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ISSUES IN CONTINUED TECHNOLOGY INVESTMENTS BEFORE SELLING A FIRM

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ABSTRACT

This essay describes the issues involved when attempting to sell a firm engaged in rapid product prototyping. The issue facing the board of directors is how to present the company to potential buyers in the best possible light. The paper concludes that the best approach is to manage product innovations effectively so that potential buyers perceive the firm as an investment that will yield positive future returns. The article is divided into eight sections. The first section discusses the situation, including rapid prototyping, profit maximization, maintaining optimal profits, investing in new technology, and market value. The second section defines the problem, clarifying its meaning and scope. The third section examines the causes of the problem. The fourth section highlights the corporate systems affected by the problem, including structural subsystems, psychological or cultural subsystems, technical subsystems, managerial subsystems, and corporate goals and values. The fifth section provides several alternative solutions. The sixth subsection states that the likely best solution is to manage innovation effectively during the corporate sale period and why this solution was chosen. The seventh section highlights the ramifications or consequences that may result from making this section, as well as the lessons learned. The final section concludes that there is no royal road when selling a rapid product prototyping firm; there are only good roads and better roads.

Keywords: Continued Technological Investment, Continuous Improvement, Corporate Sale, Incremental Improvement, Managing Innovation, Profit Maximization, Rapid Prototyping.

INTRODUCTION

This essay describes the issues involved when attempting to sell a firm engaged in rapid product prototyping. The issue facing the board of directors is how to present the company to potential buyers in the best possible light. The paper concludes that the best approach is to manage product innovations effectively so that potential buyers perceive the firm as an investment that will yield positive future returns.

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SITUATION

The board of directors requested the general manager to justify the company's continued annual investment in technology. The firm is a high-technology company that employs rapid product development and production techniques. The firm's directors are nearing retirement and want to increase the company's profits over the next few years. The directors also desire to avoid any significant investments and then sell the organization.

Rapid Product Development

According to Bullinger *et al.,* the firm sold its products in a market where rapid product and production changes are the norm rather than the exception. Consequently, rapid product development involves the extreme minimization of the time required to turn a product concept into a shippable product.[1] Although the term has other meanings, rapid product development is essentially concerned with:[2]

- Effective product specification;
- Incremental improvement;
- Clearly defined responsibility;
- Objective progress tracking; and
- Senior management buy-in.

Cagen *et al.,* argued that rapid prototyping is the effective use of a variety of computer-aided methods to create three-dimensional models of products, thereby allowing a development team to commit fewer resources and making it easier to make changes.[3]Incremental or continuous improvement aims to reduce the variability of a product or process, typically involving the resolution of problems that arise during either the design or manufacturing phase of product development.[4]

[1]Hans-Jörg Bullinger, Joachim Warschat, & Dietmar Fischer, Rapid Product Development – An Overview, 42 COMPUTERS IN INDUSTRY 2-3, 99-108 (Jun. 2000), *available at* https://www.sciencedirect.com/science/article/abs/pii/S0166361599000640.
[2]*Id.*
[3]JONATHAN M. CAGAN, & CRAIG M. VOGEL, & BRUCE NUSSBAUM, CREATINGBREAKTHROUGHPRODUCTS: INNOVATION FROM PRODUCT PLANNING TO PROGRAM APPROVAL(Prentice-Hall, Inc. 2002).
[4]ROGER G. SCHROEDER, OPERATIONS MANAGEMENT: DECISION MAKING IN THE OPERATIONAL FUNCTION (McGraw-Hill, Inc. Jan. 1993).

Schroeder pointed out that when job responsibilities are unclear or constantly changing, workers become frustrated, which can result in poor quality, low productivity, and conflict among individuals.[5]Furthermore, when performance standards are established, workers are rewarded based on their performance, including pay, promotions, status, and recognition.[6]Graham *et al.,* firmly stated that it is the responsibility of senior management to demonstrate to the workforce that they are serious about quality and product development by showing constant interest through verbal and non-verbal behavior.[7]

Profit Maximization

Another issue evident from the situation is that all members of the board of directors are close to retirement and desire to increase the company's profits in the upcoming years so that it can be sold. To understand this issue, one must ask whether the company is currently maximizing its profits. According to Colander, a firm maximizes its profits by setting its marginal revenue equal to its marginal costs, thereby establishing the quantity that will be produced.[8]The optimal price is determined by extending a vertical line from the intersection point to the demand curve and then drawing a horizontal line to the price axis, as depicted in Figure 1.[9]

