

Chapter 18

Details of the ISHIKAWA Environment

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Chapter 18

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 on page 519.

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 18.1. Primary Operations

Operation	Mouse Event	Hotspot	Page
Add	Click	Near the intended attachment point	534
Edit	Click	Arrow tail	537
Move	Click (<i>to pick</i>)	Arrow head	
	Click (<i>to drop</i>)	Near the intended attachment point	540
Delete	Double click	Arrow head	544
Resize	Drag	Arrow tail	546
Notepad	Double click	Arrow tail	557

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

Table 18.2. Secondary Operations

Operation	Menu	Selection	Page
Swap	Head or tail	Swap	549
Balance	Head or tail	Balance	551
Hide Detail	Background	< Detail	558
Show Detail	Background	> Detail	558
Zoom	Head or tail	Zoom	561
Isolate	Head or tail	Isolate	562
Print	Pull-down	File ▷ Save as ▷ Graph	566
Save	Pull-down	File ▷ Save as ▷ Data Set	581
Save	Pull-down	File ▷ Save as ▷ Image	.
Subset	Head or tail	Subset	572
Copy	Head or tail	Copy	563
Refresh	Background	Refresh	.
Unsubset	Background	Unsubset	572
Unbalance	Background	Unbalance	551
Undelete	Background	Undelete	544

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

Table 18.3. Context-Sensitive Tools

Hotspot	Mouse Event	Operation	Page
Arrow Head	Click	Begin move	540
	Double click	Delete	544
	Drag	Resize	546
	Popup menu	Subset	572
		Balance	551
		Swap	549
		Copy	563
		Zoom	561
		Isolate	562
	Arrow Tail	Click	Edit
Double click		Notepad	557
Drag		Resize	546
Popup menu		Subset	572
		Balance	551
		Swap	549
Arrow	Click	Add new arrow or	534
		complete move operation	540
Window Background	Click	Drop (finish) pending action	.
	Drag	Drop (finish) pending action	.
	Popup menu	Undelete	544
		Unsubset	572
		Unbalance	551
		Show Detail	558
		Hide Detail	558
	Refresh	.	

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

Table 18.4. File Menu

File ▷	Description	Page
New	Start a new diagram	519
Open	Open an existing diagram	582
Close	Close the current window	.
Merge	Merge in an existing diagram	563
Save as ▷	Data Set	581
	Graph	566
	Image	568
Export as Bitmap ▷	File...	568
	Customize...	569

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

Table 18.5. Edit Menu

Edit ▷	Description	Page
Copy	Copy the diagram to host clipboard	568
Clear...	Clear the window	.

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

Table 18.6. View Menu

View ▷	Description	Page
Ishikawa Settings ▷ Palettes	Line and color palettes	572
Background Color	Change window background color	.
Save Attributes	Save window attributes: size, fonts and background color	.
Balance Method	Select a balancing style	551
Resize Method	Select a resizing method	546
Primary Fonts...	Font dialog for first 3 levels	570
Secondary Fonts...	Font dialog for levels 4-10	570
Colors...	Color dialog	571
Arrows...	Arrow style dialog	579
Other...	Style dialog	580
Refresh	Refresh the window	.

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

Table 18.7. 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 537, 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 519, 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:

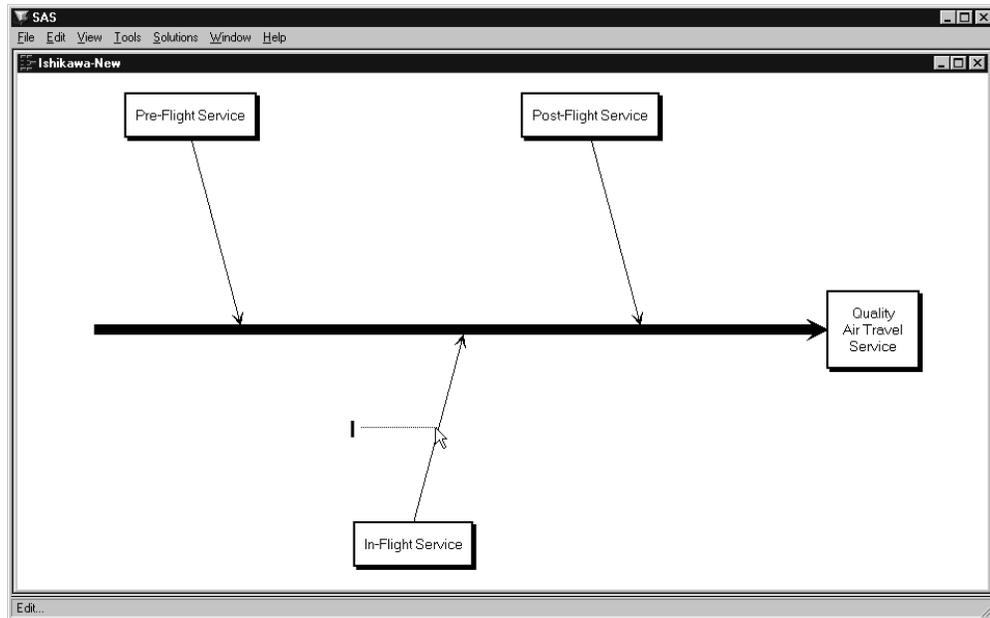


Figure 18.1. Adding the Left Stem

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:

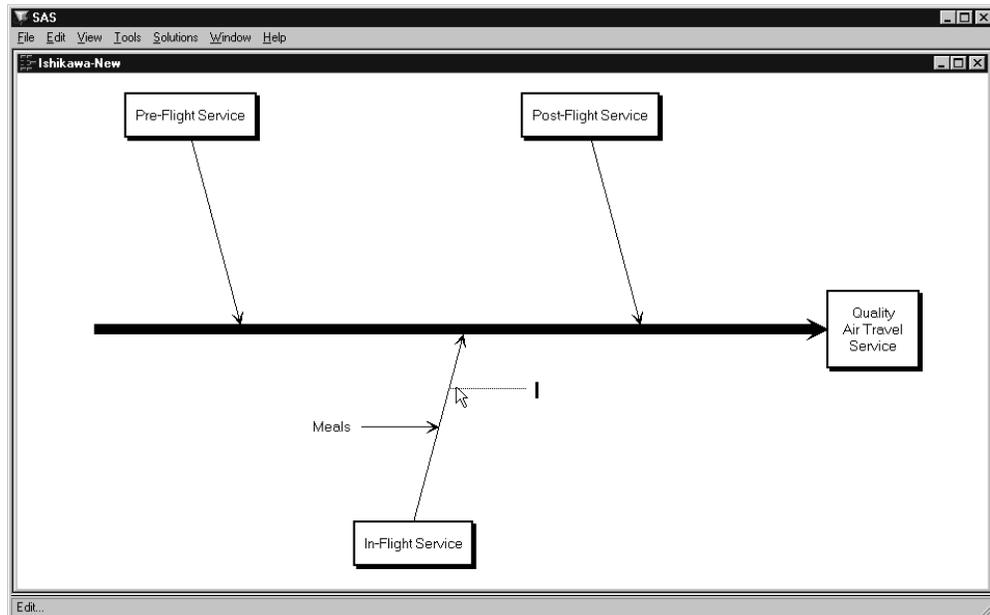


Figure 18.2. Adding the Right Stem

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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:

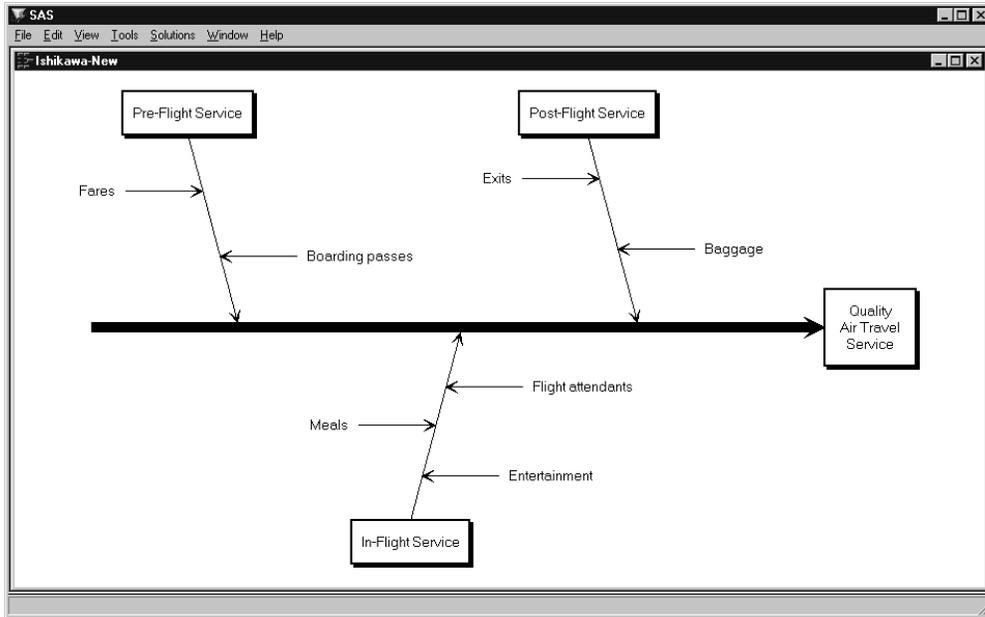


Figure 18.3. Stem-Level Diagram

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.

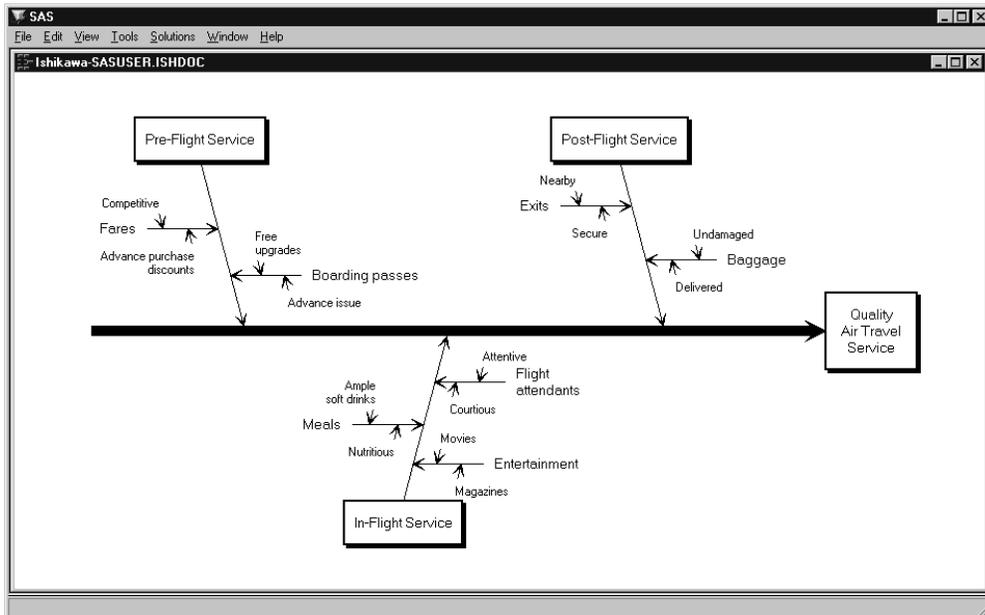


Figure 18.4. Leaf-Level Diagram

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,* 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

*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.

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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.

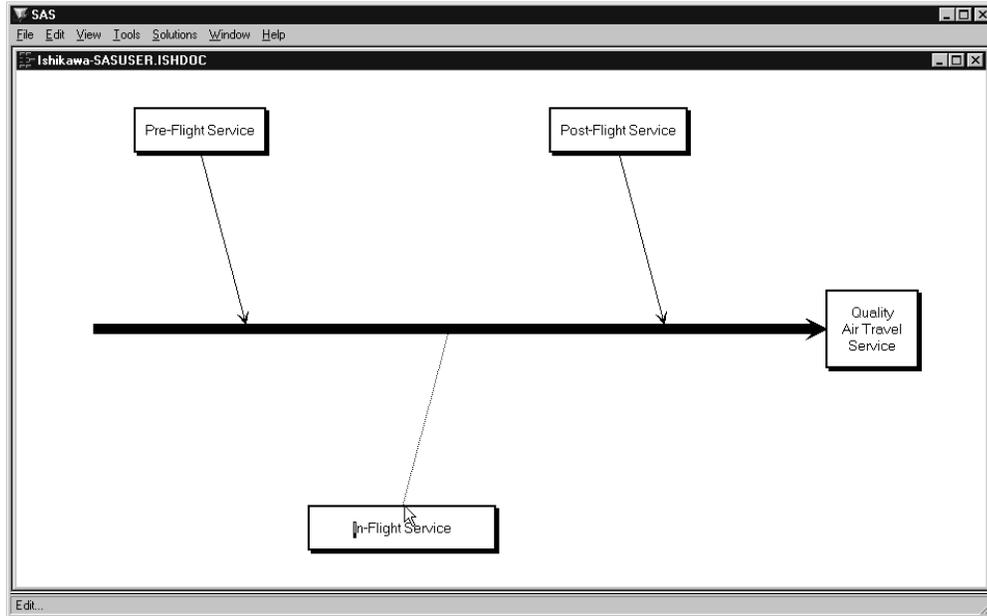


Figure 18.5. Selecting an Arrow for Editing

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:

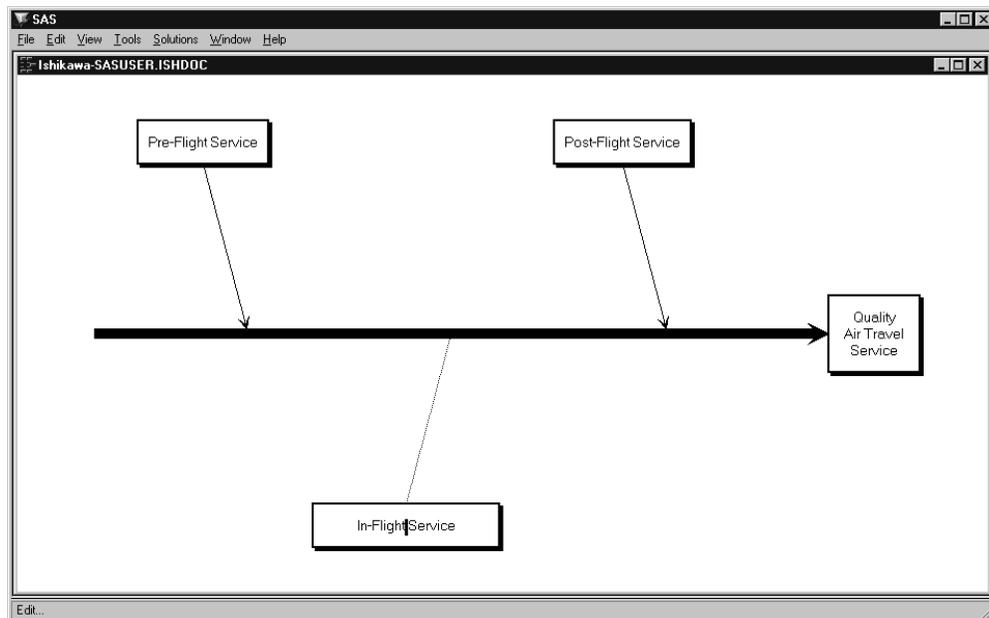


Figure 18.6. Using Cursor Keys

Now press **Return** to split the text into two lines.

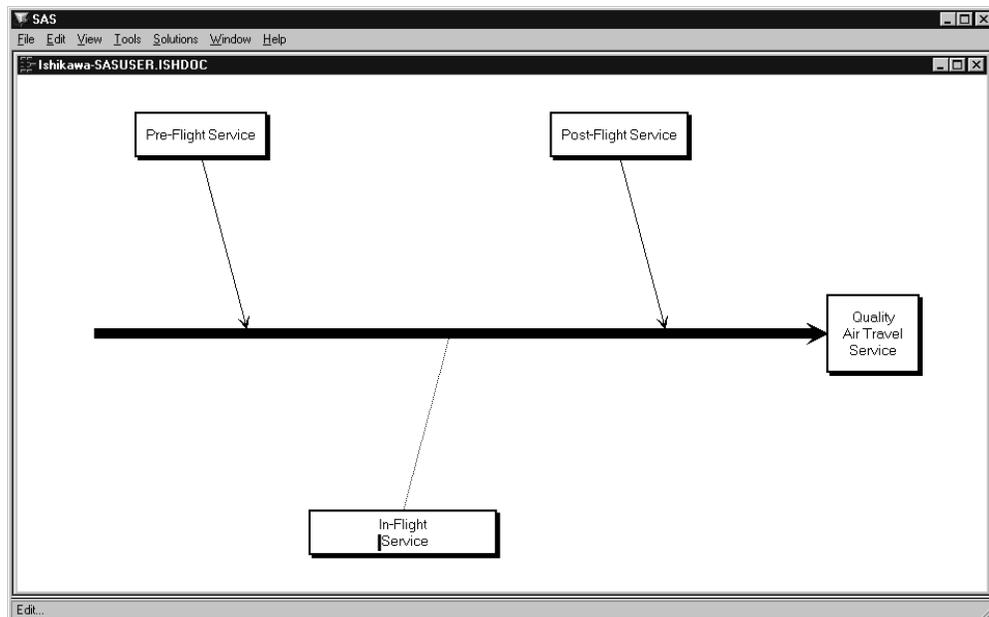


Figure 18.7. Splitting Text

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:

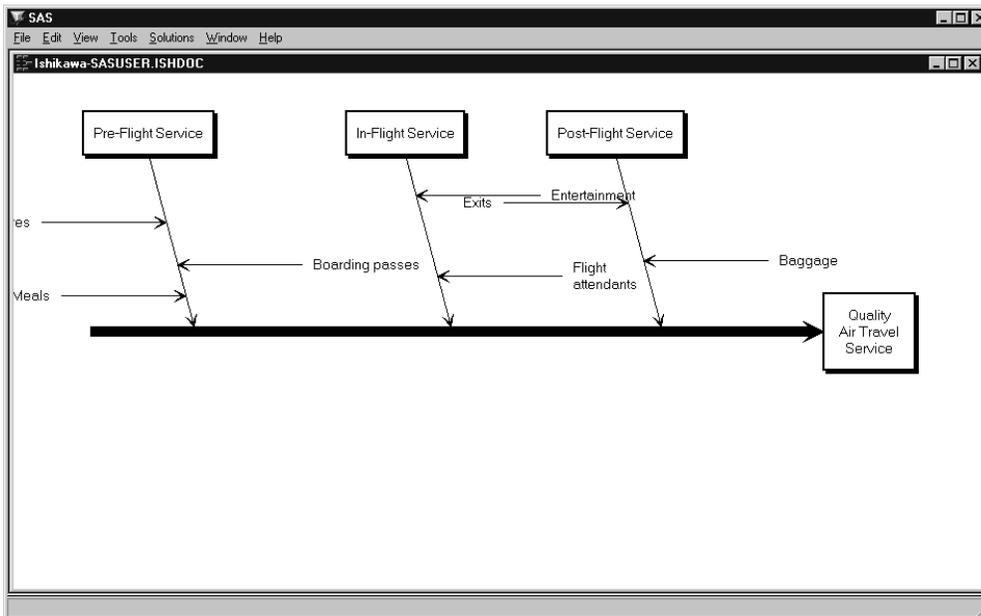


Figure 18.8. An Inelegantly Arranged Ishikawa Diagram

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.

