

Education, Entrepreneurship and Investment

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Thank you for the opportunity to participate in this conference focused on developing investment opportunities in Africa. It has provided an impetus to reflect on the MIT experience and its role and impact on economic development in the metropolitan Boston-Cambridge area over the past forty to fifty years.

Forty to fifty years is a very long time. It is at least two to three generations of leadership, leadership required to recognize what needs to be done in the short term while transferring from one generation to the next the longer term vision. Perhaps this time frame appears much longer than the needs facing Africa may demand. Nevertheless, it may be the realistic time frame. It is important for me to stress that with all the resources available around Boston-Cambridge, it certainly took more than one generation of leadership for changes to occur. In brief, I do not see solutions around the corner. I do see a need to define possible paths and getting started.

One interesting aspect of the Boston-Cambridge experience is that it continuously has been adapting to new challenges for much longer than the most recent forty to fifty years period. The direction was not always one of incremental progress. Finally, it never was the result of a grand plan. It was the result of the actions of many with one underlying characteristic – they had an interest in effecting change and a capacity to make mistakes without retribution, either individually or institutionally.

The substantial economic growth experienced in the Boston-Cambridge area has not been unique. There are comparable experiences in other locations: the area around Cambridge University in Cambridge, England, is a key example among others. To some extent it seemed appropriate to comment about the two Cambridge(s) though we could have referenced activities in and around Palo Alto, California (Silicon Valley); the Research Triangle in North Carolina; Singapore, Bangalore, India, and Munich, Germany to name but a few. Some of these will be referred to again.

With the location being Cambridge, be it in Massachusetts in the United States or in England, the name “*Cambridge*” evokes the thought of education. What is the possible role of education in economic development?

A recent study¹ carried out jointly by the United Nations Educational, Scientific and Cultural Organization (“UNESCO”) and the Organization for Economic Cooperation and Development, an association of thirty industrialized countries, has suggested that a shift has occurred in the thinking towards a greater appreciation of the value of higher education for developing countries. Previously, many thought the secret to economic growth was based on new strategies for primary and elementary education. This study, which looked at sixteen developing countries, concluded that investments in education during the past two decades “may have accounted for about a half a percentage point in the annual growth rates in those countries.” The overall results suggest that education plays a stronger role in economic growth once education levels reach a critical threshold and that “high levels of upper-secondary and tertiary attainment are important for human capital to translate into steady growth.”

If these conclusions are valid then we must explore what public policies are necessary to encourage private investment in higher education. One particular example noted in the report was that in Chile the government pays most or all of the tuition fees of 85% of the students attending private universities. This is a somewhat staggering initiative in a country where private higher education accounts for two-thirds of all places of study.

The most affirmative aspects of the study are taken from its Executive Summary:

“...robust evidence that human capital is a key determinant of economic growth and emerging evidence indicates that it is also associated with a wide range of non-economic benefits such as better health and well-being. Investment in human capital, and by implication in education, has thus moved to center stage in strategies to promote economic prosperity, fuller employment and social cohesion. ...”

Returning to the two Cambridge(s), and accepting the role of higher education (described as tertiary education) in economic development it is interesting to consider whether there is a systematic way to look at the two Cambridge(s) and some of the local experiences in order to hypothesize about or even find some key underlying drivers of even more successful economic development than that measured in the UNESCO study.

One objective would be to share a perspective as a contribution to the overall discussions at this Conference. An alternative would be that while my observations only may be partially correct, they may assist in developing a frame of reference for future planning and development discussions.

