternate sides** balancing method:

Figure 8.40 Preserving Order But Alternating Sides

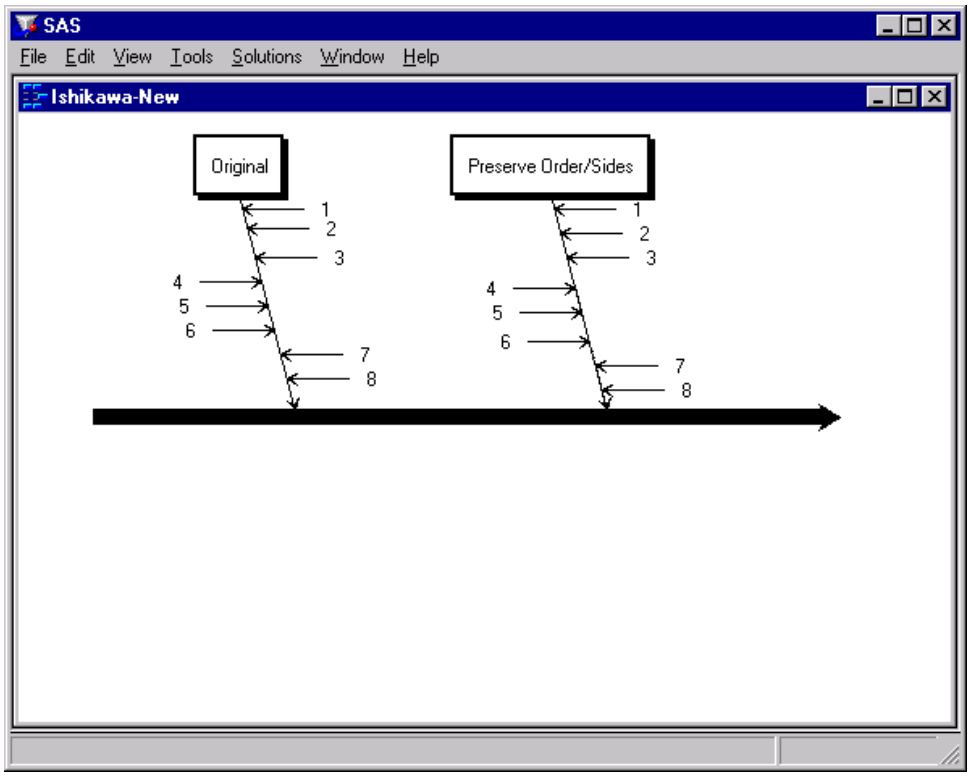


Note that the stems remain in order (*1-8*) from tail to head, but they now alternate evenly across both sides of the branch. This is the default method used for balancing arrows.

Example

The following diagram displays an unbalanced branch and a copy of that branch after it was balanced using the **Preserve order/sides** method:

Figure 8.41 Preserving Order and Sides

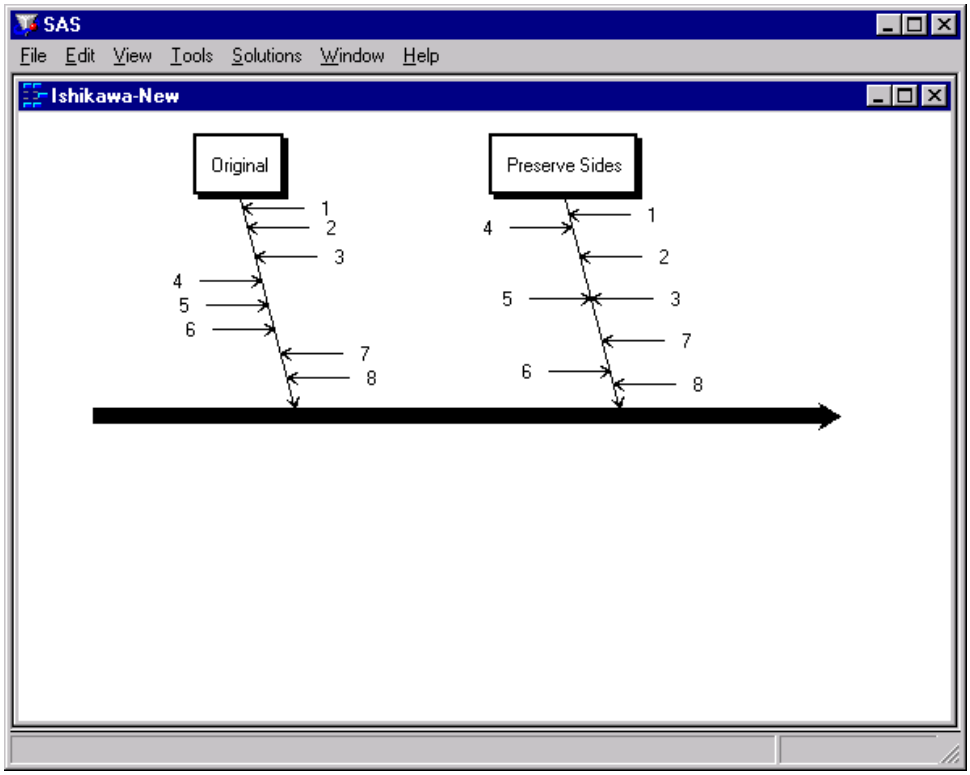


Note that stems *4-6* remain on the left, stems *1-3* and *7-8* remain on the right, and the order from tail to head is still *1-8*. However, the stems are now spaced uniformly.

Example

The following diagram displays an unbalanced branch and a copy of that branch after it was balanced using the **Preserve sides** balancing method:

Figure 8.42 Preserving Sides



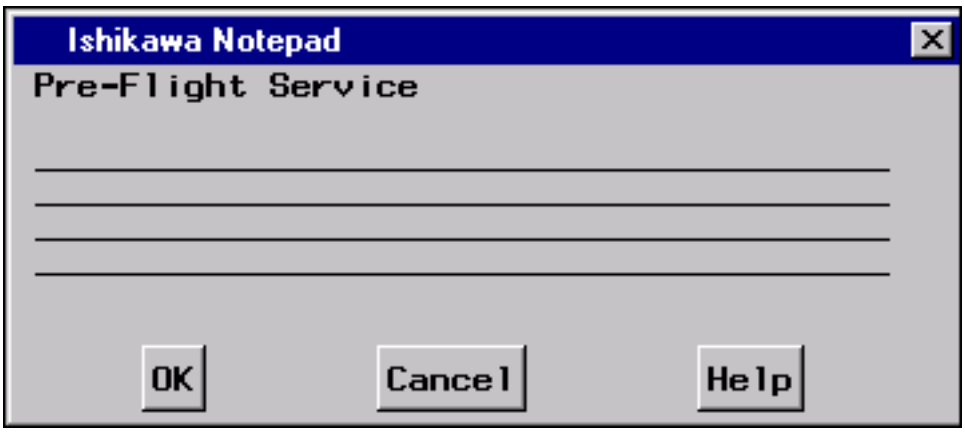
Note that the stems on the left (*4-6*) are spaced uniformly, and the stems on the right (*1-3* and *7-8*) are spaced uniformly. The two sides are spaced independently of each other.

Notepads

Ishikawa (1982) and Kume (1985) advocate the display of quantitative information with the arrows in an Ishikawa diagram.

In the ISHIKAWA environment, you can use *Notepad* windows to record or display information associated with each arrow. To open the Notepad window, move the cursor over the arrow tail and double click.

Figure 8.43 Ishikawa Notepad



Notes are limited to four lines of text with no more than 40 characters per line.

When you save your Ishikawa diagram, your notes are saved with the SAS data set.

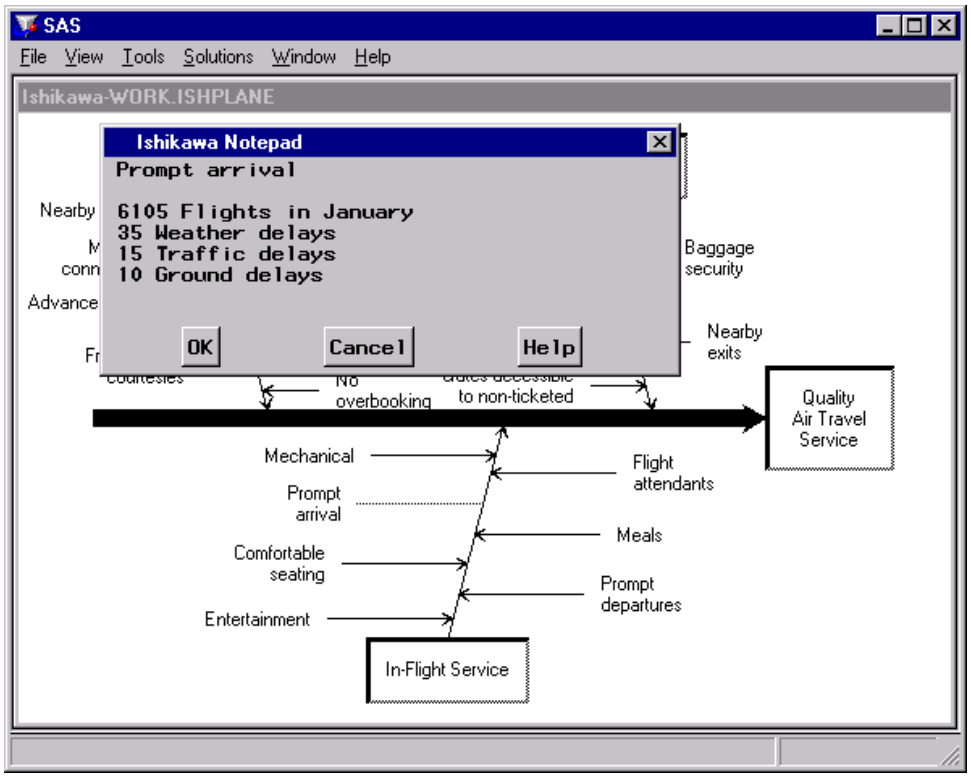
Later, when you retrieve your diagram, all the notes are restored.

You must close the *Notepad* window before you continue working in the ISHIKAWA environment.

Example

In the following figure, double clicking on the *Prompt arrival* stem reveals details about prompt arrival times:

Figure 8.44 Using Notepads to Organize Details



Managing Complexity

A major advantage of the ISHIKAWA environment is that you can quickly organize a highly complex diagram. However, not everyone may be interested in seeing all the details—at least initially.

To increase the level of detail by one level, do the following:

- Move the cursor to a background area of the window, and use the right mouse button to activate the background popup menu.
- Select **> Detail**. On some hosts, you can press the > key instead of using the popup menu (as long as you are not editing text).

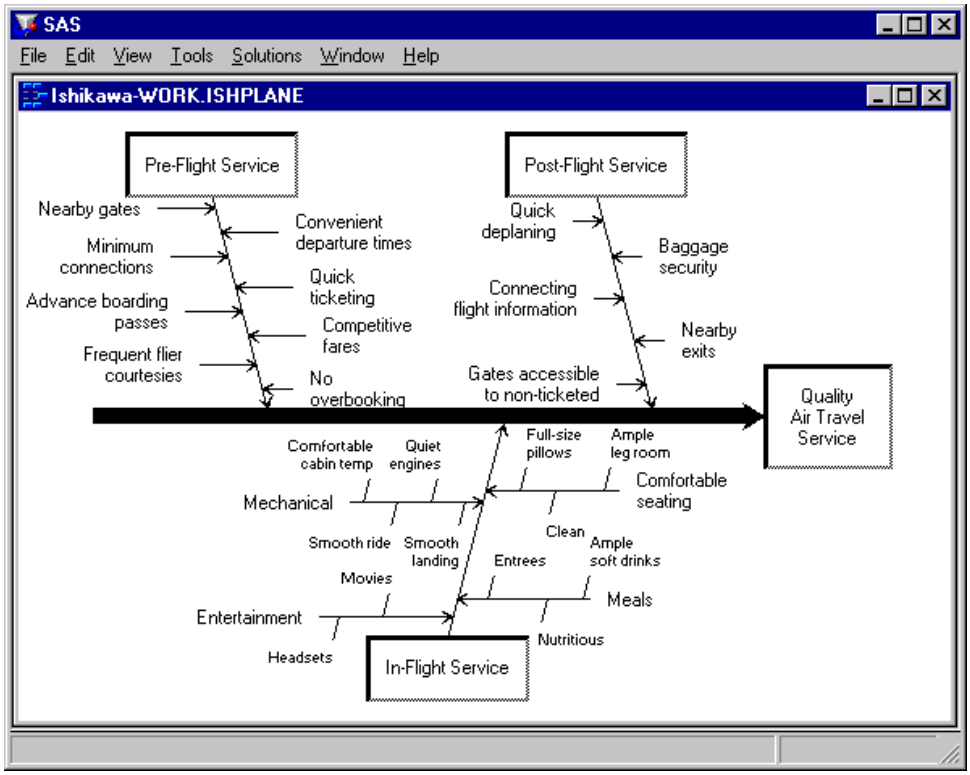
Each time you select **> Detail** from the background popup menu, the detail increases by one level.

To reverse the process and decrease the level of detail, select **< Detail** from the popup menu, or press the < key.

Example

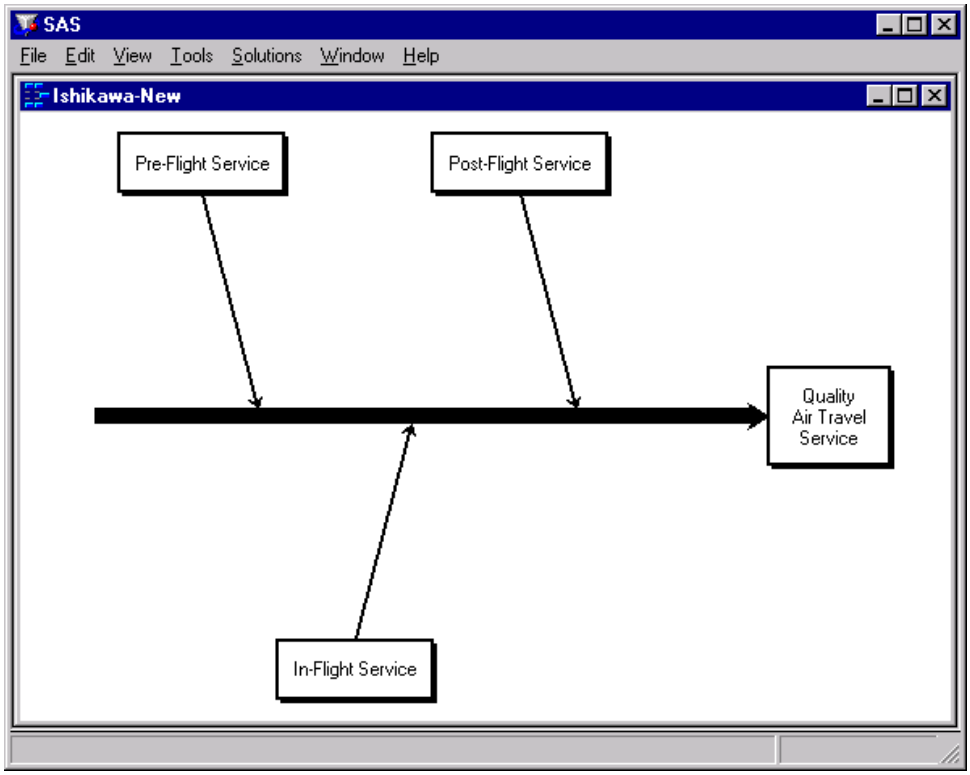
You are making an online presentation about factors that influence the quality of air travel service. The following diagram presents too many details to be a good starting point for your audience:

Figure 8.45 Highly Detailed Ishikawa Diagram



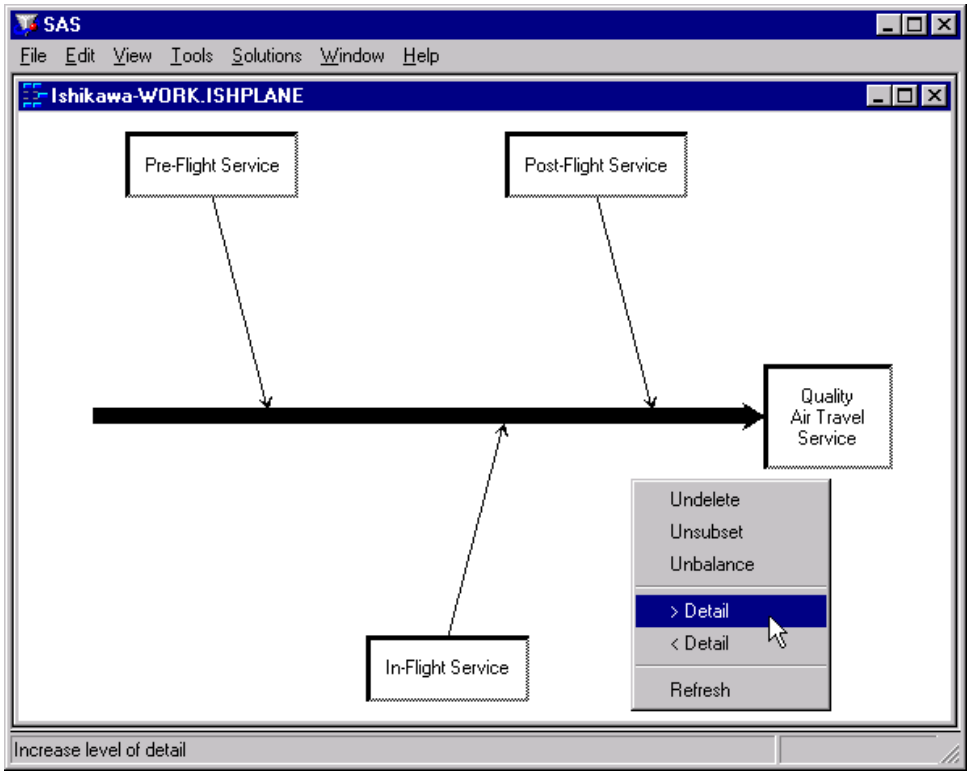
A better way to begin is by displaying only the trunk and branches.

