AIMMS

A One-Hour Tutorial for Beginners

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AIMMS

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Contents

Common AIMMS Shortcut Keys

Key	Function
F1	Open AIMMS Help
F2	Rename the selected identifier
F3	Find and repeat find
F4	Switch between edit mode and end-user mode (for the active page)
F5	Compile all
F6	Run *MainExecution*
Alt+F6	Switch to debugger mode
F7	Save the active page
F8	Open Model Explorer
Ctrl+F8	Open Identifer Selector
F9	Open Page Manager
Alt+ F9	Open Template Manager
Ctrl+ F9	Open Menu Builder
F11	Open Identifer Info dialog
Ctrl+ B	Insert a break point in debugger mode
Ctrl+ D	Open Data Page
Ctrl+ F	Open Find dialog
Ctrl+ M	Open Message Window
Ctrl+ P	Open Progress Window
Ctrl+ T	View Text Representation of selected part(s)
Ctrl+Shift + T	View Text Representation of whole model
Ctrl+ W	Open Wizard
Ctrl+ Space	Name completion
Ctrl+ Shift+Space	Name completion including AIMMS Predeclared Identifers
Ctrl+ Enter	Check, commit, and close
Insert	Insert a node (when single insert choice) or Open Select Node Type dialog (when multiple insert choices)

Chapter 1

Introduction

There are several ways in which you can learn the AIMMS language and get a basic understanding of its underlying development environment. The following opportunities are immediately available, and are part of the AIMMS installation.

- There are two *tutorials* on AIMMS to provide you with some initial working knowledge of the system and its language. One tutorial is intended for beginners, while the other is aimed at professional users of AIMMS.
- There is a *model library* with a variety of examples to illustrate simple and advanced applications together with particular aspects of both the language and the graphical user interface.
- There are three *reference books* on AIMMS, which are available in PDF format and in hard copy form. They are *The User's Guide* to introduce you to AIMMS and its development environment, *The Language Reference* to describe the modeling language in detail, and *Optimization Modeling* to enable you to become familiar with building models.

As a beginner into optimization modeling languages, you may not have much time for learning yet another tool in order to finish some project or homework requirements. In this case, concentrate your efforts on this tutorial. After completing this tutorial, you should be able to use the system to build your own simple models, and to enter your own small data sets for subsequent viewing. The book on *Optimization Modeling* may teach you some useful tricks, and will show you different (mostly non-trivial) examples of optimization models. Besides English, the tutorial for beginners is also available in Spanish, Hungarian, German, French, and Japanese which can be found on our web site: http://www.aimms.com/downloads/tutorials/tutorial-for-beginners.

As a professional in the field of optimization modeling you are looking for a tool that simplifies your work and minimizes the time needed for model construction and model maintenance. In this situation, you cannot get around the fact that you will need to initially make a substantial time investment to get to know several of the advanced features that will subsequently support you in your role as a professional application builder. Depending on your skills, experience, and learning habits you should determine your own individual learning path. Along this path you are advised to work through the extensive tutorial

especially designed for professionals. This tutorial for professionals provides a good start, and should create excitement about the possibilities of AIMMS. Individual examples in the library, plus selected portions of the three books, will subsequently offer you additional ideas on how to use AIMMS effectively while building your own advanced applications.

The one-hour tutorial for beginners is designed as the bare minimum needed to build simple models using the AIMMS **Model Explorer**. Data values are entered by hand using data pages, and the student can build a page with objects to view and modify the data. The extensive tutorial for professionals is an elaborate tour of AIMMS covering a range of advanced language features plus an introduction to all the building tools. Especially of interest will be the modeling of time using the concepts of horizon and calendar, the use of quantities and units, the link to a database, the connection to an external DLL, and advanced reporting facilities. Even then, some topics such as efficiency considerations (execution efficiency, matrix manipulation routines) and the AIMMS API will remain untouched.

Tutorials are different in scope

Chapter 2

What to Expect

In this chapter you will find a brief overview of the tasks to be performed, a compact statement of the underlying model to be built, and a glimpse of the output you will produce.

This chapter

2.1   Scope of one-hour tutorial

Once you have read the short problem description and the associated mathematical model statement, you will be asked to complete a series of tasks that make up this one-hour tutorial, namely:

Summarizing your work

- create a new project in AIMMS,
- enter all identifier declarations,
- enter the data manually,
- save your data in a case,
- build a small procedure,
- build a single page with
    – header text,
    – a standard table and two bar charts with input data,
    – a composite table and a stacked bar chart with output data,
    – a button to execute the procedure, and
    – a scalar object with the optimal value,
- perform a what-if run.

2.2   Problem description and model statement

Truckloads of beer are to be shipped from two plants to five customers during a particular period of time. Both the available supply at each plant and the required demand by each customer (measured in terms of truckloads) are known. The cost associated with moving one truck load from a plant to a customer is also provided. The objective is to make a least-cost plan for moving the beer such that the demand is met and shipments do not exceed the available supply from each brewery.

Problem description

The following table provides the data for the problem described in the previous paragraph.

Data overview

Customers	Unit Transport Cost					
Plants	Amsterdam	Breda	Gouda	Amersfoort	Den Bosch	Supply
Haarlem	131	405	188	396	485	47
Eindhoven	554	351	479	366	155	63
Demand	28	16	22	31	12	

Table 2.1: Input data for beer transport problem

The following declarations list the identifiers that are part of the mathematical program to be built.

Identifier declarations

Indices:

p	*plants*
c	*customers*

Parameters:

S_p	*supply at plant p*
D_c	*demand by customer c*
U_{pc}	*unit transport cost from p to c*

Variables:

x_{pc}	*transport from p to c*
z	*total transport cost*

The mathematical model summary below captures the least-cost plan to transport beer such that the demand is met and shipments do not exceed available supply.

Model summary

Minimize:

$$z = \sum_{pc} U_{pc} x_{pc}$$

Subject to:

$$\sum_{c} x_{pc} \leq S_p \qquad \forall p$$

$$\sum_{p} x_{pc} \geq D_c \qquad \forall c$$

$$x_{pc} \geq 0 \qquad \forall (p, c)$$

Figure 2.1: The Netherlands

Even though the above notation with one-letter symbols is typical of small   *Using explicit*
mathematical optimization models, it will not be used to represent the model   *names*
in AIMMS. Instead, explicit names will be used throughout to avoid any un-
necessary translation symbols. The number of symbols needed to describe
practical applications is generally large, and a clear naming convention sup-
ports the understanding and maintenance of large models.

2.3   A preview of your output

Figure 2.2 is a page that contains both input and output data associated with the beer transport model. In Chapter 6 you will be asked to construct this page using the point-and-click facilities available in Aimms.
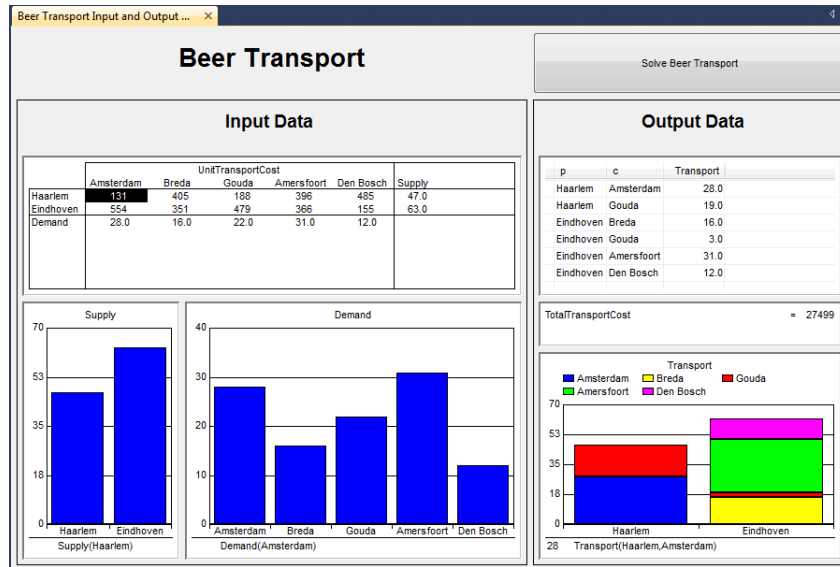
A single page

Figure 2.2: An input-output page

Chapter 3

Building the Model

3.1 Starting a new project

Assuming that AIMMS has already been installed on your machine. If there is
an AIMMS shortcut on your desktop, double click it to start AIMMS, otherwise
execute the following sequence of actions to start AIMMS:

Starting AIMMS

▶ press the **Start** button ⊕ on the taskbar,
▶ go to the **Programs** submenu, and
▶ select and click on the AIMMS icon ⬥ to start AIMMS.