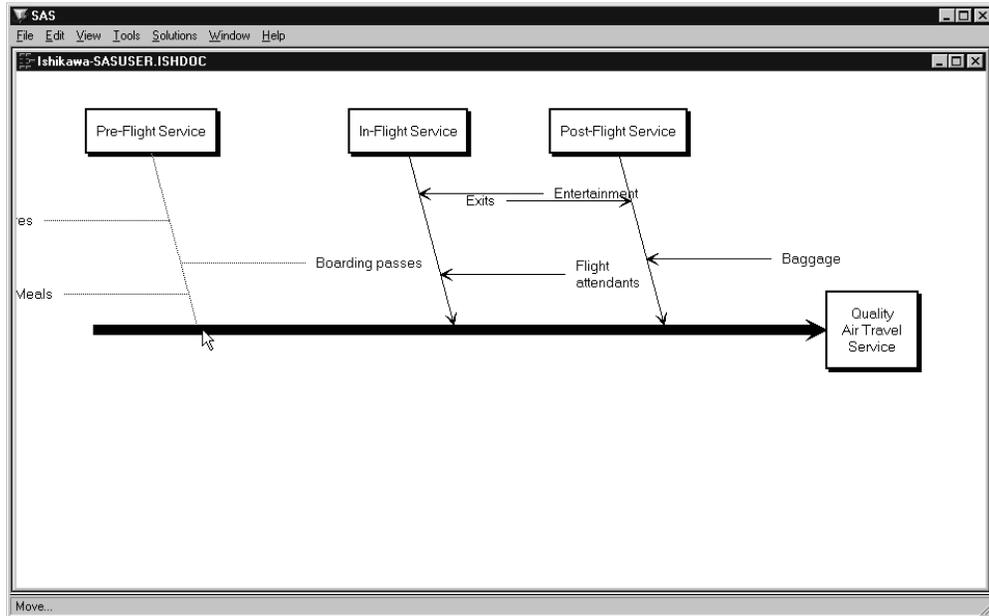


Figure 18.9. Selecting an Arrow to Move

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

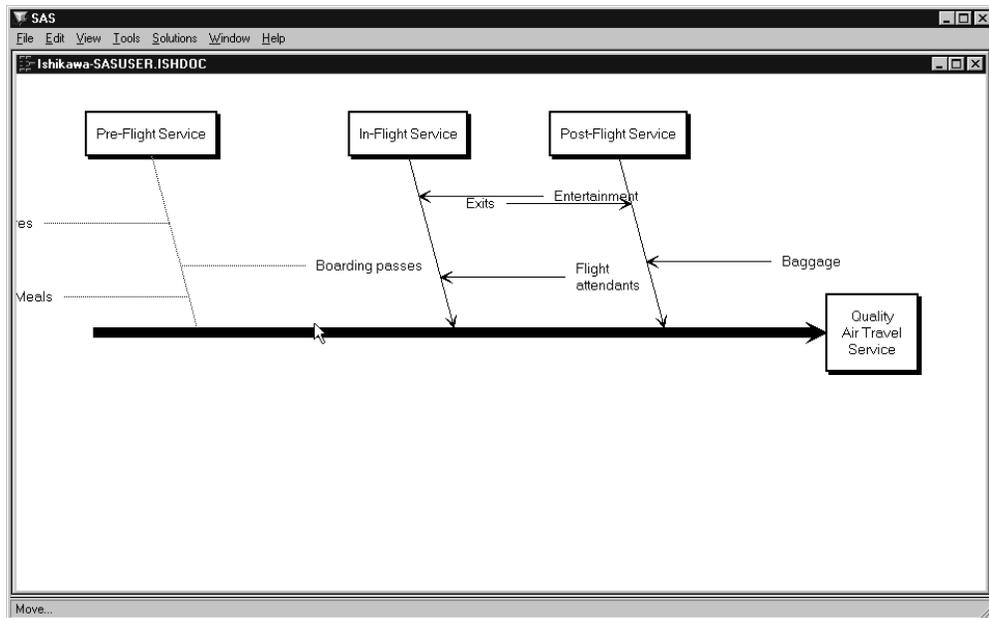


Figure 18.10. Locating the New Attachment Point

Part 4. The CAPABILITY Procedure

Drop the arrow in place by clicking the mouse.

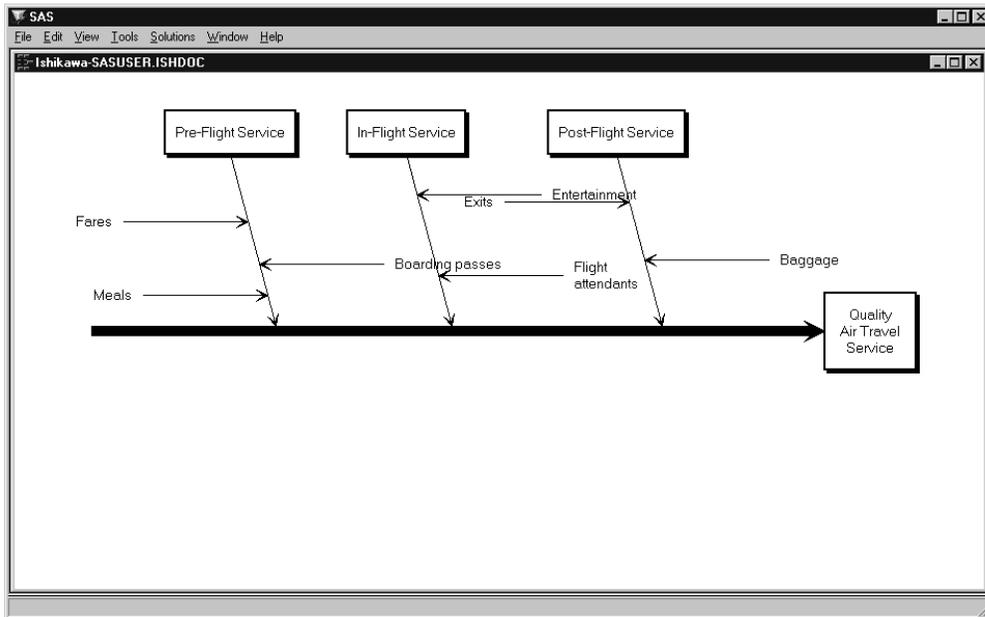


Figure 18.11. Dropping an Arrow into Position

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.

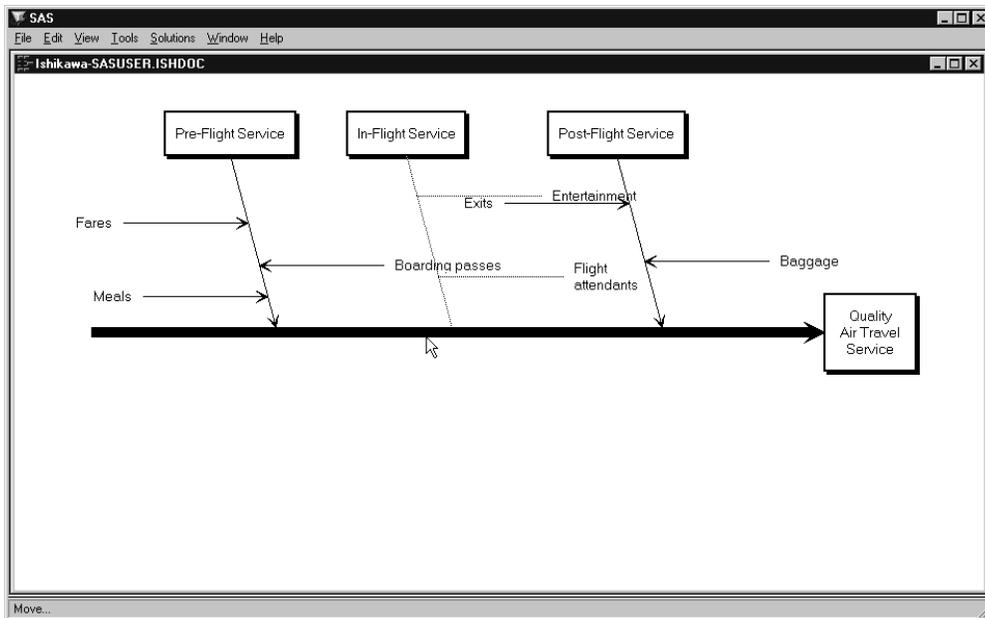


Figure 18.12. Selecting an Arrow for Reflecting

Click the mouse to complete the reflection.

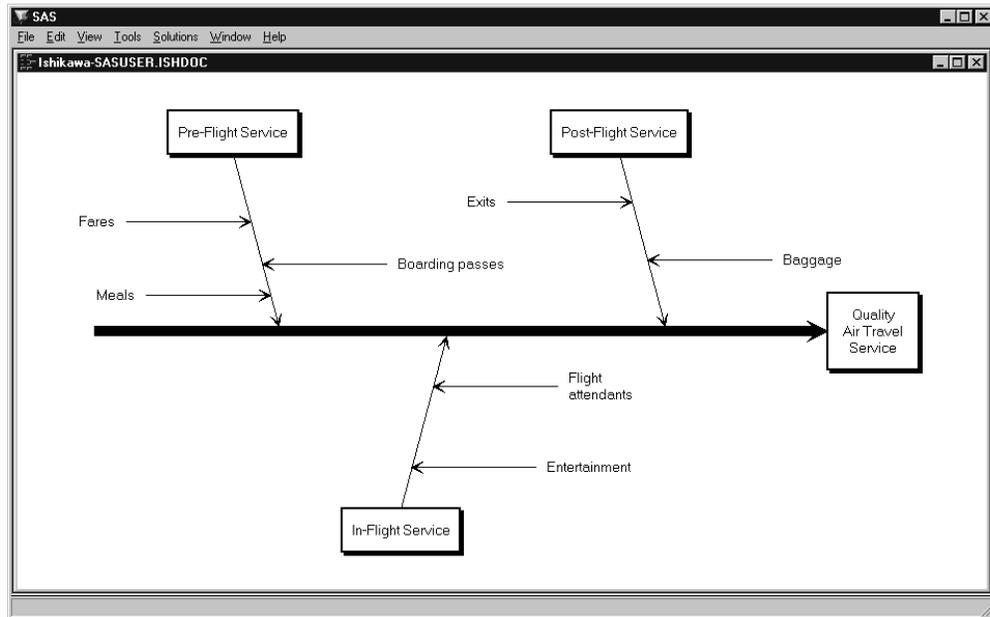


Figure 18.13. Reflecting an Arrow

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.

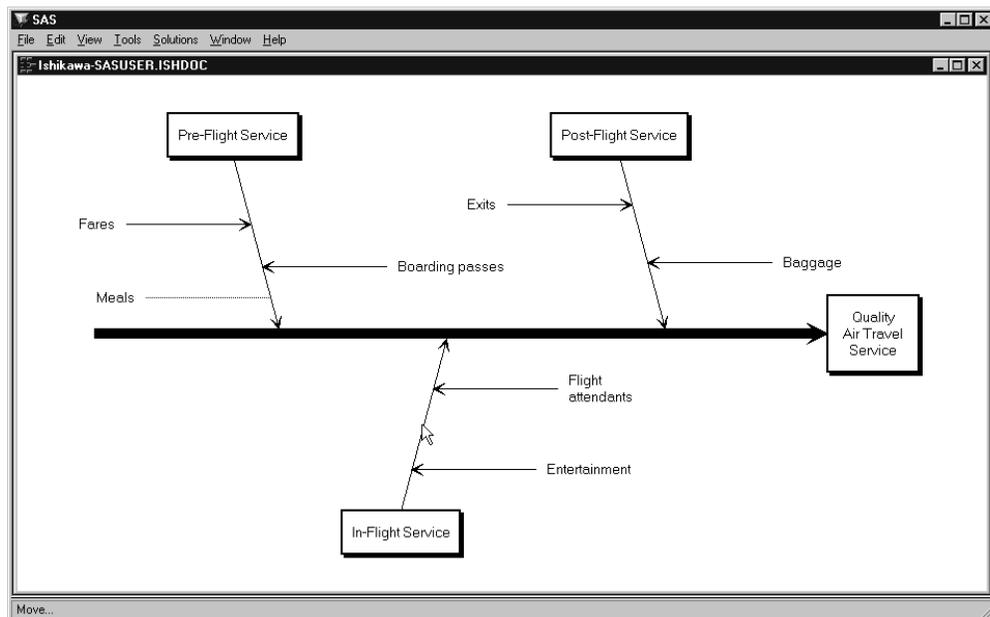


Figure 18.14. Locating the New Attachment Point

To complete the move, click the mouse.

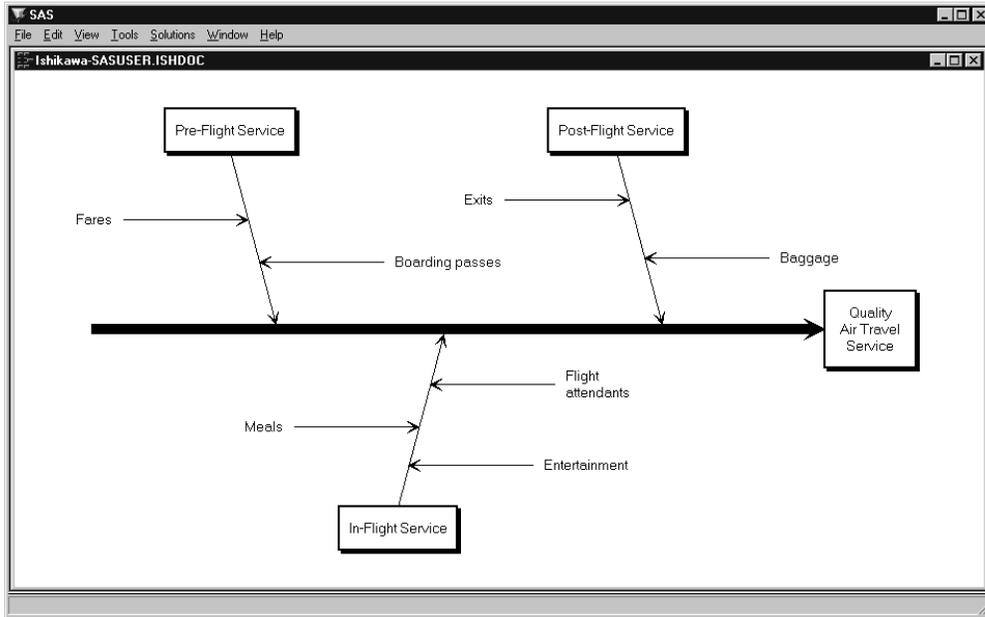


Figure 18.15. Moving a Stem

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):

