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Death of an expert system: A case study of success and failure

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ABSTRACT

A decision team composed of managers and staff experts at Mary Kay Cosmetics develops packaging for new and revised products as well as sets their prices. However, the potential for costly errors in the decision-making process motivated this group to pursue development of an expert system (ES) to assist with the problem. The ES performed so well that it changed the organization's behavior--the group ceased to meet for the purpose of developing the packaging but instead gathered just to confirm and approve the expert system's solution. Despite the clear benefits associated with using an ES approach, the group stopped using the ES application and the behavior of the group returned to pre-ES practices. This work describes from a managerial perspective how and why this valuable tool fell into disuse, and offers valuable lessons for management.

INTRODUCTION

A decision team composed of managers and staff experts at Mary Kay Cosmetics develops packaging for new and revised products as well as sets their prices. However, errors in this decision-making process have costly results. For example, incompatibility between a cosmetic product and its container can cause product discoloration or failure of the package's integrity. Consequently, the group became interested in pursuing development of an expert system (ES) to help design error-free packaging. After construction, the ES performed so well that the group ceased to meet for purposes of making the decisions but instead assembled only to confirm and approve the expert system's solution. Despite the clear benefits associated with using this ES approach, the application fell into disuse and the behavior of the group returned to the pre-ES process.

This case study is important for several reasons. It is a rare example of using expert system technology in the product-packaging domain. It also documents a significant change in organizational behavior brought about from using a new information technology. Finally, it highlights both practices for success and issues that can cause failure when using a sophisticated information technology such as expert systems.

DOMAIN PROBLEM AND ES DEVELOPMENT

Mary Kay Cosmetics decided to investigate an expert systems approach for selecting cosmetic packages and setting product prices. The company explored an ES approach for both reasons of curiosity and a desire to reduce the likelihood of errors in the packaging decision process.

The selection of packaging materials for cosmetic products poses a major challenge for the cosmetic industry. The selection criteria are based on marketing requirements and chemical composition of the product. Marketing requirements include type of dispenser and clarity of the package. The chemical requirements include the composition and characteristics of both the product and the package material. The challenge stems from reconciling these two different sets of requirements given a set of cost constraints.

The major sources of concern are product-package interaction (e.g., contamination of the product by the material of its package), product degradation over time (e.g., color change), or package failure (e.g., migration of the product through the package). Addressing these problems requires evaluation of varied decision factors such as alcohol content, solubility, oxygen or light sensitivity, fill temperature, pH, water vapor transmission rates, and the technical costs of manufacture. A packaging failure is expensive: product recall costs, costs associated with redesign and production of new packaging, lost sales, lost customer good will, and so forth (Amini, 1981).

Prior to the use of the expert system, the packaging decision effort was a loosely structured process. A cross-functional work team representing marketing, product formulation, product safety, package engineering, research and development, purchasing, and manufacturing interests made the packaging decisions. No formal procedures existed for conducting the meetings, sequencing the decisions, or selecting package materials. The team members often relied on a heuristic process based on past experience, a frequent behavioral approach. Table 1 indicates the range of knowledge and information used in the package development process.

Under the old system technical and cost reasons encouraged the marketing team charged with developing the new product to give their requirements to the product formulator and the package design engineer at the same time. The requirement to start design work before knowing the ultimate product formulation often forced later package redesign. In addition, the marketing team often asked for designs which later proved beyond the allocated budget, or technically impossible, thus forcing another redesign. Also, with such an ad-hoc procedure the potential existed for marketing to favor a given package even though the produce design team believed it inappropriate. The result was a decision process that required numerous meetings over a period

of six or more weeks, and often saw earlier decisions questioned with subsequent restarts in product design.

Table 1. Knowledge and Information Sources Used in Packaging Decision Process

- Marketing requirements contained within the product specification
- Knowledge of the chemical formulation used in the product
- Knowledge of the performance of previous container types for similar product formulations
- Results of compatibility tests on similar container types and similar product formulations
- Vendor information
- Cosmetic industry and packaging industry publications
- Manufacturing process information
- Shipping requirements (e.g., government regulations on hazardous material)

It is from such an origin that the company's interest in an expert system solution emerged. This form of knowledge-based system (O'Keefe & Preece, 1996) applies a portion of the problem-solving expertise of one or more human experts in a given field to specific problems within that field. As such, expert systems can also be considered a subset of knowledge management systems (White, 1999). One of the strengths of ES technology is its ability to offer users explanations of its reasoning process and recommendations. This educational feature was a major attractant for Mary Kay.

