AIMMS COM Object User's Guide and Reference - AIMMS COM Object Example

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Part I

The AIMMS COM Object Example

Chapter 1

An AIMMS COM Object Example

1.1 Introduction

This chapter

AIMMS comes with an AIMMS COM object, which makes it possible to easily integrate your AIMMS models with programming languages like Visual Basic. An example of how to use this AIMMS COM object is also provided. This chapter describes how to use this example. The example itself can be found in the `.aimmspack` file in the `COM Object` subfolder of the AIMMS `Examples` folder.

Assumptions

In order to be able to understand the example, you must have some knowledge of the Visual Basic language and of AIMMS.

Two example projects

The example consists of two projects, namely an AIMMS project and a Visual Basic project. The AIMMS project is called `Islands.prj` and the Visual Basic project is called `AIMMS_COM_example.vbp`. Using the AIMMS COM object, you can run, analyze and change the AIMMS project from within the Visual Basic project.

The Visual Basic example

In the Visual Basic example, various calls to functions provided by the AIMMS COM object are used. Not all functions are included in the example, but they should still give you a good idea of how the AIMMS COM object can be used. Technical details are provided as comments in the source code of the example (where necessary).

A closer look

However, before digging into the details of the AIMMS COM object, let's first have a closer look at the AIMMS `Island` project...

1.2 The AIMMS Island project

The Canary Islands

Not far from the west coast of Africa lie seven islands that are known as the Canary Islands. These islands are a part of Spain and are called Tenerife, Gran Canaria, Fuerteventura, Lanzarote, La Palma, La Gomera and El Hierro. See figure 1.1 for a map of the islands.

Figure 1.1: The Canary Islands

The airline company and its planes

Consider an airline company that wants to operate in the region. The company currently has three types of planes, all of which have different numbers of seats, fixed costs per flight and costs per flown mile. These parameters are displayed in table 1.1.

Plane types	ATR-72	Boeing 737	Fokker F-50
Number of seats	50	130	60
Cost per flight	600	1200	670
Cost per mile	20	65	28

Table 1.1: Initial plane characteristics

Environmental limitations

Due to environmental considerations, the government has put a limit on the number of daily flights of each type of airplane. The more polluting an aircraft, the less flights there are permitted per day using that particular aircraft. The initial flight limits for the three plane types are listed in table 1.2.

Limitations on the number of flights

The company wants to offer direct flights from every island to every other island at a reasonable ticket price. The government has put a limitation on the number of daily flights the company may offer between any two islands, regardless of the plane type. This means that, in order to satisfy passenger demand, the company may be forced to use a more uneconomic plane for a particular flight. The maximum number of passengers that travels between any two islands is assumed to be constant. The company always wants to transport all passengers.

Mandatory return flights

Another limitation on the schedule is the fact that if a flight from island A to island B is performed using a certain number of flights with plane type C, the same number of return flights must take place using the same plane type.

Plane types	ATR-72	Boeing 737	Fokker F-50
Flight limit	50	7	20

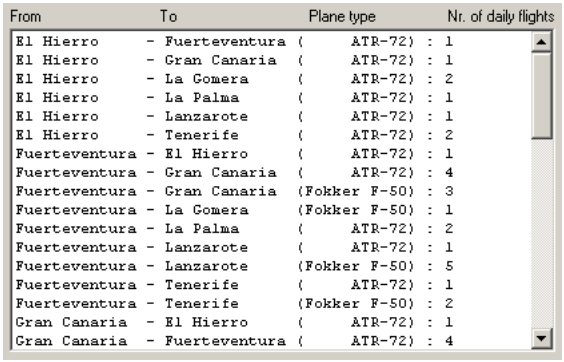
Table 1.2: Initial flight limits

Rotating schedule

Of course, this limitation has the desired effect that at the start of each day, the same number of planes of a certain type will be available on an island and therefore the same schedule can be performed over and over again...

The best flight schedule

A model written in AIMMS helps in determining the daily flight schedule that maximizes the profit. The initial data of the model consists of the data in table 1.1 and 1.2, along with the fixed passenger demand and the ticket prices of every possible flight. The schedule specifies how many flights with a certain plane type must be performed between a combination of islands to reach the maximum profit. For example, in the schedule which uses the initial data, the flight between Tenerife and Fuerteventura is performed three times per day; twice using the Fokker-50 and once using the ATR-72 (see the third and fourth line from below in figure 1.2).



