DISCUSSION

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Ranganath Shastri: 1) The graphic approach for selection stages is certainly an excellent one. How do you envisage incorporating factors such as processability, joining etc, which are non-numeric? 2) If you extend the method to specific grades as opposed to generic products, do you think response time will be adversely affected. How would you address this issue?

Mike Ashby (author's response): 1) Non-numeric data are presented as bar charts, using a ranking 1-5 for good-to-bad. Materials are selected by choosing a sector of the bar chart (the top, for instance), isolating a subset of materials with a given performance by this criterion. A parallel procedure for process selection is under development. 2) We expect the response time to remain good when more materials and grades of material are included.

Adrian Demaid: Materials selection is not necessarily a convergent problem. For example, both kettles and coffee cups are made profitably from all classes of materials. Does your system impose convergence to an artificially *best* material or is it possible to formulate questions which maintain generality of response (perhaps a best polymer, metal and ceramic)? Materials selection can depend crucially on detail. For example, nylon, polypropylene and acetal can compete sensibly for use as polymers to make jug kettles. Polypropylene has a waxy feel and attracts dust in shop windows. Can generic, top-down, numeric systems be used to select polymers?

Mike Ashby (author's response): The EMS method generates a short list of candidate materials which optimally satisfy the primary design goal; then this subset is subjected to further selection steps applying further design goals. The scheme retains (when appropriate) candidates from all classes. We ran your example: the coffee cup. Taking the first design goal as "adequate stiffness at minimum cost" (so that the cup will not bend inwards when picked up) gives candidates which include glass, pottery, aluminium, iron, wood, a number of polymers (including PE) and low-density foamed polymers. If the cup has no handle (as with cups in coffee machines) then the secondary design goal might be that of low thermal conductivity -on this criterion, polymers, polymer foams and wood are preferred to aluminium and glass. But if the cup has a handle, isolating the fingers from the cup wall, the tensile strength (to resist the tearing of the handle from the cup under the weight of the contents), then - applying the criterion of strength favours aluminium, glass and solid polymer. So the initial choice depends on a set of design goals. The subset generated in this way is then examined for manufacturability, aesthetic appeal and so forth.

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