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CREATING NEW TECHNOLOGY-BASED ORGANIZATIONS:
A SYSTEM DYNAMICS MODEL

One of the persistently neglected topics in organizational theory has been the creation and development of new organizations. With a few important exceptions, (Starbuck, 1971; Greiner, 1972; Pennings, 1981; Kimberly & Miles, 1981; Kazanjian, 1984; Van de Ven et al., 1984; Gartner, 1985) this area has received relatively little attention in comparison to that given to the problems and issues associated with large, mature bureaucracies (Miles & Randolph, 1981). This may have been an appropriate scientific response in the past, but the collective orientation of the discipline now appears to be changing to adapt to an emerging set of problems relating to how new organizations are successfully created and nurtured. Fields as diverse as organizational development, population ecology, urban planning, economic development, and group dynamics would all seem to benefit from an integrated theoretical and empirical approach to the creation and development of organizations.

Although many different disciplines have made contributions to this topic, each has generally offered a distinct research tradition, adding to the lack of integration. Separate literatures on individual entrepreneurship, organizational and management factors in start-ups, the financial structure of new ventures, and the sociocultural conditions that encourage new business creation address one part of the phenomena, but do very little to provide integration to the diverse set of issues involved in new business creation. As Van de Ven et al. (1984) have noted, each of these approaches has emphasized different units of analysis, different methodologies, and has different strengths and weaknesses.

Partially because of this fragmentation, there is still very little systematic knowledge about the processes or patterns of successful new business creation. The purpose of this paper is to set the stage for more systematic inquiry by presenting a cohesive theoretical model of the creation and development of one particular type of organization: new, technology-based organizations (NTBOs).

Our reasons for selecting this subset of organizations are both theoretical and practical. With regard to the former, it seems more likely that a theory of greater specificity will present a better targeted research agenda, will develop more quickly, and will provide an important contribution to existing theories of the organizational life cycle. With regard to the latter, this type of organization seems to be central to emerging strategies for economic revitalization (OTA, 1983). More specifically, NTBOs are seen increasingly as holding the key to innovation and change, particularly in the manufacturing sector--the economic "motor" which drives the growth of the service and retail economies (Baba & Hart, 1986).

We define "technology-based" organizations as ventures that emphasize the role of research and development in the introduction of new products or services, or as those that place their major strategic emphasis on the exploitation of technology in products, processes, or services. This

rather broad definition of technology-based organizations seeks to include all of those business organizations in which technology is a key element of business strategy. This would, in theory, include organizations as diverse as a satellite-based data transmission service, a manufacturer of low technology products with an investment in new process technology, a research laboratory, or the producer of a "high technology" product. The inclusiveness of this definition has a clear purpose: we hope to address the generic set of problems faced by organizations that are in some way technology-dependent.

The central concept in our model is that new business creation and development takes place within, and is therefore dependent upon, a local context or "ecosystem." Like any natural process, individual organisms both feed from, and contribute to the ecosystem; and characteristics of both the organisms and the ecosystem are necessary to understand the creation and development process. Such new business creation ecosystems, referred to here as Technology Development Clusters (TDCs), consist of a set of "resources" (technical expertise, venture capital, services) and existing "inhabitants" (individuals, firms, and institutions) which provide more or less of the essential "habitat" required for spawning NTBOs. A key element in the functioning of such systems is technical expertise: universities, corporate or government laboratories serve to incubate technical innovations while the surrounding community provides an environment in which fledgling organizations can thrive.

While several authors have applied ecological principles to organizational theory in recent years, most have addressed the dynamics of organizational populations and their life-cycles, (e.g., Hannan & Freeman, 1977; Kimberly & Miles, 1981). These authors have generally not examined different kinds of firms in the context of their surrounding environment, in an "ecosystem" context. Indeed, the field of ecology recognizes two major divisions or approaches. The first, *autecology*, focusses on the ecology of individual organisms and populations, while the second, *synecology*, studies systems of many species and their interaction with the immediate environment--whole communities and ecosystems (Whittaker, 1975).

This paper departs from most ecological treatments of organizational growth to date by adopting explicitly the latter approach. As such, we are concerned less about the birth and death rates of particular organizational populations than we are delving into the characteristics and functional interrelationships present in communities with the property of or potential to produce and sustain NTBOs.