Next, you will see the AIMMS splash screen. Once AIMMS has started, the splash
screen will disappear and the AIMMS window will open. Should you encounter
the AIMMS **Tip of the Day** dialog box, close it, because it is not relevant to you
at this point.

*Specifying a
project name*

Press the **New Project** button 🗋 , which is located in the leftmost position
on the AIMMS toolbar. The dialog box shown in Figure 3.1 will then appear,
requiring you to take the following actions:

*Creating a new
project from
within AIMMS*

▶ specify 'Beer Transport' as the project name, and
▶ press the wizard button 🖼 to select the folder for your AIMMS projects
  if the default folder
  '...\My Documents\My AIMMS Projects\Beer Transport'
  is not desired,and
▶ press the **OK** button.
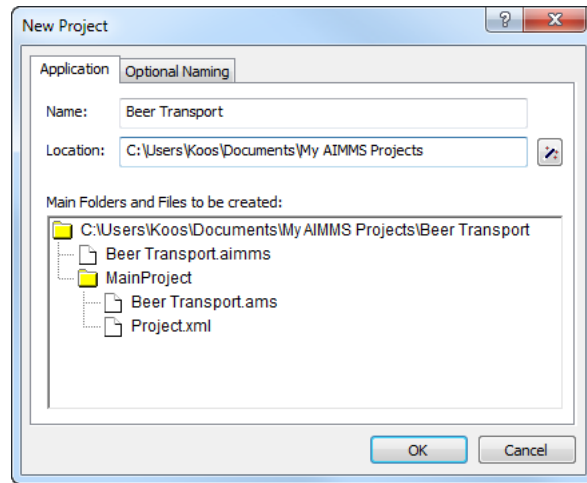
Figure 3.1: The **New Project** wizard

Next, the AIMMS **Model Explorer** and the AIMMS **Page Manager** will be automatically opened. We will look at the AIMMS **Model Explorer** first.

3.2 The Model Explorer

When opened for the first time, the AIMMS **Model Explorer** will display the initial model tree shown in Figure 3.2. In this initial model tree you will see

Initial model tree

- a single *declaration section*, where you can store the declarations used in your model,
- the predefined procedure `MainInitialization`, which is not relevant for this tutorial,
- the predefined procedure `MainExecution`, where you will put the execution statement necessary to solve the mathematical program, and
- the predefined procedure `MainTermination`, which is again not relevant for this tutorial.
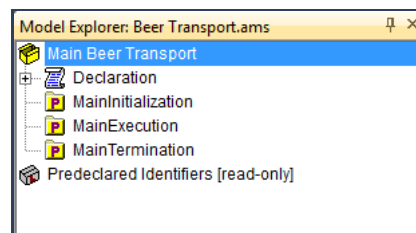

Figure 3.2: The initial model tree

3.3 Entering sets and indices

The declaration of model identifiers requires you to first 'open' the declaration section. You can do this either by clicking the ⊞ icon or by double-clicking on the scroll icon 📑. Note that double-clicking on the name of the declaration section instead of on its icon will open the attribute form of the declaration section and will therefore, at this point, not lead to the desired result. After opening the declaration section the standard identifier buttons 🆂 🅿 🆅 🅲 … on the toolbar will be enabled.
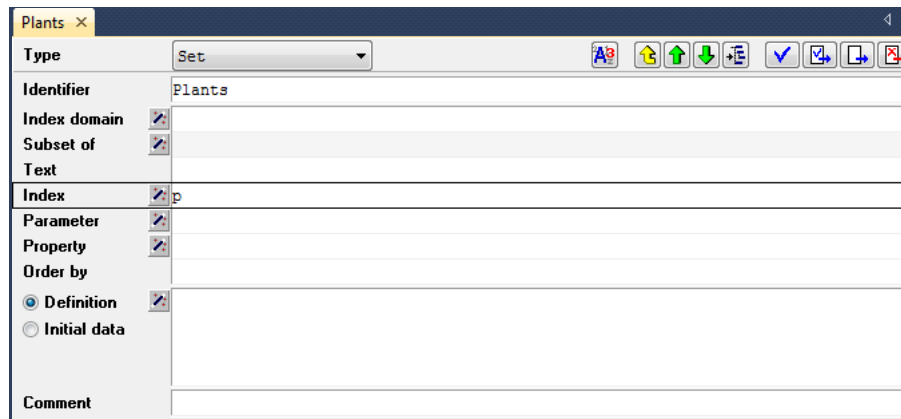
Opening the declaration section

To create a set of plants you should take the following actions:

Creating the set 'Plants'

- ▶ press the **Set** button 🆂 to create a new set identifier in the model tree,
- ▶ specify 'Plants' as the name of the set, and
- ▶ press the *Enter* key to register the name.

Next, you need to declare the index p as an attribute of the set 'Plants'. You can open the attribute form by double-clicking on the node 'Plants' in the model tree. The resulting initial attribute form of the set 'Plants' is shown in Figure 3.3.

Opening its attribute form

Figure 3.3: The initial attribute form of the set 'Plants'

To declare the index p as an attribute of the set 'Plants', execute the following sequence of actions:

Declaring the index p

- ▶ move the mouse cursor to the 'Index' attribute field, and click in the (empty) edit field,
- ▶ enter the letter p, and
- ▶ complete the attribute form by pressing the **Check, Commit and Close** button 🔘.

Next, create the set 'Customers' with associated index c in exactly the same way as you created the set 'Plants' with index domain p. Figure 3.4 contains the resulting model tree.
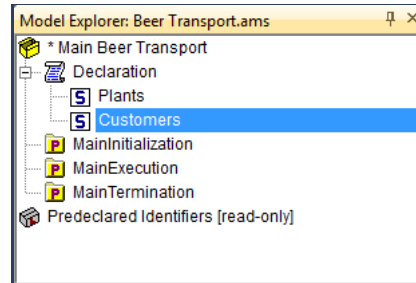
Creating the set 'Customers'

Figure 3.4: An intermediate model tree

The asterisk on the left of the project name indicates that additions to your project have not yet been saved to disk. To save your work, please press the **Save Project** button ⊞ on the toolbar.

Saving your changes

3.4   Entering parameters and variables

In this section you will declare the parameters and variables that are needed in your model. The sets 'Plants' and 'Customers' and their associated indices will be used to specify the index domain for the parameters and variables.

Domain specification

The declaration of a parameter is similar to the declaration of a set. To enter the parameter 'Supply(p)', you should execute the following actions:

Creating the parameter 'Supply'

▶ press the parameter button Ⓟ on the toolbar to create a new parameter in the model tree,
▶ specify 'Supply(p)' as the name of the parameter, and
▶ press the *Enter* key to register the name.

Note that parentheses are used to add the index domain p to the identifier 'Supply'.

The parameter 'Demand(c)' can be added in the same way. Should you make a mistake in entering the information, then you can always re-edit a name field by a single mouse click within the field.

Creating the parameter 'Demand'

The last model parameter 'UnitTransportCost' is a two-dimensional parameter with index domain (p, c). After entering 'UnitTransportCost(p,c)', the resulting model tree should be the same as in Figure 3.5.
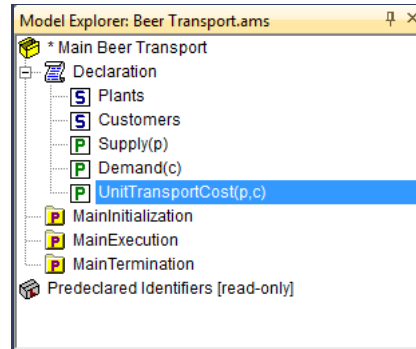
Creating the parameter 'UnitTransport-Cost'

Figure 3.5: An intermediate model tree

Declaring a variable is similar to declaring a parameter.

Creating the variable 'Transport'

▶ press the variable button Ⓥ on the toolbar to create a new variable in the model tree,
▶ specify 'Transport(p,c)' as the name of the variable, and
▶ press the *Enter* key to register the variable.