The company had no prior experience with ES technology. However, one method for developing and applying a new information technology within a company is to associate with a university partner. Development costs can be very reasonable, and the attendant risk minimal, as long as the project is well chosen. A number of expert system applications began life in this manner (Motiwalla & Fairfield-Sonn, 1998; Turban & Vedder, 1992). In this case, the cosmetics firm began a working relationship with the University of North Texas. In the first phase, graduate students built a prototype ES for the company as part of a class project (i.e., for free). In the second phase, the UNT Center for Quality and Productivity obtained a $11,000 grant from the company to support graduate students who built a second, production version of the ES.

The completed application, built using a product from Neuron Data, had over 40 rules and consisted of a mathematics tool plus two ES components. The Solubility Calculator tool facilitated the calculation of the solubility factors for new products. These calculations are tedious and time consuming when performed without computer support. However, they are vital to the process of selecting compatible packages. The first ES, the Package Material Selector (PMS),

recommended suitable package materials for a given cosmetic product, as well as any additional testing for package-product interactions. The second ES, the Product Cost Estimator (PCE), used the output of the PMS to guide users through the design of a new cosmetics package as well as help users determine the associated product cost. A more detailed description of this application is provided by Popelka and Van Dyke (1993) and Van Dyke (1994).

USAGE OF THE EXPERT SYSTEM

After development, initial work with the ES began after appropriate training of Mary Kay staff on its operation. At first the director of package development installed the ES on a portable computer and brought it to the team meetings. He would operate the ES as the others provided input data or looked on. As often happens, using the ES structured the order of tasks and the group input (Motiwalla & Fairfield-Sonn, 1998; Yoon, Guimaraes, & O'Neal, 1995). Under the new system, marketing gave their product request to the formulator first. When the formula was perfected, the director of package development would gather the needed chemical data from the formulator and operate the ES in the presence of the entire development team. All team members received a printed copy of the Es's recommendations and appropriate justifications before leaving the meeting.

The ES automated package/product compatibility, as well as some technical and cost feasibility issues. This in turn greatly speeded the entire decision process, saving approximately 4 weeks. There were no reported package design flaws associated with any of the products developed with the ES.

ORGANIZATIONAL IMPACT

Using the ES provided the team with a clear sense of direction, agreed upon by all participants, earlier in the package decision process (Boeller, 1996). For example, the design of the ES allowed it to document the reasons behind a given recommendation. This justification capability educated the group about design costs and other related issues. It became less likely that a team member would push a design that was too expensive or inappropriate. Thus the ES documentation made the initial package proposals more credible, and less vulnerable to redesign than in the past.

By formulizing much of what had previously been considered intuitive, the ES improved understanding of the decision process itself (Berry, Berry, & Foster, 1998; Boeller, 1996; Motiwalla & Fairfield-Sonn, 1998). At the start of the ES development, one design team member believed that it would take approximately 500 rules to support the decision process. That person was amazed when the final number of rules proved less than a tenth of this estimate (Boeller, 1996).

The consistency of the Es performance reassured all members that they were unlikely to overlook a constraint or skip a step in the decision process. This in turn increased the team's confidence that the outcome would be accurate and reliable. In addition, the ES smoothed the

workload and all team members spent less time in meetings. Using the ES saved the company about 10-15% of the total time required for new product development, mainly by reducing false starts and package redesign (Berry, Berry, & Foster, 1998; Boeller, 1996; Martin, Subramanian, & Yaverbaum, 1996; Motiwalla & Fairfield-Sonn, 1998).

Most importantly, the role played by the Es in the decision process became far different than originally intended (Boeller, 1996; Motiwalla & Fairfield-Sonn, 1998). At the outset of the project, the ES was only to support the decisions made by the product development team. However, initial use by the team in its group meetings showed that the ES could in fact do much of the decision work on its own. Consequently, the group moved toward participating individually on an as-needed basis while the director of packaging design operated the ES and prepared the required documentation. The packaging team needed to meet as a group only to approve the recommendations of the ES. Thus the reliable performance of the expert system caused a significant change in organizational behavior that in turn allowed the application to have a far greater scope and authority than previously envisioned.