FOUR RESEARCH TRADITIONS

Using the concept of Technology Development Clusters as an organizing principle, the literature concerning the creation and development of new organizations can be categorized into four distinct research traditions: (1) ecological factors; (2) comparative studies of new venture structures; (3) group and organizational processes; and (4) entrepreneurial characteristics. The research traditions are "nested" such that each tradition addresses progressively a more microscopic set of issues. By integrating the four traditions within a larger systemic context, the interplay between multiple levels of analysis can be appreciated without losing sight of the unique contribution that each has to make. A discussion of each of the

four traditions is presented below, and Table 1 summarizes the major findings and citations from each of the traditions.

Ecological Factors

Two major types of studies may be grouped under this tradition. First, as discussed above, research by organizational *population ecologists* has addressed the dynamics of populations of organizations and their implications for the birth and death rates of firms (e.g., Hannan & Freeman, 1977; Pennings, 1981; McKelvey & Aldrich, 1983). Second, there is a long history of research in *economic development* and *location theory* for industrial organization's (e.g., Conroy, 1975; Birch, 1981; Noyelle & Stanbeck, 1983; Reynolds & West, 1985). The latter studies examine industrial organizations decisions to locate or expand in particular metropolitan areas or regions and are usually conducted by urban and regional planners or development economists. Factors examined by these studies have ranged from traditional locational criteria such as taxes, to utility costs, and transportation; to elements of the business infrastructure such as the availability of venture capital, technical expertise and support services (Gorlow, 1984; Schwartz & Teach, 1984); to the regional quality of life and culture (Dorfman, 1983; Goldman, 1984; Rogers & Larsen, 1984; Segal, 1984).

Results from studies in this tradition have helped to underscore the importance of centers of technical expertise such as university laboratories or other types of private, public, or nonprofit laboratories (Cooper, 1984), and the key importance of attitudes toward the technology transfer process to the success of new technology-based organizations (Bullock, 1983; Abt Associates, 1984; Baba & Hart, 1986). This work has also helped to distinguish the needs of NTBOs from those of more traditional types of business organizations (e.g. Jarboe, 1983). Research in this tradition usually relies upon either survey or case methods to assess particular locations. A number of unresolved issues still exist in this area however, and the overall contribution of population ecology to understanding such phenomena has yet to be assessed.

Comparative Studies of New Venture Structures

Research and writing in this tradition have been concerned with the origins of new firms, their initial design and financing, and their ultimate success or failure. Studies have most often examined multiple firms, usually within a particular industry and region, and have generally been conducted by business economists or management scientists.

This research tradition has produced many interesting insights which greatly aid in the understanding of NTBOs. For example, several studies have shown that new technology-based organizations tend to be spawned locally, applying technology transferred from larger "incubator" organizations such as university or corporate laboratories (Cooper, 1971; Cooper & Bruno, 1977). And while relatively few such firms are successful at obtaining venture capital (most having to finance early operations through informal sources), they tend to have survival rates much higher than other small businesses (Roberts, 1970; Brophy, 1983; Bruno & Tyebjee, 1984; Timmons & Fast, 1984). This is partly explained by the fact that rather than failing, many struggling NTBOs with good ideas are acquired by larger companies (Vesper, 1980; Bruno & Cooper, 1982).