After opening the attribute form of the variable by double-clicking on the node 'Transport' in the model tree, press the wizard button ⬚ in front of the 'Range' attribute field. The resulting dialog box provides the opportunity to specify the range of values that the variable 'Transport' is allowed to take. In this case, select the 'Standard Range', then select 'nonnegative', and finally press the *OK* button (see Figure 3.6).
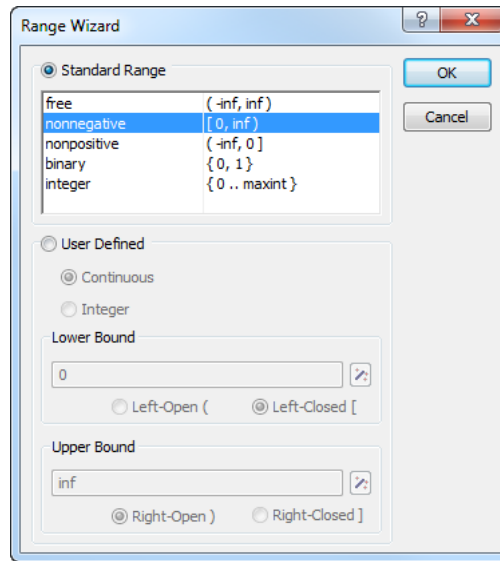
Specifying range attribute

Figure 3.6: The AIMMS range wizard

It should be clear by now how to create the variable 'TotalTransportCost'. This variable will be used to specify the objective function. After entering its name, open the attribute form. There is no need to specify the range attribute, since the default range 'free' will suffice. You are now ready to enter the following definition of this particular variable:

Creating the variable 'Total-TransportCost'

```
sum[ (p,c), UnitTransportCost(p,c) * Transport(p,c) ]
```

Simply enter the above definition in the 'Definition' attribute field. You could type the entire sentence yourself, but you can also let AIMMS do some of the typing for you. Considering the parameter 'UnitTransportCost(p,c)', the following two support features are quite useful.

Specifying definition attribute

- Type the letter *u* or *U*, and press the *Ctrl-Spacebar* combination for automatic name completion.
- Another option available to you is to drag the name 'UnitTransportCost(p,c)' from the model tree to the edit field of the 'Definition' attribute.

The attribute form should now have the same content as shown in Figure 3.7. By pressing the **Check, Commit and Close** button 🔲, you can verify whether AIMMS will accept the definition you entered.

Figure 3.7: The completed attribute form for the variable 'TotalTransportCost'

3.5 Entering constraints and the mathematical program

Creating the supply and demand constraints, each with their own definition, requires the same actions as creating a variable with a definition (as you just completed). The only difference is that you must use the button instead of the button. The following two forms should be the result of your efforts.

The supply and demand constraints

Figure 3.8: The completed attribute form for the constraint 'SupplyRestriction'

Figure 3.9: The completed attribute form for the constraint 'DemandRequirement'

A mathematical program, unlike sets, parameters, variables and constraints, does not have a special button on the toolbar. By using the identifier button ▣, you obtain access to all the other types of AIMMS identifiers. After pressing this button, select the 'Mathematical Program' entry alongside the ▣ icon, press the *OK* button, and enter 'LeastCostTransportPlan' as the name of the mathematical program.

Creating the mathematical program

The complete the attribute form of the mathematical program as illustrated in Figure 3.10. Among the attributes, AIMMS has automatically filled **Direction**, **Constraints**, **Variables** and **Type** attributes with default values and there is no need to change them for this project. You only need to fill the **Objective** attribute.

Specifying its attributes

Figure 3.10: The completed attribute form of the mathematical program

The **Objective** attribute wizard requires you to select a scalar variable. In the identifier selection wizard (see Figure 3.11), simply select the scalar variable 'TotalTransportCost', and press the *Finish* button.

Selecting the objective
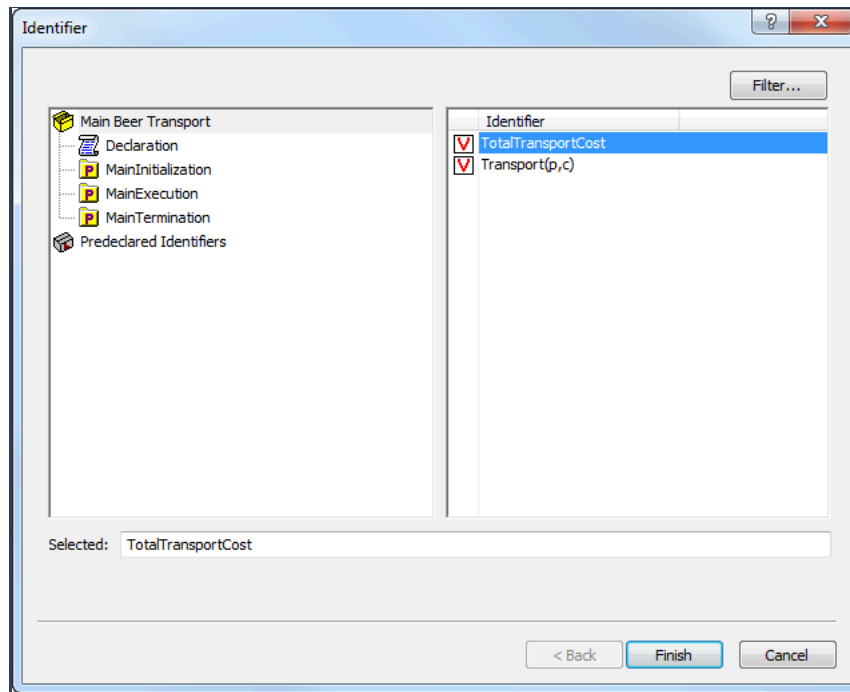
Figure 3.11: The identifier selection wizard

3.6 Viewing the identifiers

You have now entered and declared all model identifiers. The resulting model *Checking your* tree is shown in Figure 3.12. By pressing the *F5* key you can instantly check *model* the validity of your model. You will only receive a message in the event of an error. Once the validity of your model has been verified, you should save your work by pressing the **Save Project** button .
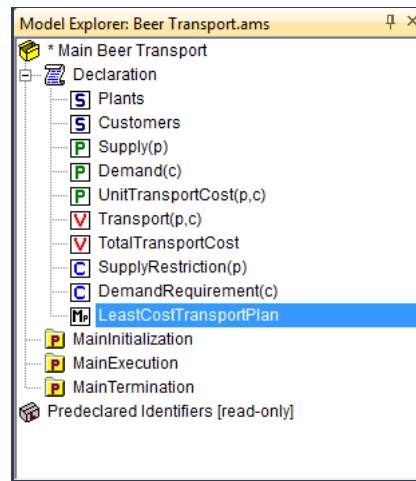
Figure 3.12: The final model tree

Even though the Model Explorer is a convenient medium with which to build and inspect your model, AIMMS provides two other ways to view your model.

If you would like to see a text representation of the model, you can do the following:

View text model

> ▶ select node(s) in AIMMS **Model Explorer**,
> ▶ go to the **View** - **Text Representation** menu and execute the **Selected Part(s)** command(see Figure 3.13).

Figure 3.13: View text model

The text model provides a simple overview of selected identifiers. For instance, Figure 3.14 shows the text model when the root node **Main Beer Transport** is selected.

```
[Text Repr] Main Beer Transport  ×
Model Main_Beer_Transport {
    Set Plants {
        Index: p;
    }
    Set Customers {
        Index: c;
    }
    Parameter Supply {
        IndexDomain: p;
    }
    Parameter Demand {
        IndexDomain: c;
    }
    Parameter UnitTransportCost {
        IndexDomain: (p,c);
    }
    Variable Transport {
        IndexDomain: (p,c);
        Range: nonnegative;
    }
    Variable TotalTransportCost {
        Range: free;
        Definition: sum[ (p,c), UnitTransportCost(p, c) * Transport(p, c) ];
    }
    Constraint SupplyRestriction {
        IndexDomain: p;
        Definition: sum[ c, Transport(p, c) ] <= Supply(p);
```
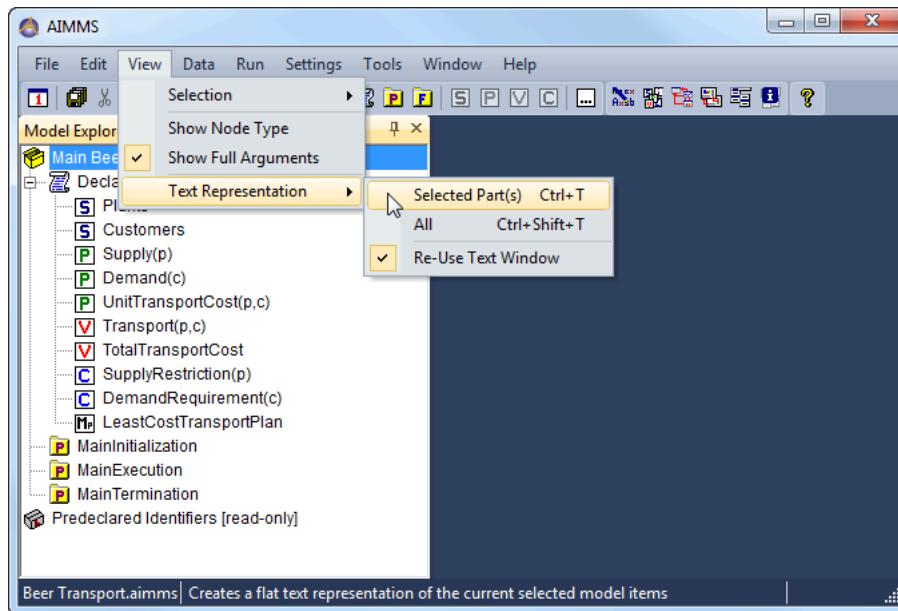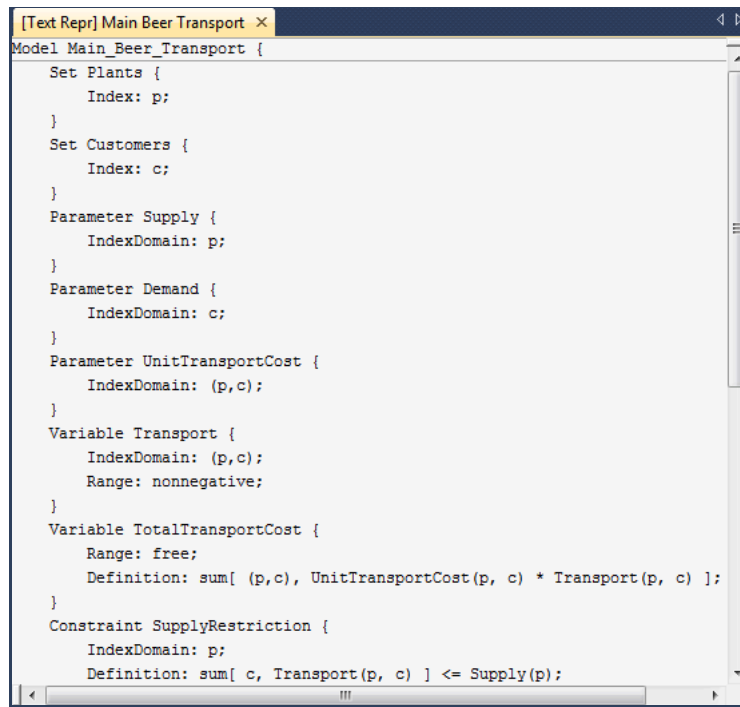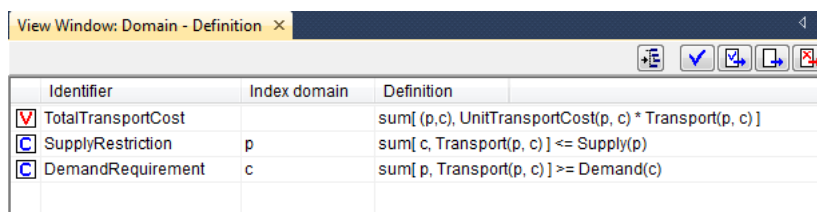
Figure 3.14: text model

