



Exercises session 8

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

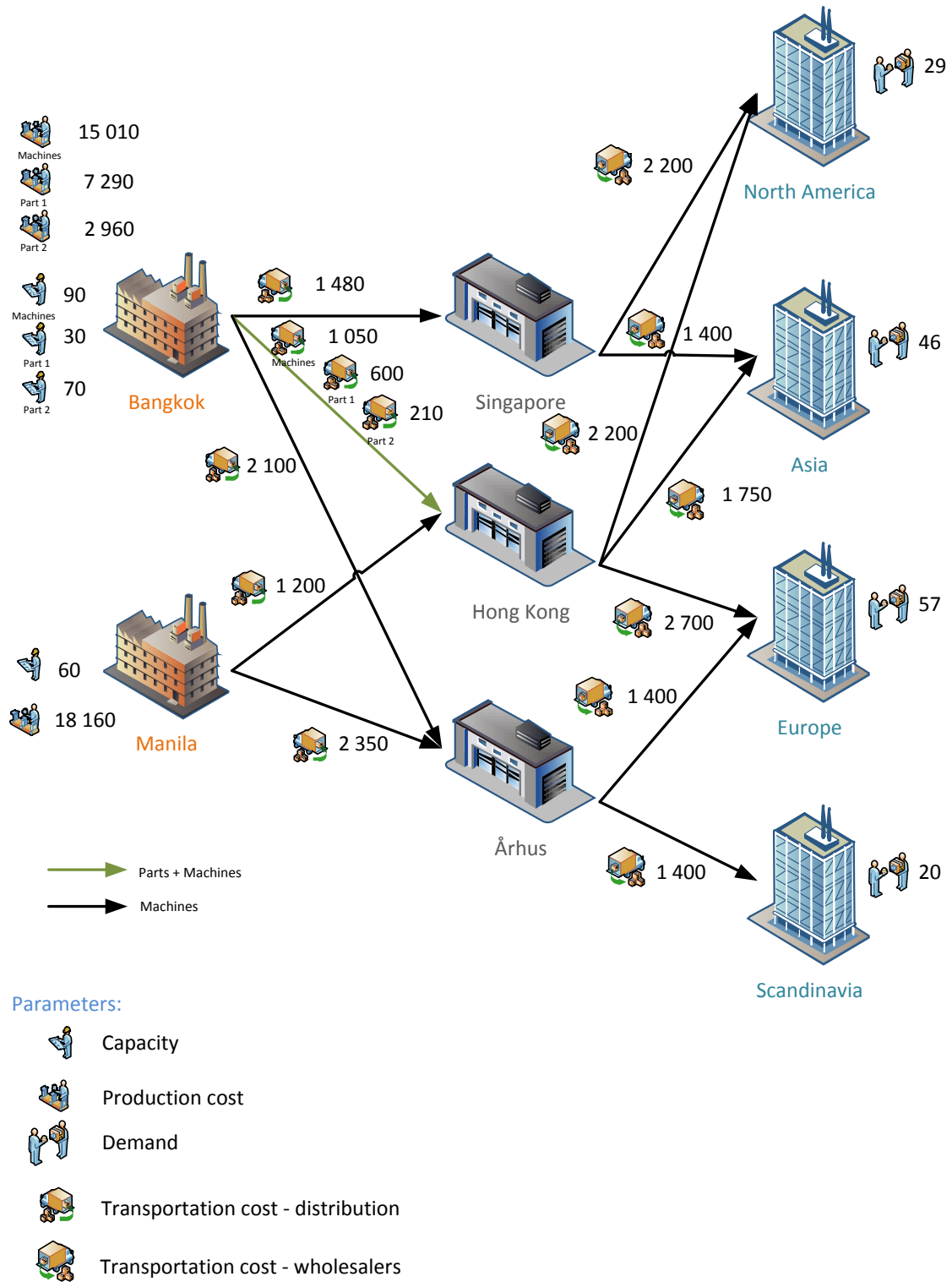


Figure 1: Network layout (Summer)