Engines Driving Knowledge-based Technology Transfer in Business Incubators and Their Companies

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Abstract

Business incubators are designed to create change, and companies associate with them because they want to change. Acquiring, sharing and using information are the basis of the exchanges through which these changes are accomplished. The information exchange process thus provides a useful way to define the engines for the changes that accompany technology transfer. Van de Ven and Poole’s typology of organizational change “motors” is used to construct an analysis of the conditions and criteria of technology transfer as a driver of change in business incubators and their companies. We add to the conditions and criteria of this typology the additional element of content – as another important element in knowledge-based technology transfer. The results define several “engines” which drive change through knowledge-based technology transfer. Three business incubators are investigated to (1) determine whether the conditions required for the change engines are present, (2) assess the type of content targeted for exchange and (3) determine the concrete circumstances of their operation.

1. Introduction

Technology transfer, first introduced by development economists as a strategy for accelerating the development of Third World countries, [1] is considered strategically important to economic development and national competitiveness. Business incubators were once positioned as “population specific” organizations that were focused on helping women, minorities and people with disabilities to start businesses.

But the business incubators of the 60’s and 70’s changed as the 80’s ushered in an emphasis on “technology specific” incubators. [2] These business incubators – through their facilities, consulting advice and networking opportunities, space, equipment, capital and management services – have sought to help their participating companies improve their profitability and their survival rate in a competitive market. [3] [4] By increasing company survival, creating new jobs, developing business models, and catalyzing a culture for entrepreneurship, incubators around the world have focused on contributing to local economic growth [5] by reducing risks for both entrepreneurs and investors.

In this paper, we identify the engines that drive these changes –for the incubators as well as their companies. These engines are described by the content of the knowledge exchanged and by the conditions of change.

2. Content

Technology transfer, the application of knowledge, relies on the exchange of knowledge between two entities (Gibson and Rogers, 1994.) The knowledge that is being exchanged may not be a fully formed idea; it may be a fully formed idea but not yet ready for application. It may be tacit knowledge – associated with subjective, simultaneous practice and not easily visible and expressible – or explicit knowledge – objective, easily processed, transmitted and stored, with the qualities of rationality, sequential and digital.

Despite the distinctions, tacit and explicit knowledge are complementary (Nonaka and Takeuchi, 1995, p.49-61) in the process of knowledge exchange and in the
processes by which the exchanged knowledge acquires value in the minds of the participants. Knowledge is created and expanded through spiraling social interaction between the complimentary entities. The so-called SECI-model, with the modes of socialization, externalization, combination, and internalization describes the processes of communication and exchange [7] [8] (Figure 1.)

<table>
<thead>
<tr>
<th>From</th>
<th>Tacit knowledge</th>
<th>Explicit knowledge</th>
</tr>
</thead>
</table>
| Tacit knowledge | **Socialization**
|                 | Sympathetic knowledge |
| Explicit knowledge | **Externalization**
|                 | Conceptual knowledge |
|                 | **Internalization**
|                 | Operational knowledge |
|                 | **Combination**
|                 | Systematic knowledge |

Figure 1. The four modes of knowledge creation and the content of knowledge created in them [7]

In some cases the explicit knowledge (culture and processes) must be incorporated into the tacit knowledge of an organization before the transfer is truly effective. In the technology transfer process, the knowledge of the two transferring organizations must, at least for a time, and individuals involved in the transfer may also share tacit knowledge.

When knowledge is exchanged to transfer technology, it is subsequently converted for application and then adapted into a solution. This valuation and adaptation are also knowledge creation activities. And hence, it is by the creation of new knowledge that technology is truly transferred.

Organizations are thus faced with the task of mobilizing the knowledge of individuals – often tacit but rich with understanding of the value of the knowledge for a solution – for exchange or adaptation into another form. The personal nature and the interpersonal requirements of technology transfer are recognized. In order to be applied, that transferred technology, that new knowledge must be transferred several times again on its pathway to organizational acceptance, product development, marketing and adoption by the end user. Transferred technology, in the form of new knowledge, travels along the “knowledge spiral.” It starts at the individual level and moves up through expanding interaction that crosses sectional, departmental, divisional, and organizational boundaries. Organizational changes occur, as the new knowledge becomes an organizational resource and asset.