Another way to inspect the model is by AIMMS **Identifier Selector**. This allows   *Identifier*
you to view several identifiers with similar properties at the same time. In this   *overviews*
tutorial you will encounter one such example of a predefined view, namely all
identifiers with a definition (see Figure 3.15). AIMMS allows you to make your
own views as you desire.

Identifier	Index domain	Definition
V TotalTransportCost		sum[(p,c), UnitTransportCost(p, c) * Transport(p, c)]
C SupplyRestriction	p	sum[c, Transport(p, c)] <= Supply(p)
C DemandRequirement	c	sum[p, Transport(p, c)] >= Demand(c)
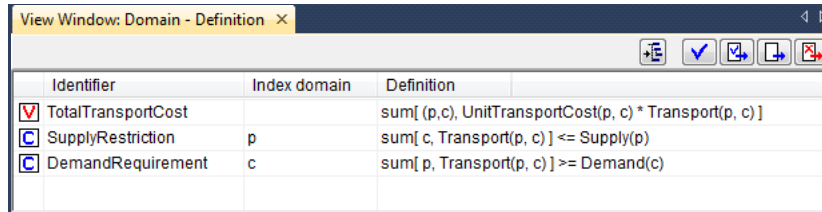
Figure 3.15: View window with identifier definitions

You can create a view window by executing the following steps: *Creating a view*

    ▶ press the **Identifier Selector** button ⊞ on the toolbar,
    ▶ select the 'Identifiers with Definition' node, and

▶ use the right mouse and select the **Open With...** command from the popup menu (see Figure 3.16).

Figure 3.16: Identifier Selector window

For the selected identifiers the view can be constructed as follows:

▶ select the 'Domain - Definition' entry from the **View Manager** window (see Figure 3.17), and

▶ press the *Open* button to obtain the overall view.

Figure 3.17: View Manager window

Chapter 4

Entering and Saving the Data

4.1 Entering set data

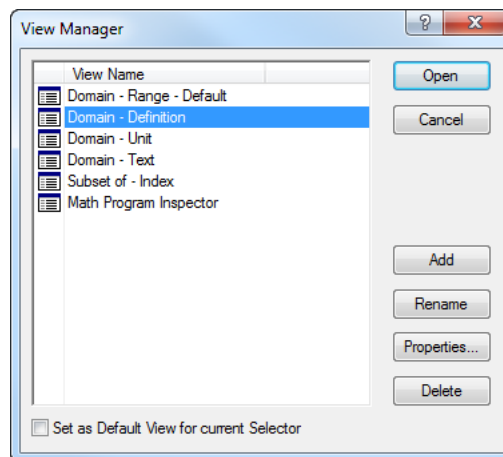Since this tutorial only contains little data, you are asked to enter it manually. *Manual data* (In the tutorial for professionals, data is imported from a database.) In this *entry* section you will encounter a standard data entry facility. Each identifier has an associated data page that you can use both to view data and to enter data.

To enter the two elements of the set 'Plants', you should execute the following *Elements of the* actions: *set 'Plants'*

- ▶ open the attribute form of the set 'Plants',
- ▶ press the **Data** button,
- ▶ move the mouse pointer to the data page as shown in Figure 4.1, and click in the empty edit field at the top of the data page,
- ▶ enter 'Haarlem' as the first element of the set,
- ▶ press the *Enter* key to register this element,
- ▶ enter 'Eindhoven' as the second element of the set,
- ▶ press the *Enter* key to register this element, and
- ▶ close the data page by clicking *Close* button (the data changes are immediately committed).

Figure 4.1: Data page for the set 'Plants'

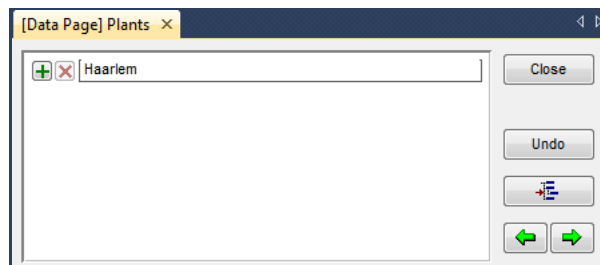To change the name of an element, just, select the element, press the delete button and enter the modified name in the same way as described above.

Changing element names

The elements of the set 'Customers' are entered in exactly the same way as for the set 'Plants'. The five elements are listed in Figure 4.2. Note that the last element 'Den Bosch' contains a blank character.

Elements of the set 'Customers'
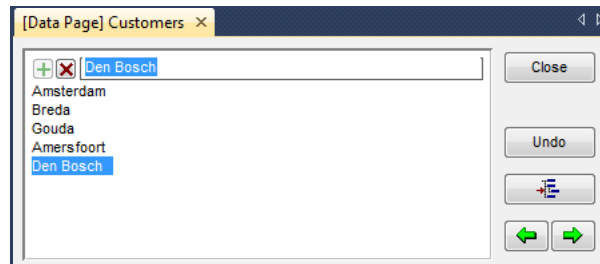
Figure 4.2: Data page for the set 'Customers'

4.2 Entering parameter data

The data page of each indexed parameter is automatically filled with the elements of the corresponding sets. All that is left for you to do, is to enter the nonzero data values.

Empty tables

In order to enter the data for the parameter 'Supply', you should execute the following actions (which are similar to the ones described in the previous section):

Supply data

▶ open the attribute form of the parameter 'Supply',
▶ press the **Data** button ,
▶ move the mouse pointer to the first data field and click,
▶ enter the number 47,
▶ press the *Enter* key to register the first value,
▶ enter the number 63,
▶ press the *Enter* key to register the second value, and
▶ close the data page by pressing *Close* button.

Figure 4.3 shows the completed data page of the parameter 'Supply'.

Figure 4.3: Data page for the parameter 'Supply'

The data values for the parameter 'Demand' are entered in exactly the same way as for the parameter 'Supply'. The five data values are listed in Figure 4.4.

Demand data

Figure 4.4: Data page for the parameter 'Demand'

The parameter 'UnitTransportCost' is two-dimensional, and requires you to complete a table. The completed data page for this parameter is shown in Figure 4.5.

Cost data

Figure 4.5: Data page for the parameter 'UnitTransportCost'

4.3   Saving your data

AIMMS has the option to store the data values of all identifiers in what is re-
ferred to as a 'case'. There are facilities both to save cases and to load cases.