REASONS FOR SUCCESS

There are several reasons why this ES proved successful. First, there was a clear match between the abilities of the information technology and the nature of the problem. The packaging decision involved multiple sources of expertise, including the technical fields of chemistry and package engineering. The human experts used experiential (heuristic) knowledge as well as factual knowledge. The problem-solving process was procedural in nature, and thus was suitable for incorporation as a network of rules. All of these traits match well with developing an expert system solution (Waterman 1986; Wong & Monaco, 1995).

Second, cost-benefit analysis favored using an expert system approach. By using graduate student labor, the application cost the company relatively little. Use of the ES greatly simplified the organization and sequencing of the package decision process, thus saving time (with fewer, shorter meetings) and effort (spent on debate, miscommunication, and redesigns). The development effort itself clarified the decision process and made the outcome of that process more easily understood (Berry, Berry, & Foster, 1998; Boeller, 1996; Motiwalla & Fairfield-Sonn, 1998).

Third, the project had a champion in the person of the director of package design, who believed in its worth and supported it continually with his personal involvement. An effective champion is an important factor in the success of an ES project (Berry, Berry, & Foster, 1998; Duchessi & O'Keefe, 1992; Motiwala & Fairfield-Sonn, 1998).

FAILURE OF THE EXPERT SYSTEM

Despite these clear benefits, Mary Kay no longer uses the expert system. Instead, the organizational behavior associated with the package decision process has reverted to what took place before introduction of the ES. The reasons behind this paradox offer important lessons about pitfalls to avoid with a project involving new IT.

The immediate problem was that the company did not train anyone to maintain the ES. During the collaborative development phase company management expressed no interest in having the university train one of its own employees in this new (for the company) information technology. After completion of the ES, Mary Kay did not continue its relationship with the university, nor did it continue any contact with Neuron Data. Consequently there was no one at the firm who knew how to use Neuron Data's software to maintain or enhance the ES. Furthermore, the entire project was conceived, developed, and utilized with little or no involvement by the firm's IT unit. There was no one within the IT unit whom the package design team could turn to for help (Dominski, 1996). Eventually, the package design team discovered that they needed to add new rules to the ES, but could not do so. This failure to evolve the ES in response to changing needs forced discontinuation of the tool.

The deeper problem, however, was the absence of a continuing champion for the project. It was an immediate manager's decision, not the team's decision or that of higher management, to investigate and use an expert system approach. When the initial champion (the director of package design) left the firm, no one replaced him (Dominski, 1996). Without a champion, no one was willing to contribute the time, money, and other resources needed to maintain the ES, either internally or through the help of the university. No one in a position of authority was willing to sustain the project and, by his or her visible support, send a message about how important the project was to the firm's success. In short, managerial failures at Mary Kay doomed the project and kept a highly successful ES from being used in the long run (Duchessi & O'Keefe, 1992; Gill, 1995; Motiwalla & Fairfield-Sonn, 1998; Yoon, Guimaraes, & O'Neal, 1995).

CONCLUSIONS

The experience of Mary Kay Cosmetics offers several important lessons for IT managers:

- Demonstrable cost savings (in this case, time saved and no packaging errors) alone are insufficient to ensure the success of a new IT application.
- The ability to reduce the friction within a group decision process alone is also insufficient.
- Higher-level management has to be committed and involved on an on-going basis to ensure continuity.
- Any new IT application must be integrated with the IT management policy of the firm so that it does not die if or when its champion leaves.
- The organization's IT shop needs to be involved with any application development using new IT, because it will consume IT resources and probably need maintenance. The IT shop should understand deployed IT applications better than anyone else in the firm.
- Perhaps most importantly, an IT application does not have to be large in size or terribly ambitious for it to impact significantly organizational behavior. All the application needs to do is meet an important organizational need in an effective, efficient, and acceptable manner. In this age of constant technological change and innovation, management needs to be prepared for this outcome, should it happen.

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