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Thoughts on Comparison of Alternatives

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Abstract

Buried in alternatives? Worried you can't tell the winners from the losers? Does your comparison process seem to go on forever, or get re-directed with each management review or new player that comes along? These are all common symptoms of a few basic process problems, and readily corrected once the root cause is understood. Even if your overall process seems to work reasonably well, following a few simple strategies will allow you to tune it to match the needs of each specific task- lowering your cost and cycle time while still reliably producing the best possible decision.

Introduction

Whether engaged in design or manufacturing, life is filled with alternatives. Various design approaches must be compared and a preferred option identified, vendors must be compared and selected, and production variables optimized. Regardless of the nature of the decision that needs to be made, some aspects are constant:

- There needs to be a defined goal or objective that is sought.
- There needs to be a set of alternative ways the objective might be met.
- There needs to be a basis for preferring one alternative over another.

In some cases, often manufacturing related decisions, the objective and comparision criteria are well understood in advance and the only variable is selection. In other cases, typically encountered during design, all three aspects are subject to simultaneous discovery and definition. Compounding both situations is the degree of overall complexity involved and the need to break overall benefit down into smaller "manageable" attributes.

The Problem with Standard Methods

Standard methods, per se, are fine so long as they are used in standard situations. Even then, success requires a degree of discipline that is often absent in organizational settings. Few software packages and training seminars are sold by promising to help you make complex decisions using robust but inherently complex analysis methods!

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There Is No "Best Method"

It's common to hear people advocate one method as better than another, and while that may be true *in a given situation*, it is a dangerous oversimplification to have only one tool available for all tasks.

The real goal is not to automate decision making by implementing a single “perfect” process, but rather to selectively employ a family of processes that assist decision makers by efficiently organizing available information, highlighting missing data / potential impact, and weeding out clearly unfavorable choices.

Early in the innovation cycle the rule is “if you can’t prove it’s impossible, keep it under consideration”. At entrance to manufacturing, the test must become “if you can’t prove it’s possible, under all combinations of foreseeable circumstances, then you must eliminate it”.

The completeness and level of definition may vary widely, but the process ultimately comes down to a structured comparison not of alternatives to each other, but of systems of alternatives against systems of criteria. The relative ranking of alternatives is derived from how they stack up against the goal, top to bottom, not how they stack up to each other.

Why make a big deal of this seemingly trivial distinction? First, it honors the need for good evaluation and design criteria, second, it avoids the trap of selecting the least bad alternative and thinking it’s a good one.

The choice of appropriate comparison method is determined by:

1. The nature of the intended comparison goal (retain the possible / remove the impossible) and required confidence level
2. The degree to which the available alternatives are comprehensive representations of the full option set
3. The availability and type of descriptive information about each alternative
4. The degree to which the criteria (goals, requirements, needs, or what have you) are complete and representative of the true overall objective
5. Knowledge of, and access to, tools and methods that make the most of the available information within defined resource and time constraints

The law of diminishing returns surely applies, as do basic principles of significance.

Thus any method that requires extensive guessing about attributes is almost certainly a waste of time, since the cumulative impact of the embedded guesses will compromise confidence in the result. On the other hand, any method that does not take into account information that is either on hand or readily obtained is guilty of wasting an opportunity.

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Thus the goal is not to find “the best comparison method”, but to find the best match of method to circumstances based on a continuously varying set of conditions. This implies that the evolution of increasingly powerful methods should follow the initial screening cycles. With lots of initial candidates, each known only superficially, the goal is to include the path towards any possible winners. As the pack thins, an investment in greater information is paid back with access to more formal methods and increased confidence in the resulting decision.

Rationalization is not Analysis

Ironically, more comparison tools are used to defend a decision already made than are used as the basis of reaching that decision in the first place. Consider what this says about the methods: a) the results they deliver aren't as good as simply working from experience and instinct, or b) the results might be good but the discipline to use the tools is lacking. In either case, the investment made in applying the tools is essentially wasted.

Lack of discipline can sometimes be related to immaturity or a failure to understand true importance, but the lack of faith in the methods themselves is often a realistic and supportable viewpoint. This is particularly true when decades of subtle engineering and market experience are forced to fit into simplistic "red/yellow/green" scoring systems.

A Realistic Goal

To apply available data, in the simplest practical manner, to achieve a defensible decision and simultaneosly understand the degree of confidence associated with that decision.

Adding *confidence* to the equation introduces examination of not only the decision, but also the means used to reach that decision. Ambiguity in "pass/fail" criteria thus becomes part of the useful output instead of being suppressed. The degree of definition associated with a given alternative is itself assessed, and used to either increase or decrease overall confidence.