*Case
management*

In order to save the data that you just entered in a new case named 'Initial Beer
Transport Data', you need to execute the following steps:

Saving a case

- ▶ go to the **Data** menu and execute the **Save Case** command,
- ▶ in the **Save Case** dialog box (see Figure 4.6) enter the name 'Initial Beer
  Transport Data' in the 'Name' field (without the quotes), and
- ▶ press the **Save** button to save your data.
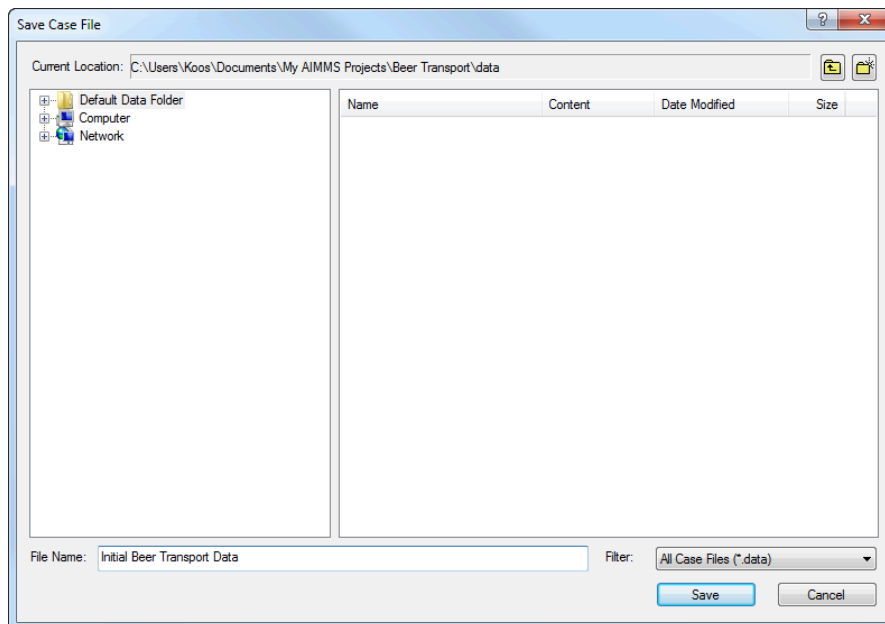
Figure 4.6: Save Case dialog box

If a project in AIMMS is closed and subsequently reopened, you may want to
reload your data. You may even want AIMMS to load a specific case automat-
ically each time your project is started. This can be accomplished (without
programming) using the AIMMS **Options** dialog box illustrated in Figure 4.7.

*Loading a case
as the startup
case*

- ▶ go to the **Settings** menu and execute the **Project Options** command,
- ▶ select the **Project** - **Startup & Authorization** folder in the option tree,
- ▶ click on the Option **Startup Case** in the right-most window,
- ▶ press the wizard button,

- ▶ select the case 'Initial Beer Transport Data',
- ▶ press the *OK* button on the **Select Case** dialog box,
- ▶ press the *Apply* button on the AIMMS **Options** dialog box, and
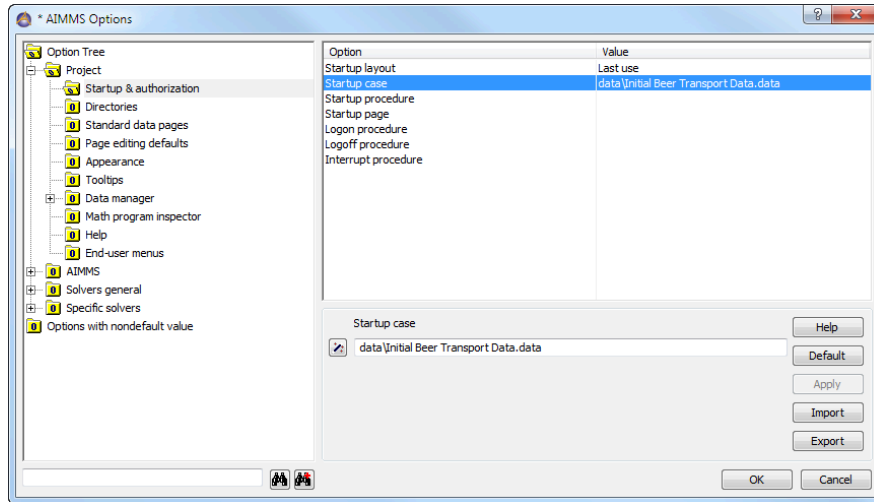- ▶ finish by pressing the *OK* button.

Figure 4.7: AIMMS options dialog box

It is a good habit to save your work regularly. The option settings above are also saved when you save the entire project. You can save the project by pressing the **Save Project** button ▨. Note that saving a project does not mean that the data is also saved. Saving data requires you to save a case.

Saving your project

At any time during an AIMMS session you can load a case manually as follows: *Loading a case manually*

▶ go to the **Data** menu, select the **Load Case** submenu and execute the **As Active...** command,

▶ select the desired case name in the **Load Case** dialog box (see Figure 4.8), and
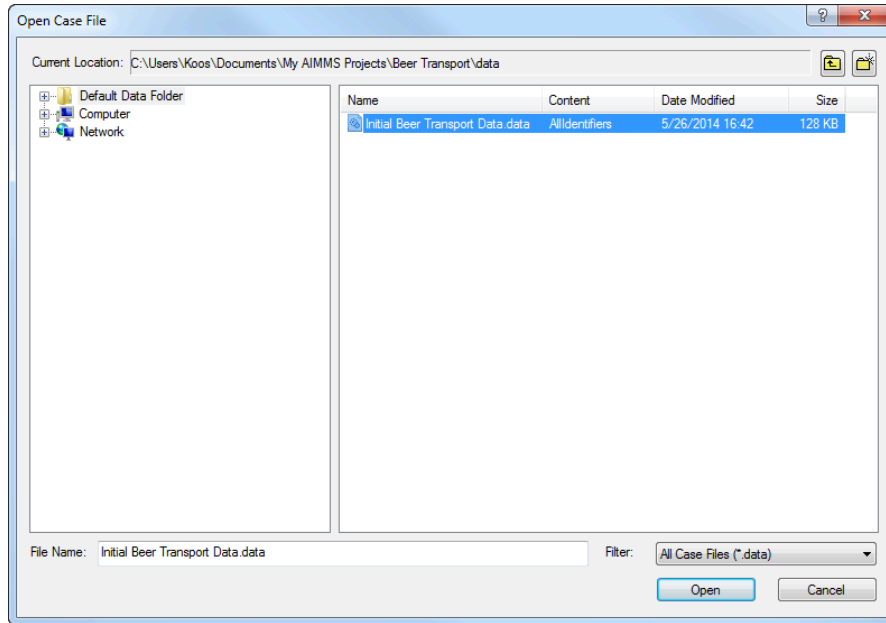
▶ press the *Load* button.

Figure 4.8: Load case dialog box

Solving the Model

5.1 Computing the solution

Thus far, you have entered all the identifiers, their attributes and their data. You will also need to build at least one procedure in order to be able to instruct AIMMS to take action. In this tutorial, you will enter two statements inside the body of the existing (empty) procedure *MainExecution*: one to solve the mathematical program, and the other to set the solution to zero when the mathematical program is not optimal.

Procedures for action
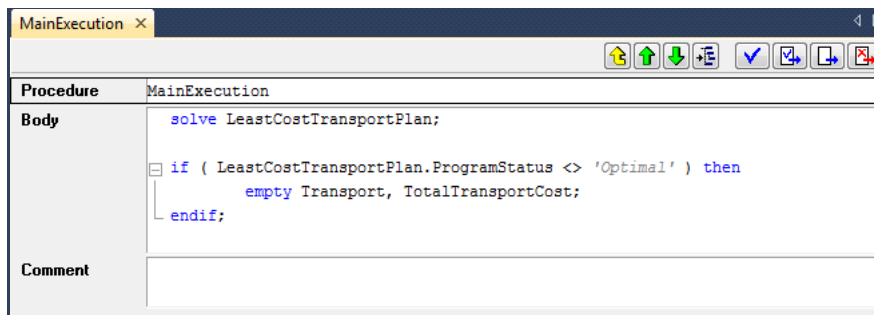
Figure 5.1: The attribute form of `MainExecution`

The procedure *MainExecution* can be completed as follows:

Building a procedure

▶ press the *F8* key to open the **Model Explorer**,
▶ select the *MainExecution* procedure and open it by double-clicking ,
▶ enter the two statements in the body attribute as illustrated in Figure 5.1, and
▶ press the **Check, Commit and Close** button to register the changes.

Should AIMMS report errors, simply check your input and make the necessary corrections.

