



## Connections Between Different Projections under the Linear-Quadratic Parameterization

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In applications of factor screening, the utility of different classes of fractional factorial designs are evaluated first by means of their projection properties. Three important and distinct forms of projection have been conceived for two-level designs: geometric projection, hidden projection, and projectivity. Although these concepts are well-defined for three-level designs, their mutual exclusivity depends on the parameterization used in the analysis of such designs. The linear-quadratic system is particularly useful in real-life applications because it yields partially aliased and interpretable interaction contrasts in three-level designs with quantitative factors. Under this parameterization, it is shown that these three projection properties are in fact connected. By means of the connection between geometric and hidden projection, it is shown how the choice of follow-up runs to de-alias factorial effects becomes the simplest exercise in integer linear programming. By means of the connection between a model-based version of projectivity, eligibility, and hidden projection, the run structure of eligible designs are illuminated more clearly, and calculations of D-efficiencies of projections onto different sets of factors are simplified. Ultimately, this investigation demonstrates that these three projection properties are all simply slightly different ways to view a more fundamental mathematical concept for the linear-quadratic system. By focusing attention on this one concept, we can obtain more enlightening results on all three simultaneously than if we dealt with each separately.

**Keywords:** D-efficiency; eligibility; geometric projection; hidden projection.