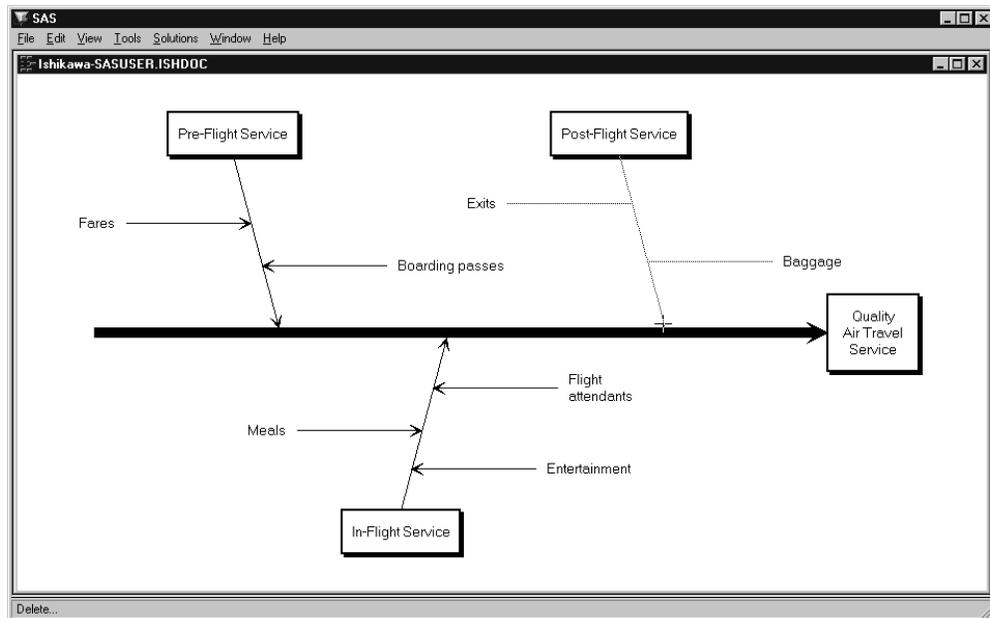


Figure 18.16. Selecting a Branch for Deletion

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

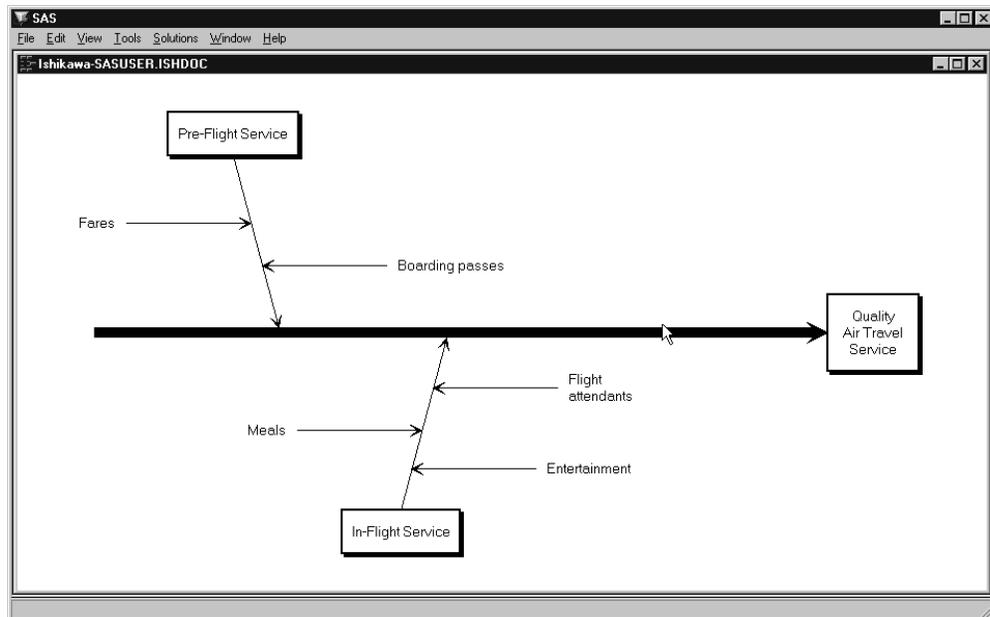


Figure 18.17. Deleting a Branch

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.

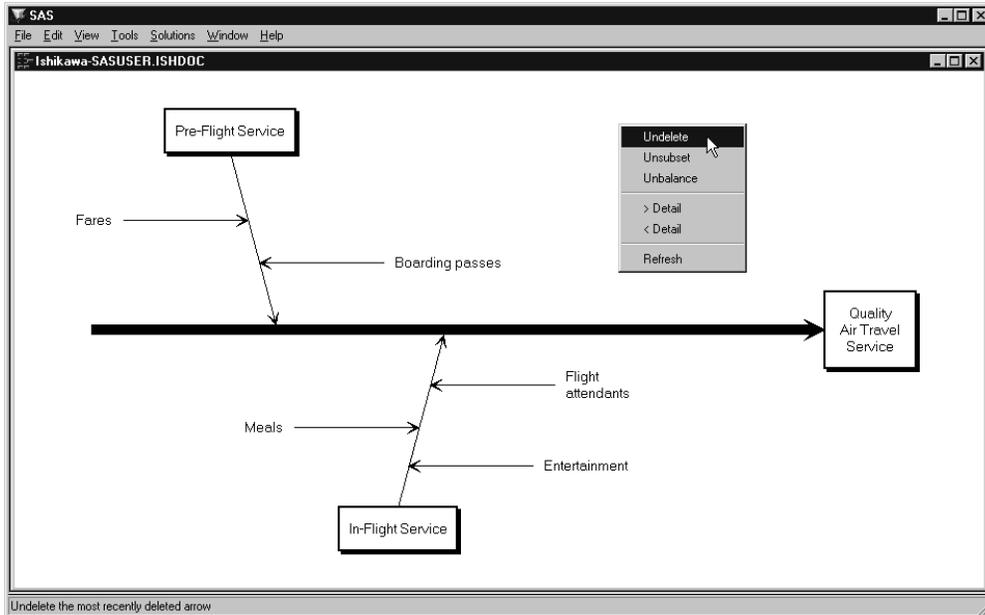


Figure 18.18. Undeleting a Branch

Resizing Arrows

You can resize an arrow by holding the mouse button down over the tail end of the arrow and dragging the mouse.* 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.

*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.

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 *unset* 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 572, for more examples of how subsets are used.

Example

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

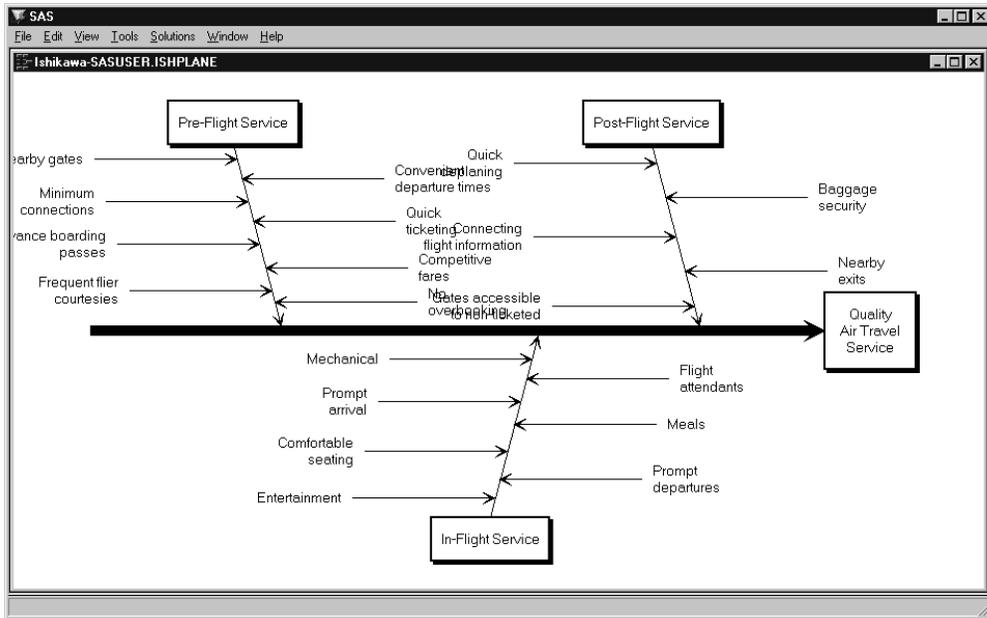


Figure 18.19. Before Resizing the Diagram

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:

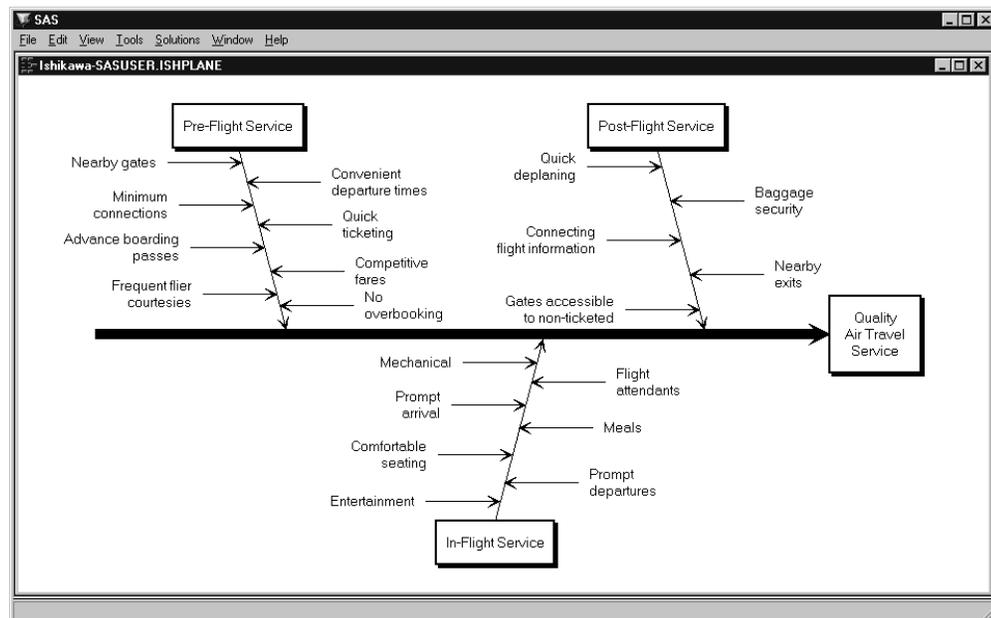


Figure 18.20. After Resizing the Diagram

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.

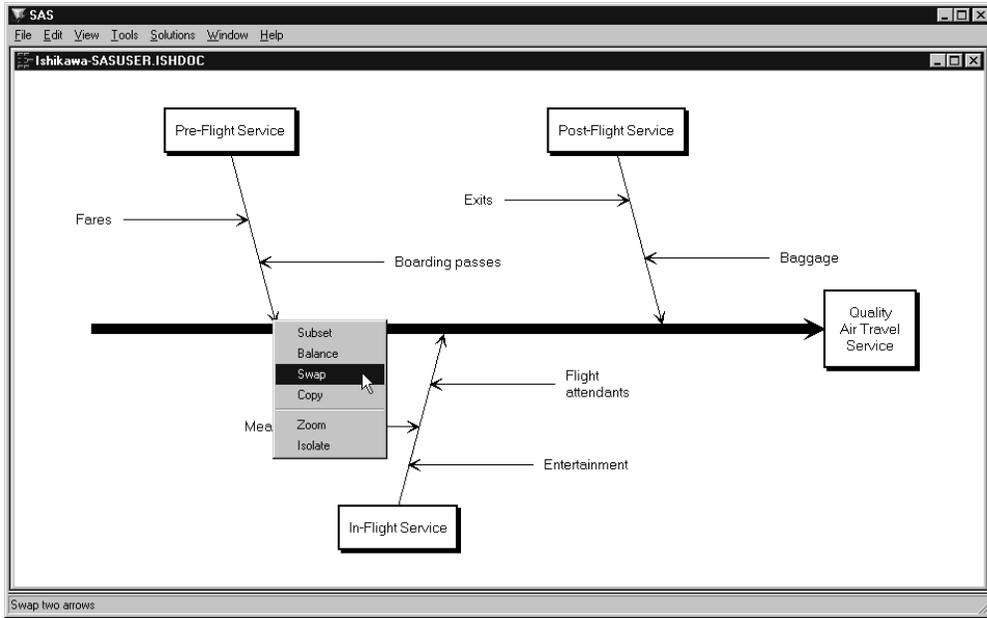


Figure 18.21. Swapping Two Arrows

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

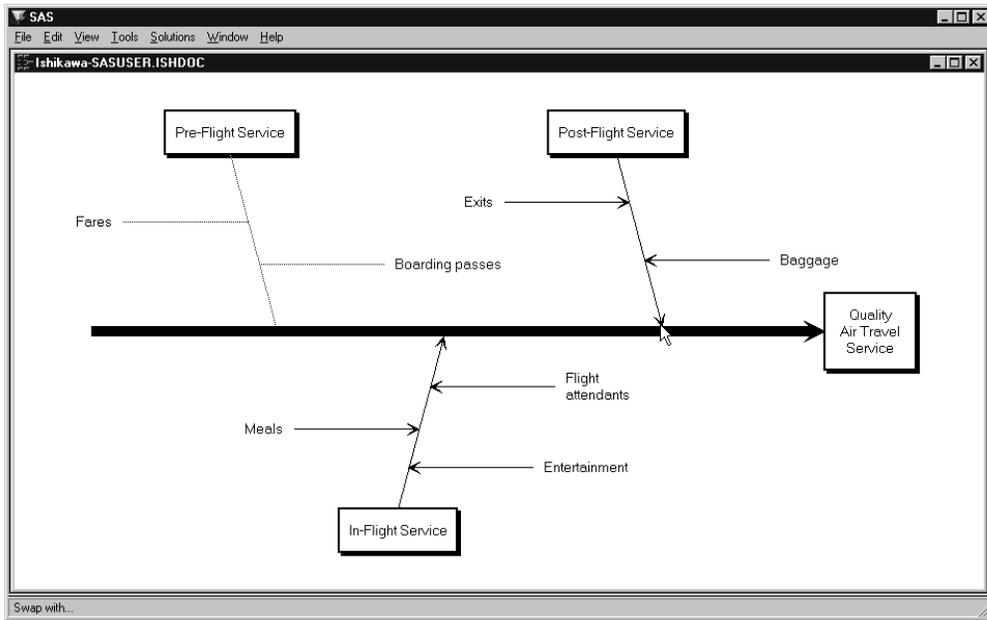


Figure 18.22. Swapping Two Arrows (*continued*)

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

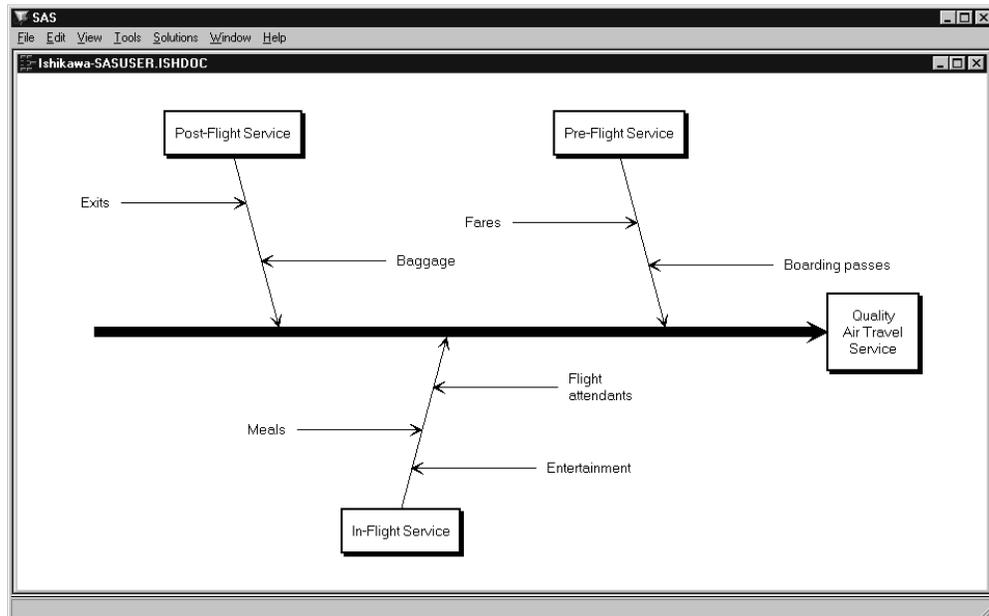


Figure 18.23. Completing a Swap

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**.

