HICCUPS IN THE ADOPTION OF INNOVATION FOR COMPLEX FINANCIAL MODELS

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ABSTRACT

There exists a vast and growing body of literature that describes the mechanisms by which innovations diffuse through a population, as well as factors that affect the speed of adoption of an innovation. This body of literature tends to focus on incidences of successful innovations. However, study of innovations that fail to diffuse widely may be equally valuable. Furthermore, major diffusion research has not addressed financial innovation in a meaningful way (Rogers, 2003). This paper focuses on complex state-of-the-art financial innovations, developed and proposed by academicians as solutions to real-world problems. This paper (1) discusses a novel financial strategy based on the use of sophisticated financial engineering products; (2) the adoption (or lack thereof) of complicated real option evaluation models to augment capital budgeting decisions; and (3) a case study to highlight implementation issues for a highly complex fixed income option model.

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I. INTRODUCTION

In his comprehensive study of the diffusion of innovations, Everett Rogers (2003) describes a curious case of an innovation that most readers of this article would agree is unambiguously of value but that, nevertheless, failed to diffuse through the society to which it was introduced. The innovation in question was the practice of boiling drinking water obtained from potentially unsanitary sources prior to use in an effort to reduce the incidence of typhoid and other waterborne diseases. The change agent, a state healthcare worker, was charged with persuading housewives in a coastal Peruvian village to include the boiling of drinking water in their everyday behavior. The effort included numerous visits to village households, explanations of germ theory of disease and presentations by medical doctors, espousing the benefits of boiling water. After a two-year campaign, only five percent of the village households had adopted the practice. Why did such an obviously beneficial innovation fail to diffuse through the Peruvian village households?

The same question can be asked of some complex state-of-the-art financial solutions to real-world problems.

On February 20, 2001, the *Financial Times* (London) described a novel proposal to redefine corporate dealmaking. The concept is to establish a financial service enterprise to provide strategic advice that includes use of financial derivatives and other financial contracts to achieve ends that would otherwise be accomplished via traditional business solutions, e.g., mergers and acquisitions, corporate partnering. Two ex-J.P. Morgan executives intended to team with General Re, a reinsurance firm owned by Berkshire Hathaway, to deliver the financial services.

This new paradigm could have enormous implications for the financial services industry. Suppose, as the *Financial Times* proposed, that General Re can assist a manufacturing client vertically integrate its operations without actually acquiring the commodity supplier. In essence, General Re would attempt to construct a package of derivatives (market-based and/or proprietary) to guarantee a supply of the commodity to the manufacturer. Therefore, General Re would be employing a financial securities-based solution to replace an oftentimes cumbersome physical transaction, i.e., a merger.

Specialty finance firms of this type illustrate the evolution of the financial service provider away from highly customized, proprietary and illiquid solutions toward a reliance on market mechanisms to address business problems. Eventually as markets become even more liquid, it is reasonable to project that market-based solutions of this type might be employed in a wide range of strategic advice applications.

While, to our knowledge, the J.P. Morgan executives and General Re never came together on this project, the potential obstacles to adoption of this innovation were considerable. Would senior management of the client firms embrace solutions that are novel, potentially quite complex and outside the dimensions of traditional tools? If so, what steps might the financial service provider take to facilitate the adoption of its strategic advice and execution strategies?

Copeland and Antikarov (2001) describe the difficulties in convincing senior management at Airbus Industrie to implement real option technology. The discussion is framed around five attributes of innovations that facilitate adoption, as described by Rogers (2003). Our presentation of the *Financial Times* proposal in section II of this paper follows the same framework. While both academics and practitioners would agree that there is significant value-added in analyzing management flexibility with real option techniques, recent empirical evidence suggests that the adoption of this technology appears to have stalled (Teach, 2003). Furthermore, Graham and Harvey (2002) point out that there is a trend for managers that have used the technology to drop it as a part of the capital budgeting process in future projects.

The purpose of this paper is to reinforce the issues raised in the *Financial Times* and real option examples with a finance case study. In the early to mid-1980s, one of the authors was involved in bringing fixed income option pricing techniques to the trading floor of some major investment banks. As will be described below, fixed income option pricing requires complex enhancements to the standard option pricing models, as the original models were developed to handle equity options. The case is meant to highlight the implementation issues that the option pricing developers faced.

