Model-based Strategic Knowledge Elicitation

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Abstract: Strategic problems are difficult. They often only exist in the mental models of some top managers. They are typically too vague to be given a precise meaning, yet at the same time concrete enough to cause discomfort. They cannot be discarded but they cannot be tackled either because the means for diagnostic and solution are lacking. The body of knowledge of strategy offers little help, in the sense that a set of tools for strategic problem solving does not exist, in practice. In science and engineering, problem solving is model-based. In the past, the social sciences and management have discarded model building due to its inherent difficulties. Today, the means are available to elicit knowledge about the symptoms of strategic problems, create a model to obtain a solution, and produce an implementation plan.

1 INTRODUCTION

In service or manufacturing organizations, information about delivery delays or quality issues is frequently handled down the ranks, according to well-understood business policies. Problems are to be solved right away, and managers at all levels are allegedly there for that purpose. Unsolved problems are a threat, and those managers will do their best to hide their existence. Eventually, top management may get rumors of cost overruns, but there will be no reason to change policies if some explanation can quickly be rationalized. Top managers may only acknowledge there is a problem when outright failures can no longer be disguised. Then, as they start to feel uncomfortable, something needs to be done.

Problems are noticeable through their symptoms, but symptoms cannot be confused with problems. Sometimes symptoms must be dealt with immediately, fully realizing there must be some underlying reason for them but also knowing that searching for that reason is a luxury that cannot be afforded. Consider the familiar example of the kid with fever. The fever must be brought down, but once the symptom is gone its causes may be difficult to trace. If there are recurring symptoms, the physician will ask questions to elicit knowledge about them. Interviewing is the most common knowledge elicitation technique, in this case used to translate the patient's mental model into a diagnostic. A diagnostic is yet another model, which will be validated through further tests and checks.

Keeping a log of the symptoms, even if in the mind, is key to establishing reference modes for problem behavior. Without at least an implicit description of how symptoms evolved over time, no problem is ever acknowledged. We all believe we can solve problems, but only the problems whose nature we understand. Early in our lives, the problems were given to us. We now consider them simple, but their answers only came if we applied the right procedures. In fact, the chosen procedure coerces the nature of the problem. Academia keeps reinforcing this pattern: we have financial problems, marketing problems, and so forth. Most problems in organizations are dealt with by executing procedures established by policy.

Problems that defy policy are difficult to acknowledge (Argyris and Schön, 1978). Devising policies to cope with emerging problems is the role of strategy. A strategy begins to unfold when top managers start feeling uncomfortable about some problem. At that point, the diagnostic consists of rightly capturing the problem symptoms. The solution consists of identifying what procedures need to be stopped or created from scratch, where the sequence of steps for doing so is called implementation. Therefore, the challenge for knowledge management research is eliciting problems early, at forming stage, rather than waiting for them to creep up and become serious.

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2 BACKGROUND

2.1 A Recurring Issue

Strategic management topics carry a certain glamor and are quite popular among business students. The classroom problems covered are challenging and generate ample discussion. Nevertheless, business strategy implementation remains problematic, perhaps since the inception of the concept. Because this fact remains mostly unacknowledged, we keep producing strategies, and we keep believing we follow them, but we actually rarely describe how to implement them.

One might think that strategic management practitioners would know better. The promise of strategic management is to identify what is important to do now in view of intended future performance. And yet, most practicing strategists don't seem to follow through the implementation of their strategies. Without proper implementation, no claims can be made about the quality of a strategy. Unfortunately, at the end of the day, companies keep struggling with how to make their intentions show up in the bottom line.

The worst case scenario is when strategy theory becomes akin to "the emperor's new clothes". When a strategy fails, executives and managers dare not blame the failure on the approach they use, seeing as others are seemingly following the same approach and allegedly doing well. Successive companies spend fortunes to buy or devise strategies that never produce the intended results, sometimes even the opposite. Repeatedly failing to produce the intended results reveals a bankrupt approach.