Part 4. The CAPABILITY Procedure

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:

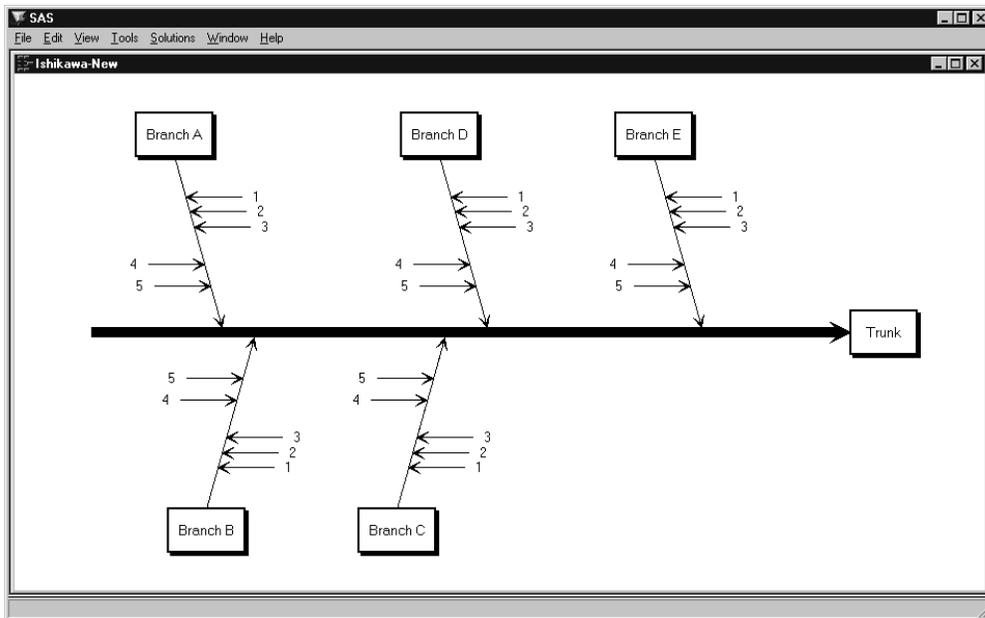


Figure 18.24. An Unbalanced Ishikawa Diagram

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

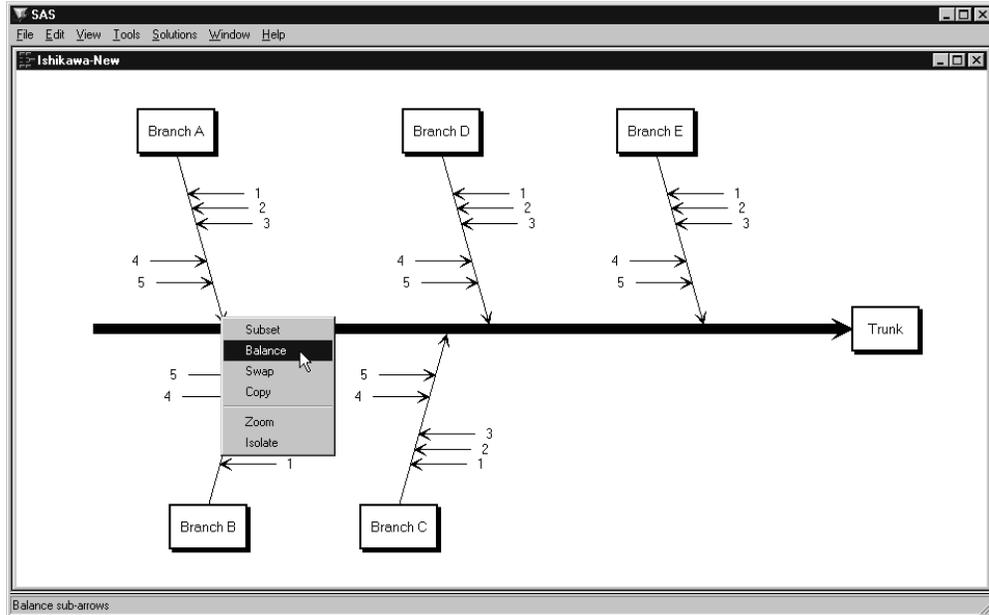


Figure 18.25. Balancing a Branch

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

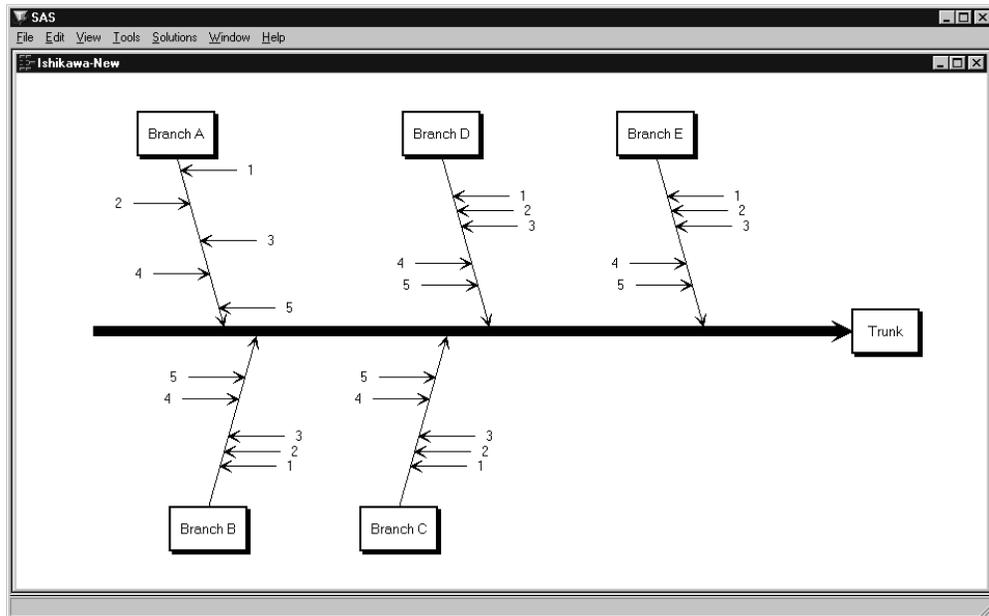


Figure 18.26. A Balanced Branch

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

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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.

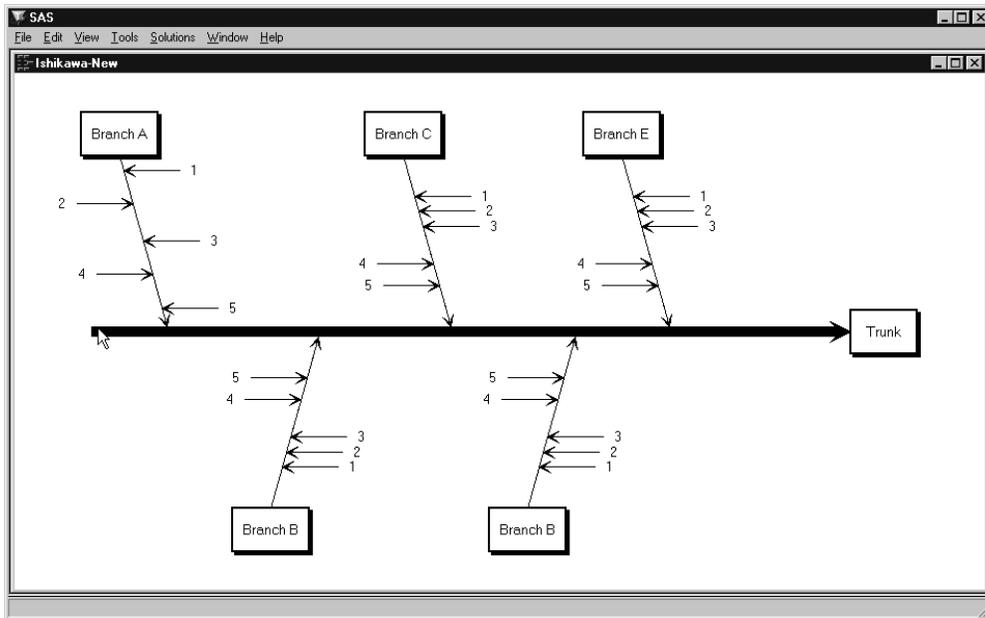


Figure 18.27. Balancing Only the Branches

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.

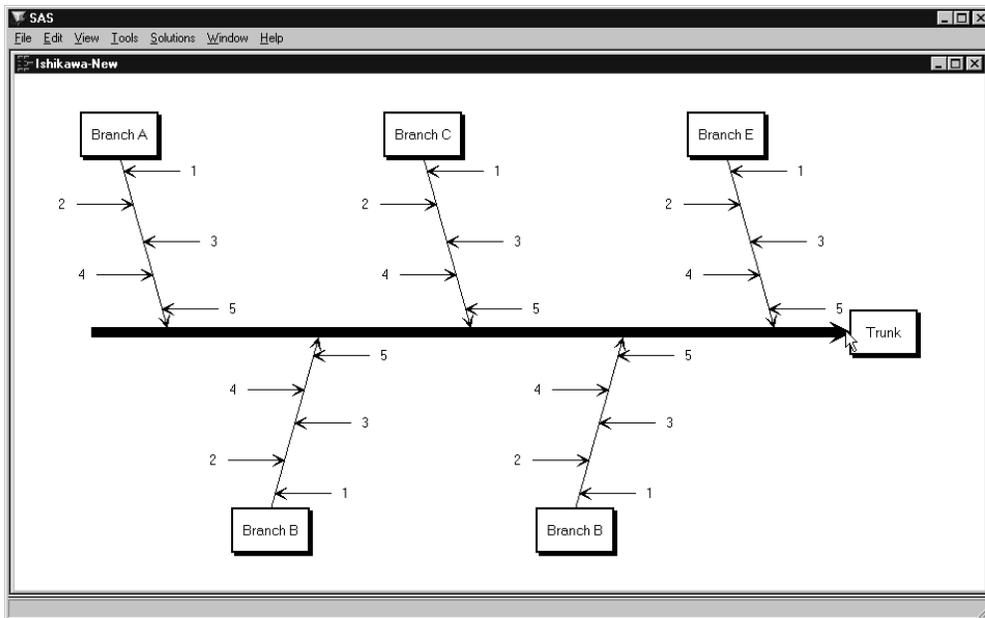


Figure 18.28. Balancing the Entire Diagram

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:

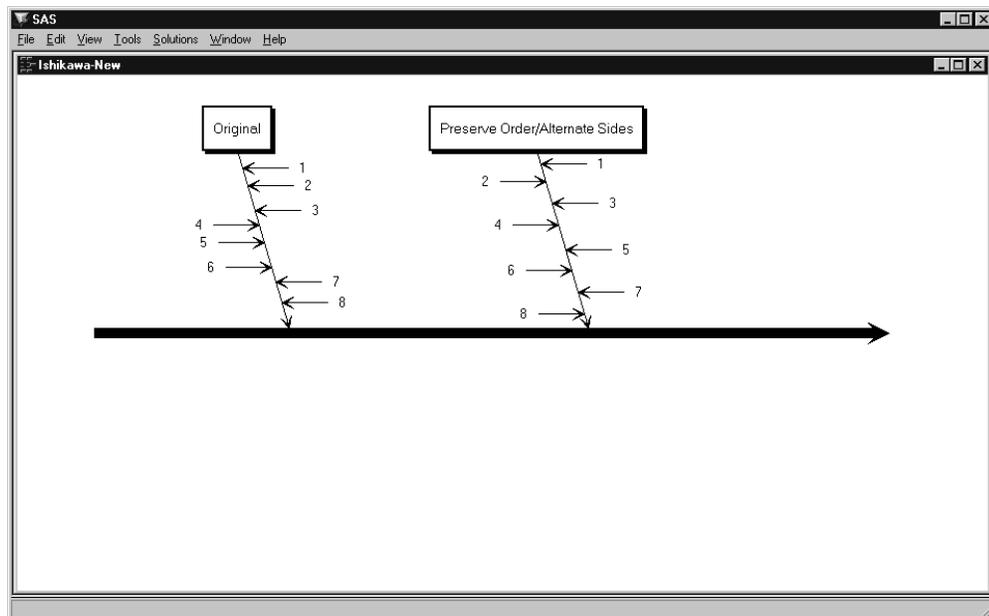


Figure 18.29. Preserving Order But Alternating Sides

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:

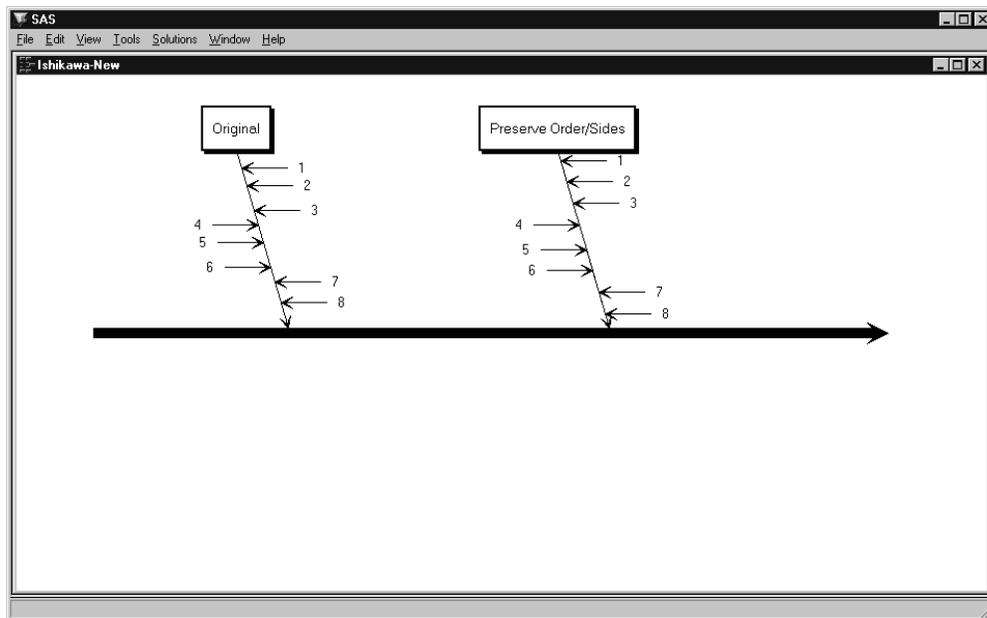


Figure 18.30. Preserving Order and Sides

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:

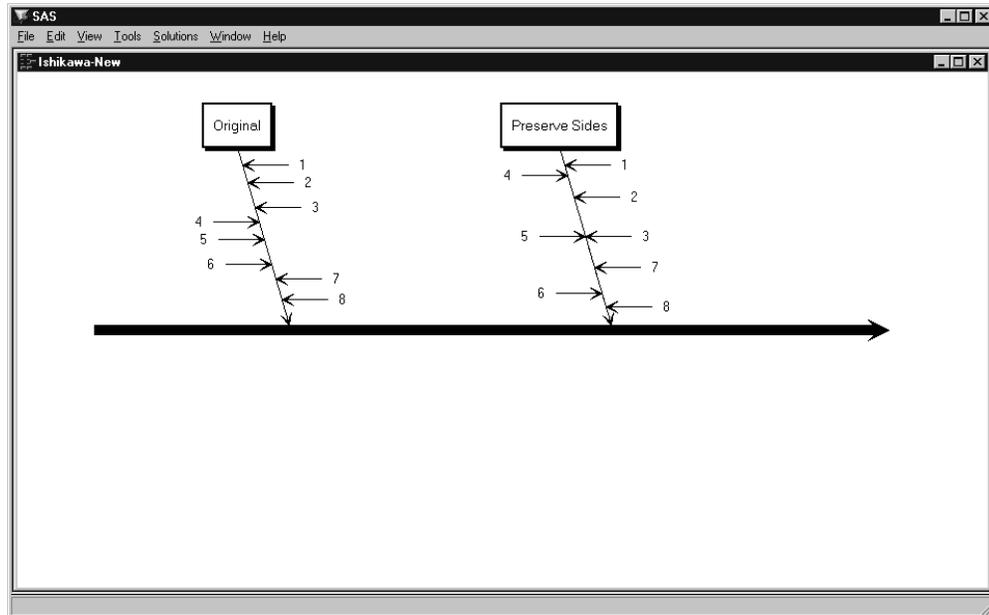


Figure 18.31. Preserving Sides

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.

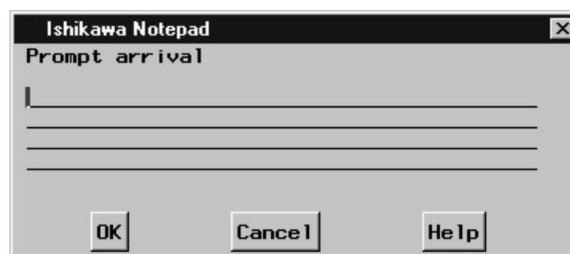


Figure 18.32. Ishikawa Notepad

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:

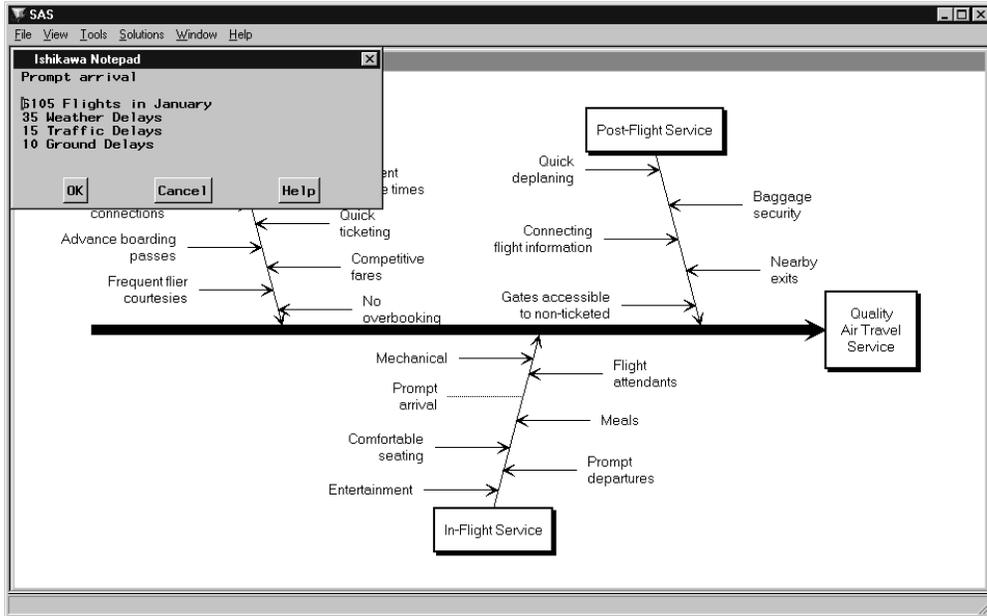


Figure 18.33. Using Notepads to Organize Details

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:

