

Commentary on the commercialization of knowledge engineering: enterprise and product development

BERNARD P. WESS, JR

Management Information Systems, Grand Alliance Group Limited, Hamilton, Bermuda & Information Architects, Inc., Needham Heights, Massachusetts, USA

Abstract

This article outlines the basic corporate engineering process that leads to the commercialization of a knowledge engineering concept, or software process. The development of a commercial product and enterprise from a technology-driven research effort or idea is quite similar to the process of continual refinement and hard work demanded by the scientific method, so the fundamentals of corporate and product development should not appear foreign to academics or those involved in corporate research. Knowledge engineering and related disciplines are on the verge of significant commercial product development efforts. The process of commercialization of ideas, particularly those derived from academic and research environments may not be intuitively obvious to the KE professional. The author outlines the general process of commercializing KE products and describes the three primary functional activities required to undertake a successful technology-driven commercial enterprise—market and customer definition, the development of the product prototype and corporate infrastructure, and capitalization.

1 Introduction

With the acceleration of the commercialization of knowledge engineering (KE) products increases, the relevance of the perspective of those who build companies around commercial systems and software products becomes more important to KE professionals. As KE emerges from research facilities, the “relevance” of KE disciplines and productivity are ultimately measured in economic terms. If we are serious professionals, we should have a deep personal interest in avoiding as many false starts and failures as is feasible under the stark and sometimes brutal realities of capitalism and commercial competition.

The degree to which governmental, commercial, and industrial enterprises adopt and internalize KE, “artificial intelligence”, (AI) and expert systems tools and products will have a great deal to do with the positive or negative connotations associated with KE as a commercially viable area of academic and research study.

The thoughts and recommendations embodied in this article are directed precisely at those in KE professions who are concentrating their efforts towards *commercialization* of KE tools, techniques, services, and products. The author has experience in the commercialization of software products in health-care, data base management, artificial intelligence, and statistical information systems.¹

Currently, the author is a co-founder of a series of inter-related companies in risk management, reinsurance, and technology formed to address the current crisis in professional liability insurance

¹ He was, for example, the first consultant to Lotus Development Corporation in DBMS and AI product development, including product review, merger and acquisition analysis. He and Mitch Kapur, Founder and former Chairman and CEO of Lotus, developed the original Lotus strategy in dealing with corporate MIS departments and information systems, products, and services.

for physicians in the US. The management team for these new ventures is composed of management information systems (MIS) and software product development professionals, health-care lawyers, insurance and corporate finance executives. Thus he has gained experience in the formation of a both corporate and product development organizations.

2 Defining a market for a knowledge engineering product

Knowledge engineering products, whether in the form of expert systems or AI software engineering tools have been, and continue to be, *technology-driven* rather than *market-driven* products, that is, they emerge into the commercial arena as a consequence of applied or pure research as opposed to being crafted in response to demand of an emerging customer base that desires a specific solution to a perceived need. Another way of describing this fundamental marketing characteristic is that an extant, but unsatisfied, customer base precedes a product when the product is market-driven as opposed to emerging as a consequence of marketing and sales education after the fact of product development, in the case of a technology-driven market.

Understanding where one's product will emerge along the continuum of market-product driven commercialization is imperative for the budding KE scientist/entrepreneur because it has a profound affect on the cost of product introduction. For example, the full emergence of data base management systems (DBMS) technology as an essential tool of MIS departments required at least the 20-year period 1968–1988 as witnessed by the emergence, growth, retrenchment and restructuring of the product lines of Cullinet² and IBM.

On the other hand, Lotus Development Corporation emerged from infancy to more than \$250 million in annual sales and greater than three million customers in less than five years. The lesson implied by the experiences of these enormously successful companies is quite clear—the earlier the commercial product can be recognized by a potential group of customers, a market segment, the earlier and more robust the commercial rewards and “success”.³ The actualization of this process in an emerging scientific discipline such as KE, by a small band of scientists and engineers who are undercapitalized and without marketing experience is the critical question. The answer to this dilemma is two-fold: *a* by active cross-fertilization of related academic and engineering disciplines, and *b* careful study of MIS functions and commercial “networking”.

The lack of cross-discipline communication and research among MIS researchers and professionals, cognitive scientists, experimental psychologists, AI and KE scientists, and MIS users has resulted in the commercial perception that AI and KE relevance is limited to applied expert system technology because interdisciplinary products appear rare. To overcome this perception and to ensure that an emerging product prototype has commercial value, the early definition of a customer base is essential, along with an earnest effort to evaluate market demands with as wide an interdisciplinary perspective as is practical.

Governmental and commercial users of complex MIS systems who will test and use a prototype are the best source of product development information beyond the core research and development staff. The objectivity of a potential customer is invaluable in avoiding false assumptions and in directing marketing and sales strategies. In addition, the most stable source of potential customers and test sites are one's colleagues in other disciplines and MIS organizations, in general. These groups, when carefully cultivated, are sources of interdisciplinary knowledge that can help develop a unique product for a market niche—a prerequisite for success in a small company.