From	To	Plane type	Nr. of daily flights
El Hierro	- Fuerteventura	(ATR-72)	: 1
El Hierro	- Gran Canaria	(ATR-72)	: 1
El Hierro	- La Gomera	(ATR-72)	: 2
El Hierro	- La Palma	(ATR-72)	: 1
El Hierro	- Lanzarote	(ATR-72)	: 1
El Hierro	- Tenerife	(ATR-72)	: 2
Fuerteventura	- El Hierro	(ATR-72)	: 1
Fuerteventura	- Gran Canaria	(ATR-72)	: 4
Fuerteventura	- Gran Canaria	(Fokker F-50)	: 3
Fuerteventura	- La Gomera	(Fokker F-50)	: 1
Fuerteventura	- La Palma	(ATR-72)	: 2
Fuerteventura	- Lanzarote	(ATR-72)	: 1
Fuerteventura	- Lanzarote	(Fokker F-50)	: 5
Fuerteventura	- Tenerife	(ATR-72)	: 1
Fuerteventura	- Tenerife	(Fokker F-50)	: 2
Gran Canaria	- El Hierro	(ATR-72)	: 1
Gran Canaria	- Fuerteventura	(ATR-72)	: 4

Figure 1.2: A fragment of the initial schedule

Initial profit

Using the initial data, the best schedule offers a profit of 84.404 dollars per day.

1.3 Model details

Three model sections

The `Island` model is divided into three sections (see figure 1.3):

1. `Island section`
2. `Plane section`
3. `Schedule section`

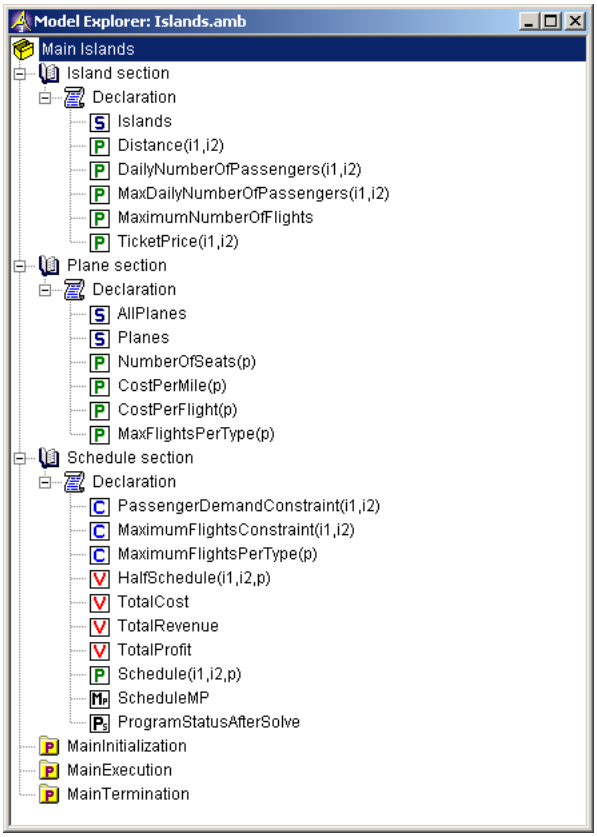


Figure 1.3: The three sections of the `Island` project

The island section

The island section contains the sets and parameters that describe the seven Canary Islands and their various relationships. The distances between all island combinations are defined here, together with the passenger demand and ticket price for each flight.

The plane section

The plane section provides all plane related information, namely the possible and actual plane types the company has in operation, together with some parameters that describe them.

The schedule section

Finally, the schedule section provides the constraints, variables and the mathematical program needed to solve the model. The schedule that will eventually be calculated is represented by the variable `schedule(i1, i2, p)`. For example, using the initial data, the value of

```
Schedule('La Palma', 'Tenerife', 'ATR-72')
```

is 6, which means that in order to reach the maximum profit every day 6 flights between La Palma and Tenerife have to be flown using the ATR-72 plane type.

Detailed comments

Every identifier in the model comes with detailed comments that describe its precise purpose. Please note the non-standard code in the MainTermination procedure that prevents the displaying of an AIMMS dialog at termination time, which would be annoying in the Visual Basic example that uses AIMMS in *hidden* mode.

Initial data

When the project starts up, the initial data is automatically loaded through the AIMMS project option `Startup case`.

1.4 The Visual Basic application

Introducing the Visual Basic application

A small example application in Visual Basic is provided with the `Island` project, to demonstrate the use of the AIMMS COM object from within Visual Basic. It consists of various windows, of which the main window is called `AIMMS COM example`. When you run the application, this window will show up automatically. To avoid errors locating the `Island` project, please start up the Visual Basic project `AIMMS_COM_example.vbp` by double clicking on the project name in the folder where the project is located, instead of first starting Visual Basic and then selecting the project.