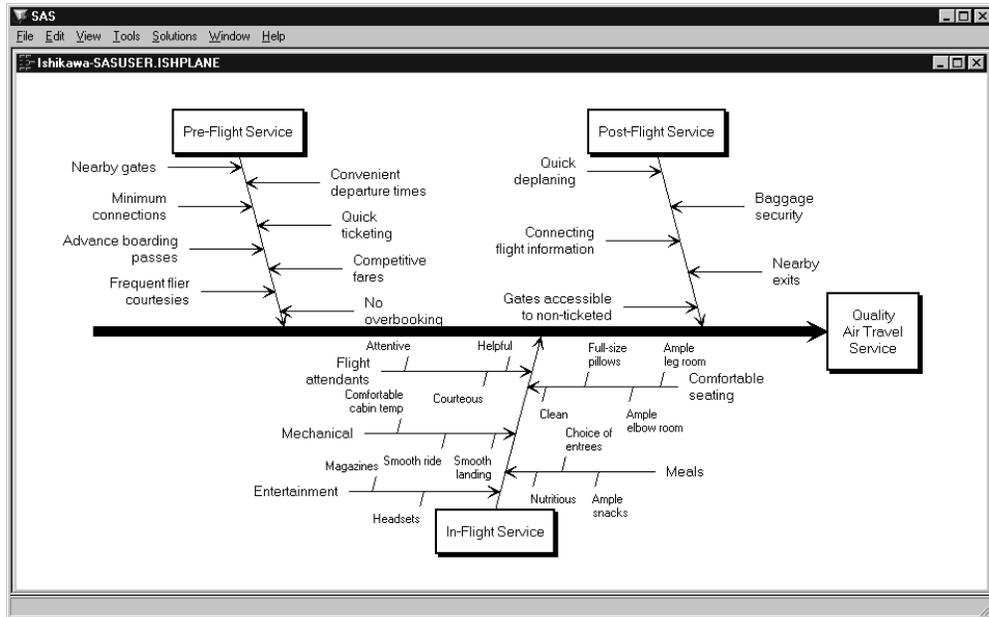


Figure 18.34. Highly Detailed Ishikawa Diagram

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

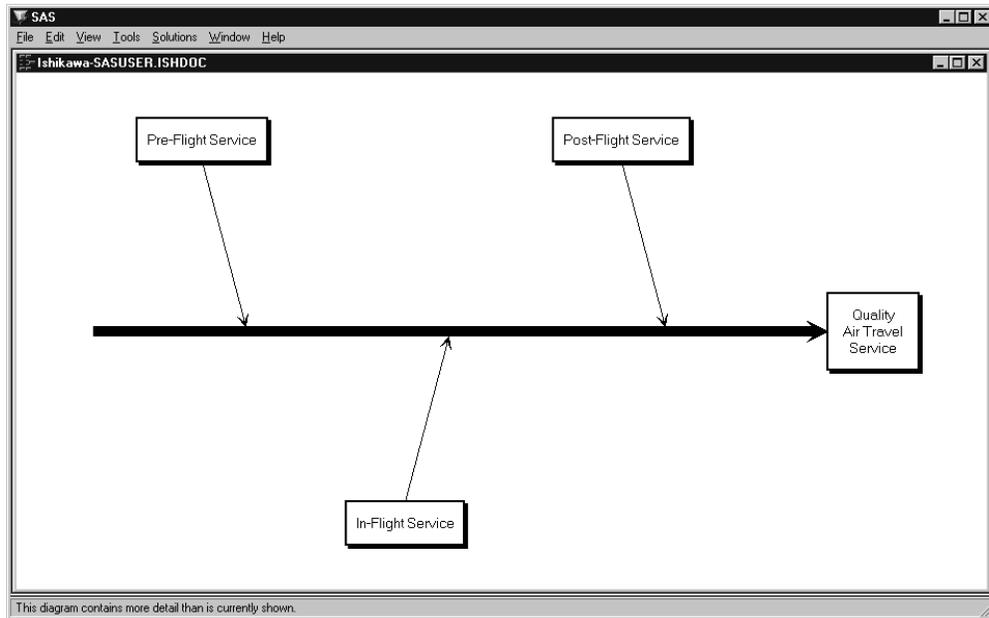


Figure 18.35. Branch-Level Diagram

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

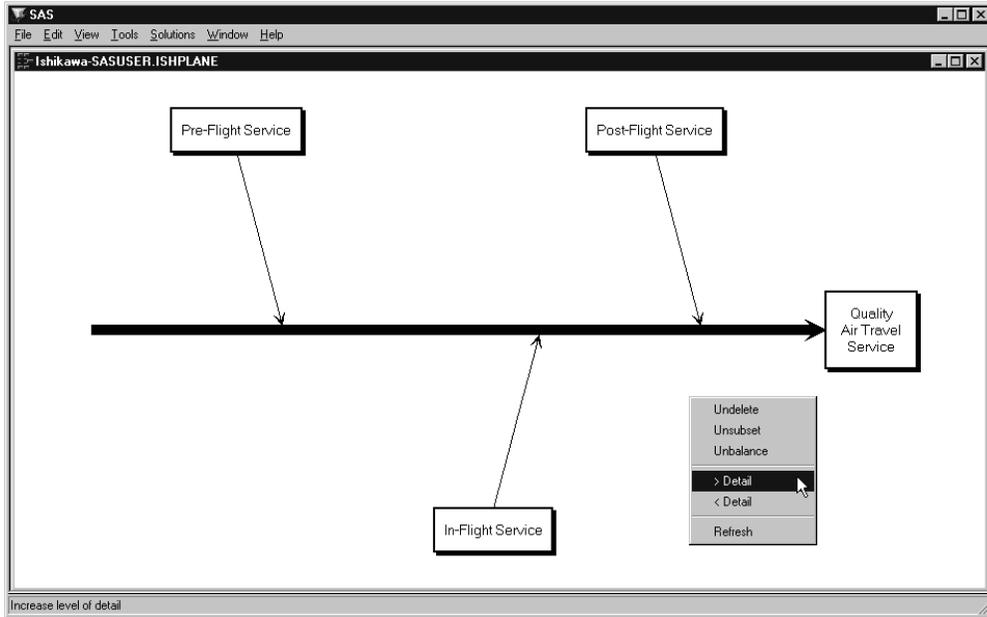


Figure 18.36. Increasing the Level of Detail
The amount of detail is increased by one level.

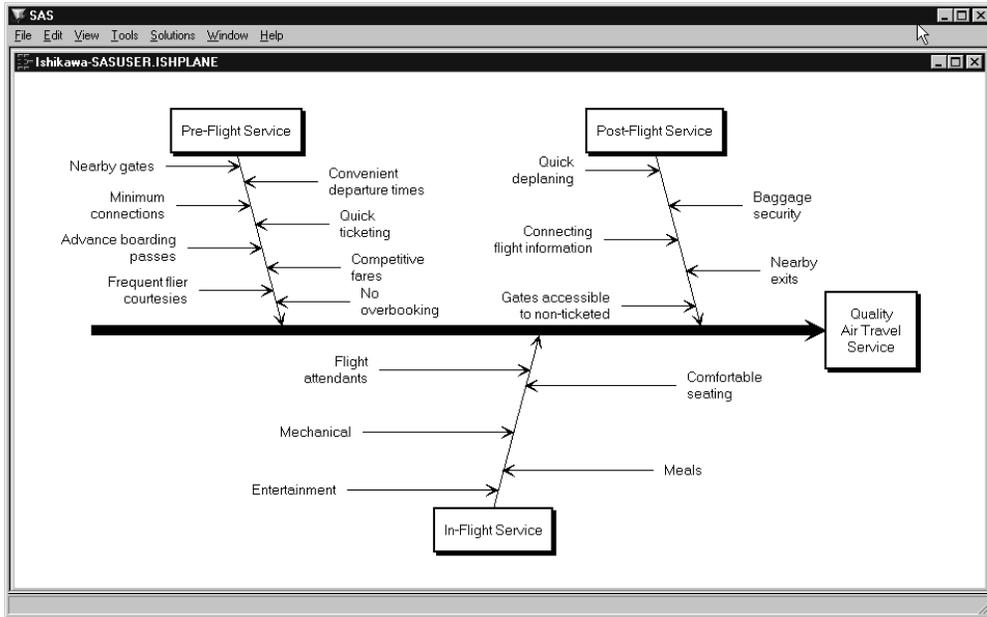


Figure 18.37. Increasing the Level of Detail

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:

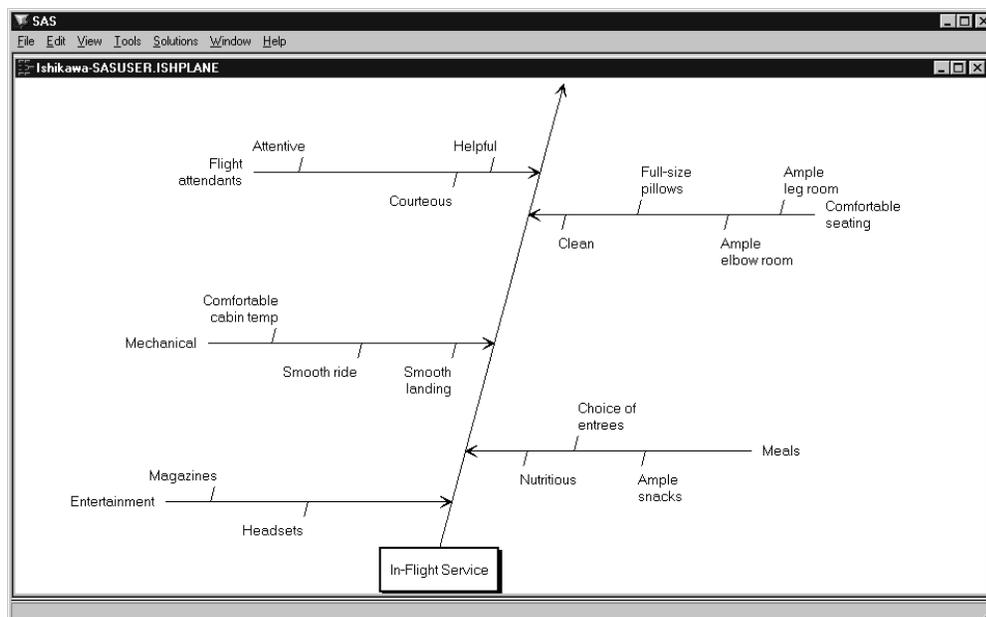


Figure 18.38. Zooming a Branch

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:

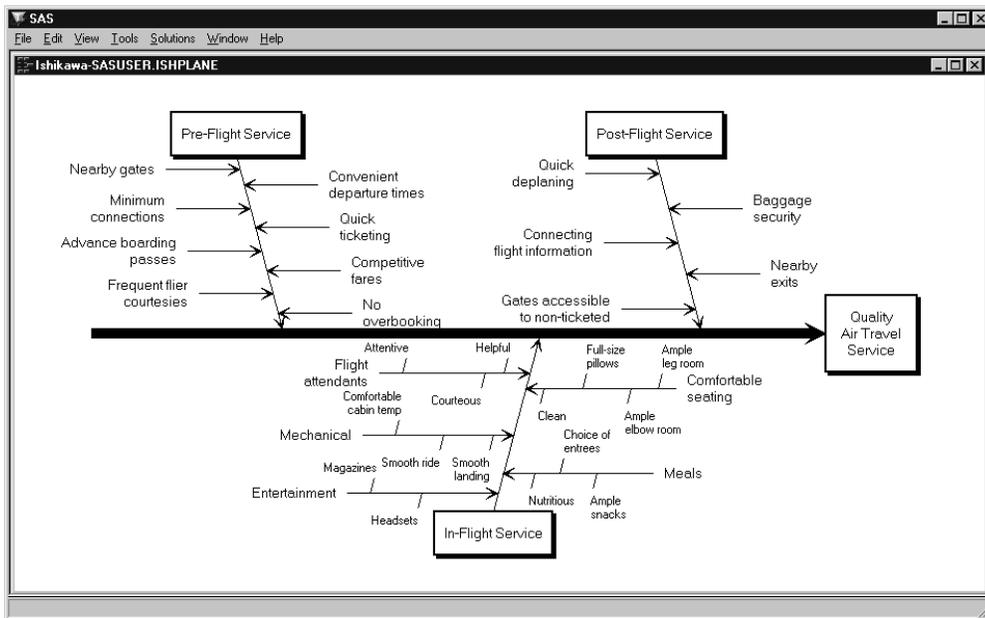


Figure 18.39. A Highly Detailed Diagram

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:

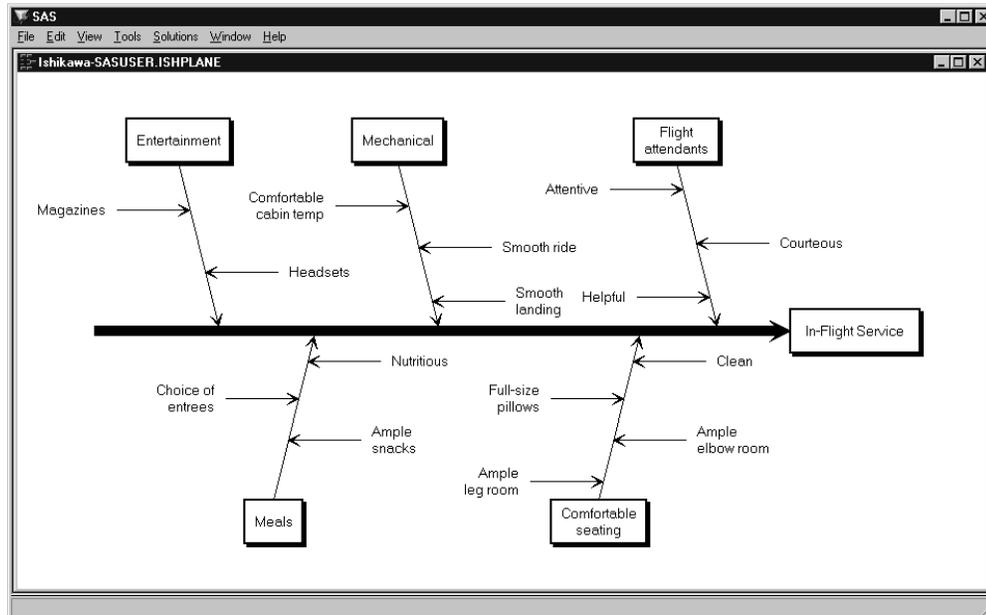


Figure 18.40. Promoting a Branch into a New Diagram

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:

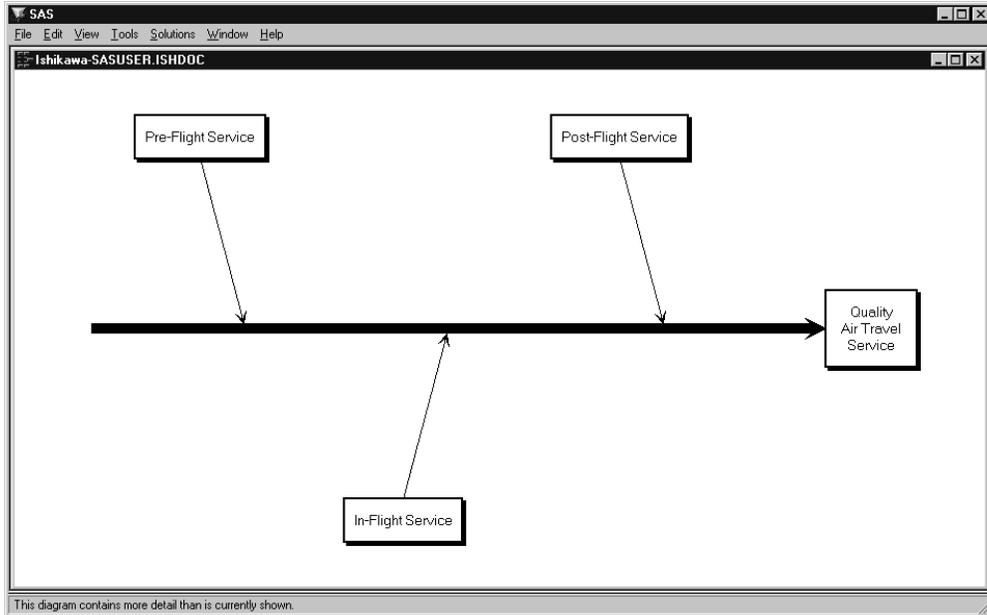


Figure 18.41. A Completed Master Diagram

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



Figure 18.42. Starting a Master Diagram

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

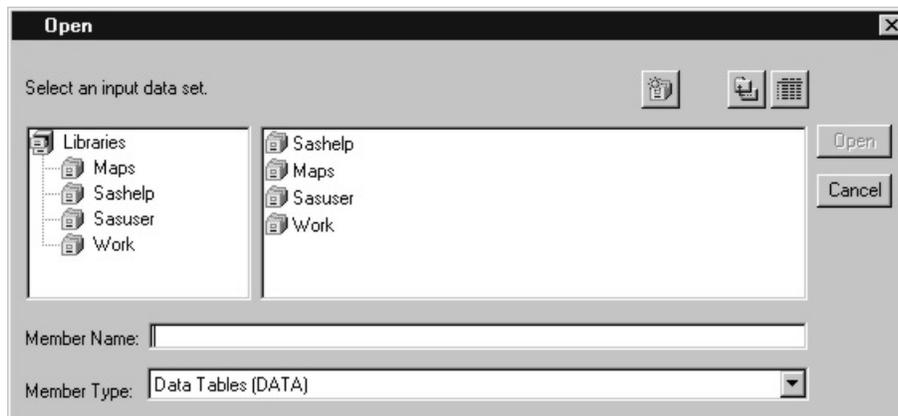


Figure 18.43. Member Selector

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.

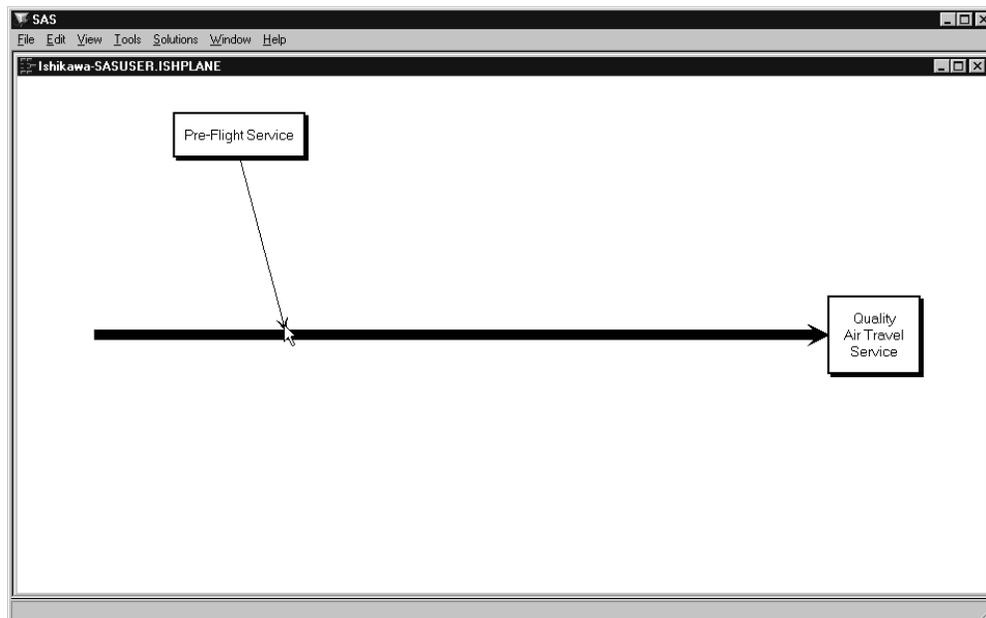


Figure 18.44. Constructing a Master Diagram

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=ps1 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 18.45. 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.