TABLE 1
The Research Traditions and Their Findings

Citations	Generic Findings
1. Ecological Factors	
Abt Associations, 1984; Baba & Hart, 1986; Birch, 1981; Bullock, 1983; Conroy, 1975; Cooper, 1984; Dorfman, 1983; Goldman, 1984; Gorlow, 1984; Hannan & Freeman, 1977; Jarboe, 1983; McKelvey & Aldrich, 1983; Noyelle & Stanbeck, 1983; Pennings, 1981; Reynolds & West, 1985; Rogers & Larsen, 1984; Schwartz & Teach, 1984; Segal, 1984	<ul style="list-style-type: none"> - Centers of technical excellence, particularly universities and other private, public, or nonprofit laboratories, are critical to the incubation of NTBOs. - Attitudes toward technology transfer in the incubators are of key importance. - Technology-based organizations are different from traditional manufacturing firms in their location preferences. Their primary needs are for <ul style="list-style-type: none"> ... a supply of skilled engineering professionals ... availability of top-notch technical expertise ... good quality of life for the generally well-educated employees ... a well-developed network of support services, supplies, and clients ... start-up capital. - NTBOs tend to cluster in particular areas and focus on particular technologies. Eventually, this agglomeration of entrepreneurs, firms, and support services reaches a "critical mass"--the point where it feeds off itself, with companies spinning off from other companies.
2. Comparative Studies of New Venture Structures	
Brophy, 1983; Bruno & Cooper, 1982; Bruno & Tyebjee, 1984; Cooper, 1977; Cooper & Bruno, 1977; Roberts, 1970; Timmons & Fast, 1984; Vesper, 1980	<ul style="list-style-type: none"> - Most NTBOs are "homegrown" rather than moving from elsewhere. - Successful ventures tend to be founded by groups rather than individuals. - NTBOs have survival rates much higher than other small businesses. - Relatively few NTBOs obtain venture capital. - Successful ventures tend to engage in rapid transfer of technology from larger incubator organizations. - Rather than failing, a high proportion of NTBOs are acquired by larger companies.
3. Group and Organizational Processes	
Bennis & Shepard, 1956; Churchill & Lewis, 1983; Galbraith, 1982; Greiner, 1972; Kazanjian, 1984; Kimberly, 1981; Maidique & Zirger, 1985; Perkins et al., 1983; Quinn & Cameron, 1983; Smith & Miner, 1983; Starbuck, 1971; Steinmetz, 1956; Webster, 1976; Van de Ven et al., 1984	<ul style="list-style-type: none"> - As technical organizations mature, they face a shifting set of dominant problems requiring different sets of skilled behaviors. - Criteria of effectiveness also shift as the organization grows. - Organizational creation is fundamentally a process of group development, with predictable cycles of euphoria and conflict. - Appreciation by technical entrepreneurs of the importance of management concerns and personnel is critical. - Successful NTBOs develop brief but clear business plans and network broadly among funders, clients, and suppliers. - Successful NTBOs tend to begin small and develop incrementally, learning from their mistakes. - For NTBOs, the events and activities <u>prior</u> to formal firm start-up are critical.
4. Entrepreneurial Characteristics	
Carland et al., 1984; Collins & Moore, 1971; Denison & Alexander, 1986; Filley & Aldag, 1986; Hagen, 1960; Hartmann, 1959; Hornaday & Abound, 1971; Hull et al., 1980; McClelland, 1965; Miller, 1983; Palmer, 1971; Schrage, 1965; Shapero, 1975	<ul style="list-style-type: none"> - There are different types of entrepreneurs, ranging from those oriented toward rapid growth to those oriented toward stability. - Successful entrepreneurs tend to have the following characteristics: <ul style="list-style-type: none"> ... drive and energy ... high need for achievement ... self-confidence ... commitment ... preference for reasonable risks coupled with responsibility for results ... ability to use feedback in problem solving ... high tolerance for ambiguity ... ability to self-impose goals ... advanced education but not premiere technical innovators ... displeasure or dissatisfaction with existing work situation.

While findings from this research tradition have been rich in information and high in internal validity, they have often been limited in their degree of generalizability. Since most studies have been restricted to particular industries in specific geographic locations (e.g., electronic firms in the Silicon Valley), it would be useful to examine other kinds of NTBOs in a variety of locations.

Group and Organizational Processes

A third tradition focuses upon the intraorganizational characteristics of start-up companies, addressing primarily behavioral rather than financial or structural characteristics (e.g. Starbuck, 1971; Kimberly, 1981). These studies sometimes compare multiple firms, but are more likely to be based upon case studies or clinical methods.

Findings from this tradition indicate that successful firms are most likely to have been founded by groups rather than by individuals, and that organizational creation is fundamentally a process of group development, with predictable cycles of conflict and euphoria (Bennis & Shepard, 1956; Cooper & Bruno, 1977; Perkins et al., 1983). Events and activities prior to formal start-up are also very critical (Kazanjan, 1984). Management and personnel concerns are particularly important for technical entrepreneurs to understand if they are to be successful (Webster, 1976).

