Real Options or Fool’s Gold? 
Perspective Makes the Difference

McGrath’s (1997) perspective on the value of technology real options is incomplete. Options to defer commercialization arise only if firms first buy the options by investing in technology development. Indeed, coevolutionary innovation processes often require firms to consider commercialization issues and the development of institutional structures simultaneously with—not sequentially to—technology development. In addition, dynamic competitive interactions render these coevolutionary processes increasingly difficult to manage. Hence, managing innovation processes from an options perspective requires careful attention to organization design. Without addressing these facets, firms playing with technology real options are playing with fire.

Coevolutionary dynamics. Technological innovation is a complex journey, from idea conception to commercialization. During this journey, managers continually confront the consequences of past decisions, as well as future choices, as they make tradeoffs between committing Type I and Type II errors (Garud, Nayar, & Shapira, 1997a). At each point managers must decide how to allocate finite resources to develop capabilities, shape institutions, and shape market preferences. Each such decision confers options to continue, expand, contract, or abandon resource commitments (Garud & Van de Ven, 1992).

Underlying these decision choices is an appreciation that technological capabilities, institutional environments, and market preferences do not pre-exist but coevolve (Garud & Rappa, 1994; Van de Ven & Garud, 1993). Coevolution not only implies slippage, but differential rates of creation and decay within different arenas. Consequently, timing is salient, as premature investments in one arena may atrophy if initiatives are not maintained, or they may benefit a free-riding rival, if maintained.

Because of coevolutionary dynamics, the act of purchasing a real option itself influences its exercise date, exercise price, and value of the underlying asset. Accordingly, in McGrath’s terminology, we have to consider not only the variance of net revenues (var $r$) and the variance of costs (var $c$), but also the covariance of net revenues and costs (covar $r,c$). Introducing covariance—which could be positive or negative—renders the impact of so-called preamplifying investments indeterminate and could even make them precluding investments.

McGrath’s model does not consider these coevolutionary dynamics. Rather, her model considers technology development as exogenous (i.e., the technology already exists) and institutions and market preferences as boundary conditions. Indeed, the model does not examine the technology development process at all.

The limitations of McGrath’s perspective are revealed in her example of investments in environmental technologies. McGrath’s model suggests that firms should defer commercialization/adoption of their technologies until regulatory (institutional) uncertainty is resolved. However, technological capabilities may atrophy if not “maintained,” making it difficult for firms to deploy their technologies if and when regulatory uncertainty is resolved (Garud & Nayar, 1994). Technology maintenance entails significant costs. A failure to consider these costs results in overestimating the value of options to defer commercialization.

Instead of deploying resources to maintain or refine capabilities, McGrath suggests that firms redirect resources toward shaping institutional environments by making preamplifying investments to enhance the value of existing technologies. However, outcomes of these initiatives also are uncertain. Preamplifying investments also are real options. Thus, instead of McGrath’s simple analysis of isolated options, firms have to deal with compound or overlapping real options.

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1 We offer only skeletal arguments on a broad set of issues that are more fully discussed in the papers we cite. Needless to say, our arguments build upon the research of many others. Paucity of space prevents us from acknowledging our debt to them; however, their work is cited in our published papers.
**Dynamic competitive interactions.** In analyzing preamplifying investments, McGrath’s model also ignores competitive interactions. Consider a rival firm deploying resources to leap-frog existing pollution-control technologies, even as it free rides on a focal firm’s efforts to shape emerging regulation. Such a situation transpired in the cochlear implants market (Garud & Van de Ven, 1990). Cochlear Corporation focused on developing its technology, even as 3M Corporation (the pioneer) focused on shaping the regulatory environment. Eventually, regulatory uncertainties were resolved in Cochlear Corporation’s favor since it had a superior technology. 3M’s cochlear implants program, starved of resources diverted to develop industry infrastructures, found it difficult to catch up technologically because of time compression diseconomies. This example shows how, in today’s world of Schumpeterian competition, diverting resources for lobbying while deferring technology development and commercialization is like playing to win battles while losing the war.

