The Silver Bullet Syndrome: A Critique of Decision Analysis

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Origins of Decision Analysis

Since the dawn of history societies have sought to illuminate the future, to predict adverse events and to anticipate the consequences of action or inaction. Primitive societies, lacking the tools to comprehend the complex interplay of cause and effect in the natural world tried to draw insight from various augurs, like reading the pattern of tea leaves left in a cup to perceive future events.

Over many centuries societies gradually developed tools to understand the natural world and mankind's place in it. Ancient Greek civilization contributed not only foundational mathematical tools and processes, but also the Socratic method of inquiry and deductive reasoning. Later civilizations, Hindu and Arab, further developed mathematics in numeric systems and algebra. The Renaissance in Europe contributed Newtonian physics, advances in trigonometry and calculus, and even accounting methods.

The beginning of the industrial age brought developments such as probability and statistics, and Bayes' theorem for dealing with conditional probabilities. These cognitive tools fueled a scientific and industrial revolution, from discovery to manufacture. The physical world came to be seen as predictable, along with the results of human intervention.

The origin of modern decision analysis was Operations Research, a discipline that arose in World War II. The objective of Operations Research was to provide "a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control" [1]. Operations Research was successful in helping war-planners determine things like the optimal distance under the sea for antisubmarine depth charges to explode, or the optimal search patterns for aircraft to locate enemy submarines. The success of the Operations Research methodology validated the use of analytical models for optimizing the performance of technological systems.

After the war various contributions were made to the mathematical models of decision theory, in the areas of uncertainty and game theory, and computers facilitated complex calculations. More importantly researchers began to examine the psychology of decision-making in attempt to explain the descriptive (observed) behavior of decision-makers as opposed to the normative (rational) behavior predicted by models.

Decision Analysis emerged from the field of decision theory, and it focuses on the application of decision theory to complex, real-world problems. The prescriptive approach of Decision Analysis has been employed not only by the military, but also by industry and government. Many contemporary business management strategies, with a variety of names such as Total Quality Management (TQM) and Six Sigma, are descendants of the decision analysis framework.

Foundations of Decision Analysis, and Applications to Socio-technological Problems

There are four pillars of Decision Analysis: Systems Analysis, Decision Theory, Epistemic Probability, and Cognitive Psychology [2]. Systems Analysis grew out of Operations Research, and its key concepts are state variables, feedback, stability, and sensitivity analysis. Decision Theory is concerned with making decisions in the face of uncertainty. Epistemic Probability further defines decision criteria as subjective – bounded by what a decision-maker knows (and does not know). Cognitive Psychology explores the implications of what decision-makers actually do (descriptive) as opposed to what a rational model of choice would dictate (normative).

The latter half of the Twentieth Century brought global communications and trade on an unprecedented scale, and along with it decisions in the public and private sphere of enormous complexity and far-reaching consequences. From the environment to the economy, the impact of decisions made in New York, London, Paris, Moscow, or Tokyo are felt around the globe. In a sense, everyone on the planet is a stakeholder now.

At the same time the end of the Twentieth Century has seen the rise of democracy around the globe, and with it a promise of transparency in governance. The most valuable aspect of Decision Analysis in this context is to formalize the decision-making process, to delineate the problem, the options, the trade-offs, and the expected results of various courses of action. The process by which decisions are made, both in public policy and in corporate governance, has become ever more explicit. Voters and shareholders have come to expect that leaders will employ more than intuition in determining the direction of their enterprises.

The rapid evolution of technology and the complex interplay of various industrial processes have introduced a great deal of uncertainty in the decision-making process. Systems Analysis has demonstrated that it can improve efficiency of production and decrease manufacturing defects when the values of variables are known. But when technologies and processes are new, the values of probable outcomes are much harder to determine. Accounting for uncertainty in the values of probabilities, Decision Theory models allow for various scenarios to be constructed, facilitating contingency planning, and hedging risk.

However useful the process of Decision Analysis, and no matter how elegant the formulas for determining probable outcomes, decisions are made by humans, who are not rational actors, and who do not possess perfect knowledge. Epistemic Probability attempts to define the realm of possibilities known to the decision-maker, not the entire set of solutions to a problem. More importantly Cognitive Psychology research has revealed many of the biases decision-makers bring to problem solving. Acknowledging their preference for certain outcomes, decision-makers may be able to factor out some of the bias that influences their choices.

