Chapter 6
Application of Concept

In this chapter the developed simulation based concept for improving energy efficiency will be applied to several case studies in order to underline applicability and potentials of the approach. Thereby different cases are being considered to show the opportunities. Each case will follow the steps of the presented application cycle. While the developed concept is generic in nature, the examples will underline case specific implementation and practical implications of each step. The case studies are based on real data from several companies; for reasons of confidentiality many values will just be given in a relative manner.

6.1 Aluminium Die Casting

The first case study focuses on a company which produces die casted parts for the automotive industry (Herrmann et al., 2011a). Products are manufactured in mass production with continuous material flow in transfer lines with rigid linkage (highly automated). Production is running in a three shift system (24 hours a day).

Step 1: Objective and System Definition

In this case study one specific transfer line for the production of a specific product shall be considered in detail. The objective is to minimise direct electricity costs while still obtaining the same output on products.

Step 2: Total Energy Consumption and Contract Analysis

Production machines in the designated area directly consume electricity as well as compressed air. However, for the purpose of this study just direct electricity consumption is considered. The actual electricity consumption of this area is not known due to missing measuring points. The considered transfer line is part of a large production site with diverse facilities. A separate bill is not available. In terms of costs, only consumption induced cost portions need to be considered (no peak surcharges or fees).

Step 3: Identification of Energy Consumers

The production area that is analysed is clearly defined. No further prioritisation is necessary – the objective is to analyse a specific production line as a whole, which
does not contain too many different consumers. Therefore all consumers will be considered. An overview of the system structure and all machines involved is shown in Figure 86. Three parallel die casting cells (which contain robots for spraying and handling as well as heating/cooling units) convert liquid aluminium into the raw part which is further processed through a saw. Afterwards, parallel CNC milling takes place on two parallel machines before abrasive blasting and palletising finalise the process chain.

![Structure of considered manufacturing system](image)

**Fig. 86** Structure of considered manufacturing system

**Step 4: Data Metering and Processing**

In the following step relevant data was obtained for all machines. As mentioned above, it is a highly automated transfer line aiming for mass production of one specific product. Thus, all process times are well defined and can be considered as constant. Based on production respectively specifically maintenance data MTTF and MTTR were calculated which describe the failure behaviour of the machines. Finally, the electrical power demand of all consumers was measured with a portable measuring device and a sampling rate of one second. A sample result of these measurements can be seen in Figure 86. For all consumers the load profiles were analysed and consumption values were allocated to the different operation states.

**Step 5: Modelling**

The whole manufacturing system was modelled with the developed energy oriented manufacturing system simulation approach. Thereby, the procedures explained in Chapters 5.2 and 5.4.6 were used. As mentioned above, a casting cell contains diverse separate consumers – besides the die casting machines (DCM) these are cooling and heating units as well as spraying and handling robots. The