As NTBOs mature, they face a shifting set of dominant problems and shifting criteria of effectiveness (Greiner, 1972; Galbraith, 1982; Quinn & Cameron, 1983; Kazanjan, 1984). Successful start-ups appear to begin small and develop incrementally, learning from their mistakes (Van de Ven et al., 1984). A strong network of funders, customers, and suppliers appears to be more important than the technical excellence of the firm's product or process (Maidique & Zirger, 1985). Firms with clear but brief business plans and strong networks appear to be the most likely to succeed (Van de Ven et al., 1984).

This research tradition has generated a series of provocative findings, but like the previous tradition they are a set of findings that are in some ways difficult to use as a basis for generalization. They are drawn from limited samples, of different types of organizations, in different regions of the country. As a result there is little comparative base from which to generalize and realize the full power of the findings.

Entrepreneurial Characteristics

The final broad research tradition that bears upon the creation and development of NTBOs is the literature on the characteristics of individual entrepreneurs. Such studies have usually traced the personality traits, background characteristics, and career patterns of individuals, and tried to relate them to the choice to pursue an entrepreneurial career, or the rate of success at starting new ventures (e.g., Schrage, 1960; Hornaday & Abound, 1971; Collins & Moore, 1971; Shapero, 1975; Denison & Alexander, 1986). Such studies have typically been conducted by psychologists, and most have attempted to develop and validate tests that can be used to uncover an individual trait called "entrepreneurship" (e.g., Palmer, 1971).

Research in this tradition has generated a number of useful findings, such as the idea that there are different types of entrepreneurs, some oriented toward rapid growth, and others more oriented toward stability (Hartmann, 1959; Miller, 1983; Carland et al., 1984). This suggests that

any research on entrepreneurship or new business creation must be specific about the goals and objectives attributed to an individual called an "entrepreneur," as well as the criteria appropriate for the evaluation of the organizations they create (e.g., Filley & Aldag, 1978). Other findings representative of this research tradition help to outline the individual characteristics of successful entrepreneurs. Research suggests that entrepreneurs are likely to have a high need for achievement (McClelland, 1965), and have self-confidence, commitment, drive, and energy (Hornaday & Abound, 1971). Their cognitive style seems to include a preference for reasonable risks accompanied by responsibility for results, a high tolerance for ambiguity, the ability to impose goals upon themselves, and the ability to use feedback in problem-solving situations (Hull et al., 1980). Entrepreneurs in technical areas also typically have an advanced education, but are not often premier technical innovators (Roberts, 1970).

While interesting in its own right, this research tradition has not generally produced findings that are pertinent to understanding new venture creation. By focusing upon individual backgrounds and traits--variables that can not be changed--rather than actual business behavior, such research provides little potential guidance for actual entrepreneurs to enhance their prospects for success.

INTEGRATING THE FOUR TRADITIONS: A SYSTEM DYNAMICS MODEL

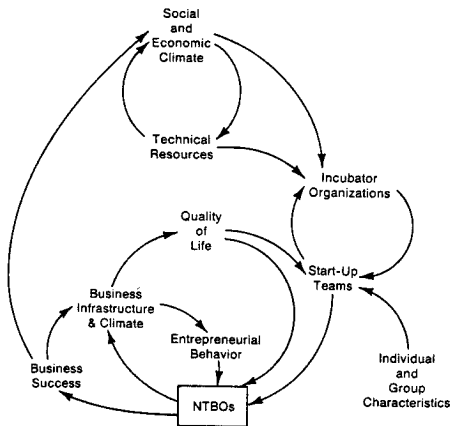
To integrate the four research traditions outlined above, the authors propose an ecosystems model using system dynamics as a vehicle. A system dynamics framework seems necessary at this stage of development because of the inherent nature of the phenomenon. A suitable model must allow for reciprocal causality, nonlinearities, multiple causality, over-identification, and sheer indeterminacy. These complexities, as well as the complexity inherent in integrating the four research traditions, must inevitably rule out the sort of linear, nonrecursive model often popular in the social sciences. A system dynamics framework generates a large number of hypotheses which can be expressed in a more conventional form, but at least at the outset, such a framework allows for the phenomenon to be examined in both process and variance terms (Downs & Mohr, 1976; Mohr, 1982). This allows for the study of both the factors and features that characterize successful new business creation, and the larger process within which new business creation is embedded.