The most fruitful area for socio-technological research in Decision Analysis is the human factor in decision-making. Sophisticated mathematical models and powerful computers have provided the means by which complex choices can be quantified and outcomes extrapolated. But many important variables, such as the value of innovation, are hard to quantify. Even if acceptable values can be established, will decision-makers abide by the evidence presented to them?

Limitations of Decision Analysis

Human judgments are not described by normative theory, but can be captured in terms of heuristics and biases [3]. In assigning weights to probabilities of risk or success, decision-makers rarely make an unbiased rational choice. Framing effects, or how the problem is posed to the decision-maker, further complicate the response. Decision-makers are generally risk-averse with gains, and risk seeking with losses. If an option is posed where the upside of a decision is emphasized and the downside is minimized, it will be the most likely choice, even if it is not statistically different than the outcomes of other choices. Furthermore, Primacy and Recency effects confer disproportionate weight to initial or final stimulus.

There are three heuristics: Availability, Representativeness, and Anchoring and Adjustment. The first heuristic, Availability, states that decision-makers assess the probability of an event based on the degree to which instances come to mind. The second heuristic, Representativeness, asserts that when making a judgment people consider the degree to which the specific information represents a relevant category or population. In other words, choices are made based on cognitive templates and associations of the decision-maker – the new information is made to fit a preexisting model. The first two heuristics can be subsumed into a heuristic called Attribution Substitution. If a target attribute is inaccessible to the decision-maker, one that readily comes to mind is substituted, especially if it is vivid or emotional. The third heuristic is called Anchoring and Adjustment. This heuristic contends that probability judgments are made by starting with a number that easily comes to mind and adjusting for additional information. The initial starting value is essentially arbitrary.

In addition to heuristics, decision-makers labor under the burden of several common biases. In general, decision-makers do not have perfect knowledge and tend to focus inordinate attention on evidence that confirms their existing beliefs. This is called the Confirmation bias, and is driven in part by self-serving motives. Similar to it is the Overconfidence bias, which is the tendency to overestimate one's own knowledge and ability in spite of what reality may dictate. The Overconfidence bias prevents decision-makers from seeking additional evidence, or contrary evidence, and also precludes objective analysis of their efforts and accomplishments. The Hindsight bias, or the "knew it all along" bias, is related in that it precludes an objective assessment of failed decisions.

Making choices is hard work, often inducing anxiety and stress. Many decision-makers are tempted to go with choices that are "good enough" and are similar to decisions that have been made before. This is called the Status-quo bias. Moreover a decision point may come after a series of choices where investment in a particular approach has already been made. Even if the choice is not optimal, the weight of the previous choices and investment makes adopting a new direction less desirable. This is called the Sunk-cost effect. Particularly when the status of the decision-maker is on the line for previous choices, the Sunk-cost effect may lead to Escalation of Commitment. The rationale for an Escalation of Commitment is not that the hypothesis was wrong, but merely that the application was not thorough or robust enough.

Silver Bullets and Six Sigma

In Western mythology a silver bullet was a weapon that could slay an otherwise indestructible monster. In modern terminology a "silver bullet" is an analogy for a simple and easy solution that can solve the most vexing and complex problem. Belief in (and preference for) such a solution is referred to as the Silver Bullet Syndrome.

Numerous business management strategies vie for adoption by managers in the corporate world today. These programs have appealing titles and sophisticated marketing materials. Many of them make sensational claims of improving efficiency, increasing sales, reducing time to market, and more. The most famous of the current field of contestants is Six Sigma.

Six Sigma was developed by Motorola, USA in 1981. The strategy originally sought to improve the quality of products by identifying and removing the causes of errors through minimizing the variability of manufacturing and business processes. It employs quality management and statistical methods to achieve a high rate of defect-free products. The name refers to a sigma rating of a manufacturing process determined by yield. Thus a six sigma process has a 99% rate of defect-free products, while a one sigma process has only 31% defect-free. By 2006 Motorola claimed $17 billion in cost savings due to its Six Sigma program.

