

Exercises session 7

Agrotech produces big bulky industrial processing machines for the food industry. The machines are composed of two major components at a 1:2 ratio (i.e. one machine is put together of one of component 1 and two of component 2). The machines have traditionally been produced at once; however it has been proven that there are savings to achieve, if the components are produced separately, transported separately, and merged in-transit. Below follows a description of Agrotech's operations. You may assume that production, distribution and merging operations all occur within the forecasted time period. Your task will be to propose production and distribution plans for the following year given different configurations of the supply chain network.

Agrotech's primary markets are Europe, North America and Asia. Being a Danish industry, the European market has traditionally been divided into Scandinavia and the rest of the Europe. Below are given the forecasted demand data (Table 1) for the following year.

	Winter	Spring	Summer	Autumn
North America	42	37	29	17
Asia	35	39	46	57
Europe	30	45	57	59
Scandinavia	5	14	20	19

Table 1: Demand of customers

Agrotech manufactures its machines in Bangkok (Thailand) and Manila (Philippines). The plant in Manila was the first plant, and hence production is less effective than at the one in Bangkok. That is why the capacity in Manila will decrease over the following year allowing for more production at the still growing plant in Bangkok. It is also in Bangkok, that separate component production is being implemented in addition to the full assembly production.

	Winter	Spring	Summer	Autumn
Bangkok	50	65	90	90
Bangkok, comp 1	0	20	30	40
Bangkok, comp 2	0	50	70	100
Manila	75	60	60	40

Table 2: Capacities of plants

Agrotech uses three distribution centers between its plants and its wholesalers in its customer zones. They are the ports of Singapore, Hong Kong and Århus. In the tables 4 and 5 are the unit transportation cost for assembled machines between the plants and each of the distribution centers.

	Winter	Spring	Summer	Autumn
Bangkok	14 560	14 770	15 010	15 830
Bangkok, comp 1	7 410	7 400	7 290	7 680
Bangkok, comp 2	2 870	2 910	2 960	3 010
Manila	17 890	18 030	18 160	18 320

Table 3: Production cost

	Winter	Spring	Summer	Autumn
Singapore	1 330	1 430	1 480	1 480
Hong Kong	990	1 020	1 050	1 110
Århus	2 100	2 100	2 100	2 100

Table 4: Transportation costs from Bangkok

The port of Hong Kong has an additional feature of offering merge-in-transit operations for the plant in Bangkok. In the Tables 6 and 7 are the unit transportation costs from Bangkok to Hong Kong for each of the two components plus the merge in-transit cost.

To get from the distribution centers to the wholesalers in each of the customer zones, Agrotech has a series of contracts with different shippers. All of these can be transcribed to unit transportation costs that are in the Tables 8, 9 and 10 (incl. terminal handling). Note that not all customer zones may be reached from all distribution centers.

The physical layout of the network, with the summer parameters' setting, can be seen on the Figure 1.

Task

- Write a mathematical model of the supply chain network above, considering just one season. (minimizing the overall cost)
- Given the seasonal data above, make a production and distribution plan for each of the seasons using OPL Studio.

	Winter	Spring	Summer	Autumn
Hong Kong	1 230	1 210	1 200	1 190
Århus	2 330	2 330	2 350	2 360

Table 5: Transportation costs from Manila

	Winter	Spring	Summer	Autumn
Comp 1	600	600	600	600
Comp 2	210	210	210	220

Table 6: Transportation costs from Bangkok to Hong Kong for separate parts

Winter	Spring	Summer	Autumn
900	910	930	950

Table 7: Merge cost of parts in Hong Kong

	Winter	Spring	Summer	Autumn
North America	2 500	2 200	2 200	2 200
Asia	1 250	1 350	1 400	1 500

Table 8: Transportation costs from Singapore to customers

	Winter	Spring	Summer	Autumn
North America	2 300	2 200	2 200	2 200
Asia	1 650	1 650	1 750	1 750
Europe	2 700	2 700	2 700	2 700

Table 9: Transportation costs from Honk Kong to customers

	Winter	Spring	Summer	Autumn
Europe	1 400	1 400	1 400	1 600
Scandinavia	1 300	1 350	1 400	1 400