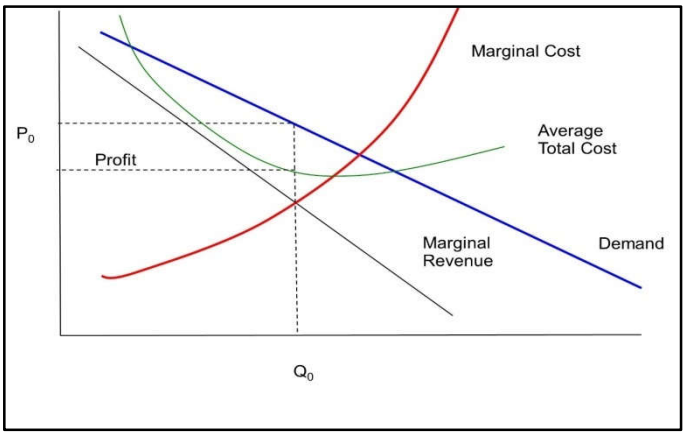

Figure 1. Profit Maximization of a Firm

The company is profitable when the total average cost curve intersects the vertical line that passes through the point where marginal revenue equals marginal cost, which is located below the demand curve.[10]Now, from the case, it is safe to assume that the firm in question is indeed profitable. However, the real question is whether the company is engaging in profit-maximizing behavior and has set marginal revenue equal to marginal costs. It may be that marginal costs are above the marginal revenue curve, which would mean that the board of directors is asking the general manager to lower marginal costs to where it is equal to marginal revenue, thereby decreasing output but maximizing profits.

Maintaining Optimal Profits

Since all members of the board are nearing retirement, it appears that they are requesting the general manager to optimize profits so that the business can be sold. However, it also seems that the Board is interested in minimizing costs, as it could be construed that they are asking the general manager not to invest heavily in new product development to keep costs down. However, it can be shown that cost minimization is equivalent to profit maximization, which, in this case, means that what the board of directors is asking the general manager to do is to maximize profits.

Investing in New Technology

It can be inferred that the board is requesting that the general manager refrain from making significant investments in new technology. This could be true, but from a strictly microeconomic perspective, it does not have to be true. Nevertheless, it is worth remembering that introducing a new technology to the market requires time and money. Since the company is already in a market where rapid product development is normal for the industry, investing in new technologies may be attractive to potential buyers. In this case, an investor would not be forced to invest the additional monies that would be needed to bring the organization to the same level as the rest of the industry. In other words, if the firm is already investing in a new technology, then this fact may enhance the market value of the firm rather than detract from it. However, this is not explicitly stated.

Market Value

Another way to look at the situation is that the Board of directors is asking the general manager to maximize the company's market value or sale price. Since the market value of a company is the price at which buyers and sellers are willing to trade the company's assets, the market value of an organization is equal to the current market price for common stock times the number of shares of common stock outstanding.[11]

The problem with this definition of market value is that the value of the firm is subject to the capricious behavior of the stock market since the price of a share of common stock can fluctuate in a seemingly random manner. Ross et al. observed that the price-to-earnings (P/E) ratio (market price per share divided by the earnings per share of common stock), the dividend yield (dividend per share divided by the market price per share), the market-to-book value (market price per share divided by the book value per share), and Tobin's Q ratio (market value of debt plus equity divided by the replacement of assets) are four ratios that attempt to posit the value of a firm.[12]Although not explicitly stated, the board of directors may aim to maximize the value of one or more of these ratios. If so, the question is which ratio or ratios are the motivating drivers, and what economic forces must be specified to ensure the values of the relevant ratios are optimized? Again, the case does not explicitly address this issue.