The central concept in this model is that of the Technology Development Cluster (TDC). TDCs are geographically-defined locations where new technology-based organizations seem to proliferate and cluster, and where a critical mass of experience, risk capital, and technical expertise evolves. As mentioned above, this concept is an outgrowth of the emerging population ecology perspective used to explain organizational births (Pennings, 1981; Hannan & Freeman, 1977) in that it conceives of urban environments as organizational "habitats" that contain the essential elements for spawning particular types of organizations. It goes beyond that perspective, however, in defining territorial "ecosystems" via unique sets of technical resources, niches, and existing inhabitants, and by defining a process by which firms gestate, materialize, and develop within that milieu.

The system dynamics model presented in Figure 1 postulates some of the key elements and functional interrelationships associated with Technology

Development Clusters. Central to the creation of NTBOs is the existence and availability of high-quality *technical resources*--expertise in research and development, computer capability and associated technical support. These resources contain the raw material--the innovative technical ideas, capabilities, and people--necessary for the spawning of NTBOs.

FIGURE 1
Dynamic Model of the System for Creating New
Technology-Based Organizations



Of particular importance in this regard is the presence and orientation of technical research and development organizations: university laboratories and institutes, as well as corporate, government and nonprofit research facilities. All such institutions create technical innovations; many of these innovations also have commercial potential. Under the proper conditions (discussed further below), these organizations and the social context within which they exist can serve to develop *entrepreneurs* and *start-up teams* motivated to exploit these opportunities. In short, they come to serve as *incubator organizations*, spinning off new firms as an important adjunct to their primary mission of creating new knowledge.

Several studies have shown that such organizations (e.g., laboratories, institutes, etc.) play an important role in the seeding, incubation, and creation of new technology-based organizations (Bruno & Cooper, 1982; Cooper, 1971; 1984; Roberts, 1970; Segal, 1984). In particular, Cooper (1984) has suggested an interesting combination of factors that tend to

make R and D organizations likely to function as "incubator" organizations. He found that those organizations that recruited capable, ambitious people, and were also afflicted by management problems or periodic crises, seemed to produce more spin-off firms. Indeed, periods of internal difficulty or externally imposed change seemed to be closely correlated with the creation of spin-off firms.

Other studies have suggested that a positive attitude toward technology transfer, or at least an attitude of benign neglect, can be an important element in the ability of a technical or research organization to spin out new firms (Abt Associates, 1984; Bullock, 1983). Again, drawing upon ecological theory, it might be postulated that new venture creation is fostered in TDCs where a *symbiotic* relationship exists between potential incubator organizations and NTBOs--where neither entity is injured by the relationship (in many situations both may benefit). In contrast, where potential incubator organizations view the spawning of NTBOs as a *parasitic* or *predatory* phenomenon, such activity would obviously be actively resisted. Baba and Hart (1986) have also suggested that the internal organization of a research setting has an important impact on spin-offs and commercial application. Universities, for example, are far more likely to produce spin-offs and applications when they are structured in a manner that encourages long-term, interdisciplinary research in direct collaboration and with direct sponsorship from industry partners.

Given that incubator organizations allow for the development and emergence of technology-based business ideas, the *business infrastructure and climate* of the TDC quickly become the next critical factor (Eisenhardt & Forbes, 1985). The vast majority of NTBOs appear to be created by local founders (Cooper, 1984) and one of the distinguishing characteristics of successful entrepreneurs is that they know many other entrepreneurs (Denison & Alexander, 1986). Thus, the presence of local entrepreneurs and the contribution that they make to the composition of start-up teams, plays a critical role in the creation of new firms. Also important in this regard are the skills and experience of local business service providers (e.g., lawyers, accountants) and the attitudes and inclinations of local investors. Indeed, one of the major barriers to the emergence of NTBOs in a given area is the lack of a "network" of such individuals (see Rogers & Larsen, 1984).

As more firms are successfully created within a given Technology Development Cluster, a perception of entrepreneurial *business success* begins to emerge. This helps to augment the network of entrepreneurial *individuals and groups*, technical linkages, capital sources, and business services that can be drawn upon by start-up teams with a technology-based new business idea. Once this system of networks reaches a "critical mass" it begins to feed off itself, multiplying the experience base that a TDC may bring to bear on the creation of new technology-based organizations. As this agglomeration process proceeds, it creates a "culture of experimentation," where *entrepreneurial behavior*--risk-taking and failure--become integral to the process of learning and technical development (Rogers & Larsen, 1984; Maidique & Zirger, 1985). Associated with this cultural development is the gradual establishment of a network of experienced investors and consultants--those risk-takers who have met with early success in such ventures and who then become active participants in the "risk capital" and start-up market. The growth of this network has

the effect of slowly altering the investment portfolios and risk preferences of an increasingly wide set of more traditional investors and consultants (Gibson, 1983; Wetzel, 1983).