Tacit knowledge held by individuals is the basis of knowledge creation in organizations, so the sharing of it among various individuals with different backgrounds, perspectives, and motivations becomes a critical activity. The sharing of explicit knowledge between individuals in different organizations is the basis of what is traditionally considered technology transfer, and in this sense knowledge must first be made explicit before it can be explicitly shared.

Technology transfer deals involves both tacit and explicit knowledge in organizations. Intervention strategies and actions undertaken by R&D consortia and business incubators, as well as through independent and serendipitous interactions, have been documented. [9] [6] For optimal effectiveness, these mechanisms should be targeted to all levels of an organization – the individual, the program or project, consortia, alliances or business partnerships to transfer technology, and top management or shareholders. [9] Active communication mechanisms, such as face-to-face meetings, and passive mechanisms, such as reports and articles, are mechanisms through which both explicit knowledge and tacit knowledge can be exchanged to fuel change. Coordinated by incubators they form an incubator for technology transfer – a framework for the engines.

Along the spiral, changes occur. The speed and thread of the spiral, reflected in the responsiveness of individuals and in the culture of the organization, influence the movement of new knowledge along the spiral. These conditions, the unit of change and the mode of change, influence the velocity and torque of technology transfer. The internal and external activities that create knowledge help to fuel the continuous innovation needed for competitive advantage (Nonaka and Takeuchi.) Continuous innovation requires continuous change.
3. Conditions: Unit And Mode Of Change

The means and motivations by which organizations change have been widely studied. In a recent review and analysis of approximately 200,000 titles, 2,000 abstracts and 200 papers, Van de Ven and Poole define four typologies of organizational change that explain how and why changes take place in and among organizations. [10] These typologies represent different generative mechanisms and event sequences. Van de Ven and Poole define these typologies by the unit of change and the mode of change. Whether the change in question is premised on the actions of a single entity or multiple entities determines the unit of change. The mode of change concerns whether the sequence of change events is prescribed “a-priori by deterministic or probabilistic laws, or whether the progression is constructed and emerges as the change process unfolds.” [10]

Across the variety of perspectives on organizational change, Van de Ven and Poole characterize the changes of individual entities as evolutionary or dialectic. In reality these typologies may represent the poles of a continuum rather than discrete and mutually exclusive alternatives. Evolutionary changes deal with groups of entities that evolve in a predictable manner as a result of their continuous response to environmental factors affecting them. Dialectic changes are those in which groups of companies change constructively in response to factors that produce a conscientious desire in which change emerges. Their typology also differentiates changes that involve individual entities undergoing characteristic life cycle changes and teleological changes – in which a company creates and implements changes that create solutions to problems it faces.

<table>
<thead>
<tr>
<th>Multiple Entities</th>
<th>EVOLUTION</th>
<th>DIALECTIC</th>
</tr>
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<tbody>
<tr>
<td>Variation → Selection → Retention</td>
<td>Thesis → Conflict → Synthesis</td>
<td>Antithesis</td>
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<tr>
<th>Unit of Change</th>
<th>LIFE CYCLE</th>
<th>TELEOLOGY</th>
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<tr>
<td>Stage 4 (Terminate)</td>
<td>Stage 3 (Harvest)</td>
<td>Dissatisfaction</td>
</tr>
<tr>
<td>Stage 3 (Harvest)</td>
<td>Stage 1 (Startup)</td>
<td>Implement</td>
</tr>
<tr>
<td>Stage 2 (Grow)</td>
<td></td>
<td>Goals</td>
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<tr>
<th>Single Entity</th>
<th>Mode of Change</th>
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<tbody>
<tr>
<td>Prescribed</td>
<td>Constructive</td>
</tr>
</tbody>
</table>

Figure 2. Process theories of organizational development and change (Van de Ven and Poole 1998)

The evolutionary typology is based on a system of variation, selection, and retention; groups of organizations experiencing an evolutionary change are likely to be motivated by the need to prevail in the face of conditions that threaten survival a competitive environment.