A brief literature review is found in Section II of this paper. Section III contains the case study, with names and affiliations disguised. Finally, in Section IV, we discuss some points that might be raised in using the case in a classroom setting.

II. LITERATURE REVIEW

As previously noted, much of what exists in the literature addresses factors that facilitate the adoption of innovations. We present these factors in three categories: five attributes of innovations and fives steps of the innovation-decision process as described by Rogers in *Diffusion of Innovations* (2003), in terms of a cost-benefit analysis, and in terms of relationships and communication channels. We then present proposed reasons for the recent apparent failure of real options technology to be widely adopted.

Rogers (2003) discusses five attributes that innovations should possess to facilitate adoption:

- Superior Ideas
- Compatibility with Existing Solutions
- Low Complexity
- Triability
- Observability

With respect to the proposed financial services innovation, consideration of the five key attributes could lead to inquiry along the following lines:

Superior Ideas – In short, are the new ideas and approaches better than the old procedures? Does the proposed solution accomplish the primary objectives at lower cost? Can the market-based solution eliminate undesirables in the old solution, conceivably in the form of additional overhead, transaction costs and the like?

Compatibility with Existing Solutions – How does the new approach relate to approaches now in use? Can the old methods be related in any way to the new methods? If so, could an incremental presentation be made to "upgrade" from the old way to the proposed solution?

Low Complexity – Ideally, all aspects of the product and technology should be transparent to all end users. Even if the conceptual basis for the procedures will be clear, it will be quite a different matter to demonstrate the efficacy and efficiency of any securities-based program to be employed. The financial service firm will face a huge educational component to take its solutions out of the "black box" and make them intuitive, compelling and understandable to senior management.

Triability – It is inconceivable that management will agree to this new approach as an alternative to, for example, an acquisition if they have had no prior experience with the technology and capabilities. It may well be necessary to introduce management to the procedures on a smaller scale to build empirical justification for the approach. To spur management to look at the techniques, the service provider might apply the technology to selected situations that are clear to management. The service provider will have at its disposal the various option pricing models and risk management software to provide scenario and sensitivity analysis at virtually no cost.

Observability – The service provider must be able to demonstrate both the costs and benefits of the solution. Fortunately, the proposed solution is meant to replicate an outcome in using older business solutions with which management is familiar. As such, General Re isn't required to "sell" the basic transaction, but rather to communicate the differential advantage to the proposed methodology.

Rogers (2003) also describes five steps in the innovation-decision process: (1) knowledge, when a potential adopter learns about an innovation; (2) persuasion, when the adopter forms an attitude, favorable or otherwise, about the innovation; (3) decision, when a decision is made to adopt or reject the innovation; (4) implementation, when the adopter puts the new technology to use; and (5) confirmation, when the adopter looks to reinforce or reconsider the adoption decision. Stabilizing adoption in the implementation and confirmation stages, including enabling the end-users to become self-sufficient in the use of the new technology, increases the likelihood of long-term adoption of the innovation. Hall (2003) points out that in the knowledge and persuasion stages, triability and observability as described by Rogers, reduce uncertainty for the adopter of an innovation. Producers of a new technology may also reduce uncertainty for a potential adopter by providing training in use of the technology at no or reduced cost.

Hall also points out that relative advantage and complexity are issues related to a cost-benefit analysis. In addition to the price of acquiring an innovative technology, the cost of an innovation often includes the cost of complementary tools, software, and/or learning. (Conner, 1998; Hall, 2003) Typically the costs associated with adoption of an innovation are fixed and upfront, while the benefits are not only uncertain but are expected to accrue over time. Furthermore, adoption of an innovation is generally seen to be an absorbing state, i.e., typically an old solution to a problem is abandoned in favor of a new solution (Conner, 1998; Hall, 2003; Kotter, 1996). Because of the fixed nature of costs and the irreversibility that is characteristic of many new technologies, a firm's decision is likely to be influenced by the firm's position and the market structure of its industry. However, a financial derivative solution to a vertical integration problem is likely to be less expensive and more easily reversed than would, say, a merger of firms.