The *quality of life* and resources of the immediate area itself also come into play. A growing body of evidence suggests that NTBOs are fundamentally different from traditional firms in their needs and choices of location (Jarboe, 1983; Goldman, 1984; Gorlow, 1984). These new ventures are dependent upon well-educated, ambitious people and are usually oriented toward research and development and the manufacture of high margin-to-weight products. Thus, few of the factors important to traditional manufacturing firms are of primary interest to new technology-based organizations: wage rates, costs of utilities, cost of living and proximity to major markets play a secondary role to such emergent factors as:

Access to technical expertise. Linkages with universities, corporate, government, or nonprofit research activities offer new technology-based organizations continuous interaction with key experts, use of facilities and services, and a steady stream of employees in the form of students, graduates, researchers, and faculty.

Availability of support services. The area must provide an infrastructure of business services of high quality and experience. Legal services, accounting and financial services and, management, marketing, and manufacturing expertise, are all critical to the survival of a newly created firm. Seed capital and venture capital networks are also invaluable to the new technology-based firm. Access to these services during start-up and the early going is critical to business success.

Quality of life. New technology-based firms also seem to cluster in areas that offer an attractive living situation. This includes such factors as overall ambiance, cultural, recreational, and entertainment opportunities, as well as housing quality, and the quality of public schools.

The only traditional locational factors which seem to be important to NTBOs are access to a good international airport for the transportation of people and products, and proximity to suppliers, customers, and other similar firms. Local zoning and building codes, economic development programs, regulation, and tax rates appear to help make some locations more attractive than others, however, it seems that the administrative attitude associated with such programs is as important as their level of stringency.

The final contextual feature of the model presented in Figure 1 is the global *social and economic climate* of the potential TDC. Although there is little research on the relationship between overall social and economic climate and the creation of new technology-based organizations, we offer a hypothesis: within those communities that include extensive technical resources, either a highly "positive" climate or a highly "negative" climate, will be associated with the creation of more technology-based firms than a complacent, "business-as-usual" climate. This curvilinear function presumes that a negative climate may lead to a reallocation of both technical and business resources in an effort to foster technology transfer and new

business development, and that a highly positive climate will also facilitate the technology transfer process and new business development.

The above hypothesis again flows from ecological theory: every community and ecosystem develops, through a process of natural succession, to a "climax" state--that mix of inhabitants that is best adapted to the resource base, as moderated by the climate (moisture, temperature, etc.) of the region. Since in nature, climate variables change only very slowly, ecosystems can and do exist in dynamic equilibrium over long periods of time, barring perturbations (e.g., human intervention) that would set them back to earlier stages of succession. In the world of organizations and human affairs, however, the social and economic "climate" can change much more precipitously (e.g., recession, technological innovation, changing values) making preexisting "climax" states obsolete, and business-as-usual an inappropriate strategy. Disequilibrium forces difficult and sometimes painful changes in roles, functions, and niches for existing organizational inhabitants.

INTRAORGANIZATIONAL PROCESSES

In addition to the complex set of situational factors that are critical to the establishment and development of new technology-based organizations, it is also important to recognize that each individual organization is a highly dynamic entity, moving rapidly through a complex set of developmental stages. As mentioned earlier, relatively little research has been done on growth and development processes within organizations, and that which has been presented does not often directly address the problems of technology-based organizations (Pondy, 1969; Starbuck, 1971; Greiner, 1972; Denison, 1985). The limited number of authors who have addressed this problem (Kazanjian, 1984; Van de Ven, Hudson, and Schroeder, 1984), have emphasized the importance of examining empirically the stages and sequences through which new technology-based organizations pass. Kazanjian (1984) has also critiqued the stage model approach and argued that most stage models concentrate on internal structural characteristics, but ignore the emergent functional problems and the adaptive entrepreneurial behaviors necessary to solve them. He also makes the criticism that existing stage models seldom include the critical set of activities that take place prior to the formal start-up of a new firm.¹

An integral understanding of intrafirm dynamics is also needed in order to access accurately "business success" for new technology-based organizations. Judging the performance of a new firm is like shooting at a moving target; it is nearly impossible to find stable, comparative measures for something that must evolve and change rapidly in order to succeed. Traditional business measures such as profitability can be very misleading: most new companies show losses in early years, and usually reinvest their earnings to fuel the growth process. Finally, the importance of different criteria of performance may vary drastically in a short period of time, thus limiting any ability to compare firms that superficially may appear to be at a similar "stage."