Figure 8.46 Branch-Level Diagram



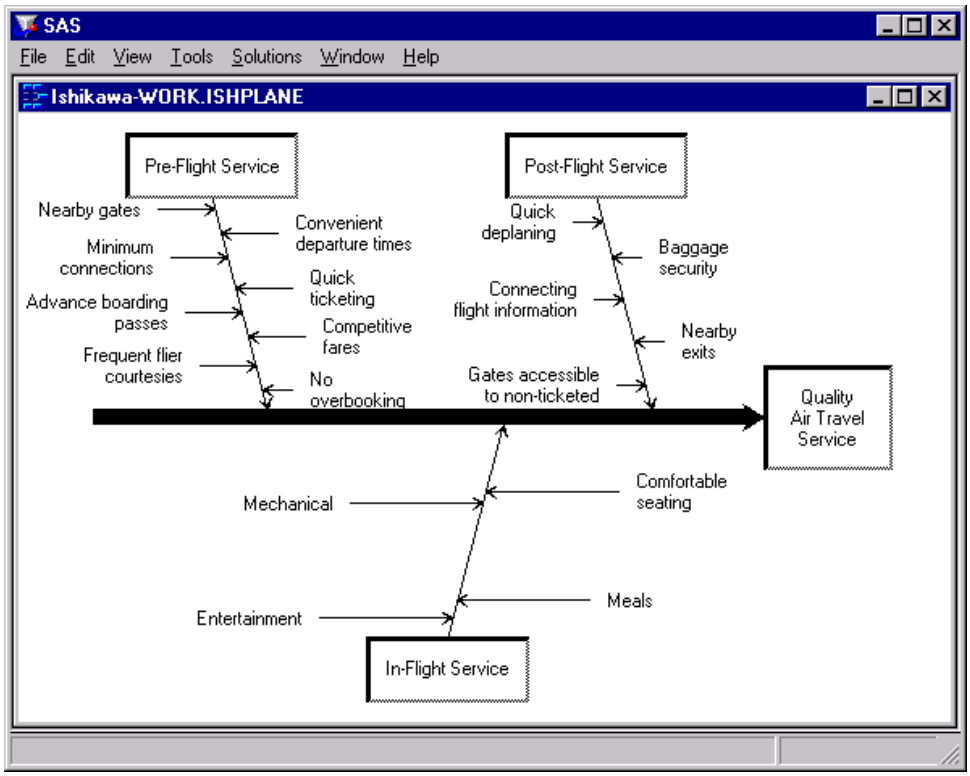
Then, at the next stage of your presentation, dynamically foliate the branches with stems, as follows:

Figure 8.47 Increasing the Level of Detail



The amount of detail is increased by one level.

Figure 8.48 Increasing the Level of Detail



Zooming Arrows

A second method for managing a highly detailed Ishikawa diagram is to work with a subsection of the diagram in a separate window. The window and the sub-arrows inside it can be resized independently of the parent window. In all other respects, the information in the two diagrams is linked dynamically. Changes in one window (for instance, moving, adding, and editing arrows) are reflected in the other window.

To zoom an arrow, proceed as follows:

- Move the cursor over the arrow head.
- Activate the popup menu using the right mouse button.
- Select **Zoom**.

To return or *unzoom*, select **File ► Close**.

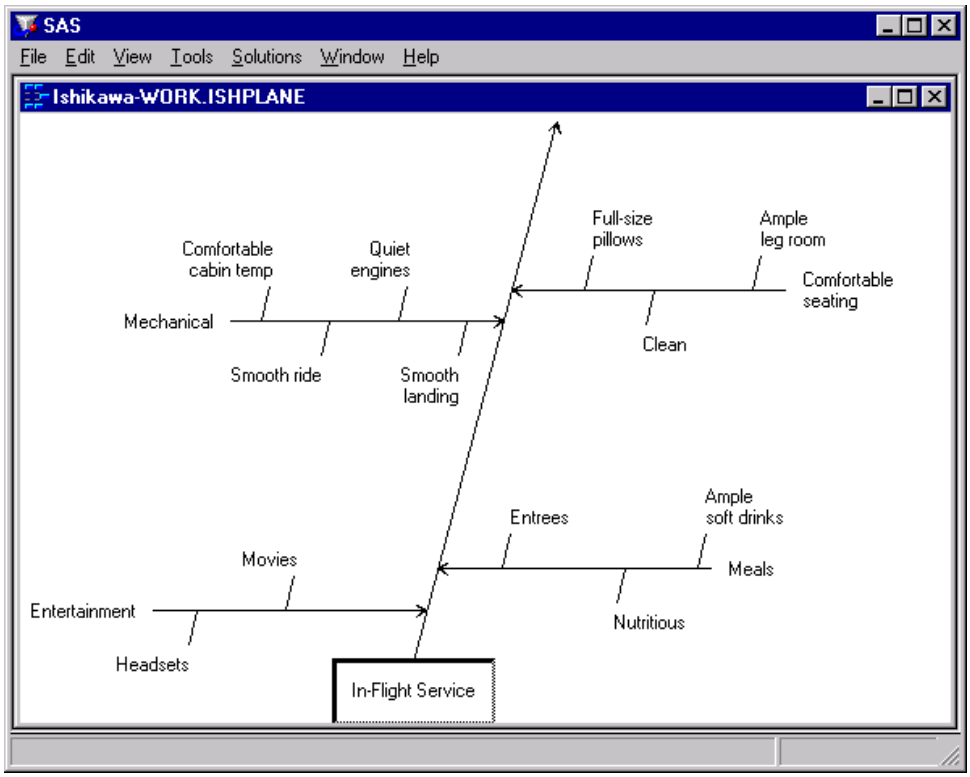
You can have up to four windows open at one time.

To reduce the amount of window management, you can specify that zoomed diagrams are to be displayed in the current window rather than in new windows by setting **Zoom Window** to *Current* in the **View ► Ishikawa Settings ► Other…** dialog.

Example

The following figure shows a branch labeled *In-Flight Service* after it has been zoomed into a new window:

Figure 8.49 Zooming a Branch



Isolating Arrows

A third method for managing a highly complex Ishikawa diagram is to view the entire diagram as a collection of smaller diagrams. Any arrow (along with its sub-arrows) can be isolated into a separate diagram in a new window. This diagram can then be easily saved in a separate file.

To isolate a branch as a separate diagram, do the following:

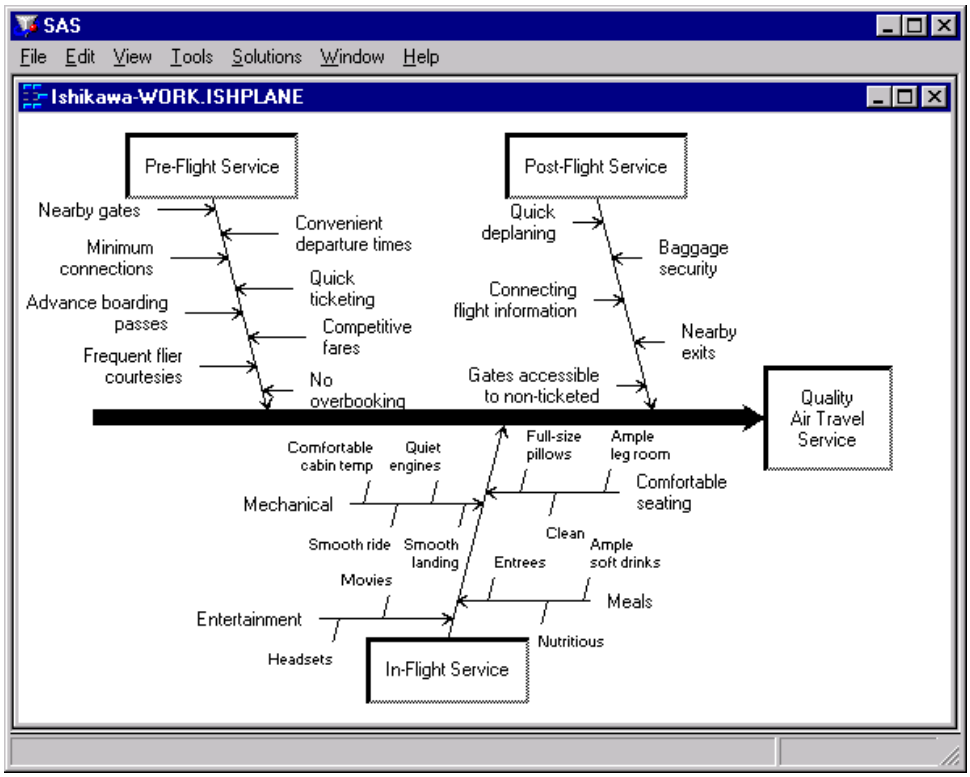
- Move the cursor over the head of the arrow.
- Activate the popup menu using the right mouse button.
- Select **Isolate**.

You can have up to four ISHIKAWA windows open at one time.

Example

Consider the following diagram:

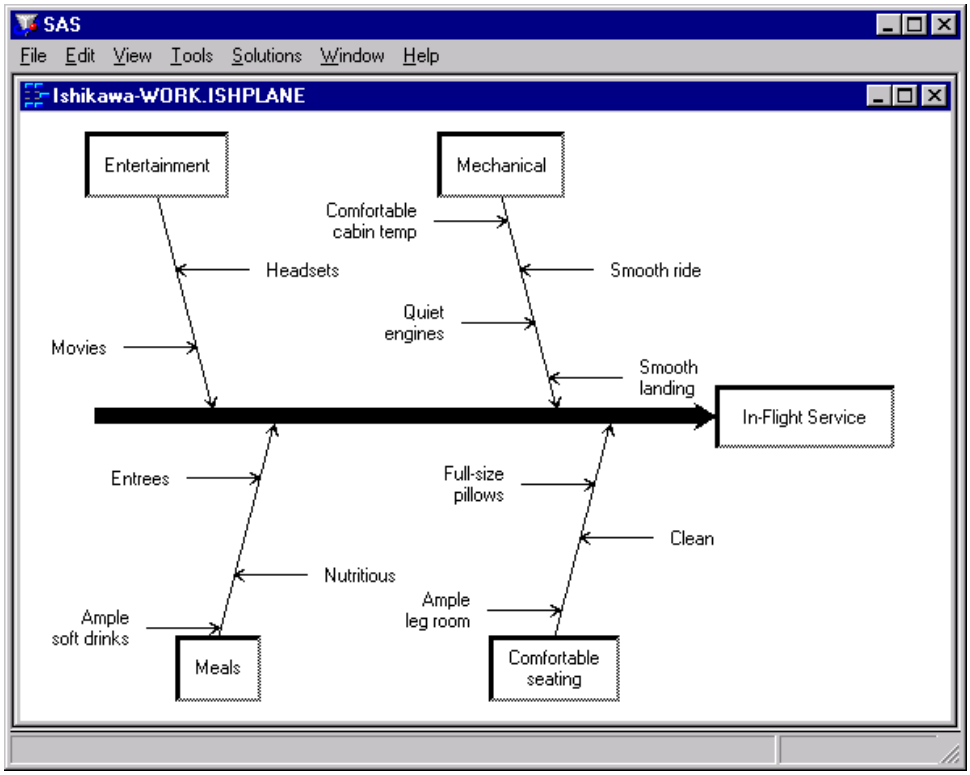
Figure 8.50 A Highly Detailed Diagram



To isolate the branch labeled *In-Flight Service* as a separate Ishikawa diagram, move your cursor over the head of the arrow. Use the right mouse button to activate the popup menu and select **Isolate**.

The following figure shows the main diagram in one window and the branch labeled *In-Flight Service* after it has been isolated to another window:

Figure 8.51 Promoting a Branch into a New Diagram



To return to the original diagram, select **File ► Close**.

Merging Diagrams

You can combine multiple Ishikawa diagrams into a *master* diagram by using the merge operation. To merge a stored diagram into the current diagram, proceed as follows:

- Select **File ► Merge**.
- Specify the name of a SAS data set that contains a saved Ishikawa diagram.

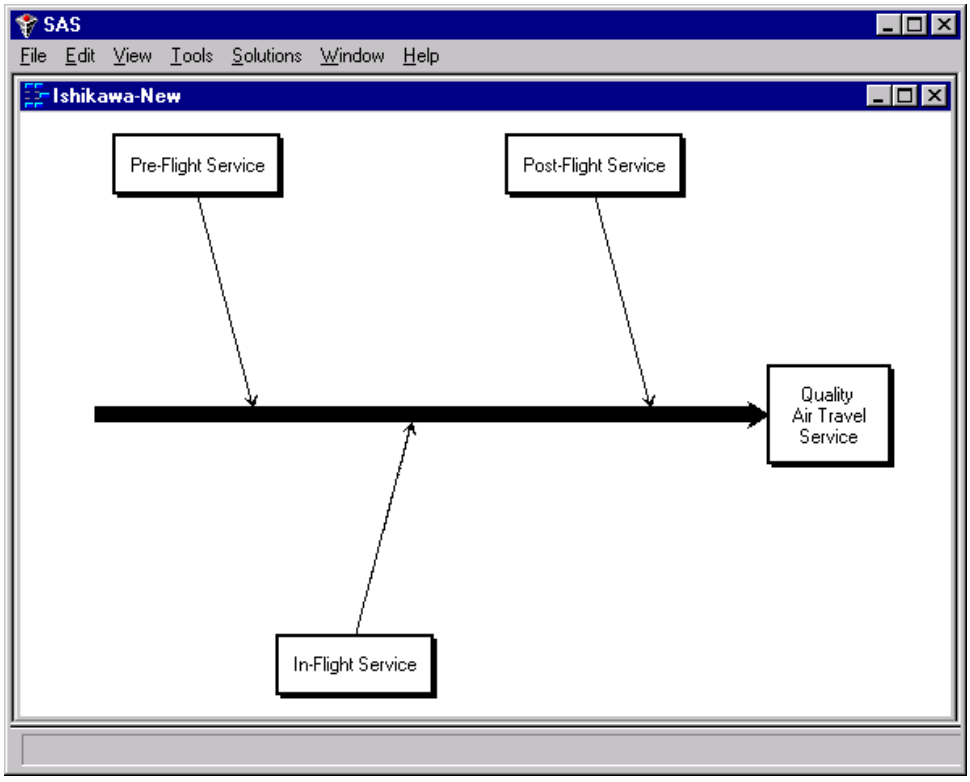
Another way to combine diagrams is to open separate ISHIKAWA windows for each sub-diagram then copy them into the master diagram. To copy all or part of an Ishikawa diagram from one window to another, do the following:

- Move the cursor over the head of the arrow.
- Activate the popup menu using the right mouse button.
- Select **Copy**.
- Position the cursor slightly to one side of the new attachment point and click (just as though you are adding a new arrow).