McGrath suggests that preamplifying investments will reduce uncertainty idiosyncratically for a focal firm. This claim ignores competitive interactions. Consider rivals all trying to shape institutional structures and market preferences. Rather than decreasing uncertainty idiosyncratically for any firm, such competitive interactions will generate multiple and conflicting cues about the merits of any course of action (Garud & Rappa, 1994). Ignoring competitive interactions, again, results in overestimates of the benefits of preamplifying investments.

When confronting ambiguity generated by multiple and conflicting cues, a likely response of firms is “action persistence” (Garud & Van de Ven, 1992). Such an escalation of path-dependent commitments is required to create new technological paths (Garud & Rappa, 1994). However, the same processes may result in “due persistence,” draining a firm’s valuable resources and thereby making it difficult for it to exercise any real options.

**Organization designs to realize option value.** Only an organization designed to benefit from real options can deal with the tensions between action persistence and undue persistence (Kumaraswamy, 1996). Organization designs for realizing the value of real options require initiatives at three levels. First, at the level of technological design, initiatives include modularization and rapid prototyping, to allow firms to benefit from deploying their technological systems in small “chunks” asynchronously (Garud & Kotha, 1994; Garud & Kumaraswamy, 1995). This provides firms with valuable feedback, even as they develop their technological systems. Modularization also generates positive externalities for firms as existing and newly developed modules can be mixed and matched in different ways.

Second, at the level of organizational routines, an ability to transfer technology intertemporally is key for firms to benefit from real options. We have labeled such an ability as representing a firm’s “transformative capacity” (Garud & Nayyar, 1994). More specifically, transformative capacity is a firm’s ability to choose, maintain, reactivate, and synthesize the modules of knowledge that it does not immediately use.

Third, at the level of the coevolution of capabilities, institutions, and markets, firms must foster learning processes that link activities in these three arenas. Initiatives in each arena then can generate feedback for the others. For instance, by building modular technological systems, valuable feedback may be obtained from users, enabling modifications even during development. These modifications are likely to increase adoption, thereby helping firms develop additional knowledge and providing them with the power to shape standards and institutions. Such feedback loops also help firms decide whether and when to escalate, scale back, or abandon initiatives and, hence, better manage coevolutionary dynamics.

A failure to consider these facets of organization design in McGrath’s model results in a potential to underestimate the value of real options for firms that do possess these organizational capabilities and to a false illusion of having real options for those firms that do not.

**Conclusion.** A comprehensive and integrated real options perspective of technology investments entails an understanding of coevolutionary dynamics, competitive interactions, and organization designs: these are not optional if firms want to play with options. Instead of battling uncertainty, as in McGrath’s model, an integrated real options perspective provides firms with an opportunity to capitalize on uncertainty and ambiguity (Garud, Nayyar, & Shopira, 1997b). First, this perspective provides firms...
with an appropriate valuation frame, preventing both excessive conservatism and optimism. Second, it provides firms with opportunities to buy the time that is necessary for coevolutionary processes to unfold and the time necessary to gain valuable information about costs, revenues, investments, and other interrelated facets of innovation. Third, to the extent that residual uncertainty remains, it provides firms with an opportunity to strike in each arena at an appropriate time to minimize down-side losses while capitalizing on up-side gain. Fourth, it facilitates the discovery of new possibilities, because existing options cumulatively beget new options.

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Only Fools Rush In? Using Real Options Reasoning to Inform the Theory of Technology Strategy: Response to Garud, Kumaraswamy, and Nayyar

If embracing uncertainty means engaging in search processes that permit idiosyncratic access to opportunities not available to others (Knight, 1921), then Garud et al. and I are in complete agreement (see McGrath, 1996; McGrath, MacMillan, & Venkataraman, 1995; McGrath, Tsai, Venkataraman, & MacMillan, 1996). Where we differ is that I have no qualms about "batting" uncertainty. To me, shaping one's fortune captures the essence of strategy and separates it from less performance-oriented disciplines.