PROBLEM STATEMENTS

The purpose of this section of the paper is to identify the problems faced by the general manager and the board of directors. The issue is to increase the firm's value so that it can be sold quickly while simultaneously investing in technology to ensure continued optimal profitability. If the company is not currently optimizing profits, then the short-run problem is to lower marginal costs so that they are equal to marginal revenue. Assuming that the company is currently maximizing profits, the major problem facing the organization is to maintain an optimal profit at least until the company is sold. If the goal is to maximize shareholder value, this translates into optimizing the

[5]*Id.*
[6]*Id.*
[7]ALAN GRAHAM, SHOJI SHIBA, & DAVID WALDEN, FOUR PRACTICAL REVOLUTIONS IN MANAGEMENT: SYSTEMS FOR CREATING UNIQUE ORGANIZATIONAL CAPABILITY (TOTAL QUALITY MANAGEMENT) (Productivity Press Apr. 2001).
[8]DAVID C. COLANDER, ECONOMICS (McGraw-Hill-Irwin 12th ed, Feb. 2023).
[9]*Id.*
[10]*Id.*
[11]STEPHEN A. ROSS, RANDOLPH W. WESTERFIELD, JEFFREY JAFFE, & BRADFORD D. JORDAN, CORPORATE FINANCE (McGraw-Hill, Inc. 13th ed. 2021).
[12]*Id.*

price per share of the firm's common stock since the number of shares of common stock outstanding is typically constant. Thus, the issue may be to maximize the firm's earnings per share or its market-to-book value. The dividend yield may not be an attractive statistic to optimize, as companies experiencing rapid product development in high-technology industries usually reinvest their profits back into the organization, paying little to no dividends. Tobin's Q ratio is probably not a candidate for optimization, as the denominator of the ratio consists of the replacement value of assets, which is subject to inflation and other fluctuating market conditions.

The statement of the actual problem facing the general manager must encompass the dynamic nature of the market, the demand for rapid product development, and the board of directors' desire to sell the firm within a few years. Thus, the problem appears to be optimizing the firm's value at the time of sale using a measure mutually acceptable to both the buyer and seller while avoiding unnecessary, burdensome expenses that detract from this optimal value due to the rapidly changing market conditions experienced by the organization.

What This Does Not Mean

The key to understanding this problem statement is to remember what it means, but more importantly, what it does not mean. The board of directors could desire to cease and desist any and all investments in new technology for the few years before the company is sold. Conversely, it could also be construed that the board is asking the general manager to critically examine the investments in new technology that are currently being undertaken, as well as all future investments, and ensure that any innovations are embarked on with the sole intention of enhancing the profitability and value of the organization. It can be reasonably assumed that the board knows only too well that the market space that the firm finds itself demands investments in new technologies to ensure continued profitability. The key here is to avoid investing in research that has less than a modicum of ability to generate revenues and profits on time.

Another thing that can be inferred from the case is that the board is well aware of the inherent risks in high technology. Furthermore, it can be projected that the board is quite conscious of the fact that some technologies have long lead times. The board may not be asking the general manager to sacrifice the long-term competitive advantage for a short-term gain, but rather, they may be suggesting that the general manager be cognizant of the risks inherent in long-term projects. In other words, the board may be requesting that the general manager be prudent in their decision-making, particularly when deciding whether to pursue new product development.

CAUSES OF THE PROBLEM

The causes of the problem are derived from basic economic principles. According to Colander, there is always the problem of scarcity, where there are too few goods to satisfy individual wants and desires.[13]In this case, it appears that the board of directors is cautioning the general manager that there may be insufficient resources to satisfy the organization's research needs. According to Tidd and Bessant, managing innovation is never easy, but it is imperative to do so.[14]Given that innovation is both risky and uncertain, the general manager could construe that the board is saying it does not want the firm to innovate, regardless of the possible rewards. The problem is that by not innovating, the company runs the risk of losing market share as a result of a radical innovation from the competition, which could rewrite the rules of the game.[15]

It may also be true that the board believes the company lacks effective innovation. They probably recognize that innovation is a core process concerned with periodically renewing the organization. In other words, the board may be suggesting that the general manager adhere to the following six generic phases in managing the innovation process:[16]

- Scan and search both internal and external environments to pick up signals that suggest various opportunities for innovation;
- Strategically select from this set of potential triggers those projects that the firm can most likely do given its available resources;
- Thoroughly explore the option and the knowledge needed to exploit the option;
- Implement the innovation promptly;
- Reflect upon the implementation experience, and
- Review the successes and failures.