Example

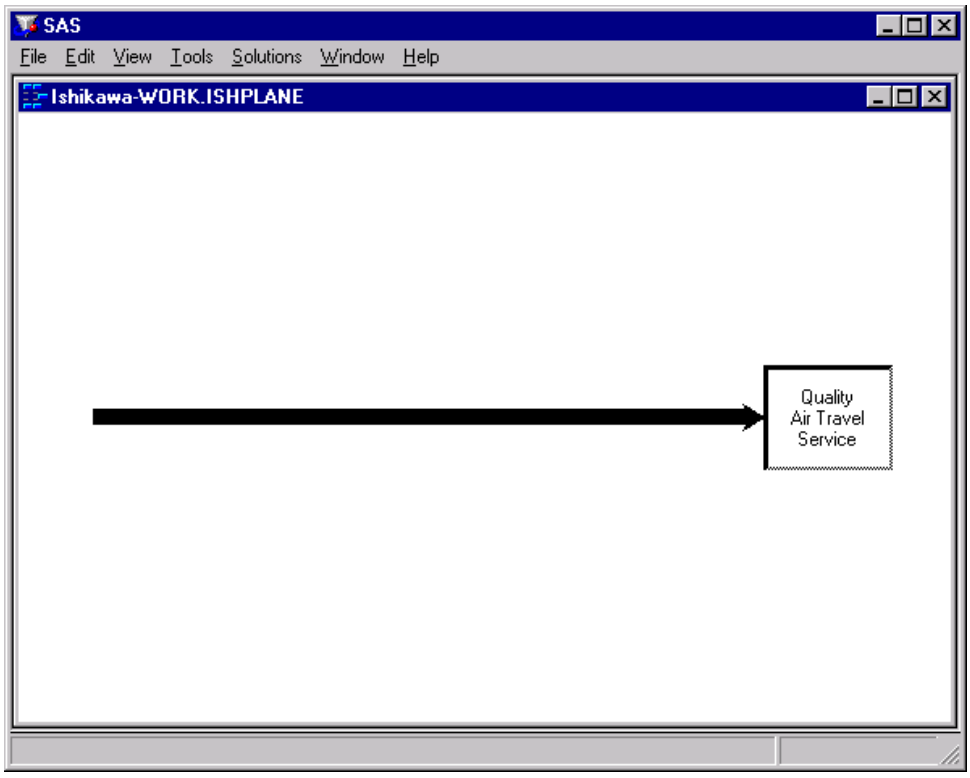
Suppose you want to create the following diagram by combining information from diagrams already created by each of the major service areas (Pre-Flight, In-Flight, and Post-Flight) and stored in different SAS data sets:

Figure 8.52 A Completed Master Diagram



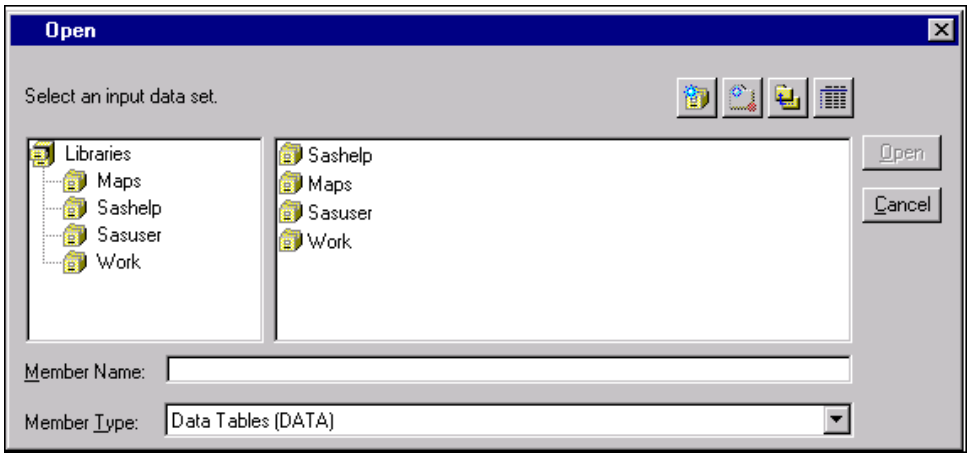
First, use the ISHIKAWA environment to create the trunk for the new master diagram.

Figure 8.53 Starting a Master Diagram



Select **File ► Merge** from the command bar to open the File Requestor dialog.

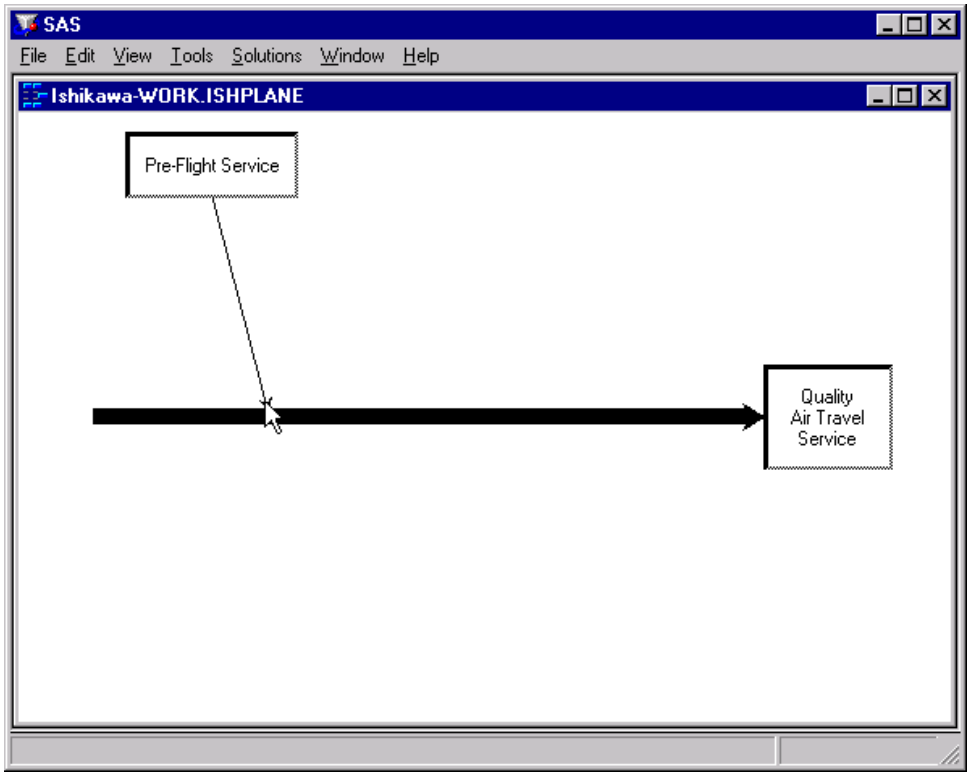
Figure 8.54 Member Selector



Specify the name of the data set for *Pre-flight services* and press **Open**.

Now click on a point along the trunk where this sub-diagram is to attach.

Figure 8.55 Constructing a Master Diagram



To complete the diagram, repeat the process for the remaining branches.

Creating Graphics Output Using SAS/GRAPH Software

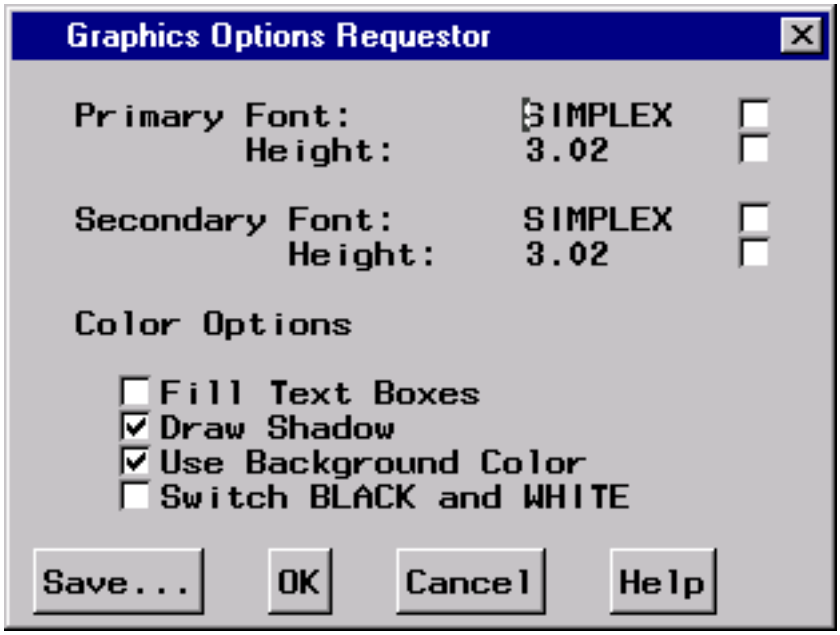
One way to create a hard copy of your Ishikawa diagram is to send it to a graphics device using SAS/GRAPH software. To do this, you should submit a GOPTIONS statement to direct the graphics output to the appropriate location and control the output format *before you invoke the ISHIKAWA environment*. For example, the following GOPTIONS statement directs the output to a PostScript device:

```
goptions target=psl noprompt;
```

If you do not specify a target device before invoking the ISHIKAWA environment, you will be prompted for one before the graph is generated.

In the ISHIKAWA environment, when you are ready to route your output to a hard copy device, select **File ► Save as ► Graph**. This opens a dialog that enables you to customize various aspects of your graph.

Figure 8.56 Hard Copy Requestor



To save the diagram to the default graphics catalog in the WORK library (WORK.GSEG), simply press **OK** and close the dialog. The default member name is ISHIKAWA.

To save the diagram to a different graphics catalog, select **Save...** and then use the Member selector window to specify a library, a SAS catalog, and a member name.

When sending a diagram directly to an output device, you can ignore the member name entirely.

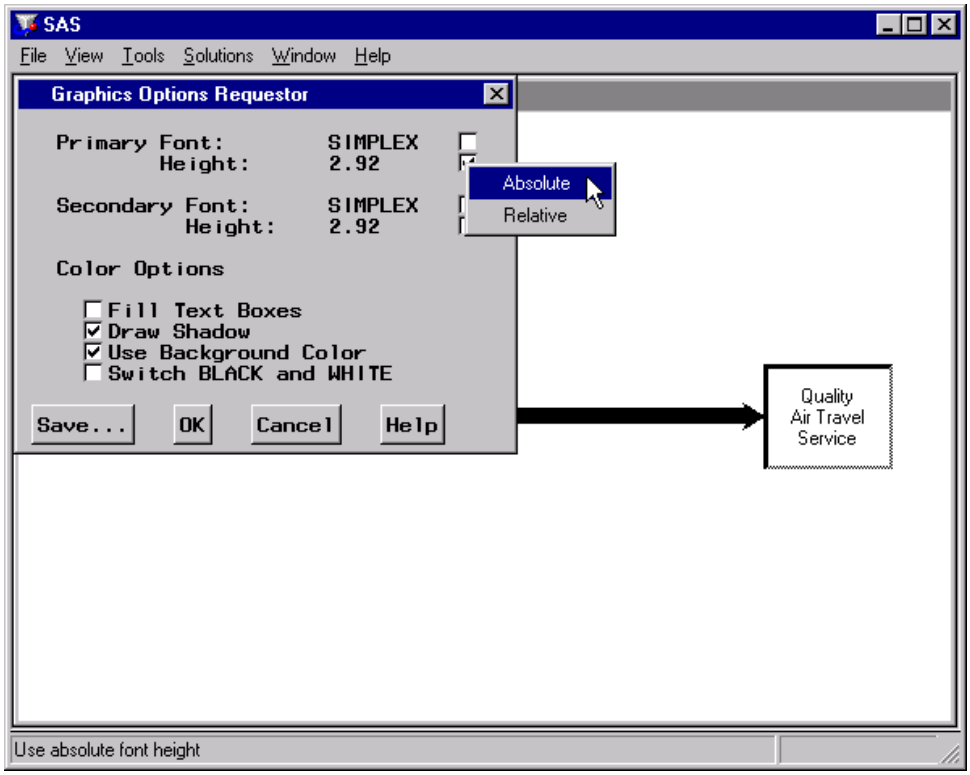
To save to your own graphics catalog, select **Save...** and then use the Save a member selection window to specify a catalog and data set name. Simply select **OK** when you want to save your diagram to the default graphics catalog (WORK.GSEG). When sending a diagram directly to an output device, you can use **OK**.

You must specify two SAS/GRAPH fonts for drawing the labels in the hard copy of the diagram. The hardware fonts used in the ISHIKAWA environment cannot be used for your hard copy. The *primary* font and size are used for the first three levels of text. The *secondary* font and size are used for the remaining levels of text.

To change fonts, enter a valid SAS/GRAPH font name in the font field or click on the button to the right of the font field to display a font requestor dialog. The default font is SIMPLEX.

You can specify the height of the text directly in the height field (in screen percent units), or you can click on the button to the right of the field to request an *absolute* height or a *relative* height.

Figure 8.57 Font Height Selector



Select **Absolute** when you want the font height in the output to be the same height as the font height used in the ISHIKAWA environment even if the output window and the ISHIKAWA window differ in size. Select **Relative** to maintain the same font height to window size proportion in both the ISHIKAWA window and the output window. The numeric value entered in the height field after either choice is a screen percent unit. The default text height is *absolute*.

Use the **Fill Text Boxes** and **Draw Shadow** check boxes to suppress the box fills and box shadows from the output. They cannot be used to *add* these features to the hard copy if they were not present in the ISHIKAWA window.

Use the **Use background color** check box to indicate whether the background color from the ISHIKAWA environment is used in the output. This option is useful when you are sending your diagram to a *color* device and you want the background in your hard copy to match that of your ISHIKAWA environment.

Use the **Switch Black and White** check box to interchange black and white when the diagram is sent to the output device. This option is useful when you send your diagram from a white-on-black display to a black-on-white hard copy device.

Click on **OK**to generate the hard copy output or click on **Cancel**to quit.

