Managing Technology within Transitory Organizational Structures

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Abstract
This paper examines non-linear adaptation to change in the high-technology environment of the computer industry. These environments are defined and the efficacy of different organizational adaptations is assessed with respect to these environments. Results from our analyses show that there is a direct and causal relationship between the employment of non-linear organizational archetypes and organizational effectiveness within high-technology industries.

1. Introduction

“Imagination is more important than knowledge. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science.” -Albert Einstein

The last two decades of the twentieth century are witnessing a rapid growth in the amount of technological development in the United States and abroad. In fact, it is estimated that more unrefined scientific discoveries have been made within this time than in all prior periods combined. Invariably, the pattern of this progress has been unevenly biased toward the development of high-technology sectors. These sectors are readily defined through their high research and development costs as a percentage of total costs. Also, the incremental costs of producing these items are low once a commercially viable design has been developed.

The most prominent example of high-technology development certainly is that of the computer industry and its supporting businesses. Within these disciplines the rate of development has resulted in computing power doubling every eighteen months (Maital, p. 140). This growth has brought with it the development of technologies and associated business sectors that were all but unknown only a few years prior. Customers of high-technology computer products have thus demanded successive technological changes to keep pace with these new capabilities. These same customers have also rejected investing in new and incompatible formats. The result of this expansion has been atypical rates of failure as many organizations have failed to adapt to these changes. Ultimately, firms within this sector have been forced to adapt to these demands at an unprecedented rate or face the ultimate measure of failure: technological and financial insolvency (Currie, 1994).

2. The Problem

The problem with this rapid growth is that the sole development and subsequent distribution of these innovations is cost prohibitive for most organizations (Lamont, et al., 1994). As a rule, when knowledge has incrementally advanced in several disciplines, firms merge complementary advances to develop commercially viable products. The manner in which these disciplines integrate thus determines their proposed technological standard. While this may simply appear to be successive technological advancement of specific scientific disciplines, the result is that the process is far more strategic and political than it appears. Consequently, it will be discussed in further detail later in this article.

The most notable characteristic of these alliances is that they form only after technological advancements in several complementary disciplines have already occurred. That is to say, technological development precedes the development of strategy that then determines the choice of an organizational structure (Leavitt & Lipman-Blumen, 1995). The organizations then form transitory alliances, but only with respect to the technologies in question. With a finite number of organizations involved in the development of computer technology, firms often find themselves collaborating with other organizations with respect to specific technologies while being solid rivals in the development of others (Usher J. M. & Evans, M. G. 1996; Zamrnuto, R. & Cameron, K. S., 1985).

Often these alliances involve nothing more than agreements on how to merge these disciplines, how to develop standards, and how to construct licensing agreements to distribute revenues. The manufacture of these products is of secondary importance and is commonly licensed to other organizations. Consequently, a nation such as Singapore, with no stake in the development of disk drive technology in 1980, became the world’s leading producer of these devices within two years (Maital, p. 96-7). Notwithstanding, the majority of licensing revenues were repatriated to United States, to those firms that were instrumental in developing the technologies and developing them into a commercially viable product (Maital, p. 96-7).

To date, academic literature lacks a theoretical foundation for understanding organizational adaptation to rapid change under non-linear conditions: conditions in which technological innovations precede the structures to manage them. As such, a gap exists regarding how firms within these sectors enter into transitory alliances (Lamont, Williams, & Hoffman, 1994). This is of relevance at this time since technological change in the computer industry has resulted in these transitory structures
being employed at an ever increasing rate (Leavitt & Lipman-Blumen, 1995). The problem with these alliances is that they have been difficult to define, predict, and control (Leavitt, et al., 1995). Further, in the absence of a conceptual framework, congruent measures of success are lacking.

To advance this understanding, the characteristics of high-technology environments must be defined. Organizational adaptation to these changes within the computing industry must subsequently be specified. The result is that a review from a non-linear approach will delineate the factors for effective adaptation in these environments.