The dialectic typology is based on a system of confronting alternatives to a “business-as-usual,” in an environment of diversity. Out of conflict produced by the environment comes a synthesis or resources that provides a new solution, which may be challenged by yet another alternative. The alternatives, as well as the new synthesis, generally involve multiple entities.

The life cycle typology is based on a system of regulation and compliant adaptation of an organization as it proceeds through the stages of: startup, growth, maturity/harvest, and termination.

The teleological typology is based on a system motivated by dissatisfaction, which proceeds through searching and interacting with alternatives, envisioning and setting new goals, and implementing those goals, following which some dissatisfaction again arises. Progression through this cycle can generally be characterized as the purposeful enactment and social construction of a consensus within an organization.
These are, of course, ideal types, created as tools to better understand conditions and processes of organizational change. They are also useful in understanding the motors that turn the knowledge creation spirals and provide the “engines” of technology transfer. It is understood that these typologies are not always encountered in pure form. Rather, observed processes are generally multi-layered and complex. With that in mind, three business incubator were investigated to: (1) determine which of the conditions required for the motor were present; (2) assess the type of knowledge targeted for exchange; and (3) determine the concrete circumstances of their operation. The three were the Software Business Cluster in San Jose, CA, USA; OuluTech Oy in Oulu, Finland; and Tecnopolis Novus Ortus in Bari, Italy. Each is described below based on interviews and data collected in 1997 and 1998.

4. Examples

Software Business Cluster in San Jose, CA USA (www.sjsbc.org) [2]

A non-profit entity started in late 1994, the objective of the Software Business Cluster (SBC) was initially to rejuvenate business in downtown San Jose. Its partners included the San Jose Redevelopment Agency and leading business organizations in Silicon Valley.

SBC first targeted large companies and provided a test facility for software. Then several years ago, it began focusing on attracting start-up companies. According to Barbara Harley, Director, who was responsible for development and interim management of the early stages, the incubator was patterned after the successful Digital Equipment Computer Incubator. Participating companies must require to be a software business, submit a brief business plan and go through an interview process with members of the SBC Advisory Board.

When the start-up company had joined the SBC, it acquired access to core facility services (furnished office space, administrator/receptionist, shared conference room, copier, fax, etc.) as well as core business services for business development and growth (lectures, seminars, workshops, one-to-one advertising, business advice from executive associates). Once established successfully, the businesses were expected to move out of the SBC to make room for new start-ups. The maximum stay for any business was two years. It was expected that by “launch,” a company – even one still in the start-up phase – would have acquired enough focus and stability to sustain its own infrastructure.

In its service to large companies in need of revitalization and its incubation of start-ups, the SBC sought to facilitate changes in its participating organizations – the predictable changes of the start up phase of business life cycle. The focus of its services was explicit knowledge via active communication mechanisms, but it also implemented programs and activities that provided an opportunity for tacit knowledge to be exchanged. This was facilitated through the informal interactions of individuals from resident companies or through advising relationships that promoted personal interaction on issues of mutual interest.

Harley reported that in the first fourteen months of its existence, the Software Business Cluster created over 140 high value jobs. In 1997 it had 23 companies and was financially self-sustaining.

OuluTech Oy in Oulu, Finland (www.otm.fi/oulutech) [11]

OuluTech Oy was established in 1994 as a profit-seeking technology transfer organization. It is jointly owned by a local university, local science park, and by the Finnish National Fund for Research and Development. According to Matti Paasovaara, Director, the high-tech incubator was focused on the improvement of the conditions of starting up high-tech businesses in the Oulu region, specifically in the areas of medical technology, biochemistry, process technology, mechanical engineering, electronics communications, and software technology.

Typically, about 50-70 start-up ideas or spin-offs have entered the preliminary evaluation at OuluTech yearly. Approximately 20 of these applicants receive a closer evaluation, in which business plans and market analyses are prepared and evaluated. From this pre-incubator phase, which last about 2-3 months, about 10 companies per year enter the incubator under a 5-year contract that assigns a percentage of earnings during that time to OuluTech. OuluTech has then provided access to facility services, services for financing, development aid and, at the same time, systematic training and consulting. After 2-3 years in the incubator, the start-up is expected to move out of the incubator. In 1996 the 10 start-ups in OuluTech Oy had created 20 new jobs and planned to double that in the next year (Paasovaara, 1996.)