2.2 Approach

Blaming failed strategies on difficult times, bad management or bad implementation is tempting, but the argument does not hold water. According to Warren (2012), both the theory and the practice of strategy are seriously flawed. Adcroft and Willis (2008) explained that the reason is because knowledge transfer from academia to practice is flawed. Thomas et al. (2013) concurred, stating that the dominant concern of academia appears to be a need for self-justification rather than practical application. Therefore, left mostly on their own, practitioners built a less than flattering track record (e.g. Craig, 2005; Kihn, 2009; O'Shea and Madigan, 1998; Pinault, 2001).

Isaac Newton is credited for having said "If I have seen further it is by standing on the shoulders of giants." The strategic management body of knowledge contributes little to understand why people rely on strategies whose implementation keeps failing. To avoid this syndrome, a mathematical metaphor from Kurt Gödel's incompleteness theorems (about inherent limitations of formal systems) suggests that one should search outside the current body of knowledge to deal with the limitations of strategic management.

This possibility is supported by Johansson (2006), who argued that intersectional innovations, combining different knowledge sources, create opportunities for research and teaching. This paper uses key historical references to provide a contribution from the systems sciences to strategic knowledge. Some fundamental principles, that were available since the birth of the field, have apparently been overlooked or forgotten by strategy makers.

3 THE SYSTEMS SCIENCE VIEW OF STRATEGY

3.1 Origins of Strategy in Systems Science

Engineering design and construction relies on finding solutions to mathematical models that incorporate knowledge about relevant laws of nature and desired system properties. For a set of initial conditions and environmental parameters, those solutions depict the characteristic behaviors of the system as functions of time, and show how the system can evolve in response to different inputs. A model with good predictive power cannot be derived when knowledge about system properties is scarce. Then again, without such knowledge, one strategy is as good as the next.

Strategy practice doesn't use mathematical models because management theory seldom uses mathematics to build knowledge about system properties. The common belief in the social sciences that useful models are descriptive, without predictive capabilities, was acknowledged early in an article published by the "Society for General Systems Research" Arrow (1956). Adding to the proof that systems knowledge was part of a manager's background, the influential theorist Chester Barnard was a member of the Society.

In those early days, general systems and cybernetics authors were seeing common feedback dynamics properties across disparate knowledge domains, quite different from engineering or physics. (The term "cybernetics" was probably intended to interest an interdisciplinary audience in the mathematical modeling background of control theory.) Among those authors was von Bertalanffy (1968), from the Psychiatric & Psychosomatic Research Institute at University of Southern California and one of the founders of the Society.

Another early relevant author was Ashby (1956), trained as a Clinical Psychiatrist but landing with a double appointment at the Departments of Biophysics and Electrical Engineering of the University of Illinois. Ashby proposed the Law of Requisite Variety, saying that a controller must have at least the same number of states as its target system. This was a fundamental result for engineering. In face of an arbitrarily large variety of disturbance inputs (Figure 1), a system's output only behaves according to its reference input if its controller follows good enough a model to produce at least an equally large variety of counteractions.

This law is fundamental for strategic thinking. As referred at the outset of section 2.2, blaming failure on difficult times or something else is always easy, in hindsight. Since the mid 1950s, it was known that a strategist attempting to oppose the organizational environment without at least an equally vast repertoire of actions was doomed to fail. Yet this principle is ignored by current strategists, which leads to the following:

Proposition 1: strategy makers confined to data analyses and to outguessing their environment miss the chance to create procedures that can face disturbances.

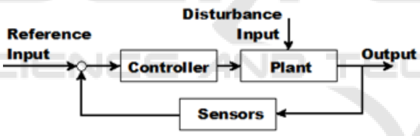

Figure 1: Basic control loop as a strategic management metaphor.

3.2 Models and Systems

Another reason why strategy theory doesn't use mathematical models to increase knowledge about system properties lies in the common misperception from social sciences that the complexity of issues is an impediment to finding useful solutions. Engineering copes with complexity by solving increasingly sophisticated mathematical models. For instance, work never ceased after Alexander Graham Bell's 1876 patent for the electric telephone. Bell himself and Thomas Edison were earlier pioneers. As interest grew, problems brought by increasing telephonic traffic became more complex. The solution of newer mathematical models successively led engineers from direct connection to manual switchboards and to worldwide switching.