Once a limited but vocal cadre of test sites and potential customers has been identified, the prototype development effort must focus on satisfying the perceived needs of the core test group. By doing so, development costs are kept low and the engineering effort is grounded in commercial reality. Failure to adhere to these principles is a major source of product and corporate failure in technology-driven companies.

² Formerly Cullinane Data Base Systems, Inc., a leading IBM mainframe DBMS vendor.

³ The moral of the Lotus–Cullinet story is that there is no substitute for superb timing, not in terms of management, capital, or product.

3 Crafting a commercial infrastructure

Once the KE professional has established an intended market segment for a KE product and has sufficiently analyzed, prioritized, and internalized the product and market knowledge available through related disciplines and test sites, the tasks of building a product and company must be undertaken. There are, in the author's experience, profound differences among the following and each KE professional must know for certain where his/her efforts must be focused along the continuum from:

- a set of computer programs to
- a commercial software product to
- a company.⁴

Once the KE professional has begun the transition from scientist to engineer (and is hurtling toward entrepreneur), the ultimate commercial question arises—what does one do first? Priorities need to be established for such tasks as: documentation of a business plan, capital acquisition, customer acquisition, selling “vaporware” (your idea). After witnessing the failure of more than half a dozen commercial software companies around the greater Boston area, one absolute truth emerges from the ashes of those enterprises—there is no substitute for a highly functional prototype that, at minimum, satisfies the perceived needs of a few potential customers.

The state of software engineering is so fragile and underdeveloped that investors do not appear willing to adequately fund software development enterprises, particularly in AI-related fields of study, which cannot demonstrate full-scale functional prototypes, regardless of the state of development of the business plan and management team.⁵ This investment community psychology is not necessarily disadvantageous to the KE professional. The major commercial successes in software engineering have almost uniformly been developed by a few professional engineers. Moreover, it appears that overfunding an early stage software engineering organization in a newly emerging discipline such as AI or KE is much more likely to result in product failure than undercapitalization.⁶ This phenomena results from “over-engineering” due to excessive hiring and capital spending prior to sufficient customer experience with a prototype.

Once minimal capital is in place to move the product development process from prototype to product, two characteristics emerge in the marketing of successful software products that weigh in favour of KE-related commercialization. They are: *a* the emergence of the “user-interface” as critical to the success of on-line real-time software products which interact with transaction processing functions in MIS departments; *b* the tremendous pressure on commercial enterprises to increase the productivity of “white-collar” workers through efficient distribution of enterprise experience and knowledge.

Most MIS executives are focusing their attention on the development of departmental information systems that are based on real-time transaction processing and office automation systems. The manner and degree to which a non-MIS professional deals with data-, information-, and knowledge-based MIS systems depends substantially on ease-of-use. KE-related (and personal computer development) professionals appear much more advanced than their brethren in, for example, DBMS research and development, in focusing on the symbolic interactions between users and software. This focus on the user-interface and ease-of-use will significantly aid the KE professional in gaining commercial acceptance of underlying technology, attracting key professionals to the enterprise, and most important, acquiring sufficient capital to complete the product development and marketing processes.⁷

⁴ The author is indebted to David McElfresh, former founding Vice President of Product Development of Lotus Development Corporation for this compact but elegant thought on software engineering development efforts.

⁵ The exceptions to this observation are those companies funded by venture capitalists in early-stage or “seed” capital phases of development that result in immediate loss of management control and, by the second round of financing, a loss of majority equity interest in the enterprise.

⁶ However, and as we shall discuss further on, undercapitalization ultimately results in *corporate* failure.

⁷ Colour graphics, windowing, multi-sessioning, context help facilities and other sophisticated components of user-interfaces contribute significantly to the appeal of the commercial prototype. Investors and potential customers are significantly influenced by such functionality because they are visually oriented with respect to a new product until the functionality is familiar.

Major gains in industrial or “blue-collar” productivity have occurred in the global manufacturing economy, but these gains have not transferred to the management functions of most service industries. This lack of production efficiency may be due, in part, to the absence of appropriate KE tools and products and the associated inability of businesses to leverage the knowledge and experience of key senior personnel. For example, the weight of the tedious paperwork in the underwriting department of an average-sized insurance company is shocking to those of us who have automated equally complex transaction processing systems. However, the use of adequate KE and AI systems and products in the underwriting process is just emerging. Pressure of commercial competition in the emerging global services economy will force service company executives to experiment with and adopt KE related products and services. Those KE product development companies which have the most precise timing of product introduction based on market demand and those which have adequate products, capitalization and sales ability will prevail.