This problem leads us to two conclusions. First, this situation underscores the importance of applying simultaneously a theory of the process by which firms develop and a theory that explains the variance in the success of new firms. A process theory can be informed by noncomparative

evaluation in ways that a variance theory cannot. A preliminary understanding of such processes may, over time, give way to a reformulated variance theory that is able to overcome the original difficulties of comparison. Second, a broad-based approach to assessing performance with comparative measures must be taken to maximize the possibility that effectiveness can be accurately measured. We propose consideration of the following five types of criteria.

Survival

Given the high rate of new business failure, often estimated to be as high as 50 percent within the first two years, simply surviving must be considered one measure of effectiveness. As Cooper (1971) has shown, new technology-based firms may well have a survival rate that is higher relative to the survival rate for firms in general, even though their mortality rate is still high in an absolute sense. Each year of survival should be taken as at least a minimum indication of effectiveness.

In addition, all forms of discontinuance do not represent failure, and some may well indicate that a firm has been highly successful. Many successful technology-based firms are eventually acquired by a larger firm that has the requisite capital to exploit the market which exists for their new products. Licensing agreements may also, on the surface, look like decline, shrinkage, or discontinuance, when in fact they represent a desired end point for a new technology-based firm. Limited research and development partnerships may provide one example of a situation in which this pattern might be intentional.

Growth

A second set of effectiveness measures is more dynamic in nature. These assess the change and growth of a new organization on a set of key dimensions per unit time. Growth in sales, growth in employment, and growth in market share can all be taken as measures of success and effectiveness for the new firm. Research may ultimately show that there is a curvilinear relationship between growth and long-term survival and effectiveness, and that explosive growth creates an instability that has negative long-term impacts. Until this point, however, our working assumption is that growth in these measures is an indication of effectiveness.

One important caveat in examining measures of growth concerns the comparability of growth rates for firms at different stages, ages, and sizes. Doubling in size is often easy for a small firm, and is also a reasonable strategy. Doubling in size for a larger firm is much more difficult and sometimes risky. Once again, this emphasizes the necessity of interpreting quantitative data in light of the processes involved in development, as well as the variations in the quantitative measures themselves.

Measures of Current Financial Health

The third set of measures comprises a set of rather conventional financial criteria designed to assess the health of a firm. These measures must be applied with care to extremely young firms, but are more appropriate as firms grow beyond the initial start-up phase. As stated, they also represent more static measures than the growth measures presented above. Obviously, change in these measures could also be used to assess the health of a firm.

Four measures might be considered, and other conventional financial measures may be added to this list as well. We would include productivity, as measured by either aggregate sales per employee, or other measures of output per unit time; indebtedness, represented by a measure such as the debt/equity ratio; liquidity, or the amount of working capital on hand as measured by the current ratio; and profitability, as measured by return on sales or return on investment.

These measures are important indicators of the effectiveness of new firms for two reasons: First, they are direct indicators of financial health and are established methods of evaluating performance. Second, and far more indirect, because these are established measures of performance, a new firm will often be evaluated by these criteria whether they are appropriate or not. This is particularly true for publicly-held firms, who much often limit long-term investment out of the need to show a better short-term financial picture.

Value

A fourth feature of the performance and effectiveness of new technology-based organizations is their net value, and the change in the value over time. When a company is publicly-held, such a measure is easily obtained through the price/earnings ratio. For privately-held firms, this value could be estimated through established valuation procedures. For research purposes, a panel of experts could be assembled that would attach a hypothetical value to each firm, or a research team could learn to apply the rules of thumb established by such experts.

Perceptions of Stakeholders

A final set of measures might include the perceptions of key stakeholders such as the principals of the company, the employees, customers, or suppliers or financiers. These measures would complement the others described above and would allow for a very broad-based assessment of the overall effectiveness of a new firm.