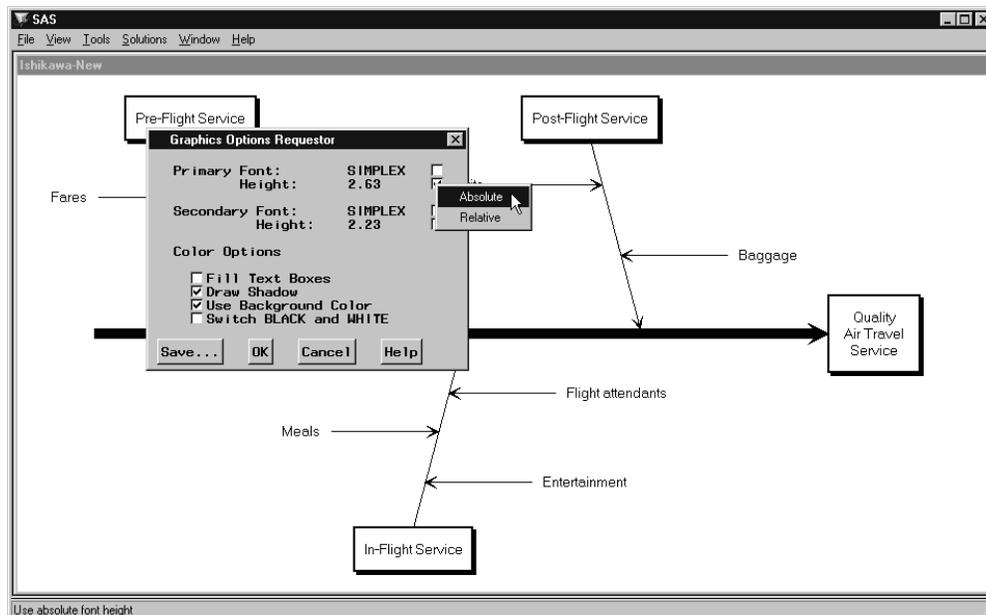


Figure 18.46. Font Height Selector

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...**.

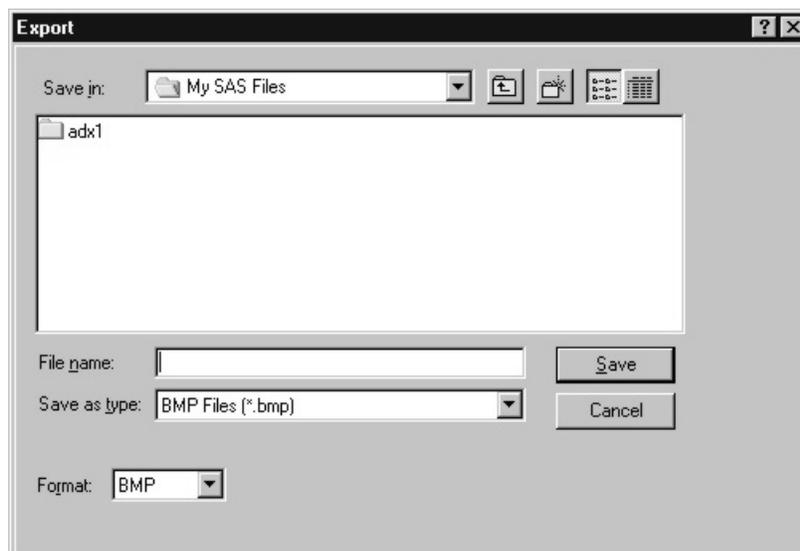


Figure 18.47. Export File Requestor

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**.

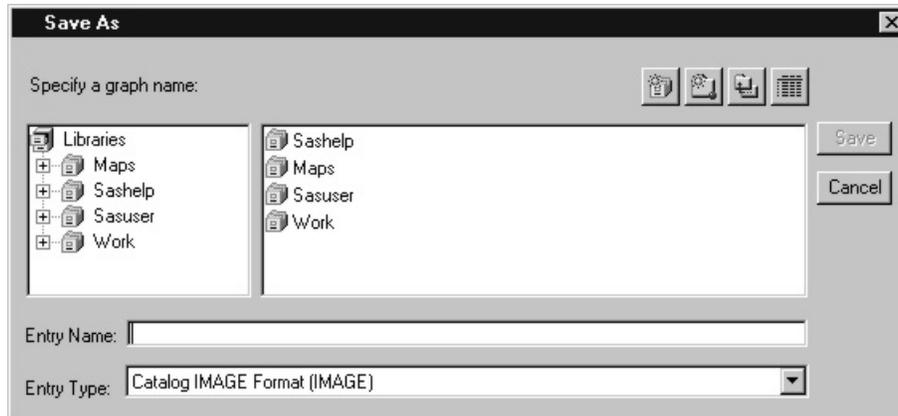


Figure 18.48. Entry Selector

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:

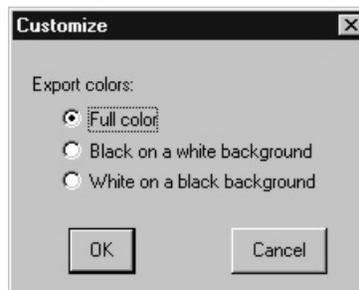


Figure 18.49. Customize Export Dialog

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 Display Manager. 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:

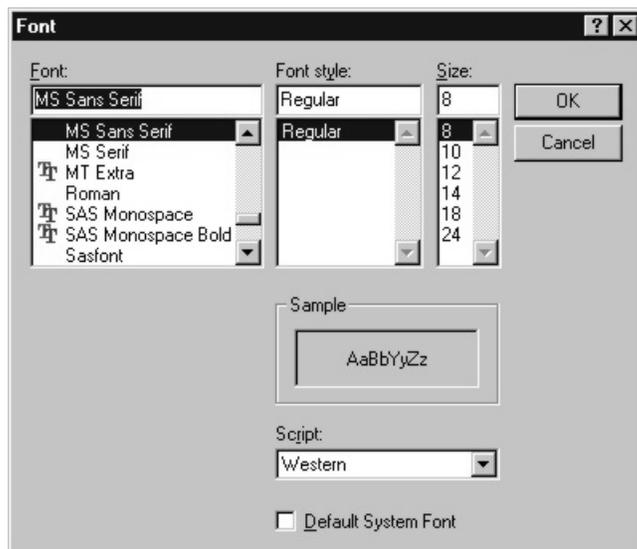


Figure 18.50. Font Requestor

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:

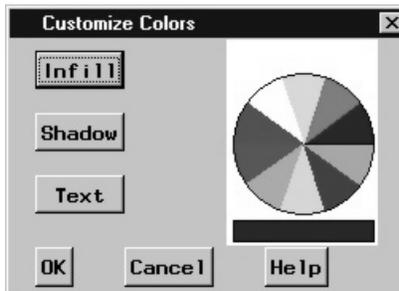


Figure 18.51. Colors Dialog

To change the fill color of all the boxes* 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.

*You cannot directly modify the colors of individual boxes from this dialog.

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.*

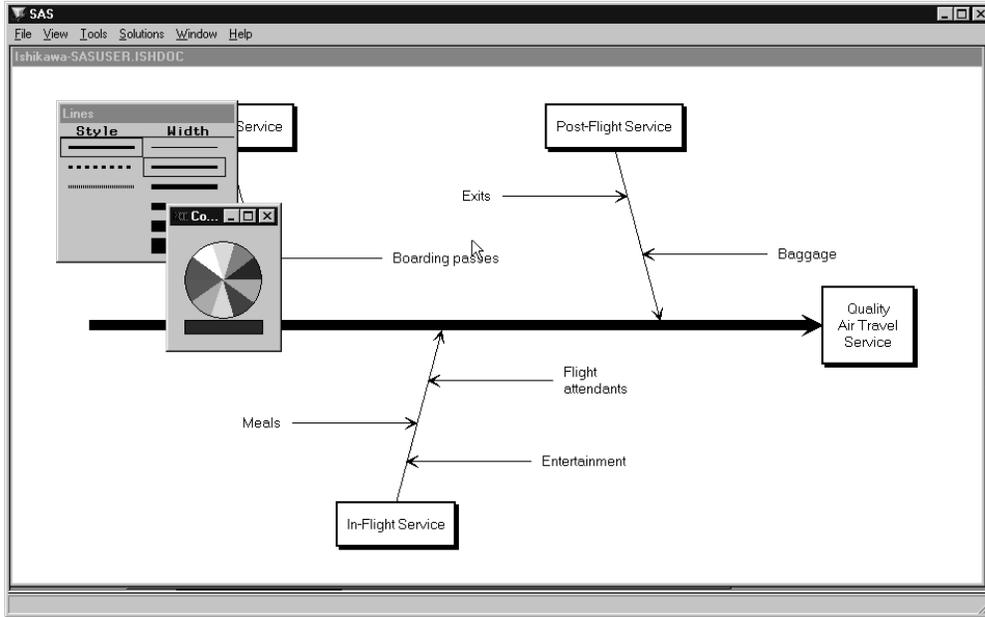


Figure 18.52. Line Style and Color Palettes

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.

*If you are working on a black-and-white terminal, you should not use the color palette.

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.

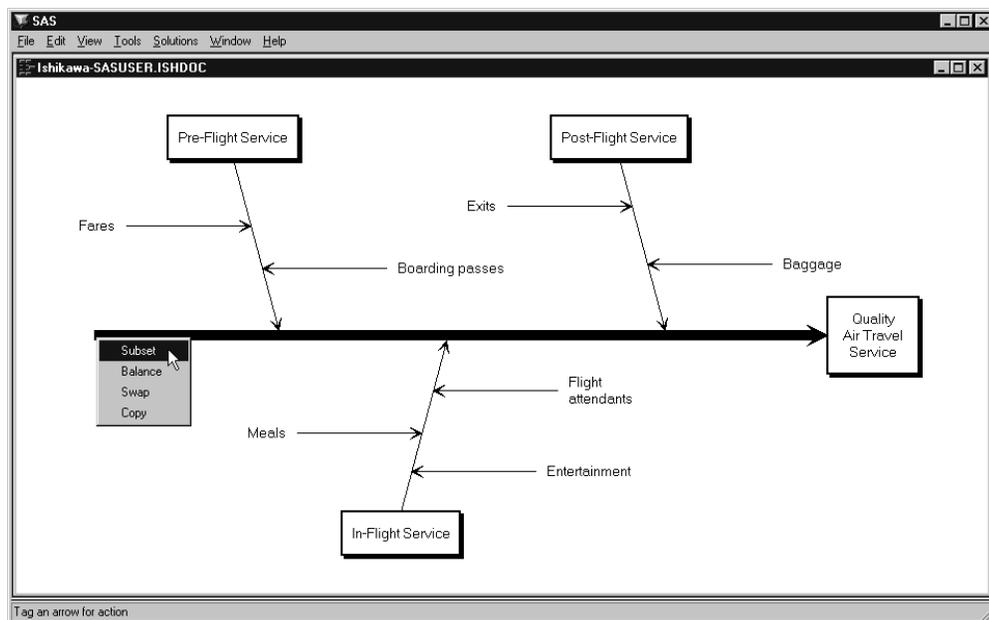


Figure 18.53. Subsetting Only the Trunk

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

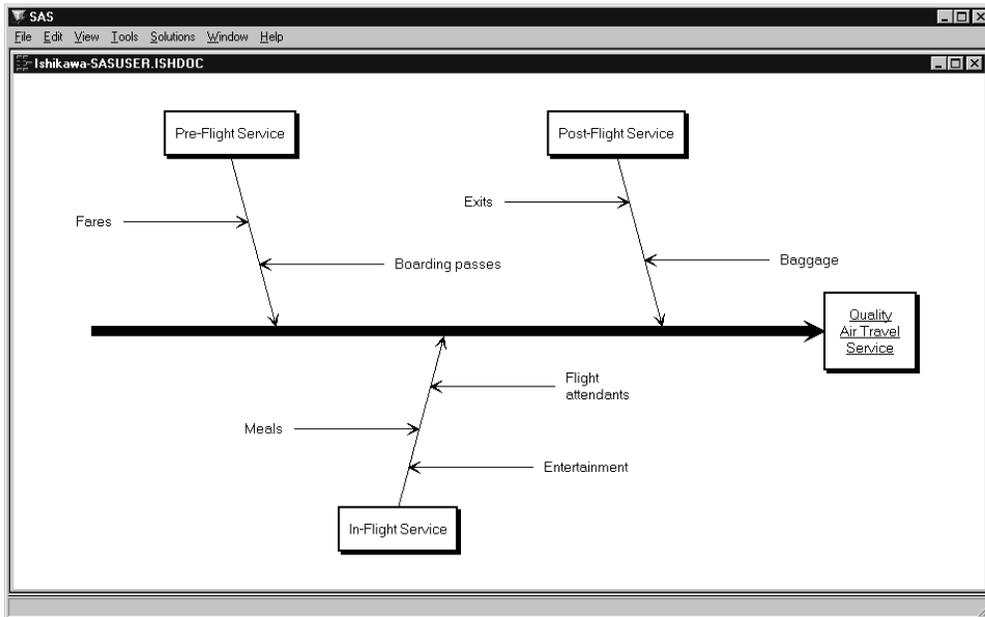


Figure 18.54. Subsetting Only the Trunk (continued)

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

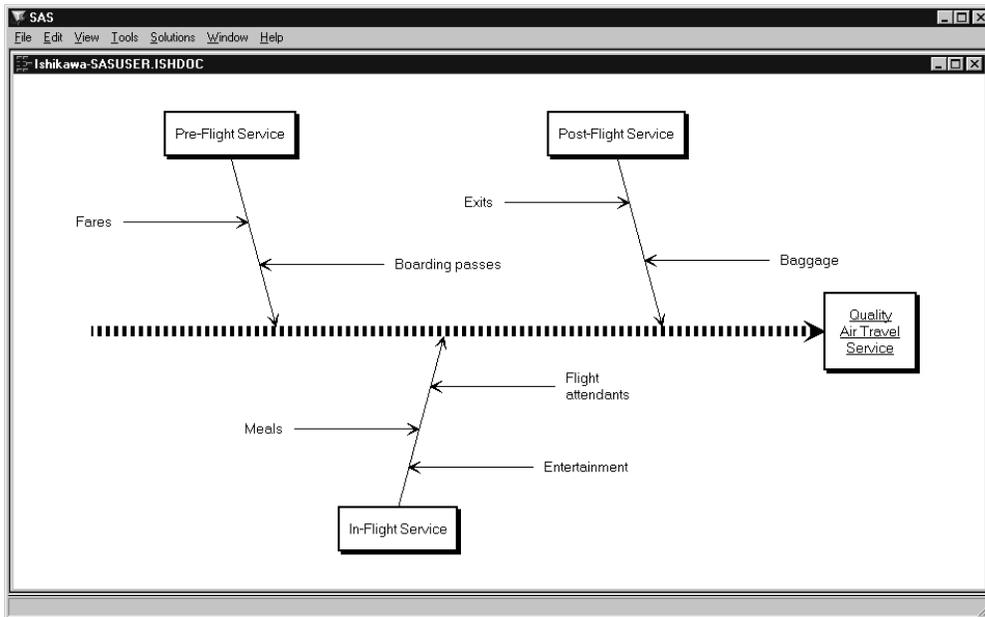


Figure 18.55. Modified Diagram

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

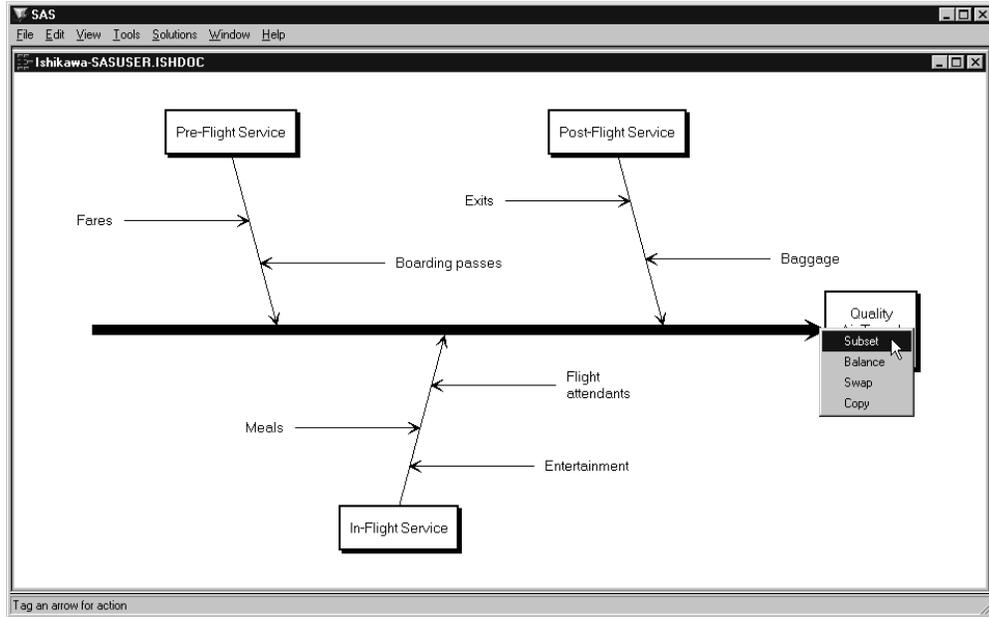


Figure 18.56. Subsetting the Entire Diagram

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

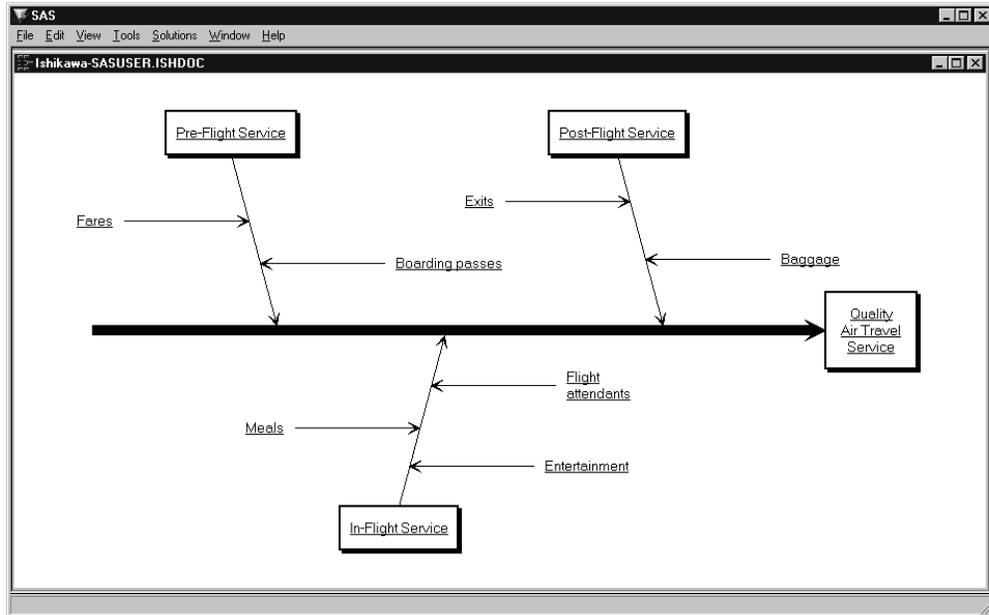


Figure 18.57. Subsetting the Entire Diagram (continued)

