Multiple-criteria Decision-making in Design Selection and Synthesis

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SUMMARY *Decision-making problems arise at every stage of the design process because of the need to make technical choices. Such problems are usually associated with multiple, potentially conflicting requirements and the creative resolution of these conflicts leads to good designs. This paper examines some of the underlying issues and related modelling strategies, with a view to exploring the rich potential of a generalized multiple-criteria approach to design decision-making. The arguments are supported by simple numerical examples.*

1. Introduction

Decision-making in engineering design can be described as those activities that relate to technical choice, in the context of addressing some stated functional requirements. The technical options may either be available and finite in number, as in consulting a catalogue, or they may need to be synthesized, as in engineering design. In any event, the implicit assumption is that the technical requirements are mutually compatible. This is the domain of classical optimization, in that there exists a feasible solution space that consists of all the technical alternatives that meet the stated functional requirements. If this is not the case, then the requirements have to be revised until they do become attainable and, from this feasible set, a member is chosen that maximizes or minimizes an objective function. This is often a valid and valuable approach for many design problems. What then is the motivation for the multiple-criteria approach?

It can be argued that, within the classic monocriterion paradigm, no specific decision-making is involved. This is because the optimal solution is unarguably identified once the feasible alternatives are established and an objective function agreed on. It is only when conflict resolution is involved that decision-making truly becomes important, and many design situations exist where the stated functional requirements may be in actual or potential conflict. The most preferred solution under such circumstances depends on the designer's or decision-maker's priorities, so that the chosen solution is based on a combination of technical possibilities and designer preferences. It is possible to argue that, in the monocriterion paradigm, any revision of requirements to make them mutually compatible is effectively an implicit statement of preferences; however, by making the necessary trade-offs transparent and capable of manipulation, the multiple-criteria view often clarifies the situation, and so leads to better decisions overall.

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0954-1828/95/030207-24