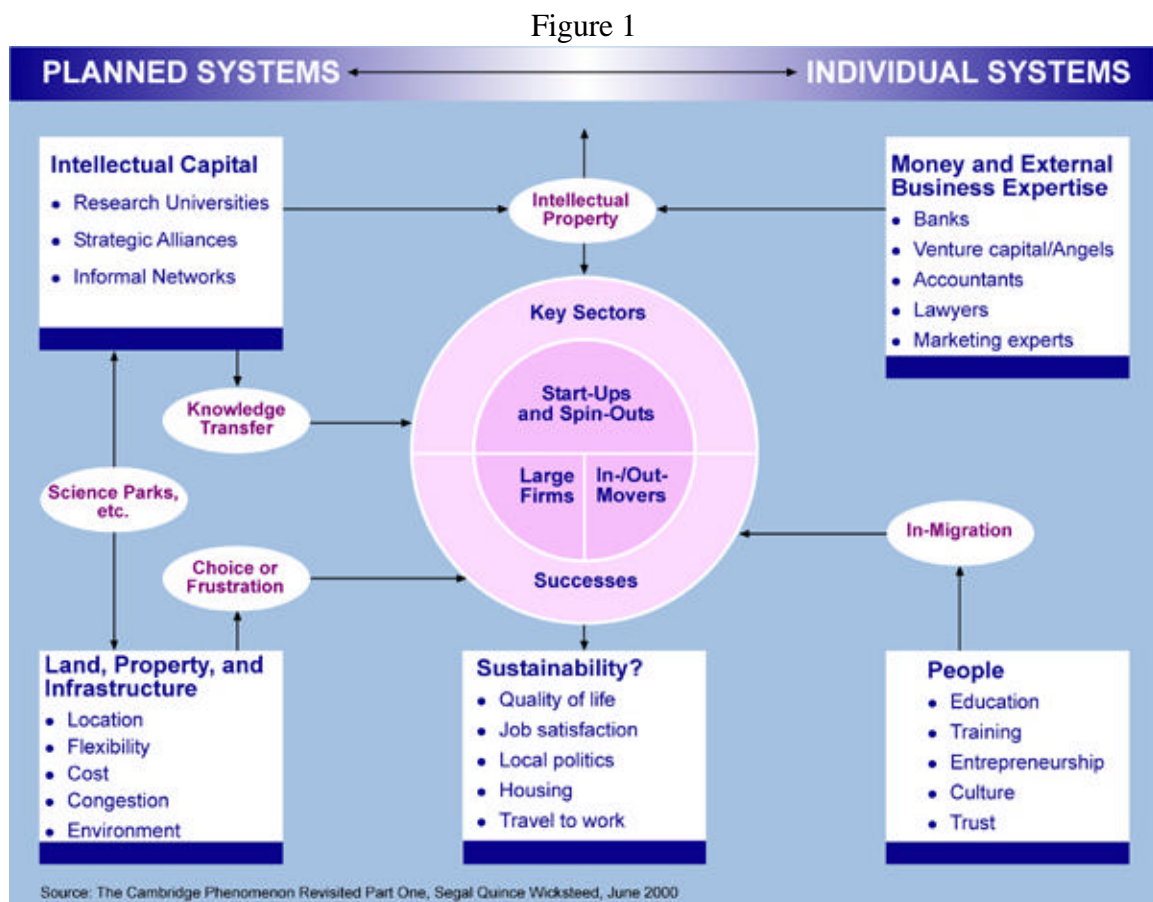
To define the nature of the economic system around each of the *Cambridge(s)* presents a complicated analysis problem. There is no one dominant theme that describes the

¹ “2003 Financing Education-Investments and Returns”, UNESCO Institute for Statistics, Organization for Economic Cooperation and Development, and World Education Indicators Programme, 2002, Paris, France.

pathways to success. Finally, as is the case for many life events, it is very dependent on the actions of individuals who were the leaders at critical times.

Whatever the difficulties, it seems appropriate to consider an overview of all the factors which have been defined with particular attention directed to some of the key drivers.

Figure 1 is taken from a study prepared by the firm of Segal Quince Wicksteed in June 2000, entitled “The Cambridge Phenomenon Revisited”². The focal point of this study was an evaluation of the Cambridge Science Park and St. John’s Innovation Centre, in England. The multiplicity of interactions and issues indicated from this illustration clearly demonstrates the complexity of adequately describing what happened in Cambridge, England, or in Cambridge, Massachusetts.



² “The Cambridge Phenomenon Revisited-Part One”, Segal Quince Wicksteed Limited, 2000, Edinburgh, London, Manchester, Hong Kong

This illustration shows the complexity of interactions. We can note three major drivers which I shall describe as:

- Intellectual Capital

This Capital might be described as being based in a research university as a key resource with appropriate methodologies for the transfer of intellectual property and knowledge.