The board may hope that a significant and discontinuous change will not adversely affect the organization's profitability. They may be reminding the general manager that disruptive technological change is messy, involving several false starts, recycling between stages, encountering dead ends, and jumping through steps that are out of sequence.[17]

The board may also be admonishing the general manager to remember that innovation does not always lead to business success.[18]According to Tidd and Bessant, if the fundamentals of the business are weak, then any given innovation may not be of sufficient strength to save the firm.[19]The board could also be hinting at the fact that the real test of an innovation is not short-term success but sustained growth due to continuous intervention and adoption.[20]Although it may not seem so to a neophyte, it is simple to succeed because of a lucky combination of ideas and a receptive market.[21]In other words, there is no substitute for being at the right place at the right time with the correct bill of goods that people want. It is quite a different matter to consistently repeat this performance time and time, leading to sustained growth. The board may also be sharing with the general manager that to be successful, innovation must be managed in an integrated way.[22]Since managing innovation is a learning process, the key is to develop an organization where the next time a similar challenge emerges, the firm can readily respond in an appropriate manner, possibly similar to the behavioral pattern described above.

SYSTEMS AFFECTED

When analyzing the situation, it is essential to remember that an organization is an open socio-technical system that coordinates human and technical activities.[23] The various subsystems that make up an organization are not isolated elements but work together,

[13]David C. Colander, *supra*, note 8.
[14]JOE TIDD, & JOHN R. BESSANT, MANAGINGINNOVATION:INTEGRATINGTECHNOLOGICAL, MARKET AND ORGANIZATIONAL CHANGE (John Wiley& Sons, Ltd. Nov. 2020).
[15]*Id.*
[16]*Id.*
[17]*Id.*
[18]*Id.*
[19]*Id.*
[20]*Id.*
[21]*Id.*
[22]*Id.*
[23]DONALD R. BROWN, AN EXPERIENTIALAPPROACH TO ORGANIZATIONALDEVELOPMENT (Prentice-Hall, Inc. 8th ed. 2010).

reacting to and influencing other system elements.[24]When viewed from this perspective, the primary components consist of:[25]

- Structural subsystem
- Technical subsystem
- Psychosocial or cultural subsystem
- Managerial subsystem
- Goals and values subsystem

The structural subsystem encompasses the formal design, policies, and procedures of the organization, typically outlined in an organizational chart that delineates the division of work and the scope of authority.[26]The technical subsystem is concerned with the functions, activities, and operations that produce the firm's final product. The psychosocial or cultural subsystem, on the other hand, deals with the network of social relationships and the behavior patterns of employees and management.[27]The managerial subsystem encompasses the entire organization through the direction, organization, and coordination of all of the firm's activities. Finally, the goals and values subsystem focus on the basic mission and vision of the company, which may include profits, growth, survival, and in this case, the eventual sale of the firm.[28]

Structural Subsystems

From the situation description, it is unclear what the effect of the problem would be on the organizational chart, division of work, or patterns of authority. If the company is operating at suboptimal profits, then the structure of the firm will need to change to move the organization toward maximizing profit. If the company is already maximizing profits, then maintaining a high level of performance may justify a structural change in the organization, particularly if key members of the functional departments retire or leave for other positions.

If shareholder value is to be maximized, the organization's structure may need to be adjusted. The critical questions are what changes are required, how they will occur, and how the change will optimize the firm's value. All of these questions have merit, but given the available data, their answers are unclear.

Psychosocial or Cultural Subsystems

People who work for organizations form relationships with other members, and the collective sum of these relationships, along with their relative synergy, form the culture of a firm. If the company is currently enjoying suboptimal profits, then the culture may need to be changed so that it is more conducive to profit-maximizing behavior. If the firm is already maximizing its profits, then employing the contingency approach to organizational development may prove fruitful, as there is no one way to manage, given the myriad possible situations.[29]Given a stable environment that possesses a low adaptive orientation, it is possible to establish general approaches to change.[30]Since the firm operates in a market space that typically experiences rapid product development, the general manager may struggle to maintain optimal profits for an extended period.

It is essential to remember that planned organizational change is an effort to modify the way the firm operates to achieve increased effectiveness.[31]In other words, for a firm to maintain a high level of profitability, or its market value for that matter, the company must be focused on constant improvement and change.[32]

The problem with the psychosocial subsystem, or corporate culture, is that it typically resists change because of the clash with the stated or unstated goals of senior management.[33]According to Brown, the key to an excellent organization is flexibility and innovation.[34]However, the problem with this firm is that the board of directors may suggest that flexibility and innovation should be set aside to ensure maximum market value. In companies that operate in markets where rapid product development is the norm, such a decision could be fatal to the firm. The culture may rebel against the board as part of a self-defense mechanism, but hopefully, such action may be unnecessary or even counterproductive.