The Six Sigma program soon attracted the attention of other large corporations, notably GE under the leadership of Jack Welch. By the late 1990's about two-thirds of the Fortune 500 companies had initiated some form of Six Sigma program. Motorola licenses the Six Sigma program, and numerous training providers certify practitioners as "Master Black Belts", "Black Belts", and "Green Belts". Six Sigma projects follow a methodology pioneered in the 1950's by W. Edwards Deming, statistician and quality control specialist, called Plan-Do-Check-Act (PDCA). The Six Sigma variant is called DMAIC, for Define, Measure, Analyze, Improve, Control.

However, Six Sigma's benefits as a quality control strategy did not transfer well to service-oriented businesses, such as Home Depot, or companies where technical innovation is key to their success, such as 3M. A *Wall Street Journal* article, "The Six Sigma Factor for Home Depot", claims that the departure of CEO Robert Nardelli was caused in part by Six Sigma "not panning out as promised" [4]. The article cited grim statistics for the retailer – a decline in stock price of 8.3% since implementing Six Sigma, compared with a 16% rise in the S&P 500 index over the same time period (during a housing boom). An analyst is quoted in the article as saying, "the retail sector is a very human thing… That's a lot different than running a light-bulb plant efficiently". A *BusinessWeek* article, "Six Sigma: So Yesterday?", claims the effect of the relentless drive for efficiency at the heart of Six Sigma irritated Home Depot's customers, and "Home Depot dropped from first to worst among major retailers on the American Customer Satisfaction Index in 2005." [5]

The "human factor" was significant at another Six Sigma adopter, 3M. In a *BusinessWeek* article, "At 3M, A Struggle Between Efficiency and Creativity", the critique is that the singular focus on efficiency "made 3M a less creative company" [6]. The article states, "At the company that has always prided itself on drawing at least one-third of sales from products released in the past five years, today that fraction has slipped to only one-quarter." The article goes on to state, "Those results are not coincidental.

Efficiency programs such as Six Sigma are designed to identify problems in work processes — and then use rigorous measurement to reduce variation and eliminate defects. When these types of initiatives become ingrained in a company's culture, as they did at 3M, creativity can easily get squelched. After all, a breakthrough innovation is something that challenges existing procedures and norms." The CEO of 3M, George Buckley, who is dialing back his predecessor's implementation of Six Sigma, is quoted in the article as saying, "You can't put a Six Sigma process into that area and say, well, I'm getting behind on invention, so I'm going to schedule myself for three good ideas on Wednesday and two on Friday. That's not how creativity works."

The *BusinessWeek* article identifies the unintended consequences of applying a quality control strategy in the wrong context. "Indeed, the very factors that make Six Sigma effective in one context can make it ineffective in another. Traditionally, it uses rigorous statistical analysis to produce unambiguous data that help produce better quality, lower costs, and more efficiency. That all sounds great when you know what outcomes you'd like to control. But what about when there are few facts to go on—or you don't even know the nature of the problem you're trying to define?"

Conclusions

Decision Analysis (or Decision Science, as some practitioners would prefer to call it) is a new field. Applied in domains where the values of components are established, such as industrial processes, Decision Analysis has proven its utility in assisting managers to optimize output. However, many business decisions involve components that are difficult to quantify, such as the value of innovation. In such cases application of the Decision Analysis process may produce unintended consequences, such as stifling creativity.

Success in one domain, for example reducing cost and increasing efficiency, may not transfer to another domain, such as increasing customer satisfaction. Yet there is a tendency to believe in "silver bullet" solutions, especially if they are derived from impressive formulas and rendered by powerful computers. The danger is that too much faith may be invested in risk models that are flawed because the values of important variables are unknown. Managers will then implement policies confidently and vigorously, unaware of unintended consequences with the potential for catastrophic error.

The global financial meltdown of 2008 was in part driven by faith in complex risk models that did not warn managers about excessive leverage. Risk assessments of various energy projects, such as offshore drilling, have a similar record of understating or overlooking the potential for catastrophic damage.

In a complex, interconnected world with powerful technological forces in play, the impact of low-probability but high-risk scenarios can be global and enduring. While Decision Analysis is a valuable tool in assessing risk, it should be recognized that as a discipline it is far from mature.

References

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