Table 10: Transportation costs from Århus to customers

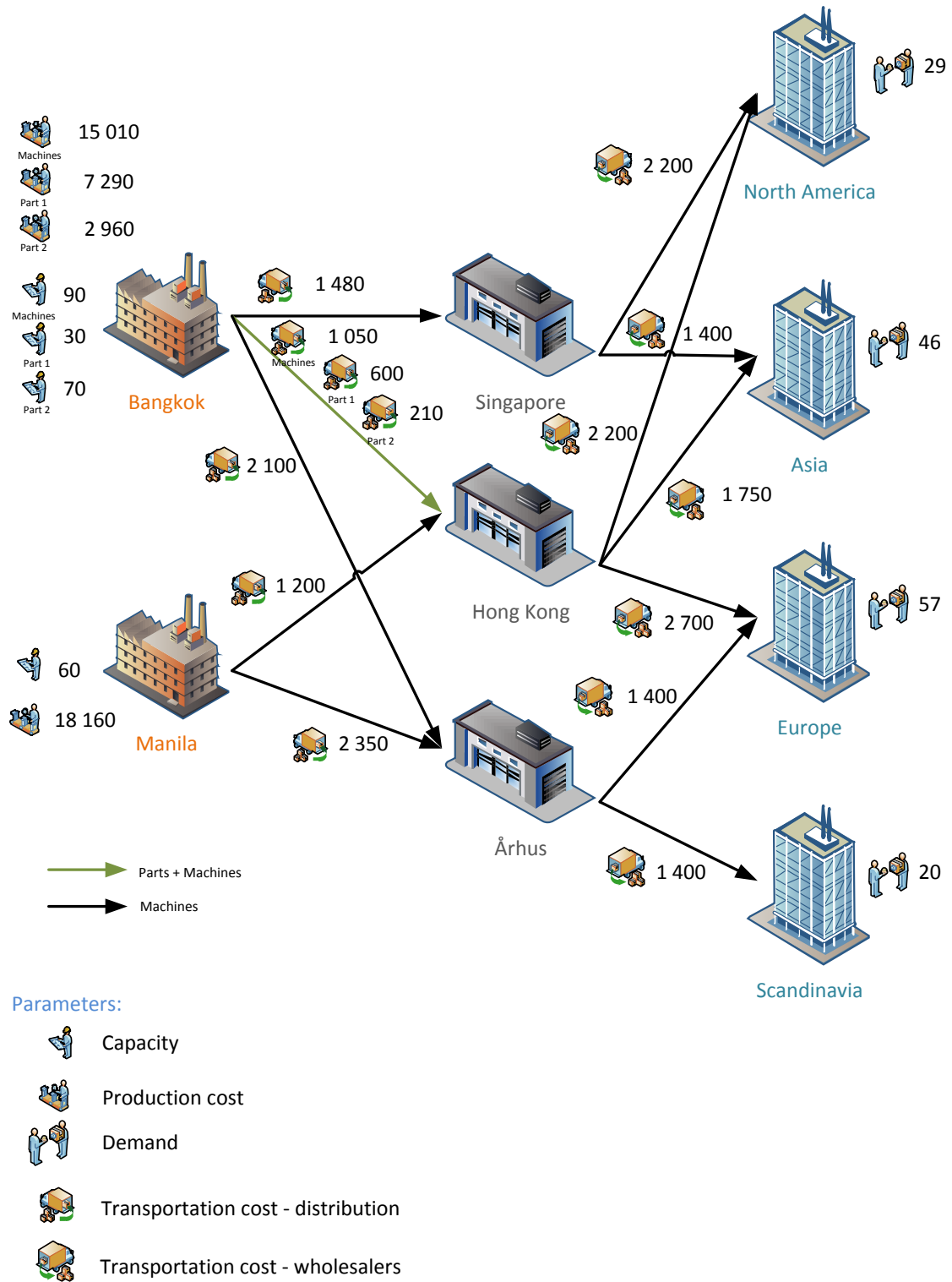


Figure 1: Network layout (Summer)