Specifically, non-linearity occurs when technological development precedes the formulation of organizational strategy and the subsequent determination of organizational structure. This repeatedly occurs in technologically turbulent environments: conditions that sustain perpetual innovation. Managerial decisions are thus made under conditions of bounded rationality. Under these non-linear conditions, the more an organization knows, the more it realizes how many variables there are, and the more uncertain its future becomes. This results in indeterminacy using traditional methods.

3. Characteristics of Computer High-Tech Environments

Technological Succession

An awareness of technological succession is critical in understanding the rapid changes in the computer industry over the last two decades. Prior to this period, only a handful of organizations possessed both the technical ability and the financial capital to solely develop unified computing systems. As such, these organizations were instrumental in the integrated development of hardware, software, and support peripherals. As the discipline progressed and brought technological obsolescence to existing systems, incremental changes occurred. However, the cost of implementing these changes was ordinarily the entire replacement of existing systems and the retraining of support personnel. With technological succession cost prohibitive for the majority of customers, successive change was slow.

Fragmentation of the computer industry came with the advent of the first personal computers. While still being produced by the same handful of organizations, low cost allowed for individual computer ownership. Thus, a new market segment developed. New organizations formed to offer these consumers higher levels of product performance at lower costs as component costs fell. The computer software industry responded by offering operating systems that were able to cope with more memory, faster integrated circuits, and increasingly complex peripherals. The important characteristic for these operating systems was their compatibility with earlier software and peripherals. Each technological development could thus be implemented with only minor incremental changes in software or in hardware. This meant that technology could be successively employed without the prohibitive costs associated with replacing an entire computing system.

Attempts to restrain this pattern of successive change through the introduction of incompatible technologies met with failure. Initial attempts by industry leaders such as IBM to re-acquire the ability to control the development of operating systems from Microsoft were unsuccessful. Similarly, the launch of its own brand of operating system, OS/2, failed.

Integrated circuit manufacturers faced similar problems. Constrained by the requirement that integrated circuit chips must be reverse-compatible with previous software, the company leader, Intel, attempted to invent a seeming revolutionary change in the microchip industry through the introduction of the Pentium name. This attempt then met with failure as the consumer market saw that it was an evolutionary, not revolutionary, change in technology. Further, Intel made an initial attempt to define itself as the industry standard bearer and copyrighted the Pentium name for its admittedly incremental computer chip. This was done to profit from any doubts that consumers still maintained regarding compatibility of their competitors’ computer chips with other industry products while indicating that it was the successor to the 80286, 80386 and 80486 legacy, hence the choice of Pentium. This effort to differentiate its product failed as initial examples of its integrated circuit chip contained inherent flaws. The result was competitors such as Cyrix and AMD used Intel’s production problems to decrease confidence in the manufacturer and to increase their own market share.

Finally, organizations that have successfully developed non-incremental proprietary knowledge have had their work relegated to specific, technologically appropriate niches. Accordingly, their influence has little effect on the technological succession that dictates industry and consumer standards. Organizations such as Apple, Silicon Graphics, and the like account for less than three percent of the overall consumer demand and thus have a negligible effect on industry standards. This is in spite of the fact that they are technologically superior in many respects. The reason for this is that, once proprietary technology has developed integral technical standards that have been accepted by industry and the consumer, incremental development has adhered to this standard as a rule. In short, when consumers demanded a graphical user interface similar to that of the Apple MacIntosh, they waited for Microsoft Windows rather than changing to an incompatible computing platform.