To obtain information about specific AIMMS keywords, you can use the right-mouse popup menu to open the AIMMS documentation on the appropriate page with a single click. For instance, you can obtain help on the 'ProgramStatus' keyword as follows:

Right-mouse for help

- ▶ position the cursor over the 'ProgramStatus' keyword,
- ▶ right-click the mouse and select the 'ProgramStatus' entry in the 'Help' submenu (see Figure 5.2).
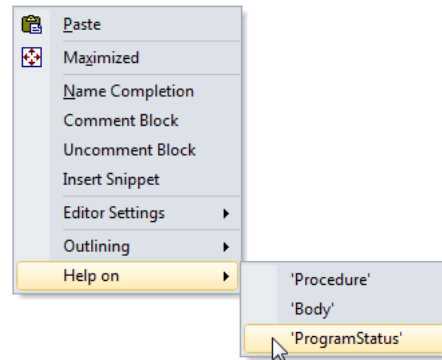

Figure 5.2: A right-mouse popup menu

The procedure `MainExecution` is special in that there is a dedicated key, `F6`, to execute this procedure. For all other procedures you can use the right mouse button to select the **Run Procedure** command.

Running the procedure

By pressing the `Ctrl` and `p` keys simultaneously, AIMMS displays a progress window with selected information on the progress it has made (or is making) during an execution phase. Figure 5.3 shows the progress window you should expect to see.
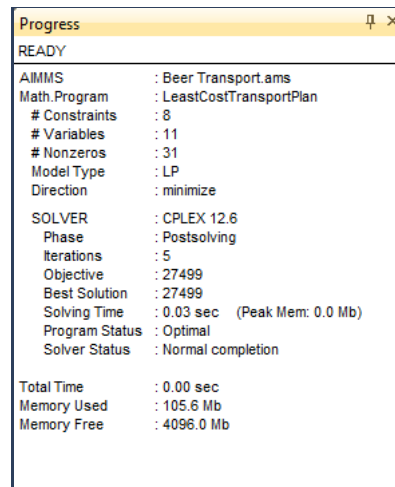
Watching execution progress

Figure 5.3: The AIMMS progress window

You have already encountered data pages while entering the elements of sets   *Results in data*
and the numeric values of parameters. Once AIMMS has computed the values   *pages*
of the variable 'Transport', these values become immediately available on the
corresponding data page. Just go to this variable in the model tree, and click
on it. Then use the right mouse to select the Data... command to open the data
page. This will open a pivot table with Transport data.

Figure 5.4: Data page displaying the solution for the variable 'Transport'

Chapter 6

Building a Page

Even though AIMMS provides standard pages for each identifier, such pages are not set up to look at groups of related identifiers. That is why model builders and end-users of an application usually prefer to interact with an application through one or more custom pages.

Building custom pages

6.1 Creating a new page

To create a new empty page you should execute the following steps:

Using the Page Manager

- ▶ press the **Page Manager** button 🔳 on the toolbar,
- ▶ press the 🔳 button on the toolbar to create a new page,
- ▶ specify 'Beer Transport Input and Output Data' as the name of this new page, and
- ▶ press the *Enter* key to register the page.

The **Page Manager** with the new page is shown in Figure 6.1.
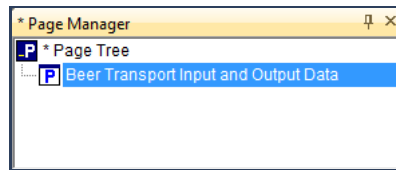
Figure 6.1: A Page Manager with a single page

Note that changes made in the previous chapter to the lay out of the Transport data table are also saved in the Page Manager.

6.2 Presenting the input data

A page is either in *Edit* mode or in *User* mode. The *Edit* mode is used for creating and modifying the objects on a page. The *User* mode is for viewing and editing the data displayed within objects on a page.

Be aware of two page modes

To open the new page in *Edit* mode:

- ▶ double click on the page name in the **Page Manager**, and
- ▶ press the ✖ button on the toolbar to open the selected page in *Edit* mode.

To create a new table, perform the following actions:

- ▶ press the new-table button 🗔 on the toolbar,
- ▶ position the mouse cursor at where the upper left corner of the new table should be,
- ▶ depress the left mouse button and drag the mouse cursor to where the lower right corner of the new table should be, and
- ▶ release the mouse button.

You can now complete the identifier selection dialog box as follows:

- ▶ select the parameter 'UnitTransportCost(p,c)' in the identifier selection wizard as illustrated in Figure 6.2,
- ▶ press the *Next* button,
- ▶ press the *Finish* button, and if necessary
- ▶ adjust the position and size of the table object such that all information is neatly displayed.

Figure 6.2: Identifier selection wizard
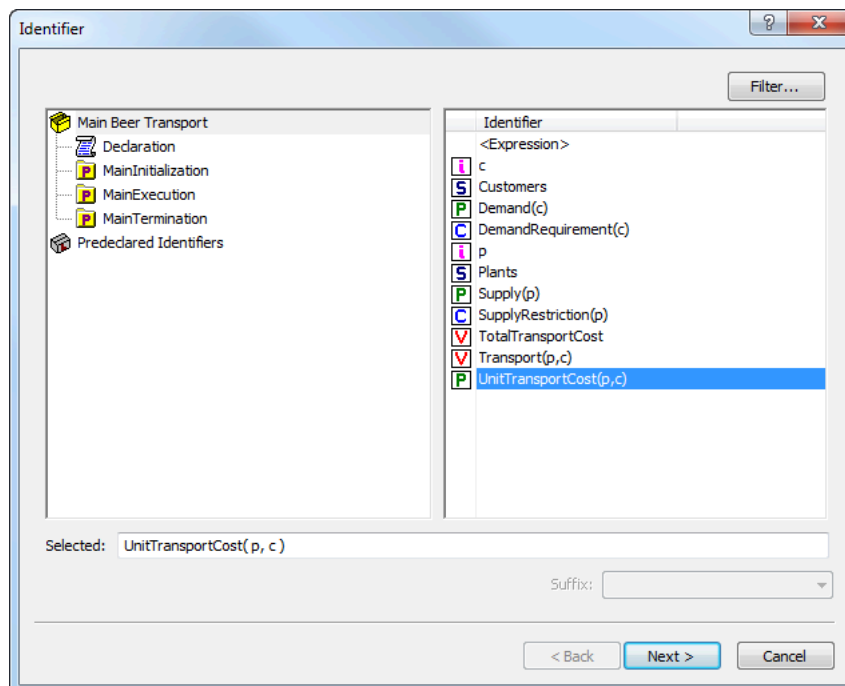
To add another identifier to the 'UnitTransportCost' table, execute the follow- *Adding supply*
ing actions in *Edit* mode: *data to existing*
  table

  ▶ select the table by clicking on it,
  ▶ press the ⬚ button on the toolbar (or alternatively, use the right mouse)
    to access the properties dialog box,
  ▶ select the contents tab (see Figure 6.3),
  ▶ press the *Add* button,
  ▶ select the identifier 'Supply(p)', press the *Next* button, and then press the
    Finish button, and
  ▶ back on the contents tab, press the *OK* button.
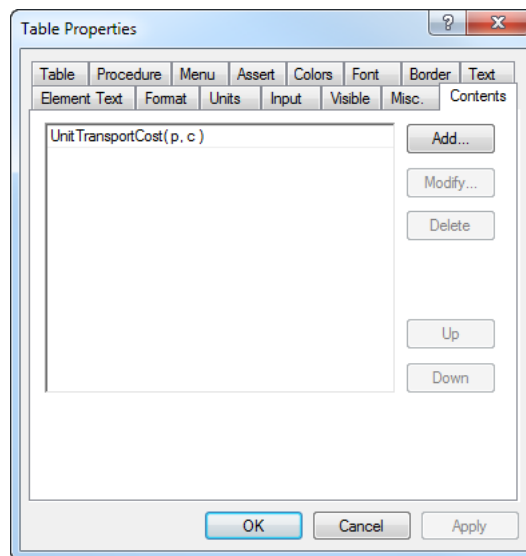
Figure 6.3: Table contents tab

You can add demand data to the table in the same way as you added the supply *Adding demand*
data. The resulting table is shown in Figure 6.4. *data to the table*

	Amsterdam	Breda	Gouda	Amersfoort	Den Bosch	Supply
			UnitTransportCost			
Haarlem	131	405	188	396	485	47.0
Eindhoven	554	351	479	366	155	63.0
Demand	28.0	16.0	22.0	31.0	12.0	

Figure 6.4: Table displaying input data

Creating a bar chart is essentially the same process as creating a table. The following steps summarize the process for the parameter 'Supply': *Creating two bar charts*

> ▶ press the new-bar-chart button 📊 on the toolbar,
> ▶ position the mouse cursor, and drag to form the new bar chart,
> ▶ select the parameter 'Supply(p)' in the identifier selection wizard,
> ▶ press the *Next* button, and then the *Finish* button.