Again, OuluTech has facilitated changes in its participating organizations. The focus of its services has been explicit knowledge, but it has also implemented programs and activities to provide an opportunity for tacit knowledge to be exchanged. The services made available by OuluTech have been oriented to the start-up phase of a participating company’s life cycle and, as such, toward facilitating changes motivated by a life cycle motors.
Bari, Italy (www.tno.it) [12]

5. Processes and Conditions

The above incubators illustrate several approaches to creating change through the exchange of information. In general, their focus has been on the start-up phase of the business life cycle and on explicit knowledge, with some attention devoted to implicit knowledge and to meeting unanticipated needs of businesses at other life cycle stages.

As a single organization, a business incubator progresses gradually through its own life cycle, accommodating new needs and opportunities for communication with its constituents and sponsors, companies it has launched and current incubating companies. Examples of how business incubators have changed over time in response to life cycle motors include the development of new management practices for selecting and admitting participating companies and changes in their equity and investment payback arrangements.

As a single entity, a business incubator is also responsive to teleological force – outside forces that can render some programs less effective or present new demands on the incubator itself. Funding changes, market changes, changes in the types of businesses needing assistance, and changes in the nature of the assistance they need are examples of such forces. The drive to respond to those forces produces a teleological driver for the organizational changes of the incubator itself.

Incubators strive for knowledge exchange. In an evolutionary mode, the participation of their companies in information sharing activities influences the retention of valued services and practices in the incubator. Business propositions, once developed, must be justified against market demand; and information exchange provides the basis for such considerations.

Knowledge exchange in incubators can also be seen as a dialectic process. The thesis of shielding the incubating companies from outside forces is confronted by the antithesis of the benefits of exposure – all the advantages and added value that sharing and transferring information bring to the incubator. Out of the exposure come new business propositions or advantages, which then become the basis of a new tension regarding whether or not the knowledge should be shared.

Providing access to information and facilitating the transfer of knowledge are fundamental objectives of these and other business incubators. Especially during the last decade, the importance of easier and faster access to accurate data has intensified as the availability, speed and volume of information exchanged has dramatically increased. Incubators have provided database searches, daily searches of Internet news, and access to professional expertise. This has been provided through hardware, software, and human resources through information professionals (Paasovaara 1996.)

Business incubators have been expected to know where the information is and how to acquire it. For example, according to Annicchiarico, entrepreneurs typically have little time to follow trade publications and special announcements related to their field, so Creazione d’Impressa has facilitated searching for and getting the needed information (Annicchiarico 1996.)
Business incubators have also been expected to know how to bring people together so that tacit knowledge (the things they don’t really know that they know or need to know) can also be exchanged. Business incubators are intended to get, use and share knowledge to benefit their companies, which have usually been start-ups. However, some incubators have re-directed at least some of their business services to help companies respond to teleological-driven changes in an information-intensive business environment. Quick access to up-to-date and reliable information is critical for: (1) information acquisition to create knowledge or product archetypes; (2) sharing knowledge to develop and justify new business and product concepts; and (3) cross-level extensions of knowledge that are important for the development of local and global relationships in the information age. New businesses need these abilities. Existing companies, especially mature companies, also need these abilities.

The business incubators themselves are driven to change along both the prescribed and constructive dimensions of change. As a group, their companies, united by technological focus, life cycle stage, geography, or other factors, may motivate the business incubators to evolve their services in response to changes in the external environment that all participating companies share – in the business climate, the technological environment, the market – an evolutionary change. In addition, sudden or dramatic changes, such as new export regulations, tax structure, or availability of venture funding, can activate a dialectic type of change – a shake-up or dramatic shift – that motivates that group of companies to change.

These forces also drive changes in the companies. The changes are driven by each company’s desire to move through the understood life cycle stages of a start-up company and require knowledge-based technology transfer. More established companies that participate in the activities of business incubators may also be driven by life cycle challenges. Teleological motors – awareness of dissatisfaction with existing conditions – and the expectation that the exchange of explicit or tacit knowledge among incubator companies and with incubator resources will ignite satisfying changes, may also drive them. The movement of information along the spiral of organizational knowledge creation is influenced by type of motor driving the change. Interventions in this process are the objective of business incubators, and their services are directed to keep the motors running and to optimize their performance.