- Financial Capital

This Capital might be described as those financial resources and expertise readily available to emerging enterprises. There are the classic groups of business advisors, banks, attorneys and marketing experts. One of the major ingredients in the United States is characterized by the institutional venture capital industry.

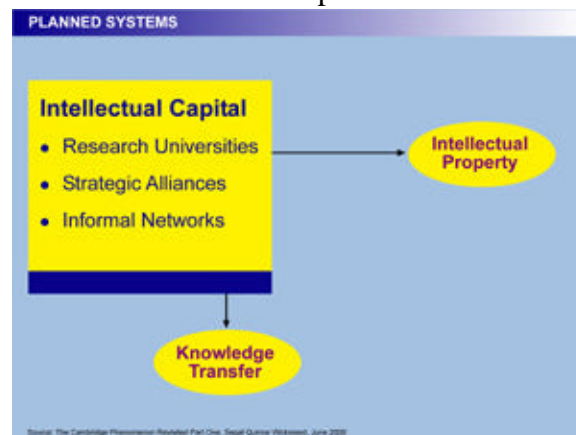
- Human Capital

This Capital is those people who are challenged by the new frontiers and do not shirk from the uncertainty of success or failure as a result of expending entrepreneurial energy.

While I focus on the MIT experience as the reference example, I affirm to you that there are sufficient written studies and anecdotal information to strongly indicate that the experiences around Cambridge, Massachusetts, have been significantly replicated in the other locations. However, the forces at work are different when explored in either different locations or different time periods.

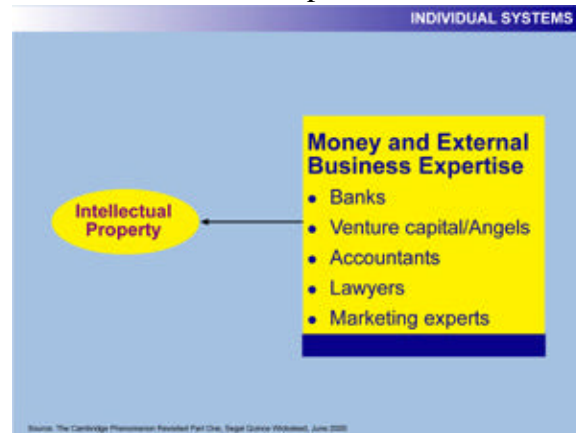
It is difficult to parse the three drivers illustrated in Figure 1 and comment only on each one of them. The reason this difficulty arises is because of the intense interaction which occurs between and among the various drivers. To highlight two of the drivers, one should refer to Figure 2 and Figure 3.

Figure 2
Intellectual Capital Driver



The major source of intellectual capital is thought to be the research universities which, through their informal networks and strategic alliances, typically with industry in selected areas of concentration, build one of the important bases to drive the complex system.

Figure 3
Financial Capital Driver



There are two aspects to the role of Money and External Business Expertise. The latter builds upon a knowledge base and infrastructure necessary to grow emerging enterprises. All of these people resources are needed to address the capital needs. It is interesting to keep in mind that one of the classical sources of capital, banks, until only recently never truly participated as the risk capitalist. MIT, as will be noted later, played a unique role in the formation of institutional venture capital organizations, organizations that needed to be developed as a counterpoint to the more conservative approaches taken by the classical sources of capital.

A perspective on how these capital components might interact might be obtained through a study by Henry Etzkowitz, Director of the Science Policy Institute at State University in New York, entitled MIT and the Rise of Entrepreneurial Science³. Etzkowitz presents a detailed analysis of the transformation of the university's role in society to an expanded one involving economic and social development as well as teaching and research. It is Etzkowitz's premise that MIT invented the format for university-industry relations that has been replicated in other locations in the United States and subsequently in other parts of the world. He traces seminal activities in the 1940s at MIT to evolving relationships among university/industry/government to processes that have become part of the foundation of modern successful economies.