Hall and Luque explain the adoption decision in terms of option theory. Hall (2003) proposes that at any point in time, rather than deciding whether to adopt or to not adopt, a potential adopter of a new technology is deciding whether to adopt or to delay adoption until later. Luque (2002) equates the value of the option to the investment threshold, i.e., the point at which the firm will invest in a new technology rather than delay adoption. Greater opportunities to invest elsewhere and/or greater uncertainty regarding the benefits of the proposed innovation result in greater call option value and therefore a higher investment threshold. In this case, a decision-maker is likely to delay adoption. Likewise, a less easily reversed adoption decision has less put option value and consequently a higher investment threshold.

Types of innovation decisions can be defined in terms of the role social systems play in the adoption process (Rogers, 2003). Optional innovation decisions are made independently by an individual without input from other members of the social system. Collective innovation decisions are made by consensus among members of the social system. Authority innovation decisions are made by a handful of individuals who hold power, status, or specialized knowledge within the social system. External or social attributes that impact the diffusion process include the type of decision as described, the communication channels used for conveying information about the new technology, the nature of the social systems present within the organization as well as to what extent the organization is networked with other organizations, and the extent of the promotion efforts of the change agent.

Conner (1998) addresses the importance of the human due diligence in the change process in order to increase the likelihood of an adequate return on change. Human due diligence may include increasing resources available to employees for incorporating the new technology or reducing unnecessary problems that may be expected to result from the change. These actions serve to reduce uncertainty and unnecessary cost associated with adoption of a new technology, echoing what we find presented by Conner (1998), Hall (2003), and Rogers (2003).

Rogers (2003) also finds that the establishment of an information exchange relationship between the change agent and potential adopter is highly important. With regards to communication channels, interpersonal communication has been found to be more effective than other forms in bringing about behavioral changes such as adoption of new technology. Furthermore, homophilous communication, occurring between two people who are more similar, is generally more effective than is heterophilous communication, occurring between two people who are different. This may be because a change agent who is homophilous with a potential adopter is better able to understand the adopter's perspective of a problem and is therefore able to frame the discussion of the relative advantage of a proposed innovation in a relevant context. (Hall, 2003; Rogers, 2003)

An organization's network with other organizations may also impact the likelihood of it adopting a new technology. Davis (1991) found that firms with a greater degree of interconnectedness to other firms were more likely to adopt normative innovations earlier. In some cases, this relationship may be explained by the role standards play in accelerating or retarding the diffusion process (Hall, 2003). In many cases, technological standards facilitate learning required for use of the new technology, increases the potential market, and therefore encourages adoption. Indeed, the larger potential market increases the ease with which an adoption decision can be reversed, hence serves as a put option (Luque, 2002).   It is interesting to note, however, that customization may be an attractive attribute of a financial innovation such as a derivatives solution to vertical integration problem.   Nevertheless, adoption of these new technologies may be facilitated by the perception of standardization.

It is interesting to note that that real option technology, such as the option to delay adoption a new technology as described above, provides an example of a complex finance innovation that appears to have failed to be widely adopted in capital budgeting. Real option technology employs modern option pricing theory to evaluate management flexibility that is often available in capital budgeting projects. Option pricing theory itself is quite complex, requiring specialized modeling and analysis. Applying these procedures to corporate project selection is further complicated by the complex contingencies often found in the projects and the usual lack of the specific financial data required to implement the technique. Refer to Merton (1973) for the development of the option pricing model and Amram and Kulatilaka (1999) for its application to real options.

Teach (2003) observes that corporate CFOs have been slow to adopt real options technology despite its clear superiority over traditional NPV analysis by way of its inclusion of management flexibility. In a 2000 survey regarding management tools used by managers, Bain & Co. found that only nine percent of the managers surveyed used real options analysis. Furthermore, the survey found that, while the average defection rate for management tools included in the survey was 11 percent, 32 percent of the managers who had used real options technology had abandoned its use during the year. In a similar study in 2003, real options technology no longer appears on the list of tools used by managers.