In my article (1997) I sought not so much to extend real options theory as to deploy real options reasoning to develop stronger and more precise theory for technology strategy. The major implication is that, through taking strategic action, managers can influence the variance of future payoffs. Real options reasoning suggests that strategists should attempt to maximize variance by disrupting boundary conditions limiting the up side of a technology's payoffs (usually revenues) while containing bounds that increase the down side of the payoffs (usually commercialization costs). If they can influence variance, particularly if this can be done in a way that does not benefit other firms, strategists can enhance the value of their technology options.

Coevolution and the covariance of revenues and costs. My specification of the problem has been misunderstood. For purposes of precision, I deliberately separate the postdevelopment process into two time periods. First is the time when net operating revenues after commercialization accrue (yielding r, revenues minus operating costs). Second is the period of reaping the technology for commercial introduction, which includes costs to amplify (resulting in c, the cost of
Eisenhardt, 1997). There is a major caveat, however. Although there may be circumstances in which such practices as modular designs allow spillovers, it is well documented that when faced with systemic innovations, firms pursuing modular or recombinative strategies usually fail (see Christensen & Bower, 1989, and Henderson & Clark, 1990).

I am delighted to see more work that seeks to further develop the real options perspective, and I look forward to future interchanges.

REFERENCES


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Of Scientific Writing and the First-Person Singular

Art Bedeian's riposte (1997) to Barry and Elmes (1997) dwarfs Barry and Elmes' modestly delimited description of the fictive nature of strategy as "created, made up, rather than something which is false" (1997: 433). Bedeian conjures a "wider implication ... that the fiction they describe as comprising strategic discourse is pandemic throughout the sciences" (1997: 840). Stung, perhaps, by Barry and Elmes, and perhaps by Chomsky's (among others) dismissal of the behavioral sciences (to which managerial strategy, arguably, belongs) as trivial and unscientific, Bedeian imputes all scientific investigation and reporting as fraudulent, alleging "the pretenses that science is free of the 'personal interests and situational contingencies' of researchers ... and that scientists are neutral observers who reserve all judgment of scientific evidence until a manuscript's discussion section are ludicrous" (1997: 841).

Bedeian's condemnation is, in my view, overstated and extreme—marred by deconstructionism's reflexively contradictory dictum that knowledge is inherently meaningless (Derrida, 1988), which is implicit in it. Bedeian's qualified endorsements of "discursive footnotes" and of "the personal and idiosyncratic" (1997: 842) pale before his muscular imprecations.

Science is not innately fraudulent; it has been, as Kuhn (1970) shows, resistant to change. Scientific reports are not intrinsic frauds, but the method of reporting—the history of which Bedeian so neatly traces—errs by denying stylistically the validity of the researcher's role and by excluding consideration of it in the report.

I will cite only two writers to make the case for including the researcher's thoughts and feelings in the research report. One is Ruth Behar, professor of anthropology at the University of Michigan and recipient of a MacArthur "genius award," who has argued persuasively for reports written in the first-person singular (1991)

1 Chomsky writes:

there are few nontrivial hypotheses relating to the question of how humans behave and why they act as they do under ordinary circumstances. ... [T]here is little significant scientific knowledge in this domain, and the behavioral sciences have commonly insisted upon certain arbitrary methodological restrictions that make it virtually impossible for scientific knowledge of a nontrivial character to be attained (1972: viii–ix).
and has done exactly that in a recent ethnographic study (1994), as "part of a growing interest in academia in acknowledging personal, emotional accounts in scholarship" (University of Michigan Research News, 1995: 11). The other is Scott Russell Sanders, professor of English at the University of Indiana and winner of the 1996 Great Lakes Book Award for his 1995 book (Sanders, 1995). Sanders explains that he asks his students to write in the first-person singular. "Instead of 'one might deduce from the foregoing examples,'" he suggests "I think." "Instead of 'the white whale inspires dread in the reader,'" he suggests "the white whale scares me" (1997: B5). He calls traditional academic writing, with its heavy reliance on the passive voice, "mealy-mouthed and evasive" (1997: B4).

We have at least to acknowledge our predisposing theories, what we hope and expect to find, and the reasons for those hopes and aspirations, and we shall confront our strengths and our weaknesses as scholars, researchers, and human beings—as they say, warts and all—to add clarity and candor to our reports.

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