Sharing of Technology

With computer power doubling on the order of every eighteen months, any specific technological development within this industry has a lifecycle of short duration, typically less than two years (Maital, p. 140). For example, with respect to the development of the floppy disk alone, the respective standards have been: 8”, 5.25”, 5.25” double-sided, 5.25” high-density, 5.25” double-sided and high-density, 3.5”, 3.5” double-sided, 3.5” high-density and 3.5” double-sided and high-density. In all,
these nine standards span a period of less than twenty years. Similarly, integrated circuit chips and virtually all other computer-related products can trace similar developments within their specific fields. Presently, the floppy disk itself is in process of becoming obsolete as alternative technologies vie to replace magnetic media with recent advances in encoding and decoding optical media.

As a result of these developments, maximum revenue from any specific technological development can only be derived through an industry-wide product distribution. Inescapably, this distribution must be accompanied with a disclosure of intrinsic product advances to allow integration into the various systems offered by each of the distributors within the industry (Dess, Rasheed, McLaughlin & Priem, 1995). Thus, the distribution of integral technical standards diminishes any advantage in proprietary knowledge that the advancing firm has over its competitors (Dess, et al., 1995). Consequently, even firms that are successful in entirely a marketable technological product must make their restrictive knowledge known in order to have their proprietary standard adopted. For this reason, firms must share their technological advances in order to profit from their efforts. In doing so, they advance the aggregate of knowledge of their competitors and thus ultimately commence the processes of obsolescence in the technology that they themselves are promoting.

The compensation for having organizational proprietary knowledge integrated into an industry standard is the realistic expectation of atypical financial rewards during the relatively short lifecycle of product relevance. Once more, the rate of advancement of knowledge has caused incremental advances in technology to occur at an increasing rate. The result has been that, even after a specific technology has been accepted as an industry standard, its relevant lifecycle is being dated at its outset.

Finally, technology is also shared through the licensing of manufacturing to outside organizations and even to competing firms. These licensed production agreements are also consistent with the understanding that many collaborators to the development of the licensed technology lack the financial ability or the desire to manufacture and distribute the products that their incremental knowledge has helped produce. Even in the presence of such capability, many of these firms elect to engage in further research and development within their specific discipline of expertise. Again, licensing agreements allow these companies to allocate production to other firms and free their respective finances for subsequent research and development (Dugal & Roy, 1996). This preserves the ability of collaborative firms to pursue further advances in their respective disciplines while allowing for earnings to be allocated in proportion to their technological contribution or in proportion to their ability or desire to produce the resultant product.

The final consideration with respect to the sharing of technology is that the existence of a licensing agreement in no way limits the allied firms’ abilities to subsequently license their respective proprietary knowledge. Uniformly, firms possessing this knowledge maintain the ability to license their specific disciplinary advances for the development of other products in the same, or in other industries. Likewise, when specific disciplinary advances become dated, technological succession dictates product evolution. Within the floppy disk drive example, the result was that a few initial proprietary advancements spanned several developmental iterations. Others, however, immediately became obsolete with the subsequent development of technology by competitors within the same discipline. Ultimately, the outcome of this behavior is the regular elimination of firms possessing dated proprietary knowledge and their subsequent replacement with the inherent knowledge of competing firms possessing further proprietary advances in those same disciplines.

Shared Development of Standards

As stated earlier, the sole development and distribution of technological innovations is cost prohibitive for most organizations (Lamont, et al., 1994). Also, when knowledge has incrementally advanced in several complementary disciplines, technological processes merge collections of these advances together into a commercially viable product. Typically, advancements in the same field parallel each other as rivals compete among one another to develop successive refinements to existing technologies. The result of this process is that at any one time, multiple alternative proposals exist that advance their respective disciplines beyond their current state.

Organizations that are instrumental in developing a proprietary ability do not solely attempt to produce a marketable technology. Rather, they seek to develop these standards collaboratively. Parallel development by any number of competitors generates the risk that rival alternatives become accepted as the industry standard. Accordingly, firms seek to diversify risk by dividing their efforts through developing multiple proprietary technologies within their area of specialization (Williamson, 1975). Organizations that fail to adapt to change in this manner expose themselves to further risk any time that a technology advances beyond the proprietary ability of their respective organizations.