Creating Bitmap Graphics Output

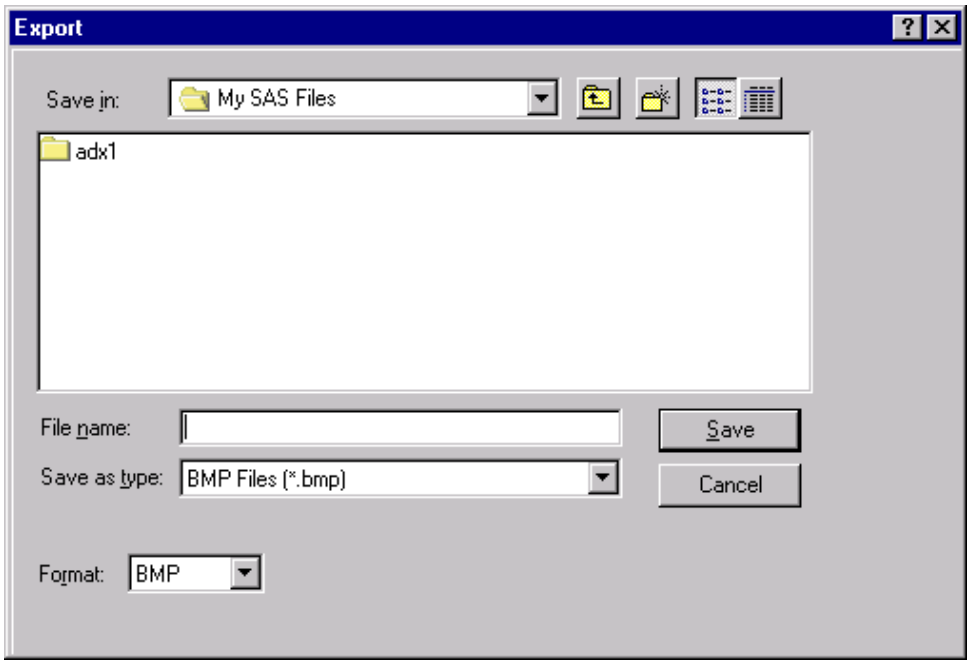
A second way to create a hard copy of your Ishikawa diagram is to export it as a bitmap to one of the following:

- the host graphical clipboard
- an external bitmap file
- a SAS/GRAPH Image catalog entry

To copy the Ishikawa diagram as a bitmap to the host clipboard, select **Edit ► Copy**. The results are host specific. For more details about copying to the host clipboard on your system, consult the SAS companion for your host.

To export the Ishikawa diagram to a bitmap file using SAS/GRAPH software, select **File ► Export as Bitmap ► File...**.

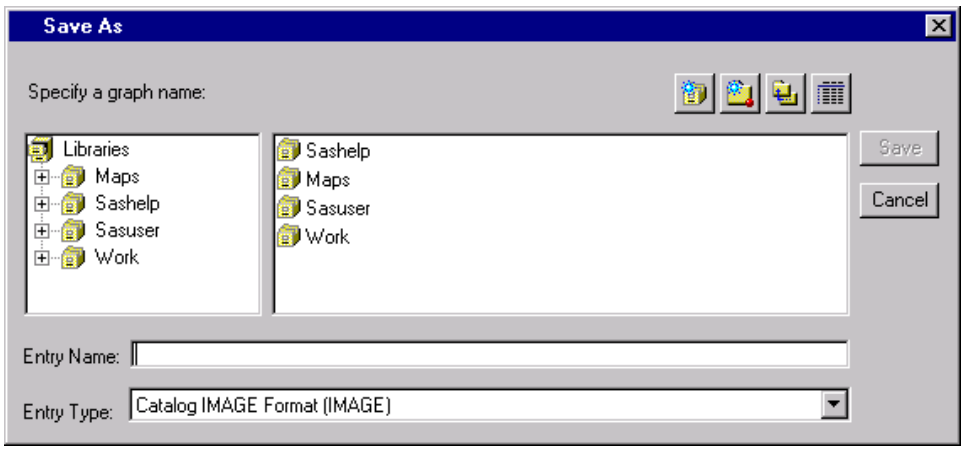
Figure 8.58 Export File Requestor



The appearance of this dialog will be host specific. For more details about the format of this dialog on your system, consult the SAS companion for your host.

To save the Ishikawa diagram as an IMAGE entry in a SAS catalog, select **File ► Save as ► Image**.

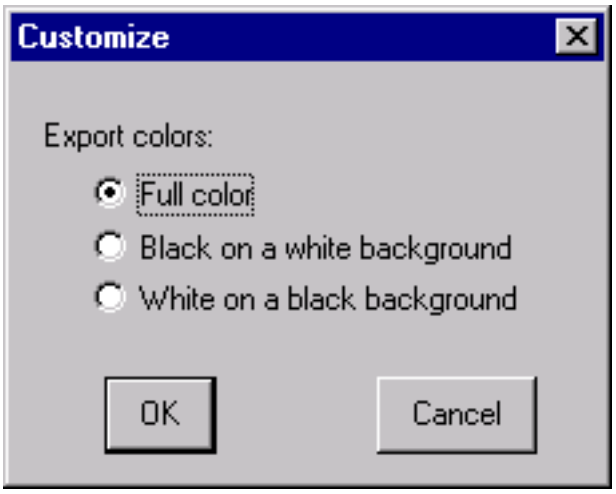
Figure 8.59 Entry Selector



You must specify a SAS catalog in which to save the IMAGE entry as well as a name for the object.

When exporting your diagram to a bitmap or saving to a SAS/GRAPH IMAGE entry, you can have the colors mapped so that color diagrams are saved in black on white or white on black. You do not have to make those changes to the diagram yourself. Use **File ► Export as Bitmap ► Customize...** to display the following dialog:

Figure 8.60 Customize Export Dialog



Select **Black on white** to convert the output to a black diagram on a white background. This is useful when the diagram is being exported to a document.

Select **White on black** to convert the output to a white diagram on a black background. This is useful when the diagram is being exported for display on a black and white terminal.

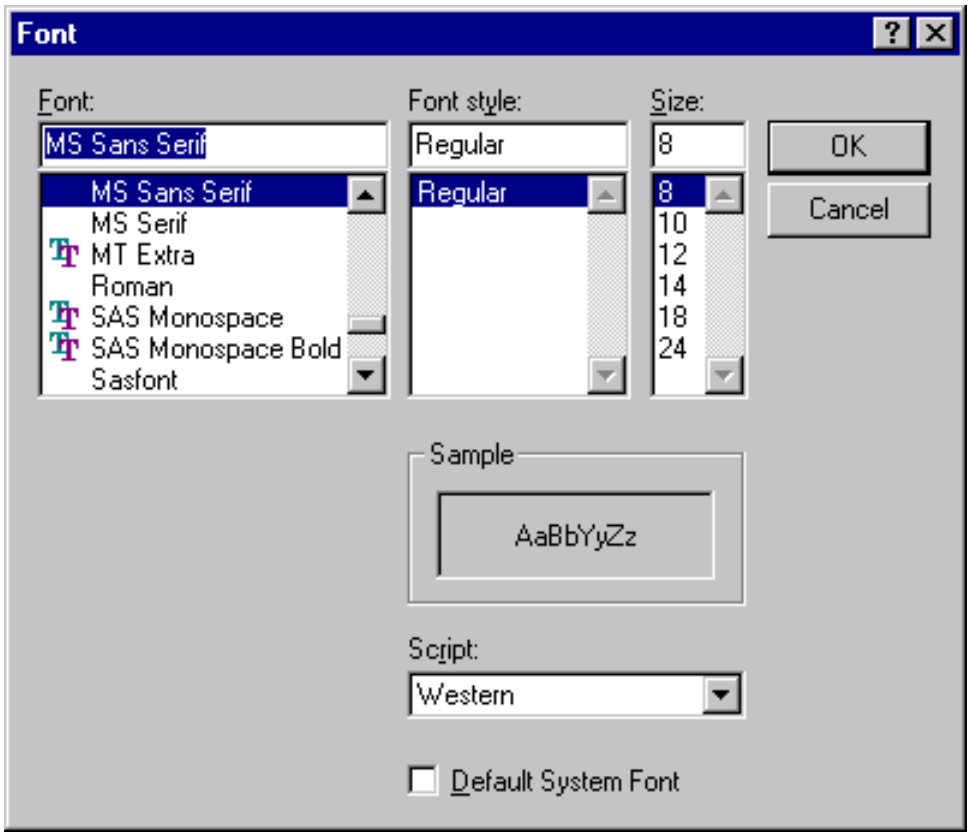
Modifying Fonts

By default, the ISHIKAWA environment uses the same hardware font as the SAS windowing environment. However, you have the option of specifying two different font styles/sizes.

The *primary* font is used for labeling arrows in the first three levels of the diagram. The *secondary* font is used for labeling arrows in the remaining levels. You will typically use a smaller font in the detailed (secondary) areas of the diagram.

To change a font, select **View ► Ishikawa Settings ► Primary Fonts...** or **View ► Ishikawa Settings ► Secondary Fonts...** to display the Font Requestor window, as follows:

Figure 8.61 Font Requestor



The layout of the Font requestor window is host specific. Typically, it will contain a list of available fonts and sizes displayed in a scrollable region. Refer to your host documentation for specific information regarding the format of this dialog.

To change fonts, select a font from the list.

You must close the Font Requestor window before you can proceed. Select **OK**to apply the font or **Cancel**to cancel the dialog.

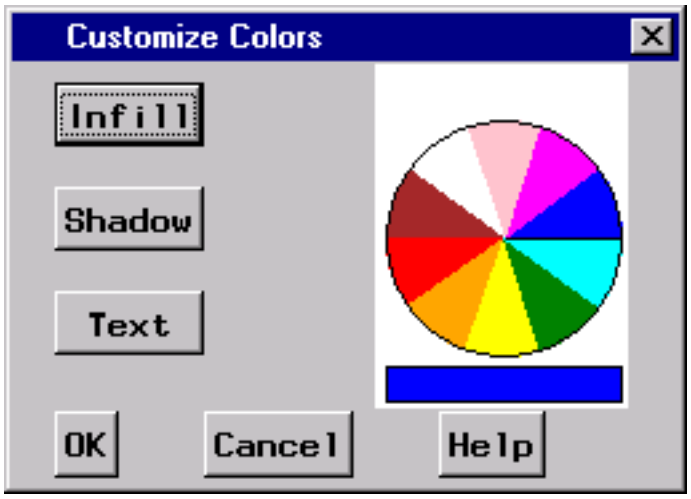
To customize your session so that these fonts are permanently associated with the ISHIKAWA environment, select **View ► Save Attributes**from the command bar.

Modifying Box Colors

By default, the box fill (background) color is empty and the shadow (outline) color is the same as the arrow color.

To modify the colors associated with trunk and branch boxes, select **View ► Ishikawa Settings ► Colors...**. A dialog, similar to the following, is displayed:

Figure 8.62 Colors Dialog



To change the fill color of all the boxes[6] in the Ishikawa diagram, do the following:

- Select a color from the color palette.
- Select **Infill**.

Once modified, the fill color is unaffected by changes in the arrow color. To return the box to an empty fill, proceed as follows:

- Select the current infill color from the color palette (if it is not already the current color).
- Select **Infill**.

To change the shadow color of the boxes, select **Shadow** and follow the same procedure.

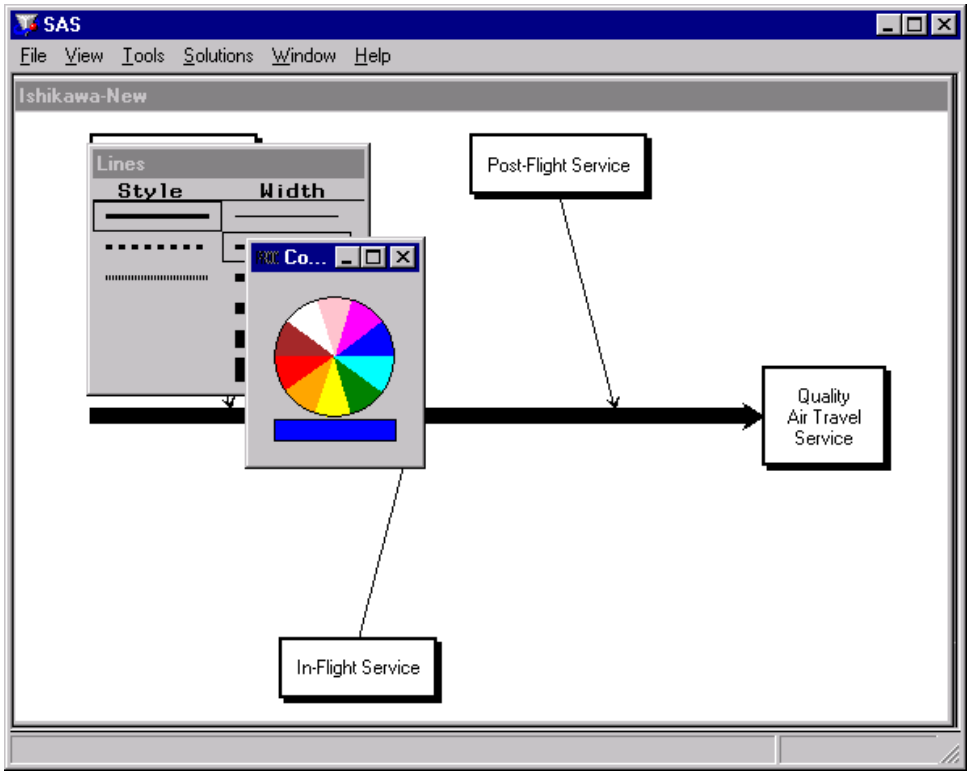
Select **OK**to close the dialog or **Cancel** to cancel the changes.

Modifying Arrow Colors and Line Styles

The ISHIKAWA environment provides a line style palette and a color palette that you can use to customize the arrows in your Ishikawa diagram. Select **View ► Palettes** to activate both palettes.[7]

[6] You cannot directly modify the colors of individual boxes from this dialog.
[7] If you are working on a black-and-white terminal, you should not use the color palette.

Figure 8.63 Line Style and Color Palettes



To specify the arrows to which color and line selections apply, subset them with the subset function. To toggle an arrow in or out of the list of subsetted arrows, do the following:

- Use the right mouse button to display the arrow head or the arrow tail popup menu. To subset an arrow and all its descendants, use the arrow head popup menu. Use the arrow tail popup menu to subset an arrow without any descendants.
- Select **Subset**.

The labels of all subsetted arrows are underlined.

On some hosts, shift-clicking on the arrow head or tail will also subset the arrow. You can subset any combination of arrows in the diagram.

You can change the color of all the subsetted arrows by selecting the desired color in the color palette with the mouse. Likewise, use the line palette to control the style and width of the arrows.

To unsubset all the arrows in the diagram, do the following:

- Move the cursor to a *background* area of the ISHIKAWA window.
- Use the right mouse button to activate the background popup menu.
- Select **Unsubset** from the popup menu.

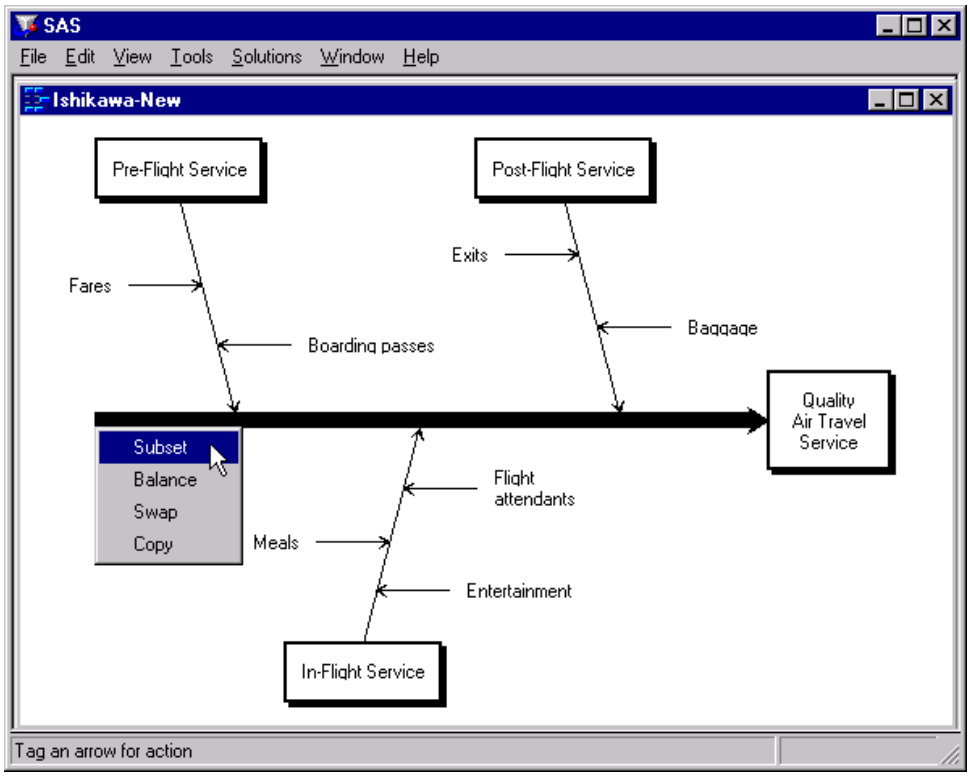
To unsubset a specific arrow in the diagram, select **Subset** from the context-sensitive popup menu for the arrow head or tail.