Teach (2003) proposes several possible reasons for the failure of real options innovation to diffuse through corporate finance practice. Among these are the sophisticated mathematics inherent to real options analysis and the "consequent lack of transparency and simplicity". Software development firms such as Decisioneering offer software applications that analyze real options; however, such software requires its own inherent learning curve. Teach also points to suspicions that analysis of growth options, a type of real option, contributed to the outrageous valuations of some dot com firms in the early 1990s.

In the next section, we present a two-part case study that describes a complex financial innovation that failed to be adopted in one instance and was adopted in the short term in another instance. This is followed by a discussion of possible reasons for the failure of a long-term adoption of the innovative model, framed in the context of Roger's five attributes.

III. THE GUTSIR GROUP, INC.[1]

In late 1983, Jerry DeLong, Vice Chairman of Lararis Bank, invited The Gutsir Group, Inc., to the Bank to discuss the potential use of modern option pricing techniques in the Bank's securities dealing operation. Lararis Bank was a preeminent merchant bank, with major offices in New York, London and Tokyo. Delong had been interested in academic finance since his days as a student at the Harvard Business School. He was convinced that introducing modern option techniques to the trading floor could provide high value-added to the Bank. Since the practical application of the techniques was in its infancy, Delong determined that it would be best to contract with outside consultants with close ties to the academic community that was on the forefront of option theory development. In fact, after a careful inventory of the research and technology capabilities at Lararis, he decided to follow this approach.

Gutsir was incorporated in 1981 as a specialized firm to develop and provide state-of the-art financial problem solving solutions. The firm was started by two academics, one maintaining his academic affiliation and the other installed as a full time President and CEO, and was located in the greater Boston area. The firm had close ties to the major academic finance centers in Boston. As such, the firm had easy access to the premier innovators in modern finance theory and to a pool of highly qualified potential employees. In fact, the firm drew its employees from this pool. At any point in time, Gutsir typically had only three or four clients with whom it was working on highly technical projects. A typical project would require considerable financial innovation and often lead to an effort to transfer the innovation to the client organization for ongoing use. The client often requested financial solutions be delivered in the form of user-friendly computer programs. Project duration could run from many months to several years.

[1] This case is to be used as a basis for discussion rather than to illustrate either the effective or ineffective handling of a business situation.

THE STAWLEY-AMY-HILL PARTNERSHIP, INC. (SAH) EXPERIENCE

At about the time Delong phoned Gutsir, Gutsir was completing an assignment with the Stawley-Amy-Hill Partnership, Inc., to develop a fixed income option valuation capability. SAH was a "white shoe" investment bank that had, in recent years, started a proprietary trading operation. In the mid-1980s, practical applications of the famous Black-Scholes-Merton option pricing model were well underway, but much less work had been done to expand the model's capabilities to the fixed income arena. For example, the theoretical extensions of the model to fixed income were only just beginning to appear in the academic literature.

Gutsir was recruited to join the SAH project by one of the leading academic innovators in option theory who had himself been retained by SAH. For over a year, the project team worked intensively to develop the theoretical framework and implementation procedures for fixed income option valuation. As part of its due diligence, SAH had this work evaluated by outside experts. The experts opined that the procedures were viable and highly likely to provide value-added on the SAH trading floor. Yet, the senior management of SAH decided not to proceed with the implementation phase and terminated the project.

The principals of Gutsir tried to understand why such obviously innovative technology addressing a highly relevant business line for SAH was not adopted. There was no doubt in their minds, that if the developed procedures worked as advertised, SAH would be far ahead of competitors in a very high margin business. A few points were clear to Gutsir:

- Based on the specialized analytical techniques used, it was likely that no one working on the project from within SAH understood the technology completely.

- The initiative and funding for the project came from the research division within SAH. The R&D department at SAH was massive and important in the corporate hierarchy (the SAH CEO at this time, Glenwood Mackus, was an MIT-trained technology aficionado). Furthermore, a senior R&D executive was the project sponsor within the bank and part of the project team. Yet, Gutsir suspected that the most senior management at the firm either did not have the project on their radar screens and/or were intimidated by the subject matter.

- The client made it clear that the consultants were hired primarily to do the analytical "heavy lifting", so Gutsir channeled it efforts to developing elegant, high level technology. In effect, Gutsir was offering a "black box" to end users at SAH.

