Reformulations for Mixed-Integer Nonlinear Programs: a surprisingly simple one with surprisingly good results in a few different applications

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For difficult optimization problems, choosing the right formulation is one of the crucial steps in devising efficient solution methods. Mixed-Integer Nonlinear Programs, which combine nonlinear and combinatorial features, offer many different avenues for developing reformulation schemes; in fact several powerful and sophisticated ones have been proposed. Often times, however, the reformulations trade useful properties (mostly, tightness of lower bounds) for a substantial increase in the problem size. We will discuss results about a simple reformulation technique which applies to a specific (convex) Mixed-Integer Nonlinear structure, where the "Nonlinear" part actually is crucial. The approach has a very limited impact on the problem size (in some cases, the reformulated problem actually has exactly the same size as the original one) while providing sizable improvements in lower bounds and a significant positive impact on total running times if appropriately implemented. A few applications of different types are reported showing the usefulness of the technique.