Technical Subsystems

Since the technical subsystem consists of the functions, activities, and operations used in the production of the firm's output, the fact that the situation explicitly states that the company is involved in a market where rapid product development is the norm means that for the general manager to ensure that the organization can be sold at an optimal price, this system must change to accommodate the dynamic environment. The key issue facing the general manager is to identify which parts of the technical subsystem must change to maximize profitability and shareholder value. The situation description does not provide specific information regarding the relevant technical subsystems, but the fact that the company experiences rapid product development seems to indicate that keeping abreast of innovation is critical to success. One way to discover if a firm is exploiting its technical subsystems is to conduct a performance gap analysis.[35]When employing this method, data is collected about the actual state of the organization using various dimensions. Additionally, data are collected on the ideal or desired state, and then the two states are compared to identify gaps or discrepancies.[36]The performance gap then becomes the basis for determining what technical interventions are necessary to bring the firm in line with its stated goals. What is interesting about using this tool is that a performance gap can exist not only because of internal conflict but also because the organization has not adapted to its external environment.[37] Figure 2 shows how to view a performance gap.[38]

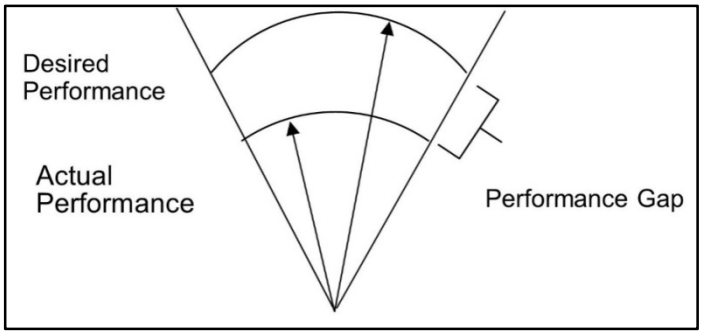

Figure 2. The Performance Gap

[24]*Id.*
[25]*Id.*
[26]*Id.*
[27]*Id.*
[28]*Id.*
[29]*Id.*
[30]*Id.*
[31]*Id.*
[32]*Id.*
[33]*Id.*
[34]*Id.*
[35]*Id.*
[36]*Id.*
[37]*Id.*
[38]*Id.*

Since a performance gap can exist for some time, it is possible that the directions from the board of directors to the general manager could be construed as the point of recognition. If so, then the board's position may be the result of a previous Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, where it was found that the organization was lacking or even overextending itself in key areas. Since rapid product development is the norm for the firm, it could be that the company was over-extending itself technologically and thus needed to be reined in. If this is so, then the board's actions may be entirely appropriate.

Managerial Subsystems

Three managerial issues need to be considered here. First, there is *managerial effectiveness*, which deals with accomplishments of specific organizational objectives and goals, or in other words, doing the right things.[39]In other words, the more effective management is, the closer the company comes to achieving its objectives and goals. Second, *managerial efficiency* is concerned with the ratio of outputs or results to inputs or resources.[40]When a firm minimizes its costs or, equivalently, maximizes its profits, it is acting efficiently. Another way to look at managerial efficiency is when a company comes close to maximizing shareholder value. Third, there is the *motivational climate* of an organization, which is made up of employee attitudes, morale, and other factors that affect performance.[41]

When the board of directors advised the general manager to alter the company's behavior to ensure it could be sold in a few years, it was asking this individual to change the managerial effectiveness, efficiency, and motivational climate of the company. The managerial effectiveness was affected because it could be inferred that the board was requesting the general manager to change the organizational objectives and goals from focusing on innovative activities to preparing the firm for sale. In other words, the board was consciously changing managerial effectiveness.

If the firm was not operating at optimal profits and needed to be, if the general manager was asked to maintain optimal profits until the firm was sold, or if the shareholder value was less than its assumed potential, then the board was attempting to improve managerial efficiency. The idea behind optimizing this statistic would be to increase the market value of the firm so that when sold, the stockholders would realize the highest possible capital gain.