The few firms that are successful at solely developing a potentially marketable technology risk it not being accepted without widespread integration into competitors’ products and further industry support. Again, it must be remembered that once a standard has been adopted, technological succession is the accepted means of furthering technical development.

4. Attempts To Create Order in Disordered Environments

Theoretical literature recognizes that the above-mentioned characteristics of these environments can be restricted through organizational diversification of risk (Williamson, 1975). A brief review of the outcome of these adaptive efforts is consequently in order. Following this is a review of the methods commonly employed by organizations to achieve these
outcomes. Admittedly, such an effort is not an exhaustive review of academic literature justifying these adaptations, nor is it meant to be. Regardless, it does provide utility in this analysis by revealing the underlying assumptions inherent in these attempts. The overall suggestion is that certain organizational adaptations are more likely to be successful in high-technology industries while others appear to be inherently less suitable (Dugal, et al. 1996).

Outcomes

Vertical expansion for risk diversification is generally employed by organizations when larger, typically industry-dominant firms seek to administer a majority of functions, from research and development through the sale and distribution of the finished product. In this manner, environmental change is controlled and order is created through the measured release of proprietary knowledge by these firms. Similarly, this outcome permits firms employing these tactics to impose guidelines upon the industry as well. The problem with this outcome, however, is that it is incompatible with high-technology industries such as the computer industry that have already experienced fragmentation. In these instances, no one specific firm is able to dominate the development and distribution of hardware, software or peripherals. At present, the only organization even remotely able to demonstrate the fiscal potential for controlling all three facets of the computer industry is Microsoft. Here again though, organizational dominance is limited only to software and even that capability is being strongly contested in the courts at the present time.

In contrast, the foremost organizational outcome of horizontal expansion, in addition to its inherent diversification of risk, is additional exposure into new markets and alliances (Trautwein, 1990). Recently, computer industry firms within concentrated markets have used the need for this outcome to target other firms for technological alliances within incrementally developing areas and within fragmented markets (Chaterjee, 1991). Consequently, these organizations retain their ability to license their proprietary technologies to related products and services or to an expanded market (Porter, 1985). This allows firms to continue to specialize within their respective discipline while licensing proprietary technology for inclusion into a diverse variety of products. Alternately, this outcome is sought when organizations completely dominate their own initial markets and attempt to enter into similar or complementary markets (Porter, 1985). Finally, this result is sought by organizations attempting to create economies of scale (Williamson, 1975). The result is that research and development costs of proprietary knowledge are thus reduced as firms rationalize these costs as being essential for inclusion into a variety of commercially viable products.

Merger and Acquisition Methods

The method most often used to employ an outcome of horizontal, and to a much lesser extent in the computer industry, vertical expansion, is that of mergers and acquisitions. Alliances of this type involve the outright purchase of another organization to transfer firm-specific skills as well as firm-based knowledge (Pablo, 1994). The actual distinction between merging or acquiring itself matters little since it is based upon whether or not the company targeted for purchase is liquidated as an individual entity or assimilated as a supporting organization. Thus, if liquidation is chosen, firm resources are pooled together and the process is labeled a merger. Conversely, if assimilation is chosen, the target organization is maintained as a subsidiary for financial reporting purposes and the operation is labeled an acquisition.

Regardless of the financial reporting methodology employed during mergers and acquisitions, organizational changes precede, and subsequently enable, the flow of skills and knowledge between the firms with this method. These methods are unsuitable in technologically incremental environments where the technology, as a rule, precedes organizational adaptations to the resultant environment. Furthermore, the computer industry’s disposition toward fragmentation and technological succession has caused organizations that have used these methods to face anti-trust issues commonly associated with these approaches. Thus, within the computer industry, this method has been relegated to the acquisition of organizations that are financially insolvent rather than organizations that offer additional proprietary knowledge to the acquiring firm.