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

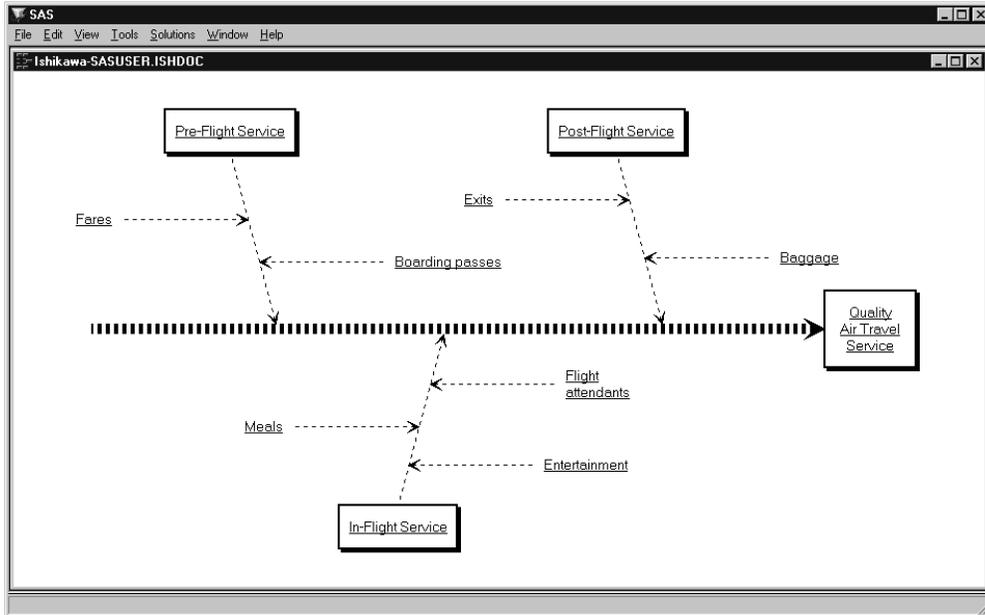


Figure 18.58. Modified Diagram

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

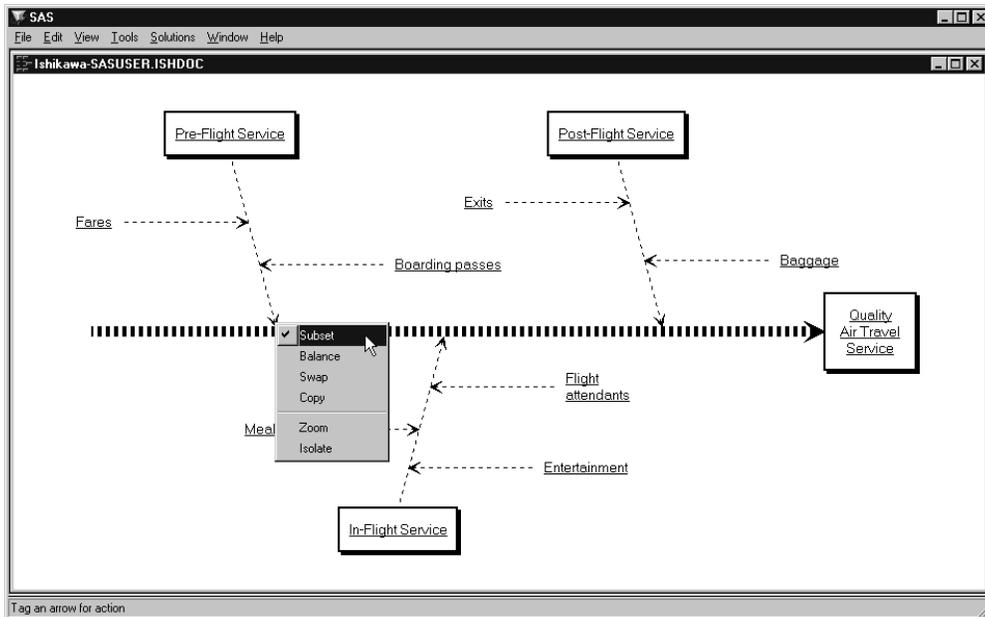


Figure 18.59. Selectively Removing Tags

This removes the underlines from the labels in these arrows.

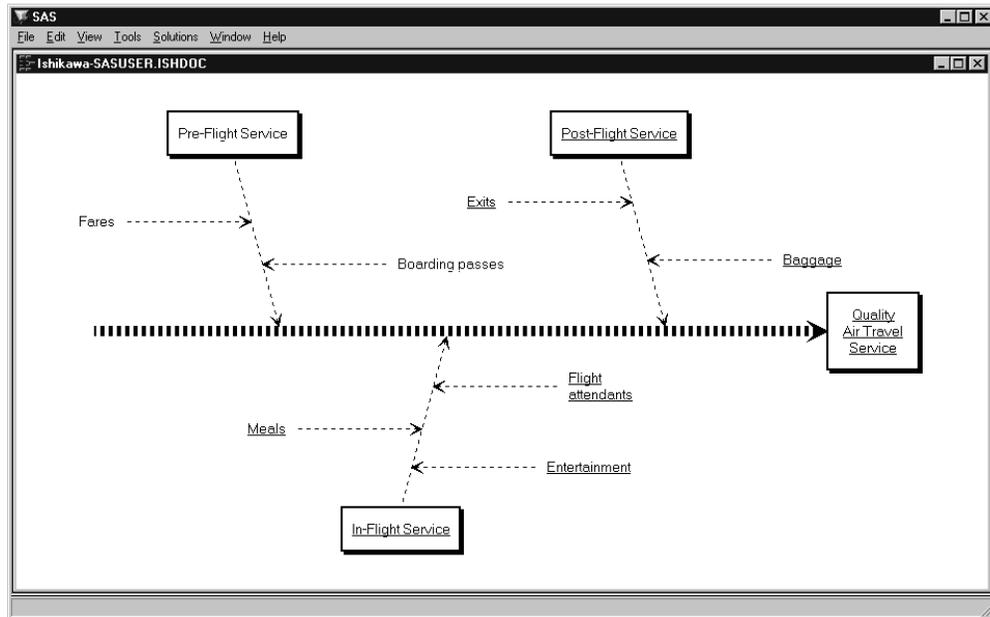


Figure 18.60. Selectively Removing Subsets (*continued*)

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:

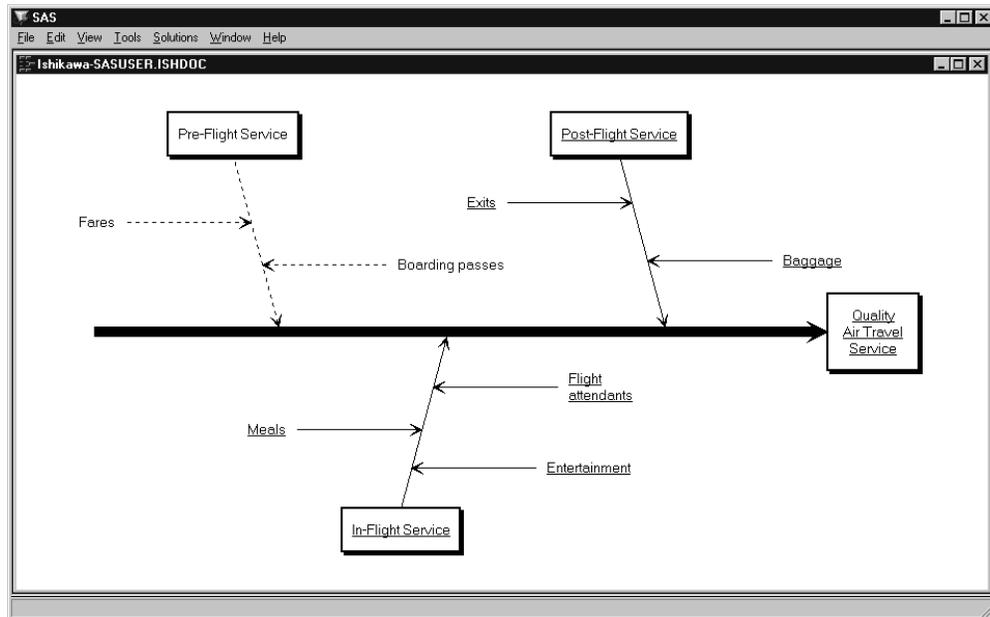


Figure 18.61. Modified Diagram

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 > Ishikawa Settings > Colors...**. The Customize Color window, similar to the following, will open:

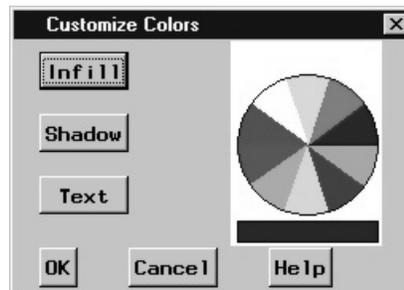


Figure 18.62. Colors Dialog

To change the text color of all the arrows* 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**.

*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 18.63. 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:

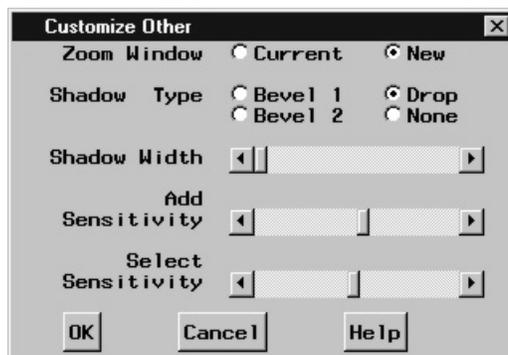


Figure 18.64. Others Dialog

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.

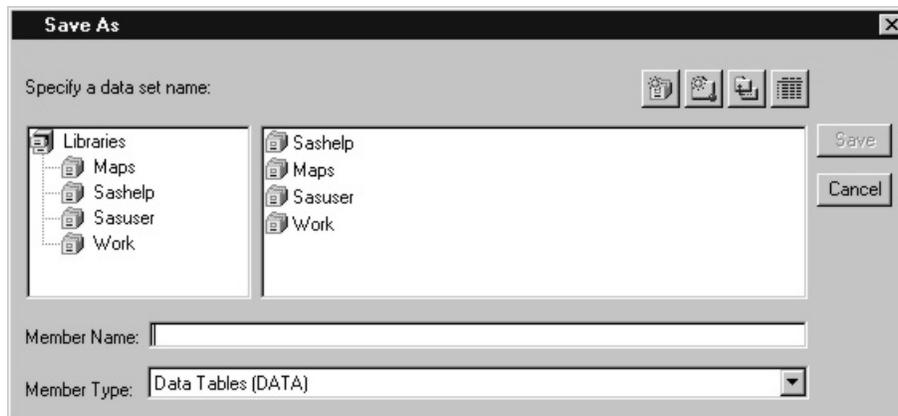


Figure 18.65. Output File Requestor

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:

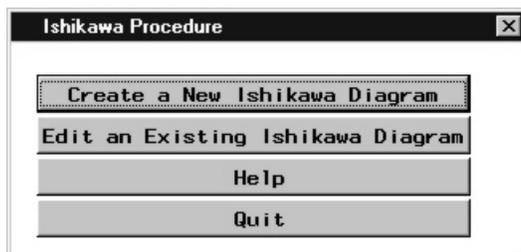
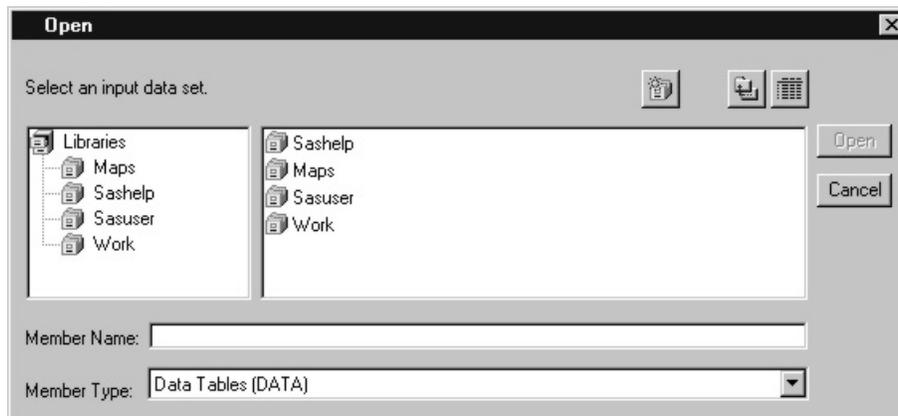


Figure 18.66. Initial Menu

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



figheadishinput2Input 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 581.

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:

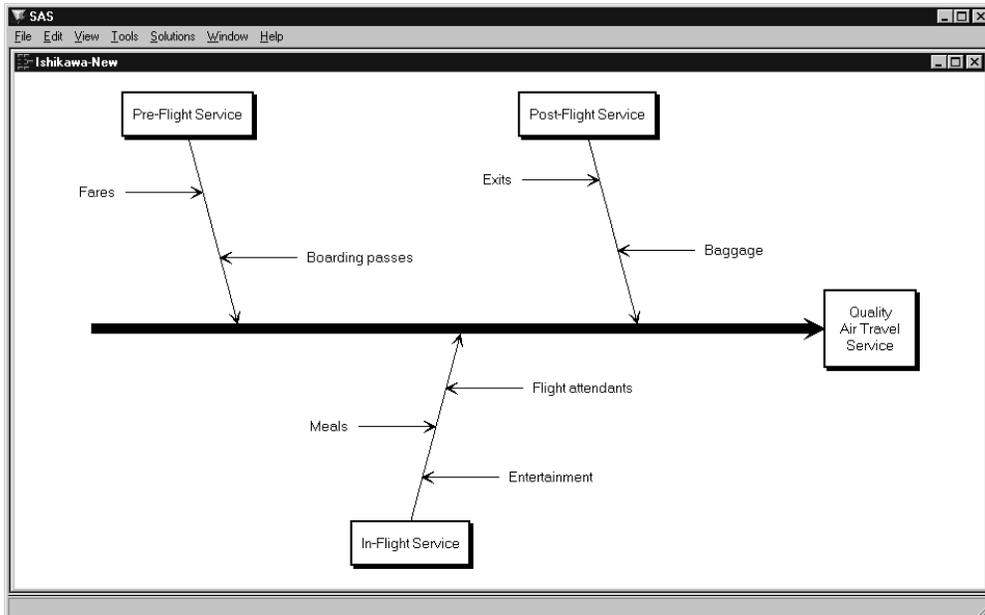


Figure 18.67. Single Ishikawa Diagram

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

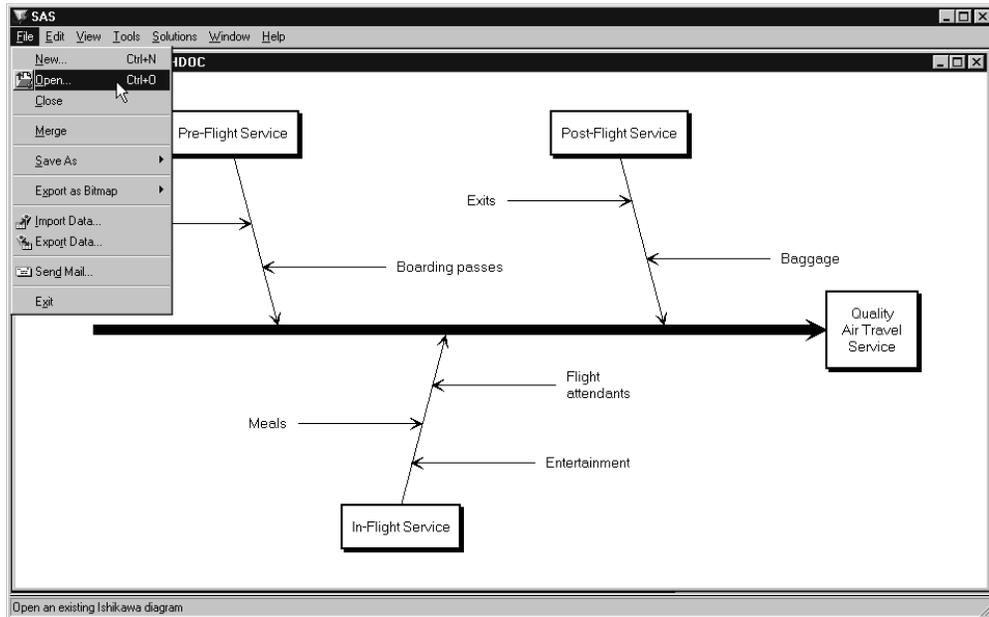


Figure 18.68. Opening a Second Diagram

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.

