For many industries and service organizations, the availability of capital goods such as rolling stock, lithography systems, MRI scanners and aircraft is crucial to their operations. To ensure the high availability of capital goods and to prevent disruptive failures, companies stock critical components and replace defective components with ready-for-use spare components. Since critical components represent a significant financial investment, defective components are usually repaired and put back in stock rather than discarded.

Companies often have the possibility to expedite the repair of a defective component. Although expediting comes at an extra price, it can significantly reduce the required initial financial investment in spare parts. Consequently, in the design of spare parts inventory systems, decision makers typically face two major questions:

1. How many spare parts should the company initially purchase and place at each warehouse?
2. When should the repair of a defective part be expedited?

We developed a decomposition and column generation based algorithm that assists decision makers in answering these questions. This optimization model minimizes the total investment costs in spare parts while satisfying constraints on the availabilities of different capital good types and on the amount of repair work that is expedited per repair resource. We performed a case study at the Dutch Railways and showed that our optimization model leads to saving potentials up to 36 percent compared to the current way of working.

Figure: Example of the type of spare parts inventory systems under consideration: A passenger railway operator, whose fleet consists of two train types and where each repairable requires one of the two available resources for its repair.