The premise of MIT's founder, William Barton Rogers, was of a university that could transfer science-based know-how to industry. This objective had at its core the introduction of practical topics into the curriculum, a model which was not supported

³ MIT and the Rise of Entrepreneurial Science, Henry Etzkowitz, Routledge – Taylor & Francis Group, 2002, London and New York

early on by most of the classical views of a university education. In recent years the MIT model has been adopted by others and most recently, through an experimental program, is being introduced to Cambridge University, England, under an initiative known as the Cambridge-MIT Institute.

It is not practical within the time allotted to fully characterize the MIT experience as it evolved over the past hundred and forty years. The key element to keep in mind was an open interface between the academy and industry, one fostered through active university-industry relationships and subsequently added to through the sponsorship of research activities, initially by the US government and more recently by international companies and governments. Examples in the latter category include the program with Cambridge University, an extensive program in conjunction with the Government of Singapore and industrial support from around the world.

A key element, also seen in Figure 2 and Figure 3, is an appreciation for the issue of technology and intellectual property transfer. There was a need to develop and evolve policies and practices regarding the ownership of intellectual property and facilitating mechanisms to transfer, for a fee, that intellectual property into the commercial market place.

Without trying to infer a linear pathway from some of the earlier ideas around MIT, one should recall that the history of the New England economy has been one of “ups and downs” - new enterprises, the displacement of manufacturing organizations to other lower labor cost areas in the United States, and then again the development of even newer enterprises. This will be illustrated below in a brief summary of two mill sites in Massachusetts. Much of these earlier ideas culminated in the 1930s and early 1940s with local business leaders and others from MIT, most notably the then President, Karl Taylor Compton, coming together to formulate a new economic base from the potentially commercializable research of the scientists and engineers of the academy. The question was what form the organizational structure should be in order to effect this transition.

It may be new information to some that what evolved from that thinking is the progenitor of the modern venture capital firm. Specifically, the formation of American Research and Development, now known as “ARD”, initially funded in part by the MIT Endowment with several MIT professors as advisors to the firm and with a board of directors composed of Dr. Compton, MIT faculty and an MIT Trustee active in the business community. It evolved out of a coalition between the Harvard Business School and MIT with the then Harvard Business School faculty member, General Doriot, taking the role of president of ARD. How very different from today to note that this first commercial venture capital firm was funded with a total of \$3 million with major financing coming through the Morgan Guaranty Trust Company in New York. Early examples of ARD’s role in the formation of new enterprises based on research at MIT were High Voltage Engineering Corporation and Digital Equipment Corporation. From that start less than sixty years ago, a world wide private equity investment market place is today supported by endowments, foundations, private and public pension funds with a resource base measured in the tens of billions of dollars.

Etzkowitz also noted the experiences of Stanford University and Silicon Valley as an enhancement of the MIT model. That enhancement gave rise to the development of a high-tech region in Northern California which has revolutionized the electronics industry for more than thirty years. Since I could be accused of being biased, I note the words of the author:

“Stanford appropriated the MIT entrepreneurial university model and adapted it to the contexts of a liberal arts academic setting and a developing region.”

Many have forgotten that the area known as Silicon Valley initially was dominated by orchards and that the individual usually referred to as “the father of Silicon Valley”, Frederick Terman, had received his early education at Stanford but his doctoral degree in Electrical Engineering at MIT, under the advice of his mentor, Vannevar Bush, one of the pillars at MIT in fostering the university/industry relationship. Time does not allow a full exposition of the processes followed by Stanford under Terman’s leadership, but it did have the characteristic of focusing on certain centers of excellence, a strategy that has been followed by other universities across the United States, and all of which are very dependent on the university/industry relationship. The approaches developed at MIT in the early parts of the twentieth century, as further amplified by the Stanford experience, has moved from activities focused on electrical engineering and computer science to the life sciences.

All of these transitions have had to work through policy formulation and conflict resolution to enable technology transfer to be a key component of a university’s mission. In addition, faculty were converted into entrepreneurial scientists who understood the importance of receiving grants from both the federal government and industrial sponsors, who understood the need to interface with the market place as represented by their interactions with industry, and finally to become active participants in the transfer of technology from the university laboratories to commercial enterprises.