Complex challenges require sophisticated solutions. System Dynamics authors distinguish two kinds of complexity. Combinatorial or detail complexity occurs when many variables can take many values. Dynamic complexity occurs when effects dont directly follow causes in time and space. Besides these, there is a third kind, equally important for strategy implementation: communication complexity occurs when uncertainty in task execution calls for intensive information exchange among participants. The mathematical relationship between uncertainty and information was established back then by Shannon (1948).

Regardless of how complex a challenge may be, strategists believe their solutions are enough for a strategy to succeed. In the absence of a powerful systems description language, faulty hierarchical communication is often blamed for strategy implementation failures. Furthermore, most modern strategy textbooks also concur that the management of strategy implementation is more art than science. This near euphemism at least acknowledges the limitations of the science principles in use in today's practice, which leads to the following:

Proposition 2: strategy makers who overlook science and proper description tools must live every day with the risk that resulting outcomes may be detrimental.

In the early 1940s, at Bell Telephone Laboratories, the discipline of coping with complexity became known as Systems Engineering. The challenges to communications engineering had grown past the models of physical systems to include social concerns such as user behavior. Integrating knowledge from different technical domains was already difficult within engineering alone, because different specialties used different vocabulary and graphical notations. In other fast growing fields, pioneers faced with identical problems felt compelled to come up with different representations (Olle et al., 1982).

Over time, different representations evolved into the Systems Modeling Language (SysML), which became a standard in 2007 (Friedenthal et al., 2015). SysML addresses many known modeling difficulties. Besides technological sophistication, systems models can now represent the richness of business and managerial interactions by taking into account the characteristics and behaviors of human users and operators.

SysML models can describe personnel, facilities, process, and performance requirements for a wide range of systems. They also contribute to better communication between people of different backgrounds. The implication for strategy implementation is that procedures can be richly communicated in SysML using terminology germane to each area of expertise.

4 THE DESIGN FRAMEWORK VIEW OF STRATEGY

4.1 A Theory of Designed Strategy

Engineering is the design and construction of systems to meet performance goals. The Accreditation Board for Engineering and Technology defines ”design” as the process of devising a system, component or process to meet desired needs. Engineering design is iteratively revised to remove deviations from the specification. Then, using constructive methods, implementation is made according to design.

Relying on quantitatively verifiable intentions is the fundamental difference that separates strategy design from the ad-hoc adoption of whatever tools are at hand. An example of a handy tool is the widely used Balanced Scorecard (Kaplan and Norton, 1992). Created for performance monitoring and control, it is often misused for strategy specification or design. However, even in engineering, the best construction and operation practices (means) will not yield results in the absence of design goals (ends). This leads to the following:

> **Proposition 3:** strategy makers who confuse ends with means increase the risk of implementing the wrong procedures.

In turn, ends are stated as specifications, which are formal quantitative descriptions of required functionality and behavior. Specifications describe what a system does when responding to inputs, but not how the system does it and much less how those inputs originate. Organizational inputs are internal or external disturbances. Seeing an organizational strategy from the perspective of a system that can be designed leads to the following:

> **Concept 1:** the specification of a strategy quantifies performance metrics for desired behavior in response to inputs.

All systems take inputs and deliver outputs. The output of a strategy is the set of policies (procedures) that cover expectable system behaviors, often including rules for handling exceptions in regular transactions. Like all complex systems, organizations are sensitive to external events, often of unknown origin and nature. A common practice to cope with uncertainty is to brainstorm around hypothetical events and build scenarios accordingly. These scenarios may have the merit of making people think about issues, but they help solve no real problems whatsoever. To actually solve those problems, competitive challenges and external events need to be thought of as just alternative system inputs. What matters is not the nature of those inputs but their impact on the system, and the consequences thereof. This thinking leads to the following:

> **Concept 2:** behavior-based scenarios describe a system’s response to changes triggered by unspecified arbitrary events.