Starting and solving

To do anything useful with the application, please click on the **Start AIMMS** button first. Doing this starts an AIMMS session with the `Island` project in the background (*hidden* mode). To verify that all went right, you can click on the **Solve Model** button to solve the model with the initial data. The **profit** field should come up with a value of 84.404 dollars. The field next to the profit-field shows the status of the mathematical program in AIMMS after solving. Please note that the time to solve the model is dependent on the machine you're using and on the solver that is used by AIMMS. When you've started AIMMS, the **Plane types** field and the **project** field are filled with the initial plane types and the full path of the `Island` project, respectively. Figure 1.4 shows the main window of the Visual Basic example, after solving the model with the initial data.

Various actions

For the sake of demonstrating some of the uses of the AIMMS COM object, various actions have been defined in the application, that can be initiated from the main window by clicking on the corresponding command buttons. Those actions are described in the next four subsections.

Learn by viewing the code

As already stated in the introduction, in order to really learn how to use the various calls to the AIMMS COM object, you should look in the subs of the Visual Basic example project. All subs have been commented properly, so studying the code should give you the necessary understanding of how to use the functions provided by the COM object in your own Visual Basic projects.

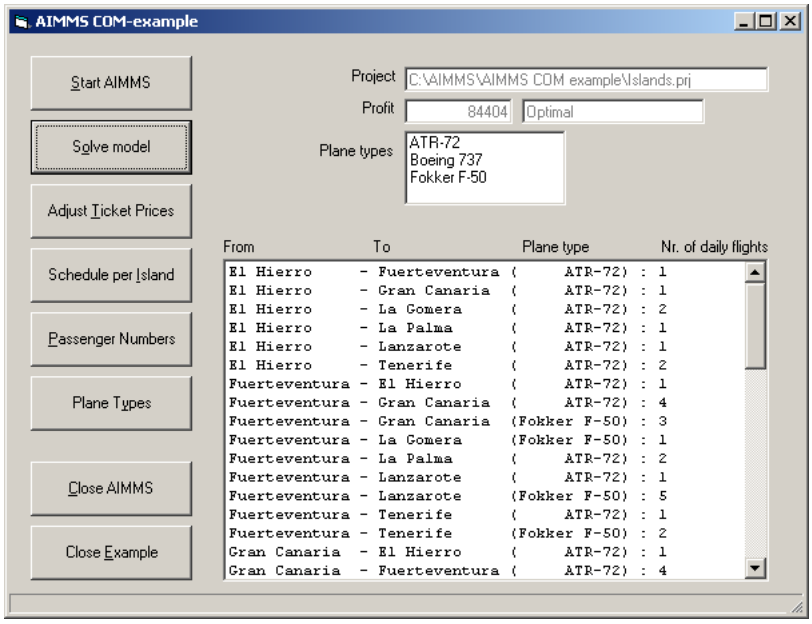


Figure 1.4: The main window of the Visual Basic project

1.4.1 Adjust ticket prices

Opening the window

Clicking on the **Adjust Ticket Prices** button brings up a window in which you can alter the ticket prices for flights that you select. Figure 1.5 shows this window.

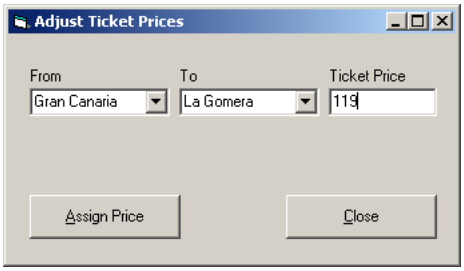


Figure 1.5: The window for adjusting ticket prices

Assigning a new price

By selecting two different islands in the **From** and **To** combo boxes, the current ticket price for the flight between those selected islands appears in the edit field **Ticket Price**. You can change this price. Click on **Assign Price** to make sure that all identifiers in the AIMMS model that rely on the ticket prices are updated.

Seeing the effects

If you like, you can change some more ticket prices before clicking on the **Close** button to return to the main window. In the main window, you can see the effects of your changes by clicking on the **solve** button. Both the schedule and the profit may have been influenced by your actions.

1.4.2 Schedule per island

Opening the window

To see just a slice of the complete schedule that you've created by solving the AIMMS model, click on the **Schedule per Island** button.

