On a Merging Reduction of the Process Network Synthesis Problem

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In a manufacturing system, materials of different properties are consumed through various mechanical, physical and chemical transformation to yield desired products. Devices in which these transformations are carried out are called *operating units*. Thus, a manufacturing system can be considered as a network of operating units which is called *process network*. A process design problem in general means to construct a manufacturing system. A design problem is defined from a structural point of view by the *raw materials*, the *desired products*, and the available operating units, which determine the structure of the problem as a *process graph* containing the corresponding interconnections among the operating units. Thus, the appropriate process networks can be described by some subgraphs called *feasible solutions* of the process graph belonging to the design problem under consideration. Naturally, the cost minimization of a process network is indeed essential where the *cost of a process network* is the sum of the costs of the operating units included in the process network considered. It is known that this problem is NP-complete, and therefore, each reduction of this problem has great importance.

In this talk, a new type of reduction is introduced which is based on the merging of operating units. The mergeable operating units are determined by an equivalence relation on the set of the operating units, and all of the operating units included in a class of the partition belonging to this equivalence relation are merged into one new operating unit. It is proved that this reduction procedure called *merging reduction* has the following property: an optimal solution of the original problem can be derived from an optimal solution of the reduced problem and conversely. The theoretical investigations providing this connection are equipped with an empirical analysis of the merging reduction on randomly generated problems which shows the measure of the size decrease under this reduction type.