Be sure to remove all subsets once you have finished modifying the diagram, since subsets affect the focus of many other operations.

Example

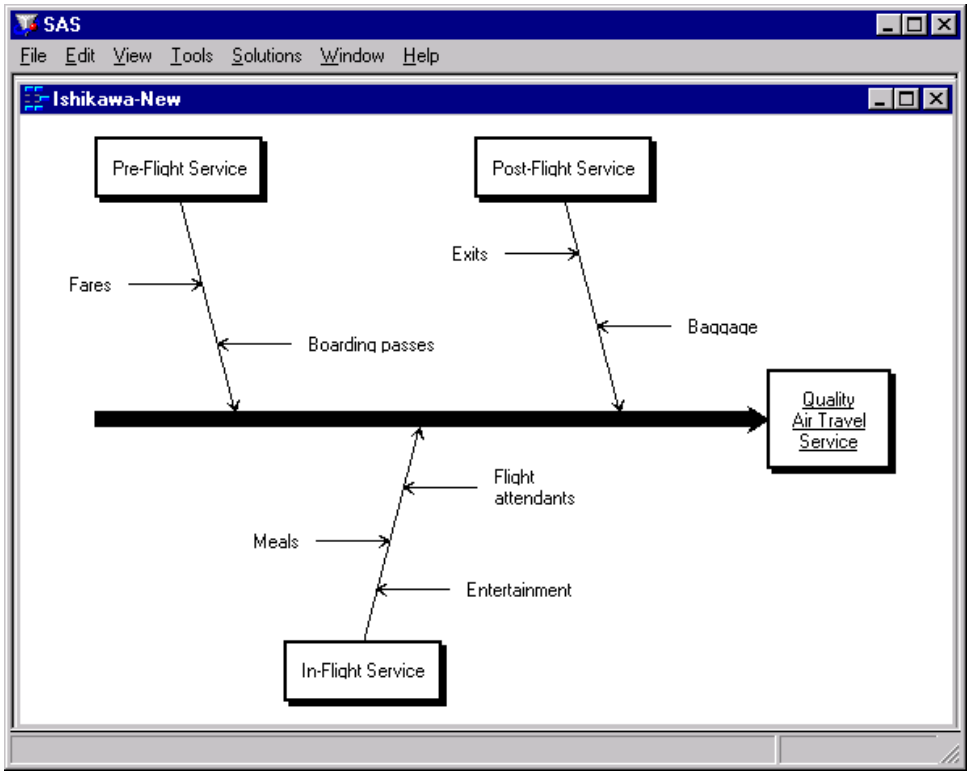
Continuing with the diagram from the previous section, subset the trunk using the arrow tail popup menu.

Figure 8.64 Subsetting Only the Trunk



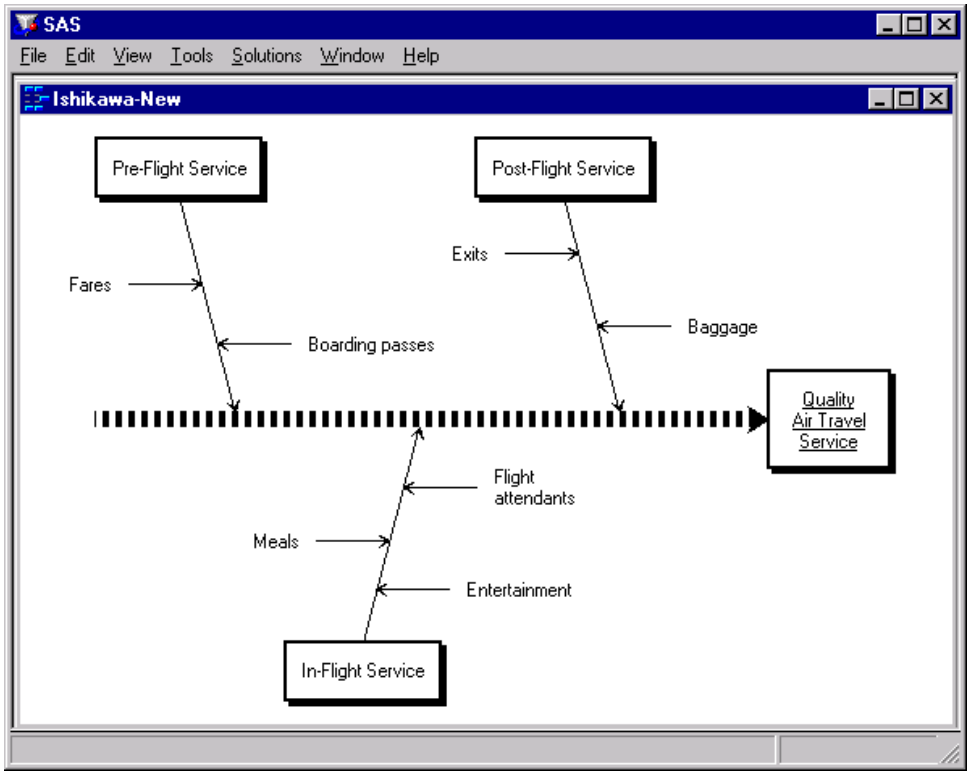
Note that only the trunk is subsetted (as indicated by the underlined label).

Figure 8.65 Subsetting Only the Trunk *(continued)*



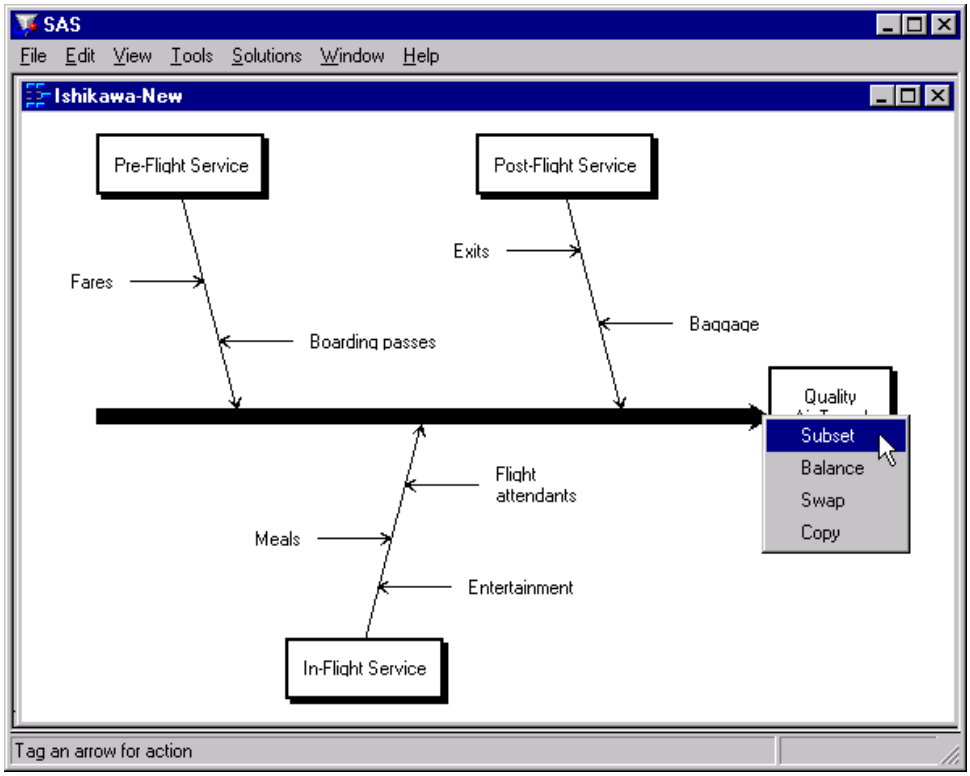
When you select a line style from the line palette, only the line style of the subsetted arrow is changed.

Figure 8.66 Modified Diagram



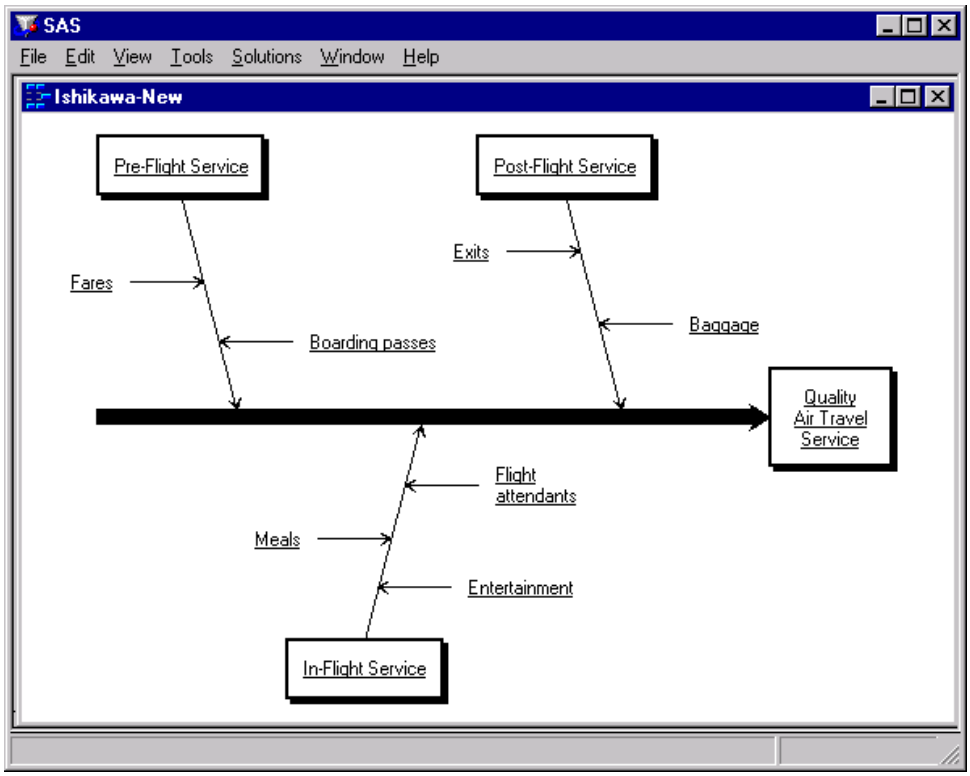
Alternately, if you subset the trunk using the arrow head popup menu, all of the arrows in the diagram are subsetted.

Figure 8.67 Subsetting the Entire Diagram



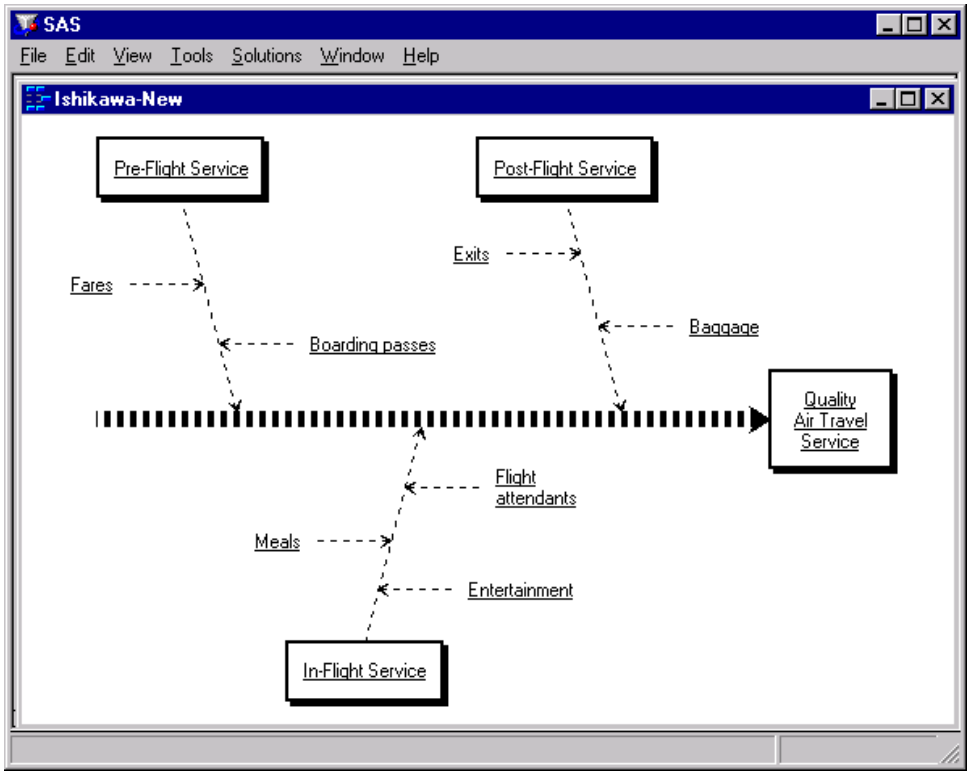
Note that all of the labels in the diagram are now underlined.

Figure 8.68 Subsetting the Entire Diagram *(continued)*



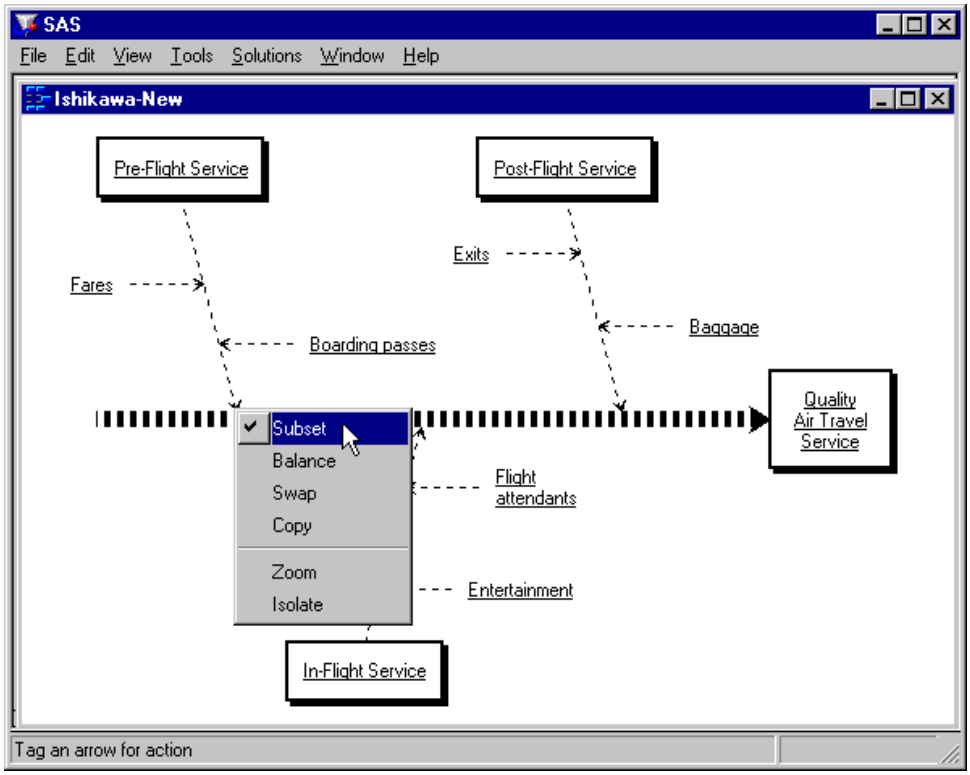
Now, when you select a new line style from the line palette, all the arrows are drawn with this line style.