As it would happen, the discussions with Delong at Lararis led to a consulting contract for Gutsir to build a fixed income option valuation model! There would be no conflict with the work just done for SAH because (1) some of the key concepts and techniques had by now found their way into the academic literature in the public domain, and (2)

Gutsir would make fundamental changes to the proprietary techniques it had used earlier for SAH.

THE OPTION PRICING MODEL (OPM)

Pricing of options has been of interest to academicians and practitioners since early in the 20th century. Prior to the 1970s, systematic attempts to value and analyze options had largely failed under the weight of contrived and unrealistic assumptions about investor preferences, market structure, etc. In 1973, Professors Fischer Black and Myron Scholes published a scientific paper that made the option valuation problem tractable and, in fact, lead to a closed form formula to value European-style (exercisable only at expiry) equity options. Shortly thereafter Professor Robert Merton solidified the theoretical basis for the solution and provided valuable extensions. Merton and Scholes would go on to win the Nobel Prize in economics for their work (Black died before the Prize was awarded, and the Nobel may not be awarded posthumously).

The fundamental insight in the OPM is that the key financial characteristics of an option can be exactly replicated with a specific position in the underlying asset coupled with riskless borrowing or lending. A dynamic strategy in the underlying and borrowing or lending can be established to "replicate" the payoffs to the option. Then, to avoid the existence of arbitrage, the replicating portfolio must be equal in value to the option. Black, Scholes and Merton showed that using a stochastic dynamic programming technique, the appropriate replicating portfolio could be determined during each time point during the life of the option. Dynamic programming, which is a backwards in time solution technique, is necessary because, *ex ante*, the only time point at which the value of the option is known is at expiry, i.e., at the end of the life of the option. It had been well-known for some time that the option value must be the maximum of its in-the-money value or zero at that time point. The solution procedure requires stochastic dynamic programming because the underlying asset (the value of the common stock in the case of equity options) is a random variable, not a deterministic quantity. Needless to say, the solution methodology at the time, and still today, was quite sophisticated. The good news is that the valuation formula derived, while looking quite ominous, can be easily programmed into a spreadsheet or even a hand held calculator. It has been amazing to observe how quickly this technology has migrated from academic seminars to widespread use in the field.

However, as practitioners began to use and better understand the OPM, they realized that there was a broad class of options for which it did not apply. For example, the OPM was not suited for American-style options which are exercisable at any time during their life and which are, by far, the most commonly traded variant in virtually every option market. The OPM formula did not strictly apply if the underlying asset paid a cash distribution (e.g., common stock dividends) or if the stochastic variable was not equity, but for example, interest rates. Furthermore, as the option markets developed, ever more complicated covenants were included in option structures. Invariably, the covenants pushed the option beyond the scope of the OPM.

To address these valuation challenges, the analyst could not work directly with the elegant solution of Black, Scholes and Merton, but rather had to employ sophisticated numerical approximation procedures. These techniques begin by building a huge decision tree in which all contingencies and covenants are included. Next, the methodology proceeds backwards from the option's expiry date in the decision tree to the present time – numerical dynamic programming. While the OPM assumed that trading took place continuously in time, any numerical procedure must, by its nature, be a discrete time approach. Moving the analysis from a continuous to discrete time setting introduced additional complications and necessary approximations. At the time of the Lararis inquiry to Gutsir, analysts were just beginning to address these important extensions to the OPM.

THE LARARIS BANK EXPERIENCE

Jerry Delong understood that considerable research effort would be required to develop the fixed income option modeling environment. While academics continued to make considerable progress on the theoretical enhancements to the OPM, precious little had been done on the practical implementation issues. Delong approved a project during which Gutsir would develop the technology using Lararis traders, the eventual end users of the technology, as a resource.

Both Gutsir and Delong agreed that it was crucial to have these traders involved early on in the project, both because they could provide input directly from the trading floor and to give them an opportunity to "embrace" the technology early on. Delong made it clear to the traders that the project was a high priority and that their cooperation and input were crucial.