Figure 3. Process theories of organizational development and change and business incubators and their companies
Individual companies adopt various practices of information exchange, modify them when they are not successful, and retain them when they are successful – a teleological process. A company’s dissatisfaction with its information sharing practices and abilities motivates it to search and interact to find an improvement to the situation. After achieving its goal, the satisfaction about the new situation eventually becomes displaced with dissatisfaction and the subsequent desires for new improvements. (Figure 3)

As with acquiring and sharing information, cross-level extension of information can be seen as a means for helping organizations survive in a competitive environment and is a basic objective of many business incubators, including those studied here.

The larger context – regional, national, and international – has been imperative for building and sustaining competitive advantage. For example, Annicchiarico mentioned finding partners in the USA as one of the knowledge activities of her business incubator organization. [12] Incubators can facilitate cross-level extension of information.

Incubators’ processes of helping their companies form international alliances and develop worldwide marketing strategies are instrumental for their developing abilities to survive in competitive environments, and the engine of evolution drives these processes. A teleological engine also drives the processes. For example, new partnerships formed among groups of companies that individually compete with each other have at the same time intensified the competitiveness of the marketplace and improved the ability of participating companies to compete in it. The synthesis of this conflict – new ways of doing business – continues to be challenged as market forces continue to shift.

According to Harley, the bigger corporations have for many years been aware that market share is impacted by the activities of other companies in other countries. For many of the smaller and start-up companies, this awareness is either new or non-existent and must be cultivated. Formerly, business incubators helped companies first target the local market then expand nationally, perhaps then internationally. Driven by teleological motors, incubators now provide services to help with both, and for some incubator companies the search for nearby and international markets has taken place concurrently.

For example, the entrance criteria for two of the business incubators included being able to identify international markets (Paasovaara 1996, Annicchiarico 1996.) Concurrently working in international environments and being able to quickly access them has become a necessity. The same environmental force has driven the modification of the life cycle of an emerging company.

In addition to sheltering the intellectual property of emerging companies, business incubators also strive to share and transfer information and knowledge to bring competitive advantage to the incubators and to their companies. For example, Paasovaara described the process of sharing information with a start-up company in OuluTech Oy on about 250 cooperation projects that were available in Europe (Paasovaara 1996.) Business incubators not only share information with their participating companies, they also share information with other business incubators.

6. Implications

A review of the conditions of the various typologies of motors reveals that both prescribed and constructive motivations for change drive incubators and their companies. Business incubators offer infrastructure and services to support the transfer for explicit knowledge, as well as tacit knowledge. These changes were analyzed using Van de Ven and Poole’s typologies of organizational development and change: life cycle, teleological, dialectical and evolutionary. The typologies, although a simplified categorization, were used to evaluate the conditions and processes of change in business incubators and their companies (Table 1.).

Changes in the industry structure and information channels have altered the time reference for many incubator companies, as well as their anticipated life cycles. Shorter product development and introduction cycles along with changes in market segmentation and distribution mean that companies may be in one life cycle phase with one product and in another with another product. A teleological motor drives a company to develop new frames of reference and new ways of setting and reaching goals at the same time that a life cycle motor drives it through anticipated stages of business development.