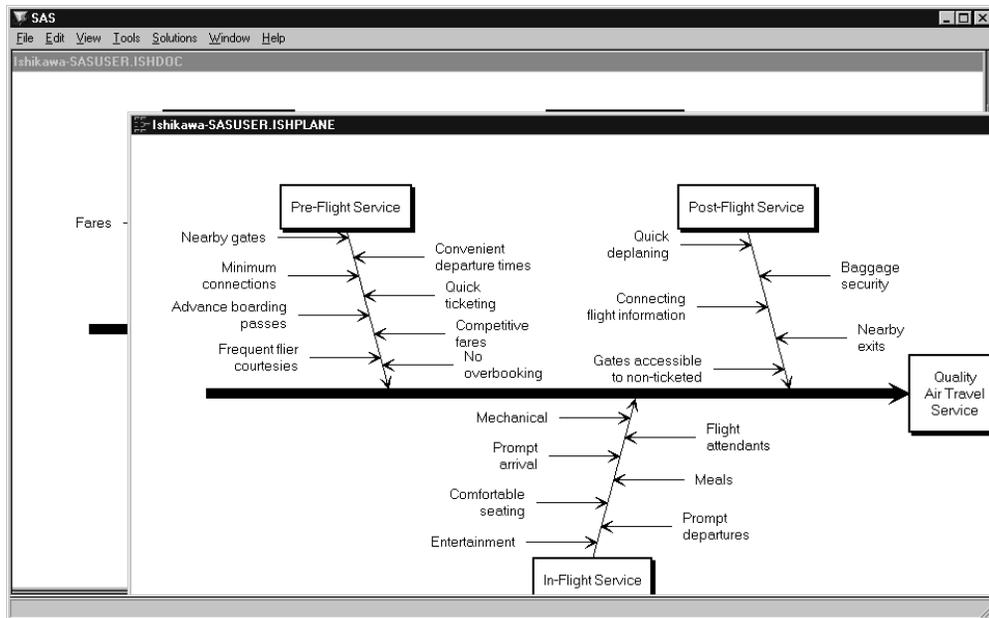


Figure 18.69. Viewing Multiple Ishikawa Diagrams

Input and Output Data Sets

ISHIKAWA Procedure

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

Variable	Type	Len	Description
<u>LEVEL</u>	Num	8	Level of detail
<u>TEXT1</u>	Char	40	First line of label
<u>TEXT2</u>	Char	40	Second line of label
<u>TEXT3</u>	Char	40	Third line of label
<u>TEXT4</u>	Char	40	Fourth line of label
<u>TEXT5</u>	Char	40	Fifth line of label
<u>NOTE1</u>	Char	40	First line of note
<u>NOTE2</u>	Char	40	Second line of note
<u>NOTE3</u>	Char	40	Third line of note
<u>NOTE4</u>	Char	40	Fourth line of note
<u>RELPOS</u>	Num	8	Relative arrow position
<u>SIDE</u>	Char	1	Side arrow attaches to parent
<u>ANGLE</u>	Num	8	Angle (non-horizontal arrows)
<u>LWIDTH</u>	Num	8	Line width
<u>LSTYLE</u>	Num	8	Line style
<u>LCOLOR</u>	Char	8	Line color
<u>TCOLOR</u>	Char	8	Text color
<u>ICOLOR</u>	Char	8	Box infill color
<u>SCOLOR</u>	Char	8	Shadow color
<u>STYPE</u>	Char	1	Shadow type
<u>SWIDTH</u>	Num	8	Shadow width
<u>RELLNG</u>	Num	8	Relative length of an arrow
<u>HLEVEL</u>	Num	8	Arrow head threshold
<u>HSTYLE</u>	Num	8	Arrow head style
<u>HLNGTH</u>	Num	8	Arrow head length
<u>HWIDTH</u>	Num	8	Arrow head width
<u>HTEXT</u>	Num	8	Font height
<u>FTEXT</u>	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 18.4 on page 536:

The SAS System				
Obs	_level_	_text1_	_text2_	_text3_
1	0	Quality	Air Travel	Service
2	1	Pre-Flight Service		
3	2	Competitive	fares	
4	2	Convenient	departure times	
5	2	Quick	ticketing	
6	2	Frequent flier	courtesies	
7	1	In-Flight Service		
8	2	Prompt	departures	
9	2	Comfortable	seating	

Figure 18.70. Input SAS Data Set

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=ps1 noprompt;  
proc ishikawa data=work.airline nofs;  
run;
```

Examples

Example 18.1. Quality of Air Travel Service

Output 18.1.1 on page 590 illustrates factors affecting the quality of air travel service.

See ISHPLANE
in the SAS/QC
Sample Library

Example 18.2. Integrated Circuit Failures

Output 18.2.1 on page 591 illustrates common sources of failure in integrated circuits.

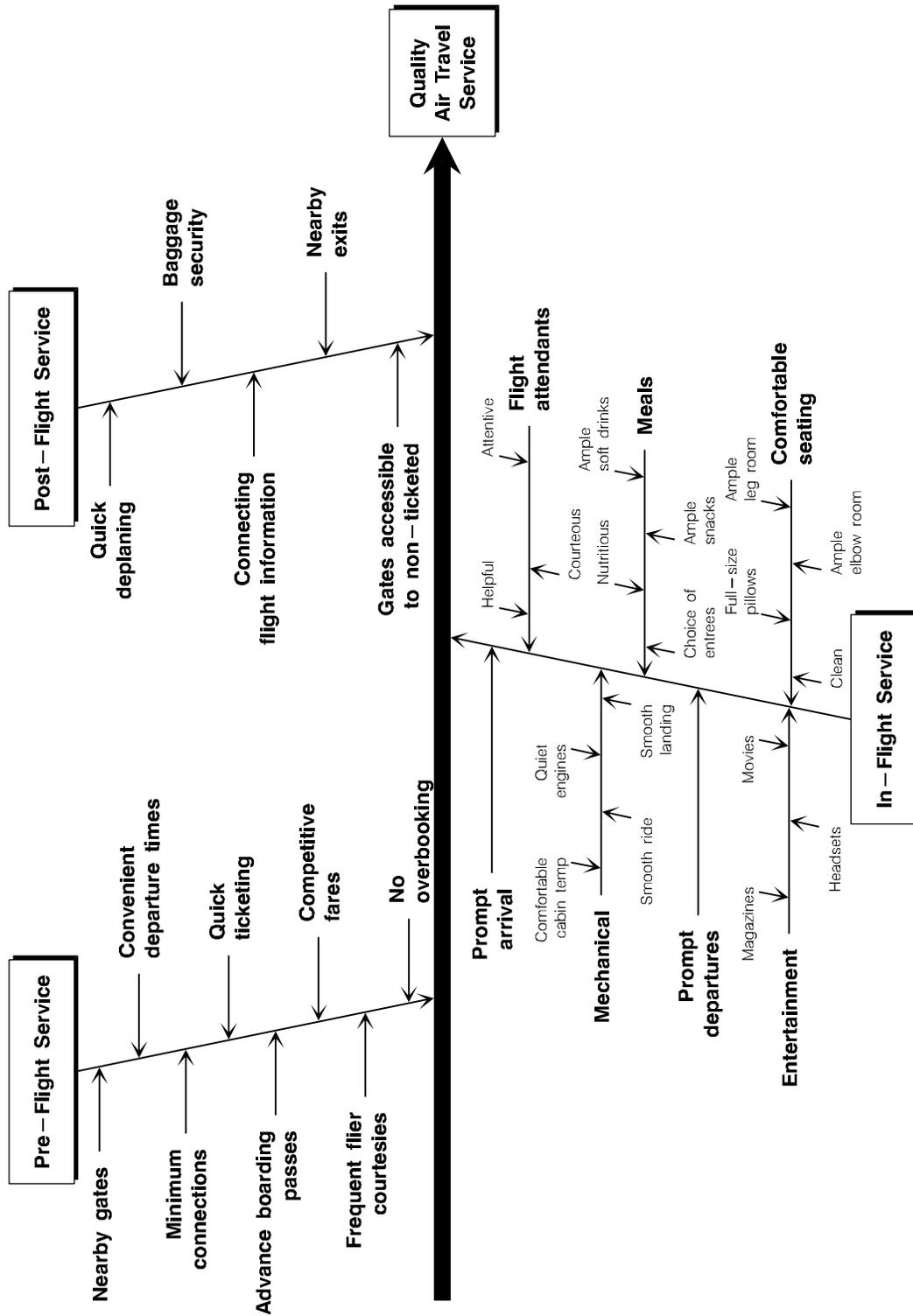
See ISHCHIP
in the SAS/QC
Sample Library

Example 18.3. Photographic Development Process

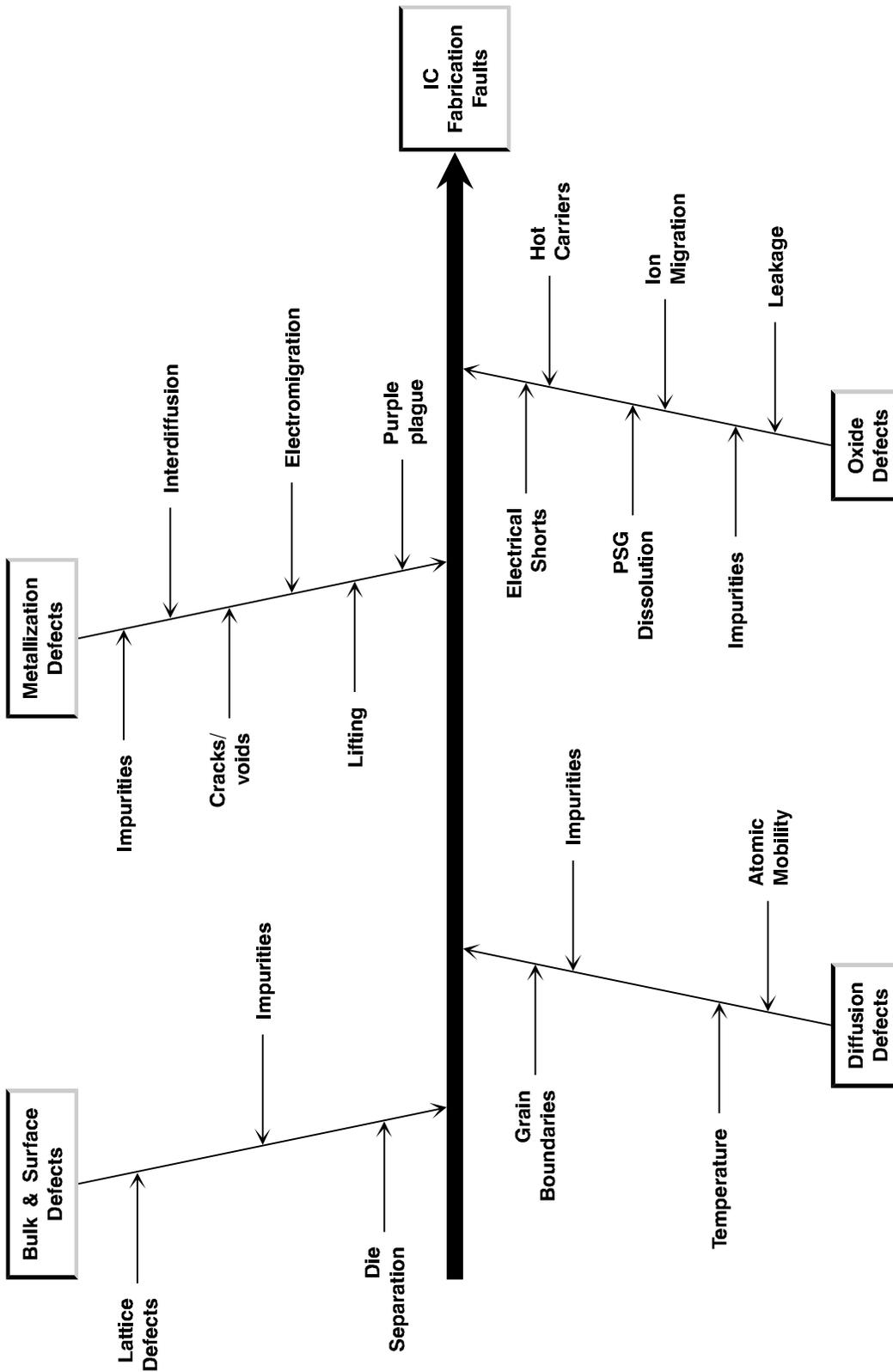
Output 18.3.1 on page 592 depicts the various stages of the photographic development process and specific quality control points.

See ISHPHOTO
in the SAS/QC
Sample Library

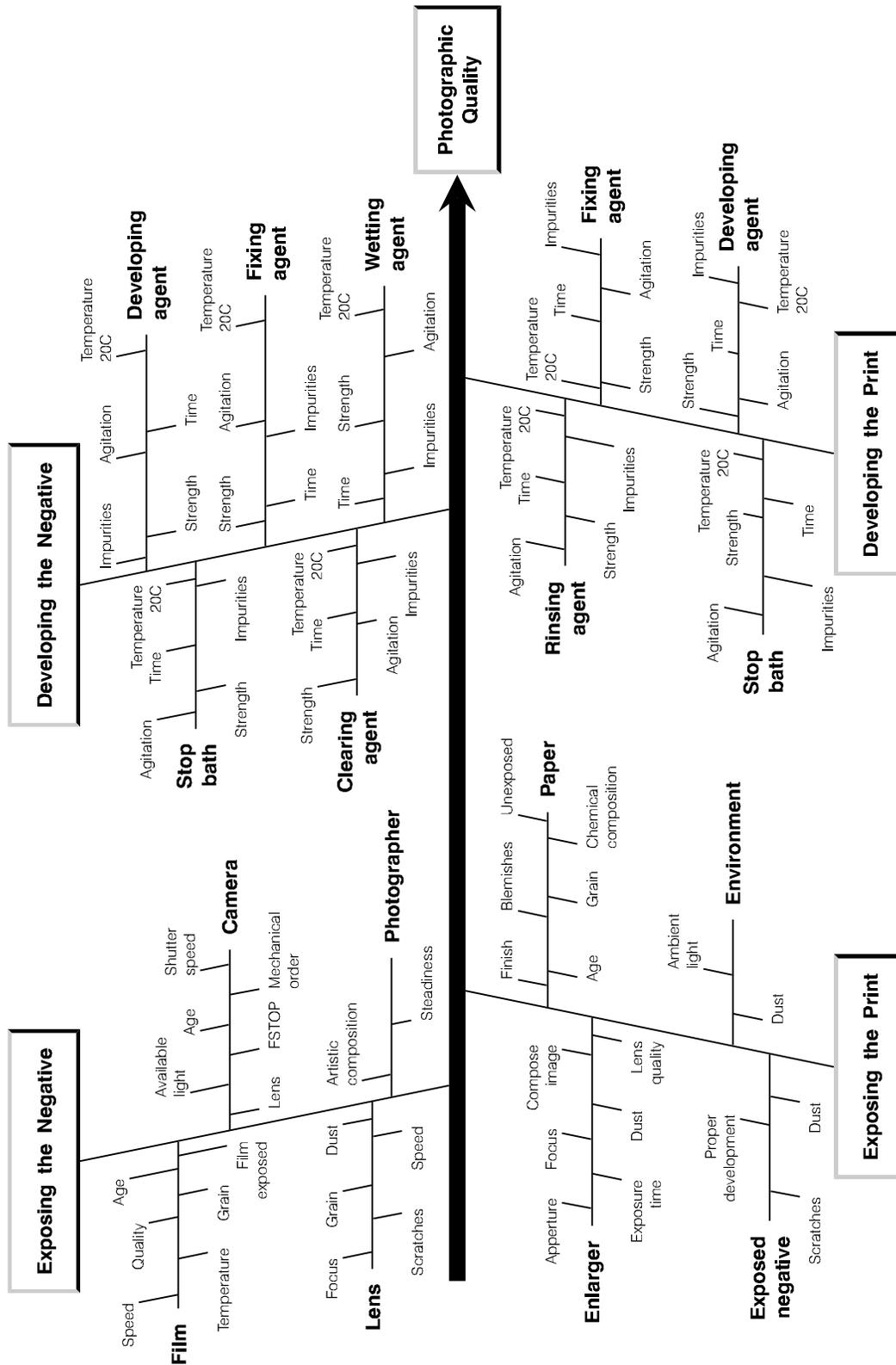
Output 18.3.1. Quality of Air Travel Service



Output 18.3.2. Common Causes of Integrated Circuit Failure



Output 18.3.3. Photographic Development Process



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