You can then create a bar chart for the demand data in the same way as you created the bar chart for the supply data. Your intermediate page should now look like the one in Figure 6.5.
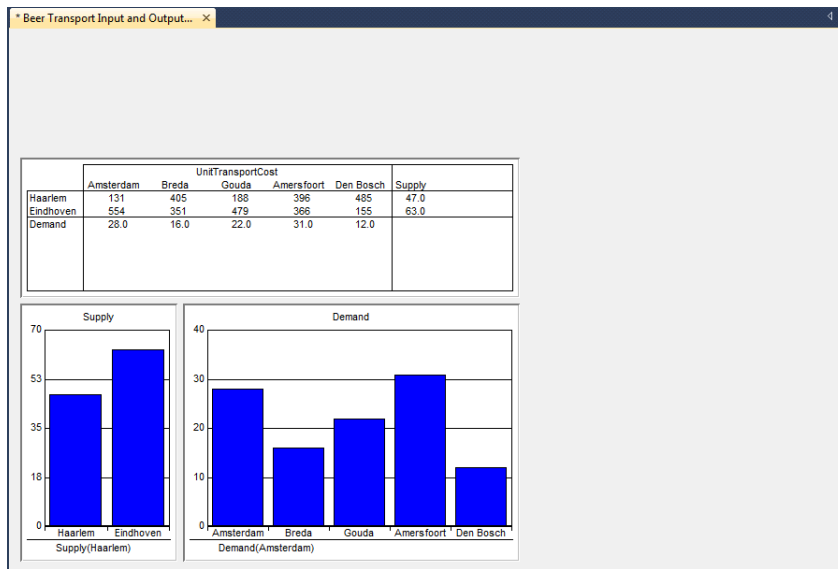
Figure 6.5: Intermediate input-output page

6.3 Presenting the output data

A composite table in AIMMS is like a relational database table: the first columns contain indices, and the remaining columns contain identifiers defined over these indices. Creating a composite table containing only the optimal solution is similar to creating a standard table or a bar chart, and requires the following actions: *Creating a composite table*

> ▶ press the 📑 button on the toolbar to create a new composite table,
> ▶ draw the table using the mouse,
> ▶ select the variable 'Transport(p,c)' in the identifier selection wizard to indicate which index values must be displayed,
> ▶ press the *Next* button, and then the *Finish* button.

Yet another way to display the solution is by means of a stacked bar chart:

    ▶ create a standard bar chart displaying the variable 'Transport(p,c)'.

    ▶ select the 'bar chart' tab in the properties dialog box as illustrated in Figure 6.6),

    ▶ instead of the default 'Overlapping' option, select the 'Stacked Bar' option, and

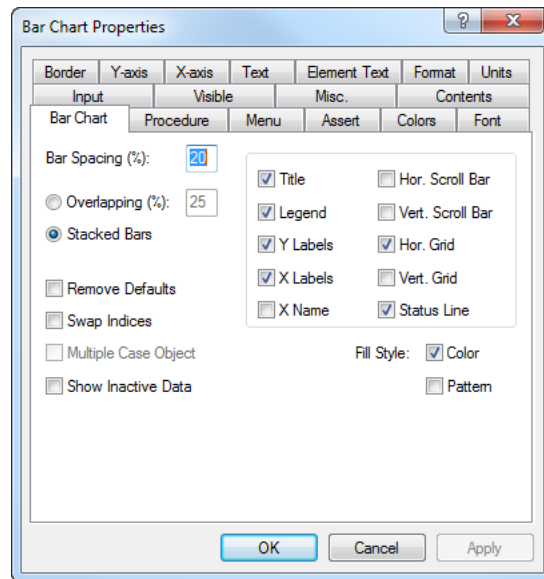   ▶ press the *OK* button.

Creating a stacked bar chart

Figure 6.6: Bar chart property dialog box

The scalar object is designed to display scalar values. To display the optimal solution value in a scalar object you should do the following:

Creating a scalar object

    ▶ press the ⬛ button on the toolbar to create a scalar object,

    ▶ draw the scalar object using the mouse,

    ▶ select the scalar variable 'TotalTransportCost' in the identifier selection wizard, and

    ▶ press the *Finish* button.

6.4   Finishing the page

Designing a professional looking graphical end-user interface is not a trivial activity, and is beyond the scope of this tutorial. Nevertheless, you will be asked to spend a little time building a nice looking page as illustrated in Figure 6.11 at the end of this section.

Building a well-organized overview

One item on this page is a button designed to trigger the solution of the 'Least-CostTransportPlan' mathematical program. To create such a button, you need to execute the following actions:

Creating a button

▶ press the 🖻 button on the toolbar to create a new button, and draw the button using the mouse,

▶ enter the quoted string "Solve Beer Transport" as the title of the button, and

▶ select the actions tab.

The action to be specified is that AIMMS executes (i.e. "runs") a procedure. In this example, the procedure is 'MainExecution'. Continue with the following steps:

▶ select 'Run' as the action to add,

▶ press the *Add* button,

▶ select option 'Procedure',

▶ press the enabled wizard button 🔁,

▶ select the procedure 'MainExecution',

▶ press the *Finish* button, and accept by pressing the *OK* button.

The completed **Actions** tab of the **Button Properties** dialog box is displayed in Figure 6.7. Note that the button can only be used to solve the model when the page is put into *User* mode by pressing the **User Mode** button 🗇.
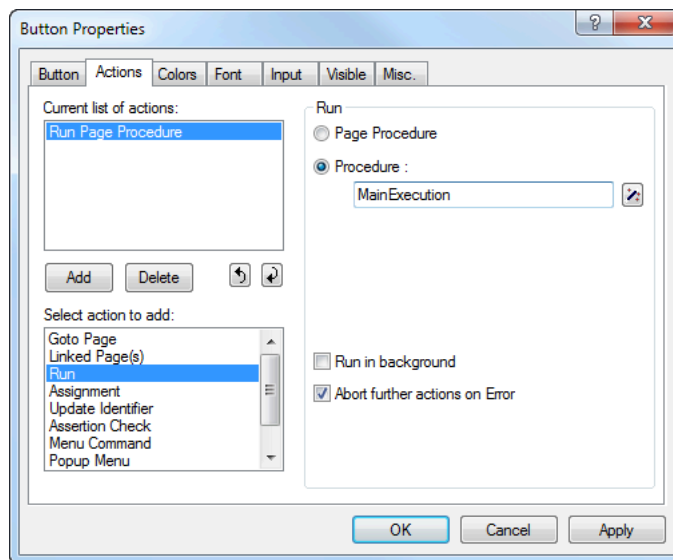
Figure 6.7: The action tab of the button properties dialog box

The resulting input-output page (see Figure 6.11) contains three text objects. The title text 'Beer Transport' can be created as follows:

Creating a text object

▶ select the **Text** command from the **Object** menu (see Figure 6.8), and draw a rectangle using the mouse,

▶ specify 'Beer Transport' as the static text on the **text** tab of the **Text Properties** dialog box,

▶ select 'Center' from the 'Alignment' drop-down list (see Figure 6.9) ,

▶ select the **Font** tab of the **Text Properties** dialog box, and
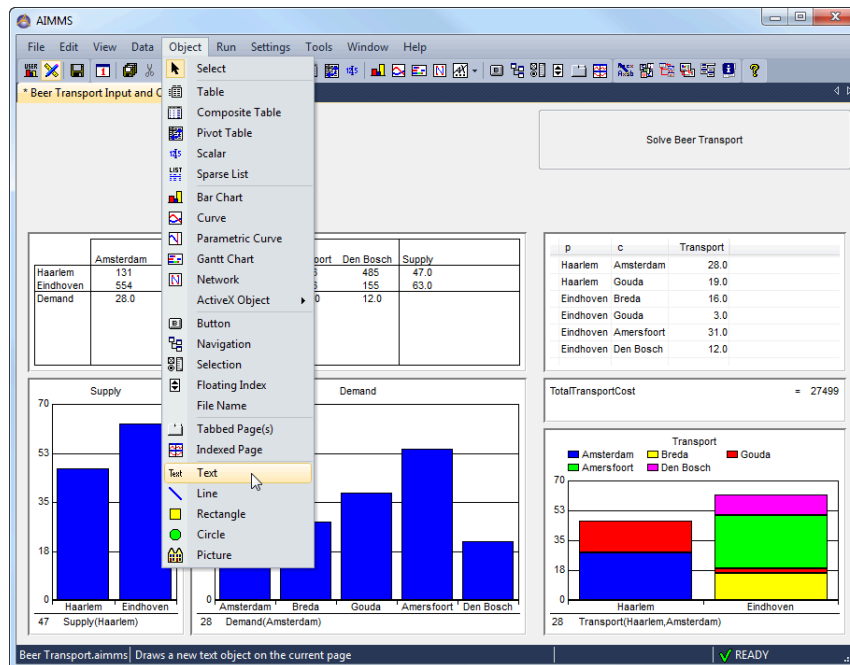
▶ press the *Add* button.