Strategic Alliance Methods

Strategic alliances are used to achieve both vertical as well as horizontal expansion outcomes. These types of affiliations are typically enacted prior to the development of specific technologies within different disciplines (Gulati, 1995). Accordingly, organizations often employ this methodology when attempting to develop marketable products for which technologies have yet to be developed. The procedure typically involves a limited number of organizations entering into an agreement to jointly develop a commercially viable product. As with mergers and acquisitions, the structural process precedes the flow of skills and knowledge. However, the distinction is that the flow of knowledge is something that will optimistically develop as the result of the types of alliances.

To date, the problem with strategic alliances in the computer industry is that they are inherently not technologically incremental. These alliances are adverse to the shared development of standards with firms outside these strategic alliances. In addition, these alliances involve the development of a legal structure that prescribes the further development of technology within each of the organizations’ disciplines. As a rule, this incremental development is then limited to the
members of the alliance within the inceptive strategic agreement.

For example, IBM, Apple Computer, and Motorola began such a strategic alliance during the early 1990s to develop and produce the Power PC computer. The intent of this alliance was to develop a commercially viable computer that incorporated a RISC-based Motorola microchip, was able to use the Apple-Macintosh brand of operating system as well as Windows, and could be manufactured in different forms by IBM as well as Apple. Invariably, consumer response was appropriately cautious, industry support failed to develop, and the attempt was abruptly abandoned by all participants.

5. The Case for A Non-Linear Perspective

Typically, in lower technology industries, structure precedes the development of technology. However, in high-technology industries, technology repeatedly precedes structure (Usher, J. M. & Evans, M. G. 1996; Zammuto, R. & Cameron, K. S., 1985). Accordingly, the linear paradigm is that the more structure that an organization has, the more power and control it has. Whereas, under high-technology non-linear conditions, the more structure it has, the more limited the organization becomes. This is consistent with the understanding that the development of bureaucratic structures slows the ability of an organization to make decisions. This then delays time to market and eliminates any first move advantage that an organization might possess.

Similarly, under linear conditions, the paradigm is that the more an organization knows, the more power and control it has. Whereas, under non-linear conditions the more it knows, the more it realizes how many variables there are, and the more uncertain its future becomes. The result is that high-technology surroundings are neither determinable nor quantifiable using existing archetypes.

What is needed at this time is the development of a non-linear conceptual model explaining organizational adaptation to rapid change within these high-technology environments (Lerwitt, et al., 1994). While many theories have addressed organizational change in response to environmental pressures, none have attempted to explain the dyadic relationship between transitory organizational structures and non-linear environments. It is in these cases that a paradigm shift occurs from functionalism to interpretivism; from malleability to control. With it, assumptions must be changed and organizations must see themselves as not being determined by the context, but to be enacting it.

Non-linear technological ventures differ from other alliances in that they are transient organizations that are clearly defined in structure, the distribution of knowledge, and the division of revenues. However, their foremost distinction is that, in all cases, incremental firm-specific skills as well as firm-based knowledge precedes entry into these alliances. The rationalization for this is that existence of proprietary knowledge is more important in such alliances than the potential for knowledge. Consequently, a diversity of firms with advances in several complementary disciplines are recognized as having a competitive advantage over larger firms which form structures to develop new technologies.

These endeavors differ from the cited methods of risk diversification in several respects. As stated, the systematic distribution of technical standards through licensing diminishes the technological advantages typically held by larger firms in other industries (Gulati, 1995). Also, firms that are successful in entirely developing a marketable technological product must disclose this intrinsic knowledge to have these proprietary standards incorporated by industry. This has the effect of continually disburising information among multiple competitors (Lamont, et. al., 1994; Meznar, et. al., 1995). Accordingly, proprietary knowledge typically held by only the largest organizations in lower technology industries does not have the same restrictive influence. Rather, competition is typically centered upon the subsequent, incremental development of technology in which the various standards are known and the manufacturing processes are widely dispersed. It is in this regard that non-linear technological ventures have a distinct competitive advantage over strategic alliances in high-technology industries.