Multiple drivers motivate change in business incubators and their companies. Many types of knowledge are needed to fuel these changes in a time frame compressed by the widespread availability and immediate accessibility of information. Incubators perform critical services in helping companies know which information is relevant and how to apply that information to create new knowledge that serves the developing business. Business alliances and partnerships enable developing companies to make timely responses to fast-changing conditions in the business environment. Therefore, business incubators serve not only their participating companies, but also may serve the network of alliances and partnerships in of
<table>
<thead>
<tr>
<th>CONDITIONS FOR OPERATION OF IDEAL TYPE MOTORS</th>
<th>CONDITIONS AT BUSINESS INCUBATOR ENVIRONMENT</th>
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<tbody>
<tr>
<td><strong>For an Evolutionary Motor</strong></td>
<td></td>
</tr>
<tr>
<td>- A population of entities exists in a commercial relationship (i.e., in a physical or social venue with limited resources each entity needs for its survival)</td>
<td>Business incubators and companies within them competing in an emerging or changing market sector.</td>
</tr>
<tr>
<td>- Identifiable mechanisms exist for variation, selection, and retention of entities in the population</td>
<td>Mechanisms of financial growth and success, patterns of spin-off and acquisition, ultimately the sector survival.</td>
</tr>
<tr>
<td>- Macro population characteristics set the parameters for microlevel variation, selection, and retention mechanisms</td>
<td>Macro population characteristics of business climate, technological environment, competitive situation, customer perception</td>
</tr>
<tr>
<td><strong>For a Dialectical Motor</strong></td>
<td></td>
</tr>
<tr>
<td>- At least two entities exist (each with its own discrete identity) that stand in opposition or contradiction to one another</td>
<td>Thesis of shielding companies from external forces and protecting proprietary knowledge, antithesis of exposure and cooperative alliances with competitors.</td>
</tr>
<tr>
<td>- The opposing entities must confront each other and engage in conflict or struggle through some physical or social venue in which the opposition plays itself out</td>
<td>Confrontation of the benefits of changing and information sharing vs. not-changing and shielding from information</td>
</tr>
<tr>
<td>- The outcome of the conflict must consist either of a new entity different from the previous two, or (in degenerate cases) the defeat of one entity by the other or a stalemate among the entities</td>
<td>The benefits of exposure to information and external forces creates a new business proposition or advantage</td>
</tr>
<tr>
<td><strong>For A Life Cycle Motor</strong></td>
<td></td>
</tr>
<tr>
<td>- A singular, discrete entity exists which undergoes change, yet maintains its identity throughout the process</td>
<td>A business incubator or a company in the incubator</td>
</tr>
<tr>
<td>- The entity passes through stages distinguishable in form or function</td>
<td>Life cycles of the business incubator or one of its organizations. Predictable categories of knowledge needed to plan development of a company.</td>
</tr>
<tr>
<td>- A program, routine, rule, or code exists in nature, social institutions, or logic which determines the stages of development and governs progression through the states</td>
<td>For a company, the old rule of entering local markets first, then entering the national and finally the international markets; the changed rule means that a company enters all the markets at the same time. For an incubator, changes in its requirements for participating companies or in the way it works with them.</td>
</tr>
<tr>
<td><strong>For a Teleological Motor</strong></td>
<td></td>
</tr>
<tr>
<td>- An individual or group exists that acts as singular, discrete entity which engages in reflexively monitored action to socially construct and cognitively share a common end state or goal</td>
<td>A business incubator or a company in the incubator</td>
</tr>
<tr>
<td>- The entity may envision its end state of development before or after actions it may take; the goal may be set explicitly or implicitly. An identifiable process of social construction or sense-making, decision making and goal setting</td>
<td>Vision of information sharing capabilities and practices and the vision of improved services offered by the incubator. Innovative response to new or changing conditions.</td>
</tr>
<tr>
<td>- A set of requirements and constraints exist to attain the goal and the activities and developmental transitions undertaken by the entity contribute to meeting these requirements and constraints</td>
<td>To build and manage alliances and networks, incubator services are offered to help individual companies share information, improve social skills, utilize the Internet, etc. Modifications made in services to better respond to needs of participating companies.</td>
</tr>
</tbody>
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Table 1. Conditions for operation of ideal type motors in business incubators and their companies
their participating companies – for both anticipate and unanticipated changes.

The convergence of motors and types of knowledge for both incubators and their companies may very well characterize the business environment of the information age. These characteristics, in addition to increased complexity and flux in the business environment, may warrant a reconsideration of the systems model for assessing organizational change and knowledge-based technology transfer. An understanding based on complexity or chaos theory may be helpful in understanding changes in business incubators and their companies. We would do well to better understand the simultaneity and interrelationship of drivers and knowledge-based exchanges, as well as the “butterfly effect” of a new company that enters a business sector or the new application of an information resource.

References.