Figure 8.69 Modified Diagram



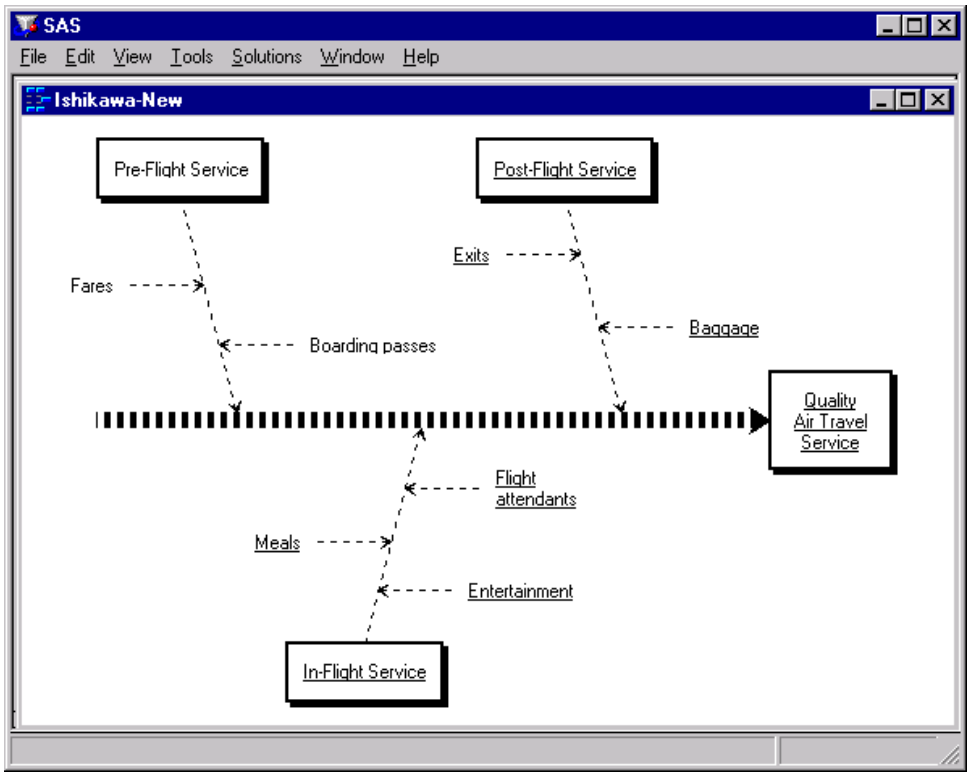
To remove the subset from the *Pre-Flight Service* branch and all its descendants, select **Subset** from the arrow head popup menu.

Figure 8.70 Selectively Removing Tags



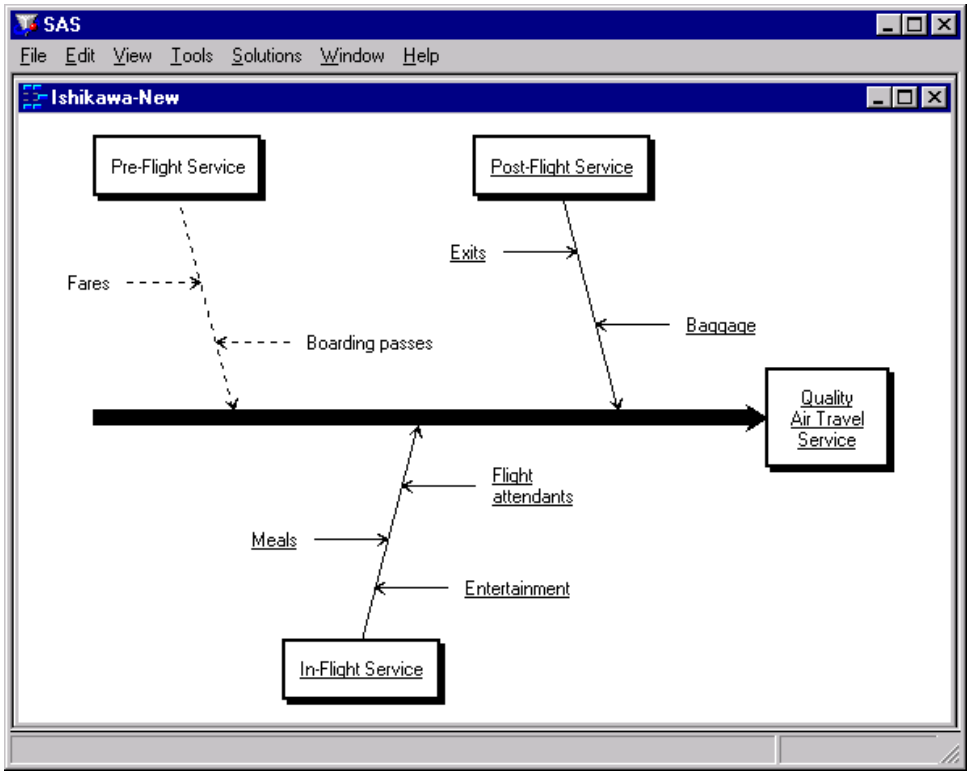
This removes the underlines from the labels in these arrows.

Figure 8.71 Selectively Removing Subsets *(continued)*



You can now use the line palette to change the line style for all the arrows in the diagram with the exception of the *Pre-Flight Service* branch and its descendants:

Figure 8.72 Modified Diagram

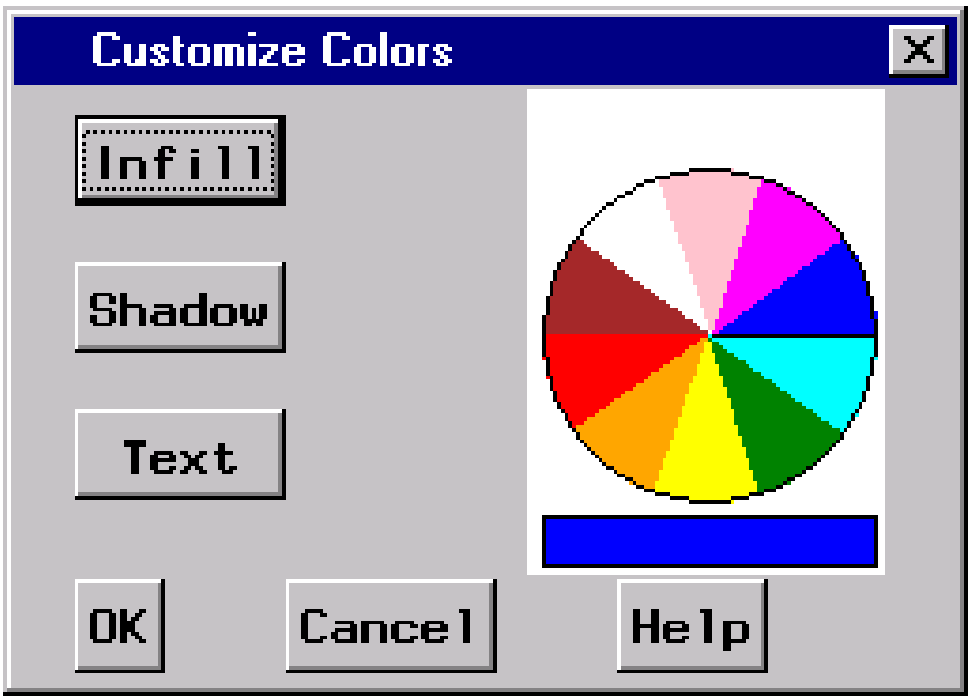


The same principles apply when making color changes—simply use the color palette instead of the line style palette.

Modifying Text Colors

By default, labels have the same color as the arrow. To modify the text color independently of the arrow color, select **View ► Ishhikawa Settings ► Colors...**. The Customize Color window, similar to the following, will open:

Figure 8.73 Colors Dialog



To change the text color of all the arrows[8] in the Ishikawa diagram, do the following:

- Select a color from the color palette.
- Select **Text**.

Once modified, the text color is unaffected by changes to the arrow color. To relink the text color to the arrow color, do the following:

- Select the current text color from the color palette (if it is not already the current color).
- Select **Text**.

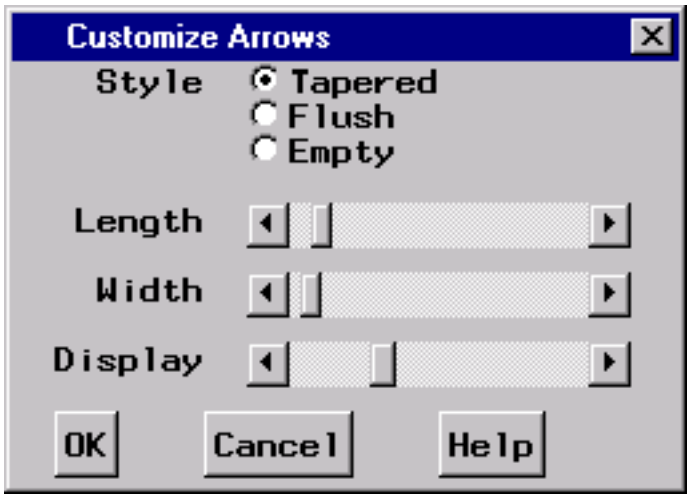
Select **OK**to close the dialog window. To cancel the changes, select **Cancel**.

[8] You cannot directly modify the text color for individual arrows from this dialog.

Modifying Arrow Heads

To modify the characteristics of the arrow heads in your diagram, select **View ► Ishikawa Settings ► Arrows...**. This opens the following dialog:

Figure 8.74 Arrows Dialog



The dialog controls the characteristics of all arrow heads. Arrow heads cannot be modified individually.

Arrow heads can be tapered, flush, or empty. Use the sliders labeled **Length** and **Width** to control the length and width of the arrow heads. Move the sliders to the right to increase the length/width of the arrow head and to the left to decrease the length/width.

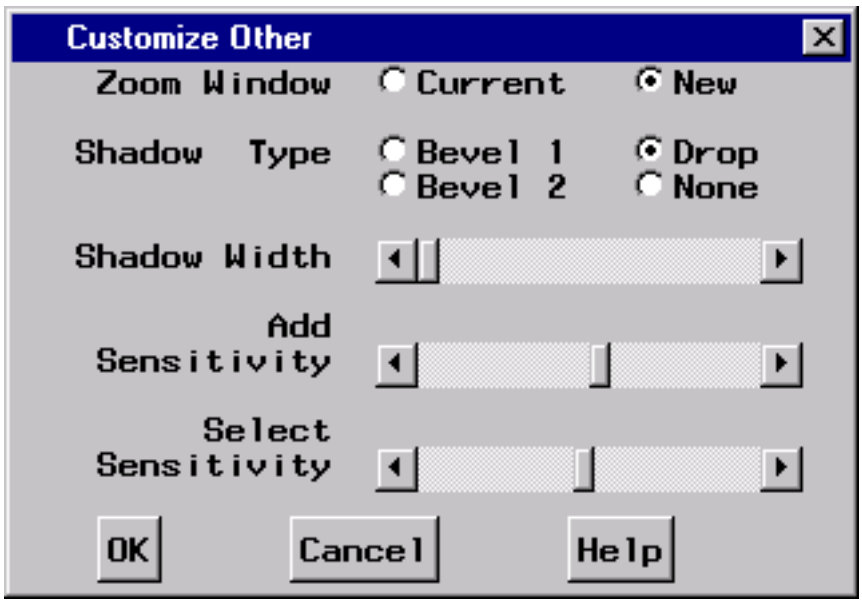
Removing arrow heads increases the readability of a highly detailed diagram. Use the **Display** slider to control the level at which arrow heads are displayed. Move the slider to the extreme left to remove all the arrow heads and to the extreme right to display all the arrow heads. Use the intermediate settings to select a threshold level of detail, above which arrow heads are not displayed. By default, arrow heads are displayed for all levels.

Select **OK**to close the window. To cancel the changes, select **Cancel**.

Modifying Environmental Attributes

You can modify other features of the ISHIKAWA environment such as zooming, mouse sensitivity, and shadow attributes by selecting **View ► Ishikawa Settings ► Other...** to open the following dialog:

Figure 8.75 Others Dialog



Zoom Window controls whether the zoom operation opens a new window or draws in the current window. Select **Current**to reduce the amount of window management required.

The **Shadow Type** button controls the type of shadow that is drawn around the trunk and branch boxes.

- **Bevel 1** draws a beveled edge box with a lower-right light source.
- **Bevel 2** draws a beveled edge box with an upper-left light source.
- **Drop** draws a box with a drop shadow. This is the default.
- **None** suppresses the shadow.

The **Shadow Width** slider controls the shadow width if the boxes have shadows or the outline width when boxes are displayed without shadows. Move the slider to the right to increase the shadow width and to the left to decrease the width.

The **Add Sensitivity** slider controls how closely you must position the cursor to an existing arrow before a mouse click results in an add arrow operation. Move the slider to the right to increase the size of the context-sensitive area and to the left to reduce the size of the context-sensitive area.

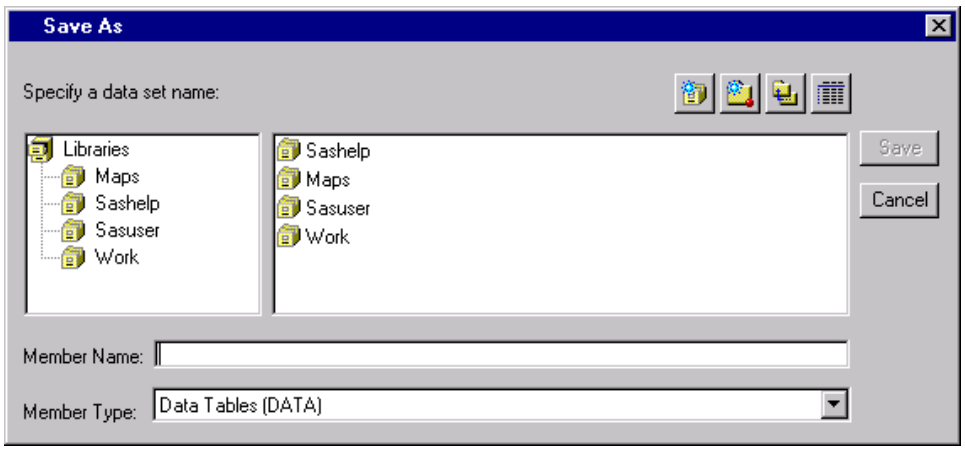
The **Select Sensitivity** slider controls how closely you must position the cursor to an existing arrow before a mouse click results in an edit, delete, move, or popup arrow operation. Operate this slider in the same manner as the **Add Sensitivity** slider.

Saving an Ishikawa Diagram for Future Editing

You must save your Ishikawa diagram as a SAS data set if you intend to edit it in the future with the ISHIKAWA environment. The ISHIKAWA environment does not reconstruct Ishikawa diagrams by reading graphics entries (GRSEG) from SAS catalogs.

Select **File ► Save As ► Data Set**to activate the Data Set Requestor window.

Figure 8.76 Output File Requestor



A list of SAS *librefs* is displayed in the Libraries tree in the left region of the dialog. Begin by selecting a libref from the list. A libref refers to a permanent SAS data library located on your host system. For example, the default SASUSER libref (on most hosts) points to a directory called SASUSER, located under the working directory of your current SAS session. Any data sets saved with the libref **SASUSER** will be saved in that directory.

To direct your SAS data sets to a different directory, select the *Create new library* tool icon to open the New Library dialog. Use this dialog to specify the directory and assign a libref to that directory.