The minimal components required for a successful commercial software product or service can be summarized as being:

- substantial customer feedback and testing of product assumptions
- a zeal for quality control and “bug” elimination
- use of the most efficient and productive software engineering methodologies
- recognition of the importance of customer service and support
- customer service and sales organization training
- comprehensive documentation and examples of use of the product
- carefully controlled schedules for product releases and modifications
- a reasonable sense of market timing.

Recognition on the part of the KE enterprise management that products must have, at minimum, these characteristics helps avoid the syndrome of undue focus on software development and the engineering process.⁸

At the end of the stage of development which results in a stable infrastructure within the company, a product and management team is emerging. Sales may not have taken place yet, but some measure of the skill of the management team will become apparent. The formation of the management team is the most important accomplishment of the emerging enterprise, even more important than the completion of the product prototype. Its success can be measured by a simple observational technique, carefully employed by successful venture capitalists and investors. It is simply the observation that the successful management team develops and sustains momentum towards success, overcoming by sheer willpower every hurdle, objection, and reason why it should not and cannot succeed—until it simply does. If the new management team cannot or does not appear to be doing so, it should be fixed or replaced *immediately*.

4 Capitalization

Ultimately, knowledge engineering products and services will achieve commercialization because of the availability of risk capital and motivated investors. Two factors make the present economic period (even considering the aftermath of the recent stock market crash) an attractive time to capitalize a KE company: *a* relatively low capital requirements as compared to other industries, particularly manufacturing and *b* the excellent financial performance of the software industry as a financial engine for earnings power. Astute investors will find the software product company attractive for these reasons and its tendency to develop a single product and nurture it carefully. The author does not support the notion, popular in many investment circles, that a single product company is somehow at a disadvantage when compared to other companies. *Every software company that has achieved market recognition has done so with a single dominant product.*

⁸ The long-term contribution to corporate overhead of research and development activities, even in the most technology-driven enterprise, is usually about 10–15% of sales, while marketing and sales expenses can exceed 50%.

As noted earlier, overcapitalization is a dangerous phenomena in software product development. Since undercapitalization is a significant contributor towards corporate failures in general, the emerging KE company, particularly one striving to define a new market segment or customer base, must be *sufficiently* capitalized. This is the point at which a carefully structured business plan is essential, along with concomitant corporate finance expertise. Corporate finance expertise means financial experience in structuring and balancing financial instruments and returns, and does not refer *per se* to venture capital expertise.

Financial instruments may be debt- or equity-based or they may be hybrids such as convertible preferred stock or bonds. Financial returns are the distribution of retained earnings, goodwill, and overall value of the enterprise to its founders, management, employees, and investors.

The relative merits of employing venture capitalists as contrasted with investment or merchant bankers by a KE enterprise must be considered by those concerned with acquiring start-up capital. Institutional venture capital is almost uniquely an American experience, having begun with the American Research & Development fund in Boston during the 1960s. As a means of funding new enterprises it is young, which may account for its excesses and high client failure rate. Europe, on the other hand, pioneered and is still dominated by the merchant banker.

In nineteenth century Europe, the merchant banker acted as a mediating party in the emergence of new industries by functioning as an industry expert and an investor in specific enterprises. But the merchant banker rarely assumed majority control of the enterprise stock, recognizing that it was better to have highly motivated owner-managers rather than simply managers and employees. This tradition almost died as a consequence of the heavy social and tax burdens imposed on entrepreneurs during the subsequent century of experimentation with socialism. What has generally replaced merchant banking is a combination of investment banking and private venture capital, with institutional venture capital only recently emerging.

Investment bankers usually take little or no equity positions in their client firms and do not participate in management. They are essentially brokers of ownership equity. The venture capitalists, on the other hand, generally take majority positions in firms and attempt to engage in active participation in management. But venture capitalists are performing poorly in the software industry with few exceptions, at least in this author's experience. This may be due to their fundamental lack of understanding of the product development process and software engineering as well as their tendency to completely dominate a company's management until the entrepreneurs are converted into employees of the venture capitalists.

As a consequence of lack of success of venture capitalists in funding software product development, a return to the European model of the merchant banker funding a new industry initiative is recommended. The supposedly benevolent impositions on management of venture capital investors are inherently in conflict with the risk-taking tendency of the entrepreneurial management team to overcome insurmountable hurdles. A capitalization process that results in the merchant banker assuming the combined roles of Chief Financial Officer and major shareholder, but not, necessarily, the role of majority shareholder is recommended. The development of the research concept and product will benefit from proper fiduciary controls, investment and commercial banking relationships and business acumen while its management team is able to succeed on its own merits. The Board of Directors assumes the role of strategist and industry expert while management assumes the dual roles of tactician and problem-solver.

Partnerships with companies, research institutions, focused governmental entities like central banks, and, of course private individuals and merchant bankers are preferred customers and investors in the early stages of growth of a KE software or service company. In the final analysis, the KE professional emerging from the research lab with a viable prototype and a host of carefully selected potential customers should apply the same level of sensitivity and selectivity to investors that was applied to both the engineering and marketing phases of commercialization.