Over the years, performance standards and other engineering principles have been extended from physical to software systems, and then to management systems. Kurstedt et al. (1988) defined a management system as the set of responsibilities of a manager bounded as a system. They generalized the definition of manager to anyone who uses information to make decisions that result in changes in the managed operations performance. Faced with external events, managers make decisions and issue policies and directives to control outputs. This leads to the following:

> **Concept 3:** the output of a management system is the net change in the operations performance that results from implemented policies.

A common dictionary description of ”design” is ”to plan the form and structure of”, whereas ”to plan” refers to ”any method of thinking out acts and purposes beforehand”. Therefore, to design is to predict what a system will do and what behavior it will display when properly built and operated in its environment. The term ”properly” implies the adoption of engineering principles throughout the system life-cycle. Too many strategies are put together not on a predictive basis, but rather on a wishful thinking basis. Designed strategies produce systems that respond to external events (disturbances, inputs) with the intended behaviors (performance). In turn, this leads to the following:

> **Concept 4:** to design a management system is to think out beforehand the actions required to respond to external events and meet specifications.

4.2 Strategy Performance

According to Wernerfelt (1984), the result of strategy implementation is the series of business transactions to acquire and dispose of organizational resources. Good implementation covers the whole strategy life-cycle for risks of overspending money and time while performing those transactions. In turn, Fooks (1993) described an approach for improving life-cycles by reducing implementation cost and time. Similar to the concept of product life-cycle, a strategy life-cycle starts when a challenge is acknowledged and finishes when the challenge is considered overcome. Strategy performance is the effectiveness and efficiency with which the management system handles disturbances.

Renowned military strategist Col. John Boyd showed how mental patterns or concepts of meaning must be questioned and reshaped to cope with a changing environment (Osinga, 2005). Boyd explained his well-researched theory in a two-day intensive briefing, which he may have delivered some 1500 times but never published. He held that continually shortening a four-step observe-orient-decide-act cycle (OODA loop) is critically important to outperforming opponents. The OODA loop is inspirational to manage a strategy life-cycle and has many similarities with the plan-do-study-act cycle (Deming, 1952).

The capability to continually evolve mental patterns by detecting and correcting errors is called learning. Argyris and Schön (1978) showed how attitudes and beliefs influence the way people learn to identify and cope with problems. They distinguish single-loop learning, which is repeatedly solving similar problems within prescribed goals, from double loop learning, which is modifying a goal given previous experience. Single-loop learning is effective for operational control (Figure 2). Double-loop learning is a distinct capability that relies on open communication up the ladder, which gives managers the feedback required to adapt the business model to changes in the internal and external environment (Figure 2).

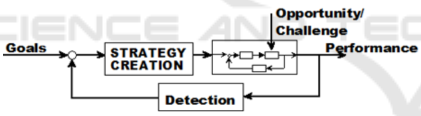

Figure 2: Acknowledged challenges impact single- and double-loop learning.

The function of hierarchical control is to enforce current policy, maintaining desired behavior in face of successive challenges. However, there is a point when current policy can no longer tackle perceived challenges, and a strategy must be devised to deal with them. The timely decision to replace current policy requires the capability to detect emerging problems, which may lie beyond the scope of the strategy as originally conceived. The problem detection process represents the outer double-loop view of how the inner single-loop management control system handles inputs.

4.3 Argument

The likely reason why business strategy implementation still remains an issue is the lack of a sound body of knowledge that supports going from inception to practice. Strategy is all about living tomorrow with the consequences of today's decisions. Faced with the need to state, or specify, the outcomes of decisions, strategists know only how to be vague, hide behind uncertain or turbulent times, and blame whatever mishaps may arise on bad implementation. They can do little else given the tools they have.

Weick (1996) warned against holding so dearly to the tools of the trade that one may lose perspective of whether they still serve their purpose. Strategy is preparing today for what the future may bring. For strategists to be held accountable for the outcome of their decisions, they not only need new tools but also a new paradigm for using them. The paradigm shift is focusing on the consequences of events, instead of on the events themselves (proposition 1). In turn, the consequences of events can be identified using system-based description tools (proposition 2).