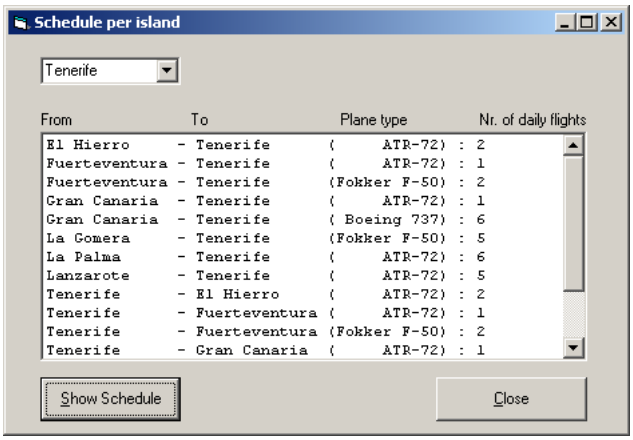


Figure 1.6: The schedule for the island of Tenerife

Displaying the schedule

In the window that pops up, you can pick an island from a list. By clicking on **Show Schedule** only those rows of the complete schedule that involve the selected island are shown. This function makes it easier to see the effects of the changes that you apply to the initial model data and at the same time demonstrates the use of selecting sliced identifiers from within Visual Basic. Figure 1.6 shows the schedule for the island of Tenerife with the initial data.

1.4.3 Passenger numbers

Opening the window

The daily number of passengers that wants to travel from or to a particular island can be changed by clicking on the **Passenger Numbers** button.

The current passenger numbers

A window appears, in which you can pick a desired island. After doing this, clicking on **Show** shows all the daily numbers of passengers that want to fly to and from the selected island. The total number of passengers involving the picked island is also displayed. Figure 1.7 shows the initial passenger numbers for flights involving the island of El Hierro.

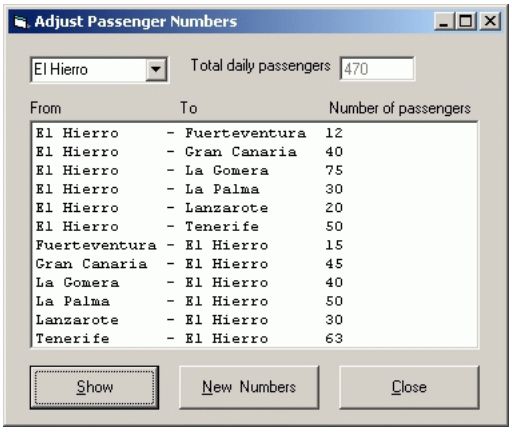


Figure 1.7: The initial passenger numbers involving flights from and to the island of El Hierro

Altering the passenger numbers

By clicking on the **New Numbers** button the computer randomly changes all displayed passenger numbers slightly, adding a value between -10 and +10 to the current number. When you've changed the passenger numbers the way you wanted, click on the **Close** button to return to the main window. You can solve the model again, using the changed passenger numbers to see the effects.

When the model becomes infeasible

In some cases the model can become infeasible. For example, if the number of passengers between two islands has grown extensively, it is possible that under the current constraints a feasible schedule cannot be determined. In that case a profit of 0 dollars is returned by the AIMMS COM object and the field next to the profit field reads **Infeasible**.

1.4.4 Plane types

Opening the window

The initial model data assumes that the company has three types of airplane in operation. You can influence this by clicking on the **Plane Types** button. By doing so, a window appears in which you can pick either an existing plane type or a new plane type from a standard list. It's also possible to introduce a completely new plane type that is not on the list. Figure 1.8 shows the window after just having introduced the `Casa CN-235` plane.

Removing or changing

When you select a plane type from the list that is already used by the company, you have two possibilities: you can *remove* this plane type (having the effect that the schedule must be recalculated using only the remaining plane types, if possible) or *change* some parameter(s) of this plane type.

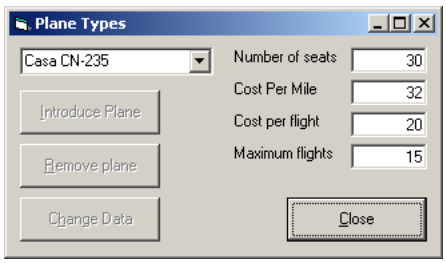


Figure 1.8: The **Plane Types** window

The plane parameters

Each type of airplane has four parameters that influence whether it's selected for certain flights or not. You can specify or change these parameters. They are:

- the number of seats,
- the cost of flying one mile,
- the static cost of performing a flight and
- the governmental limit on the number of flights allowed.

Applying the changes

When you've changed the numbers, click on the **Change Data** button to update the values in the AIMMS model. By closing the plane type window and returning to the main window, you can see the effects of your changes by solving the AIMMS model again.

Introducing a new plane

When you select a plane type from the list or type in a completely new plane type, you must fill the four parameters mentioned above in order to be able to introduce the new plane type. Again, return to the main window to see the effects of your changes by solving the AIMMS model.

Impact on solving time

Please note that changing the parameters can influence solving time considerably. It seems fastest to experiment with small changes in the existing plane types or introducing aircraft with a relatively low number of seats.