As for the motivational environment, since the firm did business in a market where rapid product development was the norm, any change in the motivational environment could harm the organization. Glen aptly observed that geeks who are intimately involved in innovation have far more loyalty to their profession or to the problem that they are solving than they have to a particular organization.[42]Since geeks have a natural disdain for an established power base, they tend to focus on internal facilitation and are exceptionally qualified in managing ambiguity and nurturing motivation.[43]In other words, if the board decides to change from an innovative organization to a strict profit- or shareholder-value-maximizing firm, then the climate of the work environment could change for the worse, at least for the people intimately involved in innovation. The result is that the innovators within the company may decide to leave, taking their expertise and knowledge elsewhere, and making the company less attractive to a potential buyer.

Goals or Values Subsystem

One of the potential problems is that the board of directors is setting the organization's goals rather than the innovators themselves. According to Brown, although challenging goals produce better performance, goals that are too difficult or inconsistent with the organization's culture tend to discourage employee participation and performance.[44]Since a corporate culture is a system of shared values and beliefs, when the board changes the organization's goals, the culture may struggle to cope. For the firm to be successful, its culture must not only achieve the goals specified by the board but also satisfy the needs of its members. In essence, the effectiveness of the firm is the key issue here. According to Brown, the key to an innovative culture is to:[45]

- Possess a culture of quick reflexes
- Have a clear focus and well-aimed action
- Encourage self-directed behavior
- Redirect anger, conflict, worry, etc. into the passionate pursuit of results
- Experiment to achieve significant results

If employees perceive the board's actions as a means to stifle innovation, then Glen suggested that innovators, whose loyalty lies with technology and their profession, may decide that other firms would more appreciate their passions.[46]Thus, the general manager is left in a conundrum, where profit and shareholder maximization are the explicit goals of the board, but implementing those goals would lower profits and shareholder value due to the employees' rebellion. Furthermore, a secret of this sort cannot be hidden for long, and thus a balance must be struck, one that is acceptable to both parties.

ALTERNATIVE SOLUTIONS

There are a variety of possible solutions to this problem, some of which are better than others, but all depend upon the situation's implicit assumptions. A list of possible alternative solutions is as follows:

- Make no changes;
- Maximize profits;
- Maximize shareholder value; and
- Effectively manage the innovative process.

Although there may be other solutions worthy of discussion, it is apparent that these four alternatives are among the most obvious ones. It should be noted that hybrid solutions may emerge, but due to the relative complexity of the mix, they are beyond the scope of this paper.

Make No Changes

This is an appealing alternative, particularly if the company is already maximizing profits, maximizing shareholder value, and effectively managing innovation. The problem with this alternative is that it is unclear what it really means, as the state of the firm is essentially unknown. The only information that can be gleaned from the situation description is that the board of directors asked the general manager

[39] *Id.*
[40] *Id.*
[41] *Id.*
[42] PAUL GLEN, LEADING GEEKS: HOW TO MANAGE AND LEAD PEOPLE WHO DELIVER TECHNOLOGY (Jossey-Bass, Inc. 2002).
[43] *Id.*
[44] Donald R. Brown, *supra*, note 23.
[45] *Id.*
[46] Paul Glen, *supra*, note 42.

to prepare the company for sale. It is also known that the firm does business in a market where rapid product development is the norm and where the members of the board will be eligible for retirement in a few years. Aside from this information, nothing is known about the economic and financial state of the organization.

This would be a poor choice if the firm is currently not optimizing either profits or shareholder value and is not effectively managing innovation. In this scenario, the board's action is entirely appropriate, and the instructions to the general manager are straightforward. The problem is that the company's state is not open to discussion, not because it is a closed subject but simply due to a lack of meaningful information.

Maximize Profits

According to the principles of economics, maximizing profits, or equivalently minimizing costs, is the goal of every firm.[47]It is not known whether the firm is currently maximizing profits. However, what is known is that the board of directors has requested that the general manager prepare the company for sale in the next few years. This could be construed as the board asking the general manager to reexamine the firm's processes to minimize costs. In a market where rapid product development is the norm, innovation can be expensive, so to reduce costs, the board may be asking the general manager to allocate less money to innovation, hoping to make the organization more attractive to a potential buyer.

If so, then the question becomes whether costs have already been minimized. If so, then any further reduction in costs may harm profitability, making the firm less attractive and thereby defeating the whole purpose of the exercise. The key is to remember that when costs are minimized, profits are maximized, and vice versa. Thus, if there is an effort to reduce costs beyond the economic minimum, this action would also lower profits and, consequently, lower the firm's selling price.