The systems view looks at behaviors over time rather than at point figures (concept 1). Considering that behaviors are a systems response to inputs, the paradigm shift consists of building future scenarios around a necessarily finite number of consequence behaviors rather than around guesswork over the countless events that may originate them (concept 2). Then, responding to each scenario calls for adopting policies that drive the desired behaviors (concept 3).

The systems view of strategy also fosters improved preparedness by supporting the creation of policies that take into account the consequences of unforeseen events (concept 4). This approach is quite foreign to current teaching and strategy frameworks. But strategy is about the means to reach desired ends, not to be confused with the means to reach the strategy itself (proposition 3).

5 KNOWLEDGE ELICITATION

5.1 Implications

A business strategy is often backed up by a business plan. Ideally, this plan describes how the operational and financial objectives of the business will be achieved. In practice, the business plan consists mainly of a financial forecast driven by market evaluation. The typical business plan may include sections describing physical operational needs, such as location, facilities and equipment, as well as required people skills and schedules. However, the traditional business plan is seldom a true plan, in the sense that its purpose is to secure approval and financing rather than to provide an execution blueprint.

Blueprints are the outcome of engineering design and a necessary means to share conceptual views when building physical systems. Business strategies deserve no less care. Under this metaphor, a strategy blueprint consists of a comprehensive sequence of activities supported by proven modeling tools. A strategy blueprint contains the functional and behavioral description of the actions that lead to the desired results. The use of this blueprint as a communication and sharing tool for the whole organization becomes a benefit that is far from trivial.

Pfeffer (1993), who received the Academy of Management Review's Best Article Award that year, said of organizational science that the field was losing identity and drifting toward an "anything goes attitude, which seems more characteristic of the present state" (p. 616). Strategic management may be falling into the same trap. Warren (2012) already painted a dark future for strategy, unless methods change. A framework for methods change was suggested by Mendes (2011), although at a price: new methods need to be taught at school before they enter the mainstream, which may be difficult if they go against the current paradigm.

The main obstacle to overcome is teaching formal modeling methods in business schools. Those are mandatory for a proper diagnostic of problems. Not too long ago there was a popular TV show titled Dr. House. The main characters were a team of diagnostic doctors that, in spite of sophisticated analysis methods, would always make two errors in each episode before finally saving the patient. But even as they were making mistakes, they were learning and correcting their mental models. Currently, most strategic problem solving methods rely not on models of the problem, but on causal brainstorming and root-cause analysis, which are ill-suited for the purpose (Mendes et al., 2016).

5.2 Value

System Dynamics is probably the best strategy modeling and diagnostic tool available. Its creator, Jay Forrester, understood the effect of time delays and decision amplification on the dynamic behavior of management systems. Forrester (1958) showed that the pattern of information-feedback relationships among management system components was far more important to explain behavior over time than the components themselves or any external events. This article summarized his 1961 book, which is still in print without revision.

Forrester created both a graphical notation and a digital simulation language to represent dynamic relationships. In his terminology, structure is the pattern of those relationships, not the hierarchical or functional chain of command. All management systems have a structure, whether designed or emergent, known or implied. Changes to the structure can be tested with a simulation model tuned to correctly replicate a behavior that is specified upfront.

This capability to design and test a structure that behaves as specified is a relevant addition to the strategy designers toolkit. Simulation also uncovers unintended consequences and suggests ways to cope with them. However, powerful as it is, System Dynamics never left the academic arena and remains in the realm of specialists. Even for them, knowledge elicitation has been an issue (e.g. Ford and Sterman, 1998; Vennix et al., 1992).

Ultimately, System Dynamics was never massively adopted because the solutions it produces must be interpreted, and the bridge to implementation is not straightforward. In the kid with fever example, the family doctor or general practitioner was the translator between the parents and the medical specialist. System Dynamics needs its translators. Those make it easy to create a System Dynamics model and later, after a diagnostic and solution are available, help translate back to managerial terms what needs to be done. Mendes et al. (2016) described in detail the first step in this strategy formulation process, the use of SysML for problem knowledge elicitation.

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