Thus the larger purpose of the comparison becomes:

- Understanding of the objective being sought, including the degree to which the existing definition fully captures all of the required characteristics.
- Understanding of how well the defined alternatives represent all available options allowed by the overall problem space, and for each individual alternative, how fully complete the definition may be.
- Understanding of the type and relative importance of all factors that make an alternative more or less desireable, along with the trade-off functions involved.

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Why Words are Better than Numbers

When numeric scores are assigned, a form of "lossy-compression" takes place. A complex mental assessment of factors goes into selecting a number, but the number cannot be reversed to provide visibility into the path used to create it. The only way to avoid this problem is to capture a clear basis of estimate for each numeric score. Thus a weighted matrix ideally contains a paragraph explanation, accompanied by a score, rather than just a score by itself.

Common Challenges and Response

Iterative Design The interaction between understanding the goal and proposing alternatives is central to all meaningful design, and each additional insight to goals opens up new alternatives, which in turn creates a richer understanding of the goal. While healthy for design, this iteration cycle means that comparison of alternatives should also be considered iterative to the extent that the underlying requirements are still being defined. Thus the benefit (and associated goal) of early trade studies is not final selection but rather an understanding of the goals and alternatives. During this period, understanding is far more valuable than scoring, and results should be described in qualitative rather than quantitive terms. (A spreadsheet filled with words can be much more useful in capturing / sharing knowledge than one filled with only numeric scores or color assessments.)

Limited Range of Alternatives The range of alternatives should consider the total set of possible solutions. The difficulty of imagining a comprehensive set of alternatives, combined with the number of discrete variants, usually results in "blind spots". Top-down analysis methods can ensure a full set of potential solutions are represented, however superficially, in the earliest iterations. The goal then becomes to screen out classess of alternatives which are obviously dominated by other solution types.

Limited Visibility to Novel Features Related to the previous challenge, but arising in this case from comparison at too high a level. As an example, two door lock designs may be readily compared to each other, but fade to insignificance if viewed at the level of the entire car. The solution is to compare key differences as discretely as possible- not as part of a substantially larger common base.

Dependency Between Attributes The ability to break large problems down into simpler pieces is central to most design effort, but there is an implied presumption of independence that may or may not hold up in practice. In particular, assessments of "complexity" "risk" "reliability" "cost" and like factors are often *strongly dependent* on the same underlying design characteristics. The net result is to unintentionally give higher effective weighting to one or more design characteristics. Assessment categories should be as discretely independent of one another as reasonably possible, and whenever dependencies do still exist, they should be clearly identified and the results suitably caveated.

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Rigid Scoring Systems Formalized conversion of opinions based on incompletely defined alternatives and attributes should always be viewed with skepticsm. It is much easier to juggle numbers to yeild the intended result than it is to argue specific merits and drawbacks. Scores that *follow* comprehensive analysis and understanding aid in the communication of results- scores that *precede* understanding prematurely end the process and distort results.

Conclusion

There are dozens, if not hundreds, of different tool classes that can be effective aids depending upon the complex mix of available information, point in the development cycle, and required confidence in the results. No single method can be called "best".

Concentrate instead on detailing the underlying goal and identifying a comprehensive range of alternatives. Use language based comparison of alternatives and desired attributes as a design tool, and stay in language based references until such time as the basis for selection becomes essentially stable. Scores then become a useful way to present results rather than a substitute for good judgement and the responsibility to make informed decisions.

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RELATED REFERENCES

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BIOGRAPHY

Mr. Iliff has over 30 years experience working on developmental projects ranging in size from a few thousand to well over a billion dollars, and has participated in all phases of project execution from proposal to close out. He has held Proposal Manager, Project Manager, Systems Engineering Manager, Engineering Manager, and other related titles in multiple industries, and is now the Director of Strategic Innovation and Senior Systems Engineer for Bjorksten | bit 7 in Madison, Wisconsin. He earned his B.S. in Engineering / Industrial Design from Michigan State University, holds an M.S. in Systems Management, Research and Development from the University of Southern California, and received Honorary Fellow appointment at the University of Wisconsin Antarctic Astronomy and Astrophysics Research Institute when he served as the Systems Engineering Manager for the ICECUBE project. Mr. Iliff is a charter member of the International Council On Systems Engineering (INCOSE), founder / prior Chairman of the INCOSE Commercial Practices Working Group, and a member of the Project Management Institute (PMI).

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