To begin the project, it was necessary for Gutsir to develop the financial modeling approach. To a first approximation, Gutsir staff worked independently in their Boston offices. The work involved building a solid mathematical foundation for the new option pricing model. This was very specialized work at an abstract level. As such, during this period of approximately six months, Gutsir effectively had no contact with the traders and very limited contact with Delong. It was clear that Delong understood the nature of this phase of the project. Gutsir was cautiously optimistic and hopeful that the traders would maintain enthusiasm for the work.

At the conclusion of this initial phase of the project, an extensive seminar/presentation was scheduled for Gutsir to discuss the work to-date. Gutsir personnel made a comprehensive presentation of the model to be built. As with the SAH presentation, it seemed to Gutsir that none of the clients in the room completely understood the materials presented. In fact, the traders, notorious for short attention spans, seemed preoccupied with monitoring their trading positions.

On the other hand, it appeared that everyone was comfortable taking everything presented at face value. Gutsir suspected that much of this acquiescence came because the traders weren't trained to evaluate the complex finance on its own merits. It became obvious that the traders would be treating the financial model as a "black box". However, to Gutsir's delight, the traders were very eager to learn that the next phase of the project would involve them – to design user interface computer screens, to establish the performance parameters for the software, etc.

Over the next six months, Gutsir personnel developed a good working rapport with the Lararis traders. Gutsir devoted many person-hours to working on the trading floor and asking traders for input. As prototype versions were prepared, the traders assisted in the validation process. As with the seminar presentations, the traders were preoccupied with their trading positions at all times. When Gutsir asked the traders any in-depth questions that required them to fully engage in the developmental work, it was clear to Gutsir that the traders took the "path of least resistance" to get to a solution. Because of this, Gutsir could only really count on the traders for snippets of information, most factual, not conceptual.

Within a short period after this development phase, Gutsir installed a self-contained fixed income option model on the trading floor for beta testing. The plan was to run the system side-by-side with the trader's books for bond options and interest rate caps, floors, swaps and swaptions. Traders were authorized to use the system to assist with their actual trading as they deemed appropriate. Miraculously, the system performed well! Since the model tended to price the underlying asset relatively accurately, traders became confident in using the system in their operations.

To see why traders reacted this way, consider an option on a bond. Since the fixed income option model was driven off interest rates and their stochastic movements, the model was fully capable of valuing both the bond (the underlying) and the option on the bond. But in many cases, the bond (as opposed to the option) is traded on a relatively large, liquid and active market. In such circumstances, traders would deem the market price to be reliable. Then, if the model price for the bond matched (up to a small error) its observable market price, the traders had more confidence that the option price was also sensible. This result partially explains why the model quickly gained traction as the valuation and hedging engine for dealing in the fixed income derivatives. Without exception, all of the trading books showed profitable operations.

As time passed, Gutsir staff observed several situations that affected the seamless adoption of the technology. These circumstances were even more prevalent in the cases of new traders, personnel who had not been involved in the developmental phases of the project:

- Computer Bugs – It is inevitable in any large computer system that there will be programming errors. These errors are typically embedded in the computer code and can compromise any aspect of the system: input/output functions, processing, etc. When these errors occur, the system will typically shut down, lock up at the faulty operation and/or cycle through improper processing avenues. Typically, to solve the problem, a software engineer must debug the program and provide a software patch to end users. Clearly, in a trading environment in which trading opportunities may only be present for a matter of seconds or minutes, breakdowns of this type can be debilitating. In virtually all such situations, the trader will lose the opportunity to put on a potentially profitable trade. Traders seemed to have zero tolerance for even a few occurrences of these computer bugs. In fact, Gutsir noticed a tendency for traders to revert to naïve pricing models with fundamental weaknesses so as to avoid the occasional bug.

- Extensions and Enhancements – The market for fixed income derivatives was in the 1980s, and is still today, a rapidly evolving market in which new variants of options are devised on a regular basis. In fact, the field of financial engineering concerns itself with building new option contracts to address special purposes or to fill a new market niche. Traders naturally wanted and expected the model to be generalized to the new financial instruments in "real time"! Of course, in most cases, this was impossible. The traders typically failed to remember that the basic model itself ran to several hundred thousand lines of computer code, and that the new financial instruments may well contain features that could not easily be molded into the existing structure. Seemingly small changes in the option covenants could have major ramifications in the valuation process. Given the time it could take to develop the new theoretical framework and deliver a user-friendly computer program update, the current trade opportunity would have disappeared, and it would be entirely likely that a new variant had already evolved.