Another distinct advantage of these alliances is that they are intrinsically able to adapt to uncertainty and disordered environmental situations. Again, in mergers, acquisitions, and strategic alliances, structure predates the development of knowledge. As these firms spend time to merge their distinct organizational cultures, they lose their first move advantage. This in turn makes for dis-synergies. Also, these alliances produce situations in which firms are legally entwined with their technological collaborators. The result is a lack of malleability through these obligations. The result is that a change in industry’s acceptance of developments in any one associated discipline means a failure of the alliance, merger, acquisition, or sole development itself. In contrast, non-linear technological ventures repeatedly form different technological solutions from the aggregate of advances in the different disciplines. The result is that these alliances are able to excel against the above-mentioned organizational adaptations and change from the viewpoint of the number of potentially marketable technologies that they offer to industry. Furthermore, these alliances are able to bring about these technologies at the moment that a suitable solution becomes viable. This solidly contrasts with the limited ability of mergers, acquisitions, or strategic alliances that are repeatedly constrained by the terms established in their inceptive agreements.

6. Hypotheses

The following two hypotheses are presented, and are consistent with, a non-linear perspective. In them, organizational change is justified from this theoretical bias. It is the specific intention of these hypotheses to indicate that the non-linear model offers utility in delineating effective adaptive
behaviors in high-technology environments. This conceptual understanding is necessary at this time to predict and control behaviors crucial to effective organizational adaptation to these same environments.

**Hypothesis 1**: If a firm is involved in a merger, acquisition or a strategic alliance, then it is less likely to earn licensing revenues from that respective technology than a firm involved in non-linear technological ventures.

As previously submitted, the prerequisite for entry into mergers, acquisitions or strategic alliances is participation in a legal structure prescribing the development of technology by each respective member and while limiting incremental development to the same. Accepting these restrictions ultimately increases the limitations that firms have rather than decreasing them. Further, the involved organizations are able to produce fewer potentially marketable technologies for industry than their rivals. Consequently, it is offered that these firms are less likely to actually earn licensing revenues than organizations retaining their ability to enter into non-linear technological ventures with the aggregate of firms with advances in the different disciplines.

**Hypothesis 2**: If a firm develops a proprietary ability and attempts to solely develop or produce a marketable product, then it is less likely to earn revenue than a firm entering into a non-linear technological venture to secure collaborative disciplinary knowledge.

Organizations should weigh the benefits of solely developing products against those of entering into several non-linear technological ventures. It is offered that in rapidly changing environments that share technology through licensing and resist sole development by withholding industry support, sole development is inappropriate. Therefore, it is proposed that single-technology joint ventures will yield more revenue than sole development of a product.

7. **Methodology**

The research methodology that was used in this study consisted of time series analysis of data published in the various organizational journals, industry trade publications, and online journals. Within these publications were exhaustive listings of each of the organizations involved in specific technological fields. Also, industry consumption rates were charted for each of the various commercially available products. Past and present product lifecycles were depicted in these journals and papers and indicated specific product launch dates, growth rates, maximum sales, and intersections (equivalent sales volumes and revenues) between older and incrementally newer technologies.

With respect to the two hypotheses, this comprehensive listing of specific products was used to generate a list of final product manufacturers. This was then used to generate licensing information and this information was subsequently used to determine the extent of participation by the various principals as well as determine their respective revenue. Specifically, revenue information from these licensees was gathered from their respective 10-K and 10-Q forms via the Internet from the Securities and Exchange Commission’s Web pages. Further, detailed information about these licensing agreements was found through the documentation contained in each of the organization’s footnotes on these same forms.