While it may often not be possible to use all of these five measures in every situation, the diversity and indeterminacy of the concept of effectiveness for a new firm makes it clearly desirable to use multiple measures of performance to accommodate the complex and volatile nature of new firms.

DISCUSSION AND CONCLUSION

While extensive research has been conducted over the past 30 years in discrete topics related to the more general phenomenon of new venture creation, there has been little attempt to synthesize or integrate these research thrusts into a systematic model. This paper has attempted such a conceptual integration, combining variables at the individual, group, organizational, and environmental levels. The process of synthesizing the disparate studies and research traditions suggested two important conclusions that have implications for the direction of future research.

First, while extensive research attention has been directed at the backgrounds, traits, and characteristics of successful entrepreneurs, there has been relatively little empirical examination of the critical *problems* faced by entrepreneurs in the process of initiating NTBOs and even less

investigation into the *behaviors* needed to resolve or overcome those problems. The work of Kazanjian (1984) and Van de Ven et al. (1984) stand as two exceptions to the above statement and point the way to a relatively uncharted territory, rich with research questions. By focusing on real-time problems and corresponding behaviors (i.e., the internal dynamics of new ventures) rather than existing demographics or traits, future research might provide prescriptions that entrepreneurs can actually utilize to change their behavior to the benefit of both the individual and the fledgling company. Emphasis upon *predicting* entrepreneurial proclivity must give way to *facilitating* effective individual and group behavior in the context of the start-up process.

Second, the integration of existing research traditions points to the usefulness and importance of understanding the environmental context of new firm creation: NTBOs are not created in vacuums or homogeneous settings. Particular locational factors (e.g., the quality and attitude to technical incubator organizations, the entrepreneurial climate and business infrastructure, and the overall quality of life of the area) are extremely influential in determining the types of firms created, the rate of new firm start-up, and the chances for growth and successful development for those firms. Most work taking this approach has focused on the importance of Stanford and MIT to the development of the Silicon Valley and Route 128 high-technology agglomerations (e.g., Cooper, 1984; Roberts, 1970; Rogers & Larsen, 1984). Future research might examine the creation process in other locations using the Technology Development Cluster (TDC) concept developed in this article as the sampling frame. Assessing the individual and organizational factors of NTBOs at a variety of contrasting TDCs might enhance greatly our understanding of the importance that the external environment plays in facilitating or inhibiting the successful creation of NTBOs.

Such studies might also facilitate assessment of the impact that new firm growth and development has on the "success" of Technology Development Clusters. The complexities of evaluation effectiveness at this more aggregate level are enormous and clearly cannot be dealt with in this paper. It seems clear, however, that one might begin with concepts like new job creation, the production of exportable goods, value added, and the contribution of a given population of new technology-based organizations to the image and reputation of the TDC region.

Recently, the authors have initiated such a project aimed at examining the internal (organizational) processes and external (environmental) influences for a sample of firms in a rapidly growing TDC in Southeastern Michigan (Denison & Hart, 1985). Using the Federal Unemployment Insurance records maintained by the State of Michigan, a sample of 1500 firms has been selected and will be studied longitudinally over a five-year period.² While this sample was selected to be representative of the region as a whole, it was also designed to oversample new, high-growth and technology-based firms.

To the authors knowledge, this study is unique, both to the field of organizational research and economic development. There have been few studies using probability samples of new organizations, and none have been conducted using unemployment insurance records as a sampling frame, with a focus on the creation and development of new businesses. Indeed, it appears that the approach to studying NTBOs described in this

paper holds great promise for synergy between related but often separated fields of application. In particular, this approach provides productive cross-fertilization among such fields as organizational development, group dynamics, urban regional planning, and economic development.

NOTES

¹The authors are currently focusing on these problems in a research project (Denison & Hart, 1985) and another manuscript (Hart & Denison, 1985).

²For details on the use of unemployment insurance records as a basis for business firm sampling, see Birley (1984) and Connor et al. (1984). Evidence indicates that these records are superior to other more commonly used sources for business firm samples such as Dunn and Bradstreets and telephone directories. Unemployment insurance records are particularly good in their coverage of small, new firms—precisely the kinds of firms that other sources have the most difficulty with.

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