- Accuracy – When Gutsir first installed the fixed income valuation system in the mid-1980s, traders were delighted to be able to systematically evaluate the options, even with potential pricing errors of 10-30 percent. Prior to systems of this nature, because the financial structures tended to be new and complex, the traders were not confident in their ability to price the instruments to even within a 50 percent error range. However, as the markets developed and hedging strategies got ever more sophisticated and complex, it became desirable to generate extremely accurate pricing results. Of course, in complex situations using models that are numerical in nature, not exact, it is unrealistic to expect pricing to tight tolerances.

EPILOGUE

Despite the occasional hiccups with the technology, the Lararis traders successfully used the Gutsir system for several years. It also is fair to say that the traders never became self-sufficient in using the system. As such, the Bank kept Gutsir on retainer during the entire period. Gutsir personnel interacted with the traders on virtually a daily basis, usually by telephone, to explain confusing results, talk through new trading opportunities, interpret system output, fix computer problems, etc. This was a very intense period for Gutsir staff – because of the short time window available for most trades, Gutsir was expected to resolve any issues in real time. Also, since the traders were doing trades with counterparties and on markets around the world, the real time aspect became 24/7. Needless to say, the situation was highly stressful for all parties involved. Yet, since both sides had a strong financial incentive (Gutsir earned its retainer fee; Lararis ran profitable trading books), the arrangement persisted.

In the late 1980s, Lararis changed the management structure on its trading floor. The new management team decided to move in a different technology direction and replaced the Gutsir technology with competitive systems. Shortly thereafter, many of the traders that used the Gutsir system left the Bank to start their own money management firms or to move to other trading jobs.

IV. THE GUTSIR GROUP, INC. – SOME TEACHING POINTS

We believe that a productive methodology for analysis of the Gutsir Group, Inc. case is to consider the attributes of innovations as described by Rogers (2003). The fundamentals of the case are quite similar to the Peruvian water and real option examples – beneficial innovations that are extremely likely to provide high value-added if implemented. Yet, in the case of SAH, the technology was never implemented and in the case of Lararis, the innovative technology was not retained, even after accomplishing its desired function, i.e., supporting profitable trading books.

One might infer from the case facts that the Gutsir personnel were fixated on building a state-of-the-art model, probably mistakenly believing that modeling elegance and analytical fire power were sufficient to "sell" the technology. As MIT's Professor Paul Samuelson quoted Albert Einstein in a recent PBS Nova episode (2000), "Elegance is for tailors". While our hypothetical tailor could survive on elegance alone, it will likely not be sufficient in other endeavors. It would appear that Gutsir did not take the requisite marketing steps to facilitate the adoption of the fixed income model either at SAH or Lararis.

How might the discussion address Roger's five attributes?

There are both direct and circumstantial evidence that Gutsir's <u>ideas</u> are <u>superior in many ways to the previously existing solutions.</u> The existing solutions had fundamental and obvious flaws – existing techniques could not be counted on to provide sensible results on a regular basis. As such, the new technology faced a relatively low hurdle to demonstrate improved performance. SAH had the work vetted by outside experts with a positive response. The SAH project team included a luminary in academic OPM circles with an international reputation. Gutsir personnel were trained at the top Boston area universities. The discussion leader may well want to probe whether such credentials are either necessary and/or sufficient conditions to guarantee a superior end product. One could compare this situation to the Long Term Capital Management (LTCM) hedge fund disaster. LTCM boasted a star studded management and trading staff; see Perold (1999) for further discussion.

So, *ex ante*, there were good reasons to believe that the ideas would be superior. Furthermore, on an *ex post* basis, the technology showed itself to be superior as it delivered profitable fixed income books at Lararis.

While both of Gutsir's clients were aware of the Black-Scholes-Merton OPM, Gutsir had difficulty showing how the new technology was compatible with this existing solution to a similar problem. When Gutsir tried in its seminars to both clients to make the link between existing theory and practice and the fixed income approach, the complexity inherent in both models came to the fore. It is difficult to make the argument that the new is an upgrade from the old when clients can not evaluate the old or the new on their own merits.