A sample of 364 agreements were codified and assigned to merger, acquisition, strategic alliance or non-linear technological venture categories from the information contained in these publications. Remaining licensing agreements were subsequently used to determine which of the leftover arrangements were the result of sole organizational attempts to produce a marketable product or to manufacture these products themselves. In this manner, the revenues generated from mergers, acquisitions, strategic alliances and attempts to solely produce marketable technologies were statistically compared to the revenues generated from non-linear technological ventures to see if significant differences exist. Both hypotheses were subjected to ANOVA to test for significant mean differences in the dependent variable between non-linear technological ventures and other approaches.

8. **Results**

The result of the first hypothesis indicate that there are significant differences between the dependent variables at the p < .01 level of significance. Accordingly, we reject the null hypothesis HI and accept that there is a significant difference in licensing revenue between firms involved in mergers, acquisitions or strategic alliances and firms involved in non-linear technological ventures. In addition, the difference between the dependent variables yields a statistically significant result in the manner predicted. Correspondingly, we accept that non-linear technological ventures yield significantly higher licensing revenues than mergers, acquisitions or strategic alliances.

The result of the second hypothesis also reveals a significant difference between the dependent variables at the p < .01 level of significance. Here we also reject the null hypothesis H2 and accept that there is a significant difference in revenue between firms that solely attempt to develop or produce a marketable product and those that enter into non-linear technological ventures. Again, the difference between the dependent variables yields a result in the manner predicted.
Thus, we accept that non-linear technological ventures yield significantly higher revenues than attempts to solely produce marketable technologies.

Respectively, the basis of comparison for both hypotheses is the non-linear technological venture. The ultimate result thus becomes that the non-linearity and interpretivism are preferable method of forming alliances in these environments.

9. Implications for Managers

Fragmentation within the computer industry has resulted in a technologically turbulent environment. Under these non-linear conditions, further knowledge results in additional potential which then results in organizational indecisiveness. With additional knowledge furthering the affects of bounded rationality, managers must make the paradigmatic shift from functionalism to interpretivism.

The first implication is that licensing revenue will increase with non-linear organizational forms. This is important for managers to realize because further research and development requires a disproportionate amount the revenues that these firms generate. This revenue drain is to such an extent a majority of firms elect to license production to other firms rather than tie up needed capital. This then leads to the second implication; to survive in a technologically turbulent environment characterized by perpetual innovation, firms must generate revenue for new products and processes. Finally, the third implication is that linear ways of collaboration lead to firm obsolescence. This then leads to the strategic obsolescence for linear ways of collaboration in high-technology environments.

10. Limitations And Suggestions For Future Research

Admittedly, there are significant limitations to the applicability of this study at this time. Foremost among these is that it is presently limited to those segments within the computer industry that are characterized by rapid change. The supposition behind this limitation is that it is these segments of the computer industry that are the most profitable and consequently are the most fundamental in shaping the industry as a whole. Accordingly, effective organizational adaptation to change is viewed from the perspective of revenue generation through licensing. Firm effectiveness in all other conditions and by other means of measurement is, at present, undetermined. A second limitation to this study is that it does not address the establishment of industry standards by means other than technological succession, shared development, and enacting the environment. It is widely acknowledged that larger organizations have the collusive ability to forestall technological advances by competitors through a variety of means other than enactment. Ultimately, while the justness of these tactics remains to be adequately deliberated, it must be conceded that they have a noticeable effect within the computer industry at this time.

A third limitation is that is that this study can only be generalized to the computer industry at this time. Subsequent inquiries should focus upon developing an understanding of how our findings apply to other high-technology industries such as pharmaceuticals. Finally, succeeding efforts should address industrial characteristics such as concentration ratios to determine if these factors have an effect on the results that we have found.

Figure 1
Hypothesis H1 ANOVA Results of Linear Merger, Acquisition and Strategic Alliance and Non-Linear Technological Ventures Revenues

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Figure 2
Hypothesis H2 ANOVA Results of Linear Sole-Development and Non-Linear Technological Ventures Revenues

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11. References


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