Maximize Shareholder Value

The notion of maximizing shareholder value is probably more palatable to serious students of business than that of maximizing profits. Optimal profits could be viewed as mercenary and greedy, whereas maximizing shareholder value has an altruistic ring, as it would potentially put money in the pockets of the firm's shareholders. In this era where mutual funds and other financial institutions hold corporate common stock, maximizing shareholder value could be perceived as helping a large number of people grow incrementally richer.

Because the price of common stock fluctuates in a seemingly random manner, Ross et al. stated that the price-to-earnings (P/E) ratio, dividend yield, market-to-book value, and Tobin's Q ratio are four ratios that can be used to determine whether shareholder value is being optimized.[48]The advantage of employing these ratios is that they have an approximate ability to predict the future. It should be noted that these four statistics are indicators, not predictors, as they provide a rough approximation of what could occur.[49]Thus, it can be inferred that the board is instructing the general manager to maximize one or more of these statistics in the hope that by doing so, the stock price will increase, ensuring that the shareholders will receive a substantial return on their investment when the company is sold.

The fact that these four ratios are indicators rather than predictors, and only rough approximations are possible, raises some concerns about their use as a driver. In an attempt to maximize shareholder value, the general manager may indeed optimize the value of one or more of these four ratios yet still not maximize shareholder value for the simple reason that not all the value of a firm operating in innovative markets is contained in the price of its common stock. There may be intangibles present that significantly alter the perceived value of a firm.

Effectively Manage Innovation

It may be true that the board recognizes that innovation is a core process that must be nurtured to ensure the firm sells at a high price. As previously suggested, the board may be asking the general manager to follow the six generic phases in managing the innovation process; namely:[50]

- Scan and search both internal and external environments to pick up signals that suggest various opportunities for innovation;
- Strategically select from this set of potential triggers those projects that the firm can most likely do given its available resources;
- Thoroughly explore the option and the knowledge needed to exploit the option;
- Implement the innovation promptly;
- Reflect upon the implementation experience; and
- Review the successes and failures.

Although this may be a stretch, the board may be implying that by cautioning the general manager about managing innovation, they are suggesting that disruptive technological change is a complex and uncertain proposition, involving several false starts and resulting in increased costs.[51]

In accepting this option, the general manager may be assuming that the proper management of innovation will necessarily maximize profits, equivalently minimize costs, or even maximize shareholder value. The general manager may believe that the value proposition of a firm in a rapidly changing product development market is quite different from the value proposition of a company in a more stable market space. The general manager may feel that the reason for the difference is that the content of the value proposition changes from state to state at a high velocity or accelerates at a significant pace. On the other hand, the board may or may not share the general manager's assumptions. They may be only concerned with the upcoming sale, and this may be due to their perspective, whether it be less dynamic or even static. Regardless, the key issue here is that the board and the general manager understand and effectively communicate with each other.

Solution and Ramification

The purpose of this section of the paper is to select one of the alternatives discussed above, and then describe the possible ramifications to both the board of directors and the general manager.

SOLUTION SELECTED

Although this author recognizes the intrinsic bias of being a proponent of innovation, it is the opinion of this author that the last option is probably the best option for the general manager to pursue. In other

[47]David C. Colander, *supra*, note 8.
[48]Stephen A. Ross, Randolph W. Westerfield, Jeffrey Jaffe, & Bradford D. Jordan, *supra*, note 11.
[49]David C. Colander, *supra*, note 8.
[50]Joe Tidd, & John R. Bessant, *supra*, note 14.
[51]*Id.*

words, the general manager should strenuously attempt to effectively manage the innovative process present at the firm.

Justification for the Selection

In making this selection, several caveats need to be discussed to ensure that the proper decision is made. Since the board is asking the general manager to prepare the organization for sale, the company must present its best face to a potential buyer. This means that the firm needs to closely examine its profits and/or shareholder value to determine if it is possible to optimize them. This is the correct approach, provided that potential buyers value the innovative efforts of the firm and that the company is engaging in those innovations that will yield the highest returns. A priori, this may be difficult to achieve, since no one knows the future with certainty. However, if the general manager is sufficiently insightful or has the good sense to hire insightful employees and then possesses the humility to listen to them, then there is an excellent chance that the solution selected would indeed be the correct one.