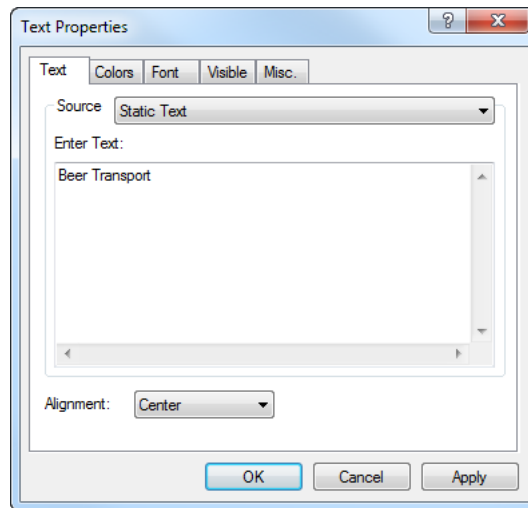Figure 6.8: The **Object** menu of a page in *Edit* mode

Figure 6.9: The text tab of the text properties dialog box

You can now specify and name the appropriate font, and thereby complete the text object.

▶ select 'Bold' as the *Font Style*, and '20' as the 'Font Size',
▶ press the *OK* button,
▶ specify 'Title' as the name of the new font,
▶ press the *OK* button to return to the **Text Properties** tab,
▶ again, press the *OK* button to leave the **Text properties** dialog box,

The other two text objects displaying the text 'Input Data' and 'Output Data' are created in the same way. Instead of using the newly constructed 'Title' font, you should create a second custom font, named 'Header' font, of size '14'. The font tab of the **Text Properties** dialog box is displayed in Figure 6.10.

The page is completed by adding two rectangles to emphasize that there are two groups of objects representing input data and output data. Assuming that you have rearranged and resized the objects to fit neatly together, you can draw the rectangles as follows:

Creating two rectangles

▶ select the **Rectangle** command from the **Object** menu, and
▶ draw the rectangle using the mouse.
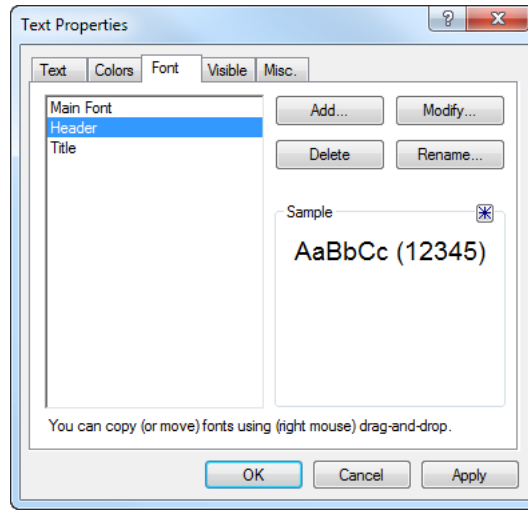
Your page should now look like the one in Figure 6.11.

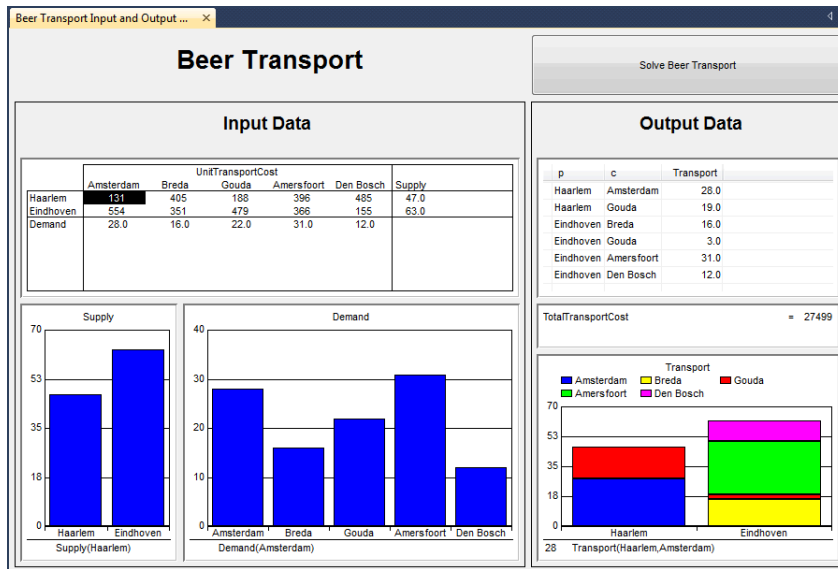Figure 6.10: The font tab of the text properties dialog box

Figure 6.11: An input-output page

Chapter 7

Performing a What-If Run

7.1 Modifying input data

Having developed the input-output page, you are now ready to *use* the page. For this purpose you must put the page into *User* mode by pressing the **User Mode** button ▣.

Page user mode

The input-output page allows you to see the effect of changes in either the demand, the supply, or the cost figures of the transport model. Just change any input data, re-solve the model, and view the resulting output.

What-if analysis

For example, to change the available supply in 'Haarlem' you can perform the following actions:

Dragging a bar chart

▶ in the 'Supply' bar chart, select the bar representing the supply in 'Haarlem',
▶ position the mouse pointer at the top of the bar, and simply
▶ drag the mouse upwards to increase the supply from 47 to 57 (see Figure 7.1).
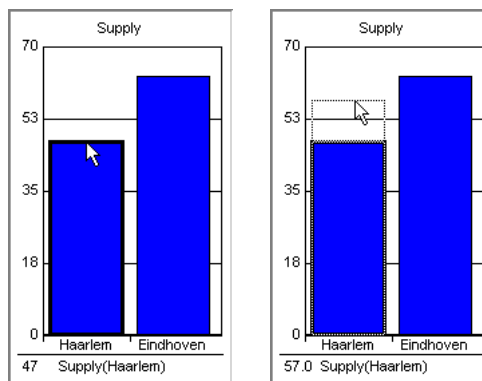

Figure 7.1: The dragging process for supply data illustrated

Alternatively, you can click on the corresponding bar, and enter the new supply value of 57 in the edit field on the lower left part of the bar chart.

You are now ready to re-solve the model. To do so, simply press the **Solve Beer Transport** button at the top of your page. You will see an improvement (i.e. decrease) in optimal cost from 27499 to 26626.

Re-solving the mathematical program

Note that a cost decrease could have been expected, because the entire capacity of 'Haarlem' had been used initially. By increasing the supply at Haarlem, 'Gouda' no longer needs Eindhoven as a second supplier (see Figure 7.2).
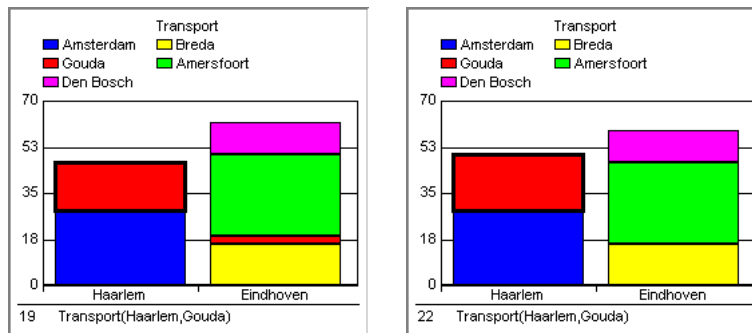
Improvement explained

Figure 7.2: The effect of changes in the supply data

Common AIMMS Shortcut Keys

Key	Function
F1	Open AIMMS Help
F2	Rename the selected identifier
F3	Find and repeat find
F4	Switch between edit mode and end-user mode (for the active page)
F5	Compile all
F6	Run *MainExecution*
Alt+F6	Switch to debugger mode
F7	Save the active page
F8	Open Model Explorer
Ctrl+F8	Open Identifer Selector
F9	Open Page Manager
Alt+ F9	Open Template Manager
Ctrl+ F9	Open Menu Builder
F10	Open Data Manager
Ctrl+ F10	Open Data Management Setup
F11	Open Identifer Info dialog
Ctrl+ B	Insert a break point in debugger mode
Ctrl+ D	Open Data Page
Ctrl+ F	Open Find dialog
Ctrl+ M	Open Message Window
Ctrl+ P	Open Progress Window
Ctrl+ T	View Text Representation of selected part(s)
Ctrl+Shift + T	View Text Representation of whole model
Ctrl+ W	Open Wizard
Ctrl+ Space	Name completion
Ctrl+ Shift+Space	Name completion including AIMMS Predeclared Identifers
Ctrl+ Enter	Check, commit, and close
Insert	Insert a node (when single insert choice) or Open Select Node Type dialog (when multiple insert choices)