To select the libref **SASUSER**, move your cursor over that entry in the list and click. The region to the right of the Libraries tree is used to display any existing SAS data sets in that library.

To save your diagram in an existing SAS data set, use the mouse to click on an entry in the list. The *member name* field will be updated to reflect your choice. If you want to save your diagram in a new SAS data set, move your cursor to the *member name* field and type the new name (in this example, SERVICE).

Select **Save**to save the diagram and return to the ISHIKAWA environment or select **Cancel**to cancel the save.

Reading an Existing Ishikawa Diagram

To enter the ISHIKAWA environment and resume editing an existing diagram, you must have previously saved the diagram as a SAS data set. The ISHIKAWA environment *does not* allow you to modify graphs stored in SAS/GRAPH catalogs.

You can specify the name of this data set when you establish the ISHIKAWA environment with the following statements:

```
proc ishikawa data=libref.dataset;
run;
```

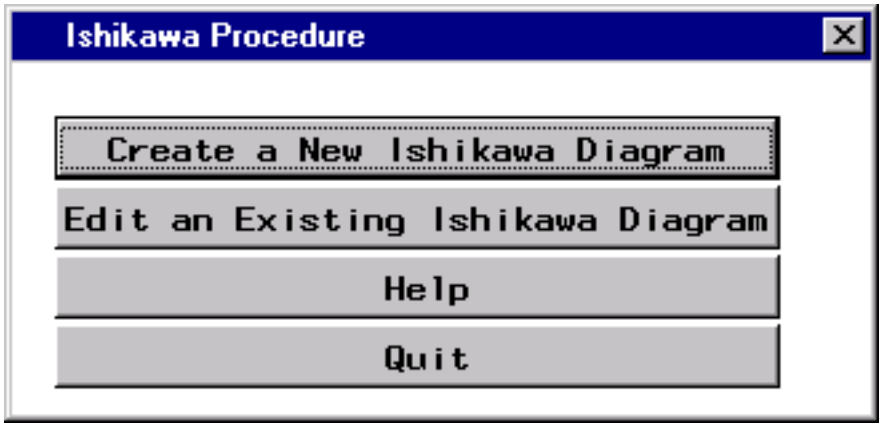
Alternatively, the ISHIKAWA environment will prompt you for a data set after you invoke the environment with the following statements:

```
proc ishikawa;
run;
```

When you specify a data set in the PROC statement, the ISHIKAWA environment is initialized and your diagram is displayed up to the branch level. The message area will indicate if any additional detail is hidden. You can edit your diagram even if some of the diagram is hidden. To add or remove detail one level at a time, select **> Detail** or **< Detail** from the background popup menu.

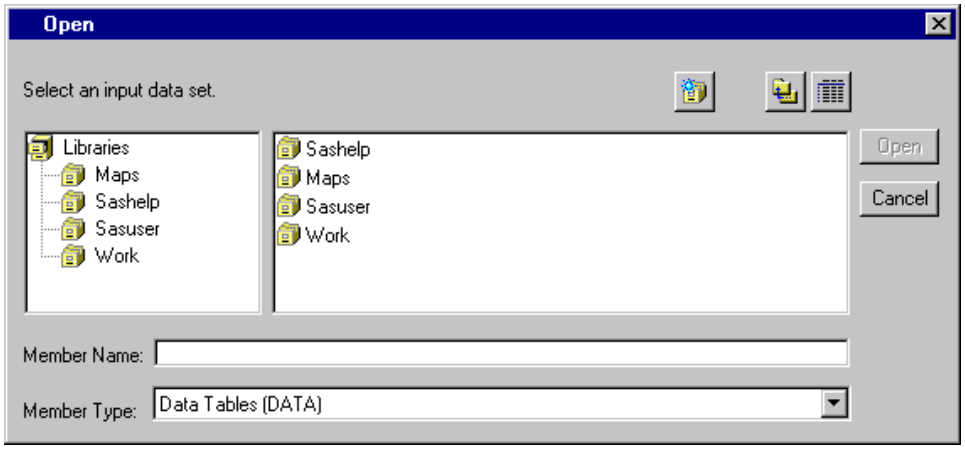
When you do not specify a data set in the PROC statement, you will see the following menu:

Figure 8.77 Initial Menu



Since you are editing an existing diagram rather than starting a new diagram, select **Edit an Existing Diagram** to activate the Member Selector window.

Figure 8.78 Input Member Selector



Use the Member Selector window to specify an input SAS data set. For information on how to specify the SAS data set name, follow the steps outlined in "Saving an Ishikawa Diagram for Future Editing" on page 766.

To establish the ISHIKAWA environment and display the diagram you have selected, select **Open**. The diagram is displayed up to the branch level.

To quit or start a new diagram, return to the main menu by selecting **Cancel**.

Displaying Multiple Ishikawa Diagrams

The ISHIKAWA environment enables you to view multiple Ishikawa diagrams simultaneously for side-by-side comparisons of different diagrams. You can also use this feature to transfer information between diagrams, since the move and copy operations function across windows. You can have up to four ISHIKAWA windows open at one time.

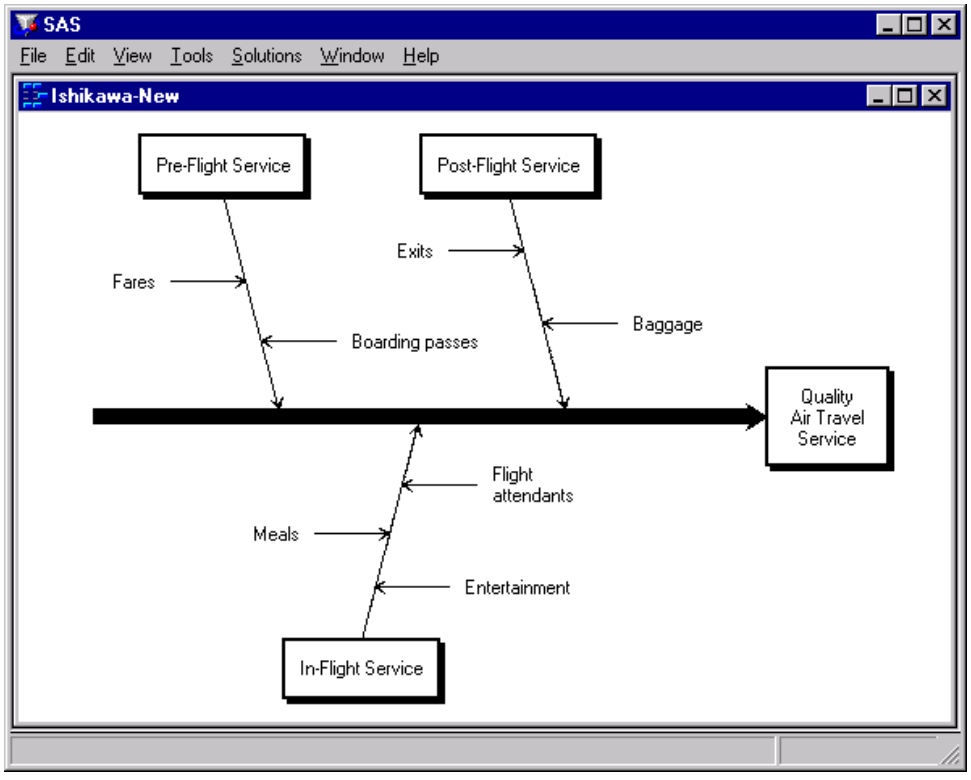
To open a window for another Ishikawa diagram, select **File ► Open**. This will display the Member Selector window, which you can use to specify the name of the input SAS data set for the other Ishikawa diagram.

You can also start new diagrams while displaying other Ishikawa diagrams. To open a window for a new Ishikawa diagram, select **File ► New**. This opens an ISHIKAWA window with a template for a new diagram.

Example

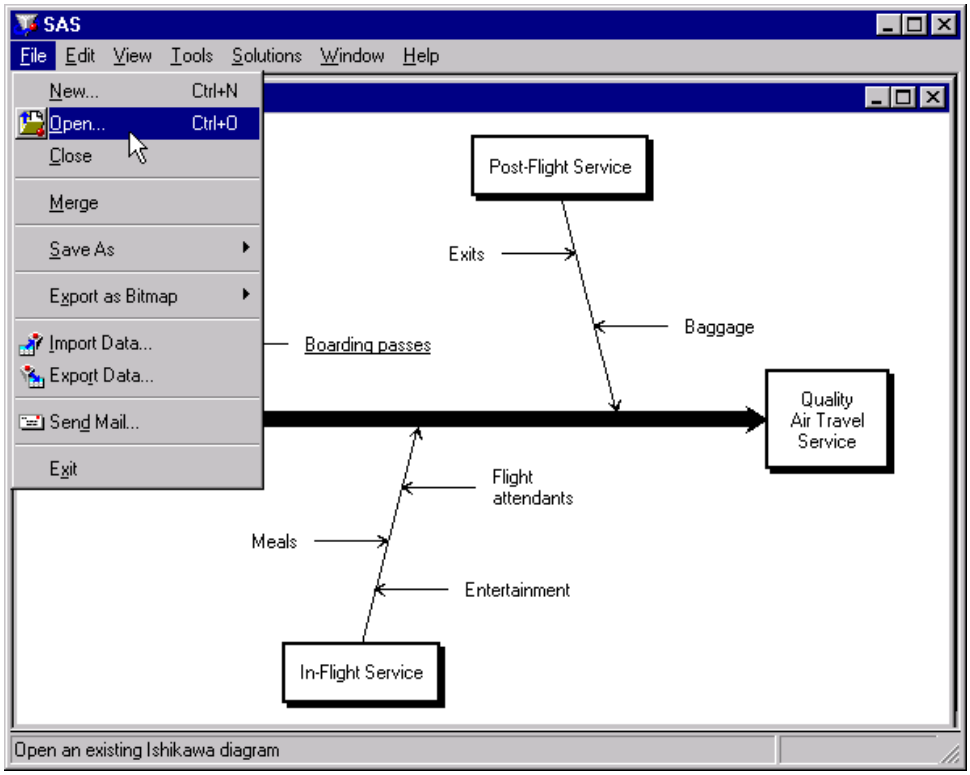
The following figure shows an Ishikawa diagram for *Quality Air Travel Service* after an initial brainstorming session:

Figure 8.79 Single Ishikawa Diagram



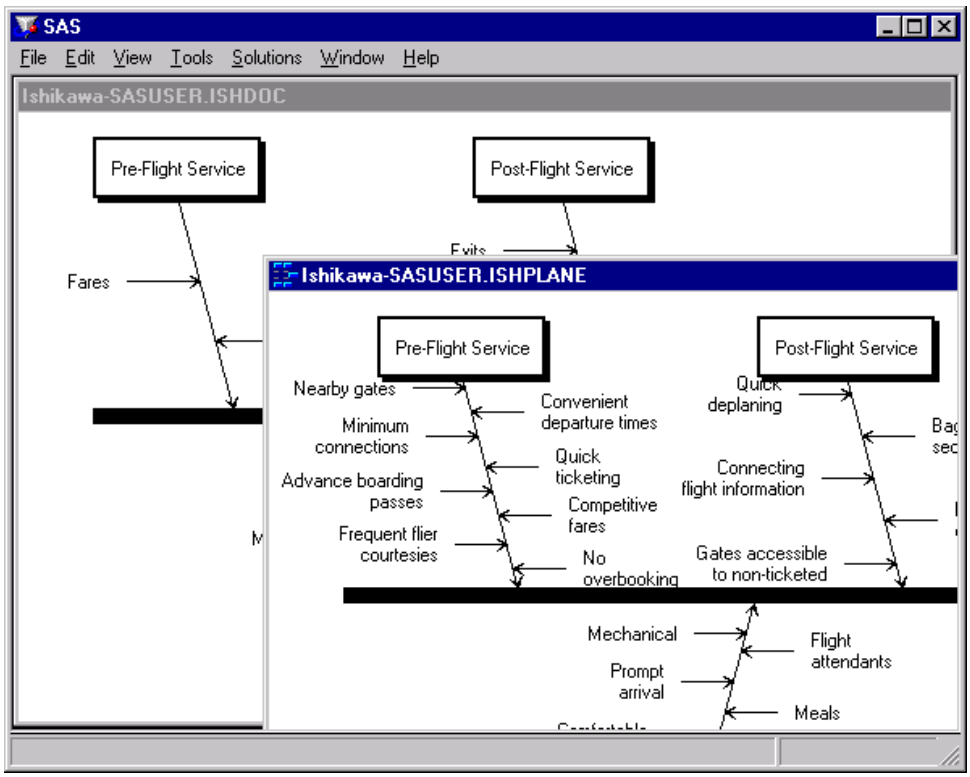
The current diagram and another Ishikawa diagram can be viewed simultaneously by selecting **File ► Open** from the command bar.

Figure 8.80 Opening a Second Diagram



In this situation, displaying both diagrams concurrently emphasizes the improved understanding of the process. It also enables you to transfer information from one diagram to another.

Figure 8.81 Viewing Multiple Ishikawa Diagrams



Input and Output Data Sets

The following is a complete list of the variables in output SAS data sets created by the ISHIKAWA environment:

```
Variable    Type    Len    Description
-------------------------------------------------

_LEVEL_     Num       8    Level of detail
_TEXT1_     Char     40    First  line of label
_TEXT2_     Char     40    Second line of label
_TEXT3_     Char     40    Third  line of label
_TEXT4_     Char     40    Fourth line of label
_TEXT5_     Char     40    Fifth  line of label
_NOTE1_     Char     40    First  line of note
_NOTE2_     Char     40    Second line of note
_NOTE3_     Char     40    Third  line of note
_NOTE4_     Char     40    Fourth line of note
_RELPOS_    Num       8    Relative arrow position
_SIDE_      Char      1    Side arrow attaches to parent
_ANGLE_     Num       8    Angle (non-horizontal arrows)
_LWIDTH_    Num       8    Line width
_LSTYLE_    Num       8    Line style
_LCOLOR_    Char      8    Line color
```

```
_TCOLOR_    Char      8    Text color
_ICOLOR_    Char      8    Box infill color
_SCOLOR_    Char      8    Shadow color
_STYPE_     Char      1    Shadow type
_SWIDTH_    Num       8    Shadow width
_RELLNG_    Num       8    Relative length of an arrow
_HLEVEL_    Num       8    Arrow head threshold
_HSTYLE_    Num       8    Arrow head style
_HLNGTH_    Num       8    Arrow head length
_HWIDTH_    Num       8    Arrow head width
_HTEXT_     Num       8    Font height
_FTEXT_     Char      8    Font
```

Only the variables _LEVEL_ and _TEXT1_ are required in the input data set for the ISHIKAWA procedure. Each observation in the input data set corresponds to a particular arrow in the diagram. The order of the observations is critical because it defines the relationships of the arrows.

- The trunk is always the first observation.
- The remaining observations are ordered so that leaves are nested within stems, stems are nested within branches, and branches are nested within the trunk.
- The variable _LEVEL_ is numeric and indicates the level within the diagram. The trunk has a level of 0, branches have a level of 1, stems have a level of 2, and so on.
- The first line of text in a label is stored as _TEXT1_, the second as _TEXT2_, and so on.

Example

The following is a partial listing of the SAS data set used to create the Ishikawa diagram shown in Figure 8.15:

```
data ishplane;
   length _text1_ _text2_ _text3_ $ 40 _side_ $ 1;
   input  _level_ _text1_ & _text2_ & _text3_ & _relpos_ _side_;
   datalines;
0  Quality              Air Travel          Service  -1.00  .
1  Pre-Flight Service   .                   .         0.26  T
2  Competitive          fares               .         0.68  R
2  Convenient           departure times     .         0.18  R
2  Quick                ticketing           .         0.43  R
2  Frequent flier       courtesies          .         0.81  L
1  In-Flight Service    .                   .         0.61  B
2  Prompt               departures          .         0.21  R
2  Comfortable          seating             .         0.35  L
;
```

Note the structure of this data set:

- The trunk (always the first observation) has a _LEVEL_ value of zero.
- All subsequent observations for which _LEVEL_ is equal to one are branches that emerge from the trunk.