RAMIFICATIONS OF THE SELECTED SOLUTION

The ramifications of selecting this solution are manifold, even if they are uncertain. There is a possibility that implementing the proposed solution could lead to a decrease in profits and a decline in shareholder value. This could occur if the company is sold during the middle of a product development life cycle when costs are being incurred, but no revenue is being generated. It should be remembered that the value of any innovations to a potential buyer may be perceived as an intangible commodity whose dollar value would be estimated and/or negotiated.

Another consequence of effectively managing innovation is that profits and/or shareholder value may increase over time. This may be because a given product is nearing the end of its product development life cycle at the time the board requests the general manager. In this case, the previous effectiveness of managing innovation may become readily apparent, particularly if the resulting product is successful in the marketplace. In such circumstances, the general manager has the tools in place to argue effectively that correctly managing innovation has value to the organization, and thus the current management style needs to be enhanced and promoted, for there is a high probability that it will be the basis for a successful sale.

The final outcome proposed in this article is that managing innovation effectively will neither improve nor detract from the firm's bottom line. If the management strategy discussed above is incorrect, or if the company is already experiencing the optimal benefits of its behavior. The effective management of innovation is not making the organization worse off, and so the value of the implied loss function is zero. What this means is that the suggested solution is appropriate, even though better solutions may exist.

Lessons Learned

One of the obvious lessons learned is the definite lack of detailed information. However, by making reasonable and appropriate assumptions, some recommendations and conclusions can be made. The key is to remember that any assumptions postulated are subject to review based on the analysis results. Effective communication between the general manager and the board is essential. With that said, none of the parties that are involved in this case should ever forget that the innovation that occurs in markets where rapid product development is the norm needs to be managed effectively. However, that notion is defined in various ways, and there are a variety of ways to intuit what effective innovative management means. One thing is sure: it must be defined in such a way that profit is maximized, costs are minimized, and shareholder value is optimized. Without this happening, managing innovation is helter-skelter at best and an unmitigated disaster at worst. Such is the life of a general manager put in this position.

CONCLUSION

In the form of a case study analysis, this article describes the issues involved when the board of directors of a company that engages in rapid product prototyping wants to sell the firm in the near future or within a few years. The issue facing the board of directors is how to sell the company without losing its technological edge. When a board of directors is preparing to sell a firm, it must ensure that the organization is performing optimally to obtain the best possible price for its shares. With a rapid prototyping company, the optimal approach is constantly evolving due to its rapid product development. Rapid prototyping can result in significant research and development expenses, where payback is uncertain. Thus, although there is no silver bullet that resolves the situation, profit maximization and the maximization of shareholder value may solve the firm's problems, or it may be an albatross around its neck. If there is a solution, it is to manage product innovation so that the organization effectively ensures that the stock sale price is as high as reasonably possible. There are no royal roads here, only good roads and better ones.

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Donald L. Buresh earned his Ph.D. in engineering and technology management from Northcentral University. His dissertation assessed customer satisfaction for both agile-driven and plan-driven software development projects. Dr. Buresh earned a J.D. from The John Marshall Law School in Chicago, Illinois, focusing on cyber law and intellectual property. He also earned an LL.M. in intellectual property from the University of Illinois Chicago Law School (formerly, The John Marshall Law School) and an LL.M. in cybersecurity and privacy from Albany Law School, graduating summa cum laude. Dr. Buresh received an M.P.S. in cybersecurity policy and an M.S. in cybersecurity, concentrating in cyber intelligence, both from Utica College. He has an M.B.A. from the University of Massachusetts Lowell, focusing on operations management, an M.A. in economics from Boston College, and a B.S. from the University of Illinois-Chicago, majoring in mathematics and philosophy. Dr. Buresh is a member of Delta Mu Delta, Sigma Iota Epsilon, Epsilon Pi Tau, Phi Delta Phi, Phi Alpha Delta, and Phi Theta Kappa. He has over 25 years of paid professional experience in information technology and has taught economics, project management, negotiation, managerial ethics, cybersecurity, business law, and quality management at several universities. Dr. Buresh is an avid Chicago White Sox fan and is active in fencing épée and foil at a local fencing club. Dr. Buresh is a member of the Florida Bar.

MISCELLANEOUS CONSIDERATIONS

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