Lararis' beta test was an attempt to address triability. It would appear that the test was reasonably successful – based on the test, the traders later adopted the technology and were sufficiently receptive that they even used it during the trial period to trade the live book.

The benefits of the new technology were clearly observable when the technology was in use – even on a daily basis! The traders marked their book to market every day so as to demonstrate the profitability of the book. Furthermore, prior to the implementation of the technology, there were no alternative analytics available to use. Thus, the fixed income option innovation scored very high in the observability dimension, both in being able to define success (as measured by profitability) and at the execution level.

However, it appears the technology did not continue to be superior in other ways when considered from the perspective of the end users, the traders. The traders expected a simplistic solution into which they could plug assorted inputs and have a near instantaneous accurate output. Traders lost patience with the delays caused by software bugs. In addition, further iterations of the innovative technology that would take into account ever-changing option contract covenants, were not available with sufficient immediacy to meet the needs of the traders. This lack of flexibility in all likelihood contributed to the failure of long-term adoption of the fixed income option technology.

It could be interesting for the discussion leader to explore the ramifications of the traders' short attention spans as discussed in the case. During the seminars delivered by Gutsir, in dealing with the computer bugs and in insistence on instantaneous turnaround, the traders repeatedly demonstrated this characteristic. Is there a fundamental disconnect between a personality and operating style necessary for the trading floor and first generation complex financial innovation?

Rogers (2003) also describes seven roles of the change agent (Gutsir in our example) in the successful diffusion of an innovation. A brief study of how these roles were played out in the Lararis case reveals that Gutsir was successful in fulfilling many of these roles, by Gutsir's actions or by the client's actions. For example, Lararis identified a need for change and diagnosed problems with the then current technology. Gutsir and Lararis, through its due diligence, created an intent to change, i.e., made a determination that adoption of the proposed innovative option strategy was likely to be beneficial. Together, Gutsir and Lararis translated the intent to change into action by developing the new model and implementing it on a trial basis. What roles, then, did Gutsir fulfill with less success?

Rogers (2003) speaks to the importance of establishing an information exchange relationship. Gutsir personnel established a relationship with Delong, the Lararis Vice Chairman, and set expectations regarding the amount of research effort that would be required in developing the new model. However, the development of a good working rapport with the Lararis traders, who would be the end users of the technology, was delayed until six months into the project. Is it possible that inclusion of traders earlier in the development process might have increased their understanding of the complexity underlying the "black box" solution that they expected?

Rogers also speaks to the importance of stabilizing adoption and preventing discontinuance. This is particularly important when a client is at the implementation or confirmation stage, the final stage in the five-stage innovation-decision process described in detail in *Diffusion of Innovations* (2003). Clearly when Lararis was at a confirmation stage with the change of management, Gutsir was not successful in preventing discontinuance of the option valuation model. Discontinuance may result from a decision to replace some technology with a better solution or from disenchantment with the technology. It is likely that the Gutsir technology was replaced with an alternative solution.

The final role of a change agent described by Rogers (2003) is achievement of a terminal relationship, meaning enabling the client to become self-sufficient in the use of the technology. As explained in the epilogue, the Bank never became independent users of the option valuation technology. Rather, Gutsir remained on retainer to the Bank, providing on-call availability at any hour for the duration of the relationship.

In short, the Gutsir Group was able to demonstrate the superiority of its fixed income option pricing model to the old technology, as well as compatibility with existing solutions. Gutsir was also able to demonstrate triability and observability for the most part. However, there were several factors that may have contributed to failure to adopt the model in the long run. Fits and starts in the implementation stage, characterized by frustration on the part of end users, seems to be due to a high complexity. The discussion leader may want to draw an analogy between this case and the high complexity of the Airbus Industrie case. The information exchange relationship was also problematic, possibly due to the heterphilous nature of the groups involved and the resultant inability of each to see the other group's perspective, i.e.; the developers seemed to not appreciate the traders' short attention spans and need for instantaneous answers, and the traders did not appreciate the complexity of the model.

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