- Observations 4 and 5 are both leaves that emerge from the preceding stem (observation 3).
- Likewise, leaves 7 and 8 emerge from the preceding stem (observation 6).

You can use this data set as a way of extracting text and notepad information from the diagram.

Syntax

There are only three options that can be specified in the PROC ISHIKAWA statement, since the ISHIKAWA procedure is primarily a user-driven procedure.

DATA=*SAS-data-set*

identifies the name of a SAS data set that specifies an existing Ishikawa diagram. By default, the procedure will prompt you to edit an existing Ishikawa diagram or start a new one. When you specify the DATA= option, the procedure bypasses this initial menu. For example, the following statements simplify editing an existing Ishikawa diagram saved in a SAS data set:

```
proc ishikawa data=work.airline;
run;
```

NEW

starts a new Ishikawa diagram. By default, the procedure will prompt you to edit an existing Ishikawa diagram or start a new one. When you specify the NEW option, the procedure bypasses this initial menu and starts with a new diagram. Do not specify any other options when using the NEW option. For example, the following statements simplify starting a new Ishikawa diagram:

```
proc ishikawa new;
run;
```

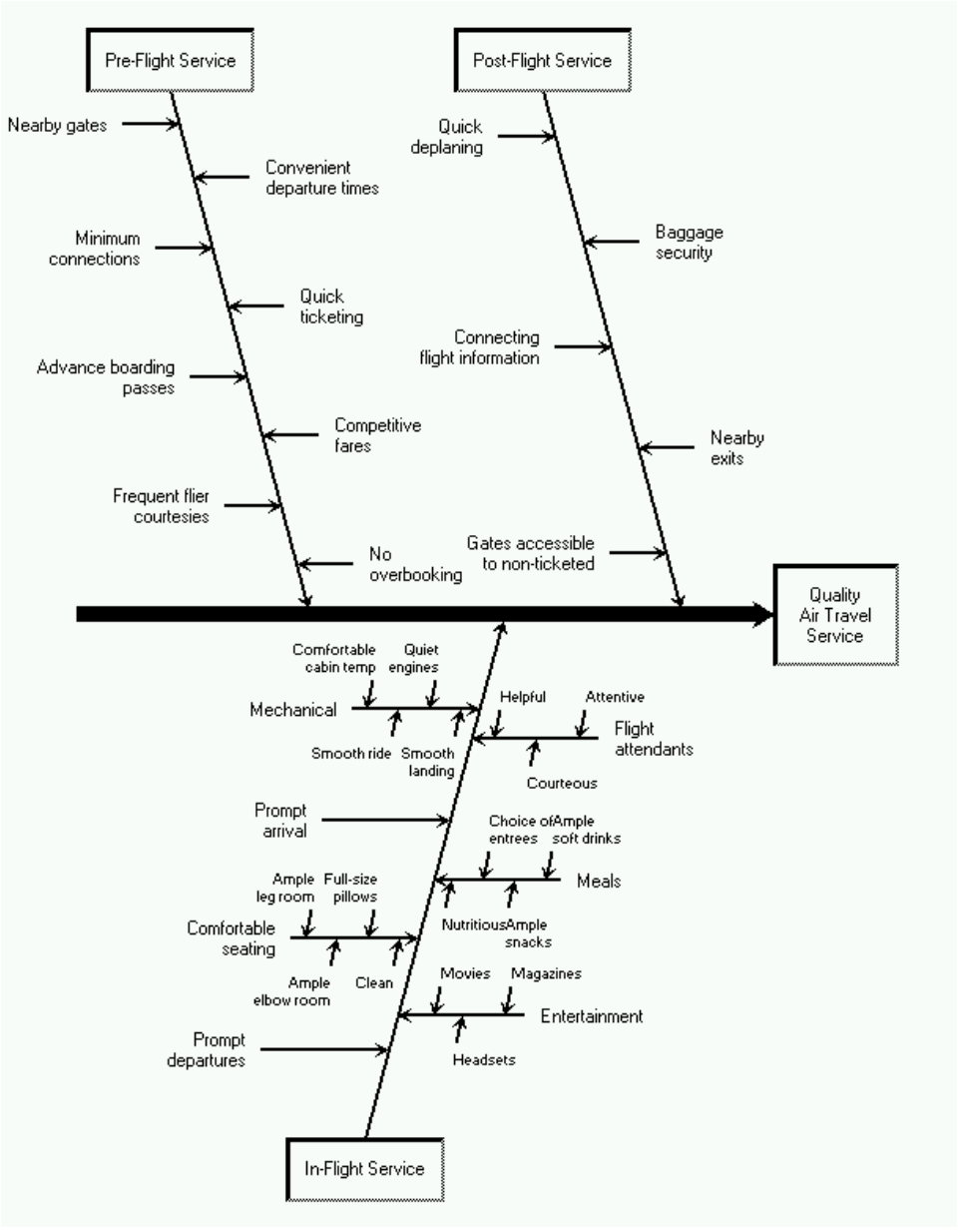
NOFS

allows you to create hard copies of Ishikawa diagrams saved as SAS data sets without invoking the interactive features of the procedure. You must specify the DATA= option when you use the NOFS option. For example, the following statements create a hard copy of the Ishikawa diagram saved in the SAS data set *work.airline*:

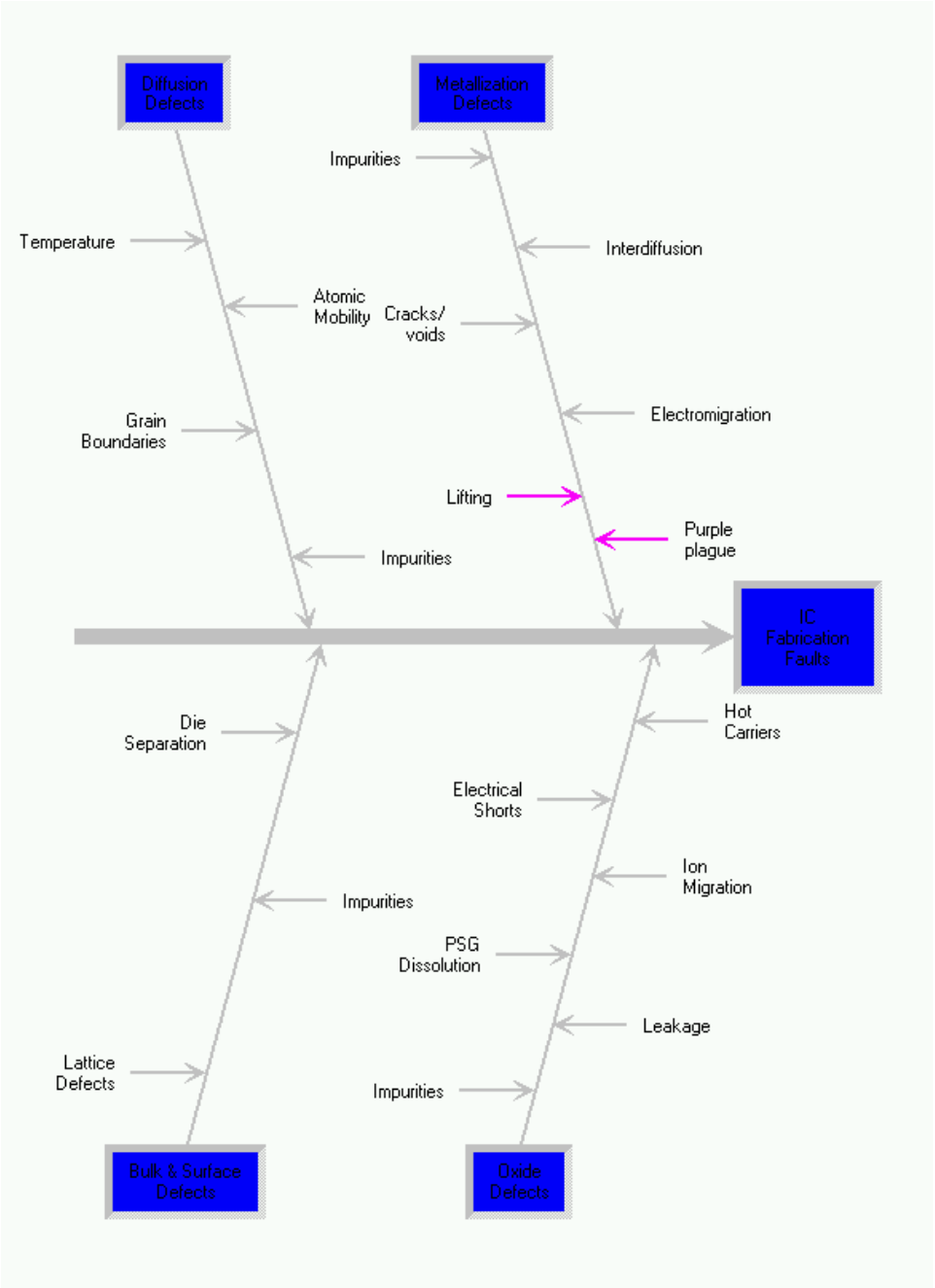
```
goptions dev=psl noprompt;
proc ishikawa data=work.airline nofs;
run;
```

Examples

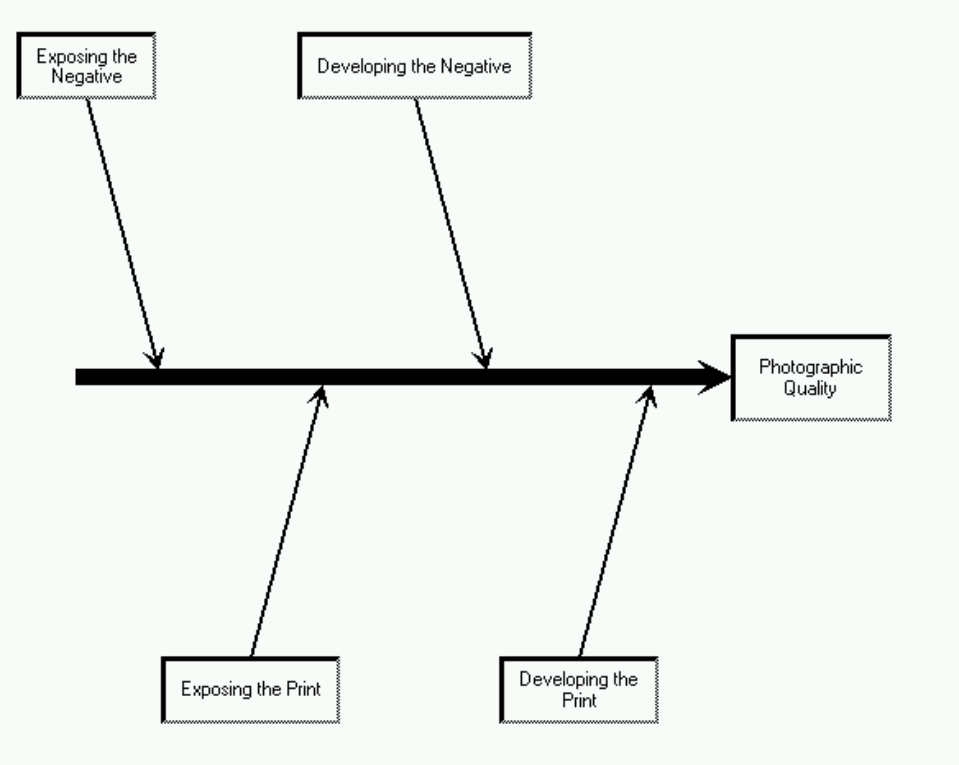
Example 8.1: Quality of Air Travel Service



Example 8.2: Integrated Circuit Failures



Example 8.3: Photographic Development Process



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Subject Index

Ishikawa diagrams
- adding arrows, 711–715
- aligning arrows, 732–739
- arrow colors, 755, 757–763
- arrow heads, 765
- arrow line style, 755, 757–763
- arrow line width, 755, 757–763
- balancing arrows, 732–739
- box color, modifying, 755
- box shadow, 765
- clipboard graphics, 752, 753
- color, arrow, 755, 757–763
- color, box, 755
- color, palette, 755, 757–763
- color, text, 763
- context-sensitive operations, 698, 708, 709
- data collection, 739, 740
- data presentation, 739, 740
- deleting arrows, 724–727
- detail, decreasing, 741–743
- detail, increasing, 741–743
- Edit menu, 710
- editing existing diagrams, 767, 768
- editing labels, 715–718
- examples, 774
- examples, Integrated Circuit Failures, 775
- examples, Photo Development Process, 776
- examples, Quality of Air Travel Service, 774
- exporting diagrams, 752, 753
- File menu, 710
- fonts, modifying, 754
- Help menu, 711
- highlighting arrows, 755, 757–763
- history, 696
- hotspots, 698, 708, 709
- isolating arrows, 745, 746
- labeling arrows, 715–718
- line palette, 755, 757–763
- managing complexity, 741–749
- merging diagrams, 746–749
- mouse sensitivity, 765
- moving arrows, 718–724, 729–739
- multiple diagrams, displaying, 746–749, 769
- notepads, 739, 740
- output, bitmaps, 752, 753
- output, graphics, 749–751
- output, SAS data set, 766, 767, 771–773
- overview, 696
- palettes, colors, 755, 757–763
- palettes, fonts, 754
- palettes, lines, 755, 757–763
- printing, bitmaps, 752, 753
- printing, SAS/GRAPH output, 749–751
- resizing arrows, 727–729
- SAS data set, input, 767, 768, 771–773
- SAS data set, output, 766, 767, 771–773
- saving, bitmaps, 752, 753
- saving, clipboard graphics, 752, 753
- saving, graphics, 749–751
- saving, SAS data set, 766, 767
- subsetting arrows, 727–729, 755, 757–763
- summary of operations, 708–711
- swapping arrows, 729–732
- syntax, 773
- tagging arrows, 727–729, 755, 757–763
- terminology, 697
- text entry, 715–718
- tutorial, 699, 700, 702–707
- undo, 724–727
- View menu, 710
- zooming arrows, 743–745, 765

Syntax Index

Ishikawa diagrams
- adding arrows, 711–715
- aligning arrows, 732–739
- balancing arrows, 732–739
- data collection, 739, 740
- data presentation, 739, 740
- deleting arrows, 724–727
- detail, decreasing, 741–743
- detail, increasing, 741–743
- editing existing diagrams, 767, 768
- editing labels, 715–718
- exporting diagrams, 752, 753
- fonts, modifying, 754
- highlighting arrows, 755, 757–763
- isolating arrows, 744–746
- labeling arrows, 715–718
- managing complexity, 741–749
- merging diagrams, 746–749
- moving arrows, 718–724, 729–739
- notepads, 739, 740
- output, bitmaps, 752, 753
- output, graphics, 749–751
- output, SAS data set, 766, 767, 771–773
- overview, 696
- printing, bitmaps, 752, 753
- printing, SAS/GRAPH output, 749–751
- resizing arrows, 727–729
- SAS data set, input, 767, 768, 771–773
- SAS data set, output, 766, 767, 771–773
- saving, bitmaps, 752, 753
- saving, clipboard graphics, 752, 753
- saving, graphics, 749–751
- saving, SAS data set, 766, 767
- subsetting arrows, 727–729, 755, 757–763
- summary of operations, 708–711
- swapping arrows, 729–732
- tagging arrows, 727–729, 755, 757–763
- terminology, 697
- text entry, 715–718
- undo, 724–727
- zooming arrows, 743, 744, 765

ISHIKAWA procedure, 773
- syntax, 773