Is this to suggest that some combination of Education and Entrepreneurship leads to economic growth? Consider that *The Economist*⁴ recently reported on a study at the National Bureau of Economic Research which noted that the observation of David Ricardo on the law of comparative advantage may not be applicable to developing nations. You may recall Ricardo’s premise that countries should specialize in their areas of strength while relying on trading partners to supply other needs which are not part of their special skills. *The Economist* noted a recent paper by two Harvard economists, Hausmann and Rodrik⁵, in suggesting that “economic development is a haphazard process of self-discovery”, with the result that it is almost impossible to spot a

⁴ *The Economist*, Finance and Economics, March 1, 2003, p 70.

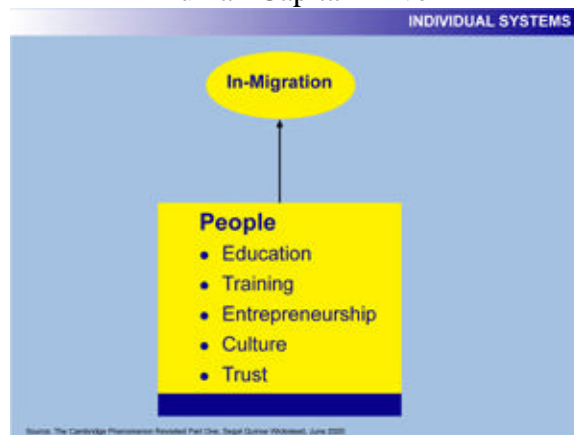
⁵ “Economic Development As Self-Discovery”, National Bureau of Economic Research Working Paper No. 8952, as cited in *The Economist* issue of March 1, 2003.

comparative advantage in advance.” The Economist had important words to amplify the results of the study:

“Neither economists nor emperors can be relied upon to pick winners. The best bet is entrepreneurial trial and error.”

If entrepreneurial trial and error is the key, how does one define the environment in which the entrepreneur can thrive? It is postulated that innovators in developed countries can be provided incentives to take entrepreneurial risk for their activities. These incentives include patents, trademarks and other forms of intellectual property protection or by having unique positions in the marketplace. However, in a less developed environment the chances are that the intellectual property route may not be either attractive or even feasible. Early entrepreneurs in a developing country may be adapting businesses or even copying business ideas from elsewhere rather than being the core innovators. There then is a need to think creatively of ways to protect the first movers in a developing nation so that sufficient incentives exist for those willing to take the business risk. The specific forms of these incentives need to be explored and developed.

Figure 4
Human Capital Driver



As originally formulated in the study about Cambridge University, the in-migration of Human Capital may not be fully appreciated. One can easily imagine that if there are vibrant enterprises that human resources might be drawn to those enterprises. One can relate vignettes of individuals who moved to Silicon Valley to be “part of the action”. What may be evolving is less the movement of individuals and more the movement of enterprises. Last year, Novartis, a world-wide pharmaceutical company, concluded that it was unable to draw sufficient human capital to its global research headquarters in Bern, Switzerland. It set out on a search for alternative sites in the United States. One underlying characteristic of the alternatives considered was proximity to major research and medical laboratories. Novartis concluded their search by locating within a quarter of a mile of the MIT Biology Department and less than two miles from the affiliated hospitals of the Harvard Medical School and Harvard University.

The potential for enhanced interaction of global companies with the faculty and research scientists at a major research university, in the United States or elsewhere, cannot be overstated. One could also conjecture on the possibility of a “greenfield” development of a research university, supported by both public and private resources, to serve as an attractor for global companies within defined areas of expertise. Such a possibility is being explored by at least one graduate student at MIT with a vision for a Pan-African Institute of Technology. This Institute would be designed to draw back to Africa many individuals with demonstrated capabilities in research across disciplines to reverse the brain drain, and to be the core of an organization from which interaction with global industry would emanate. The thesis is that this new Institute would be located in an area which would allow for the presence of global companies at the periphery of the Institute. One small example of what this might look like is shown in Figure 5 which provides a small example of commercial enterprises located around the MIT campus within a half mile radius.

Figure 5
Some of the Commercial Enterprises Proximate to the MIT Campus

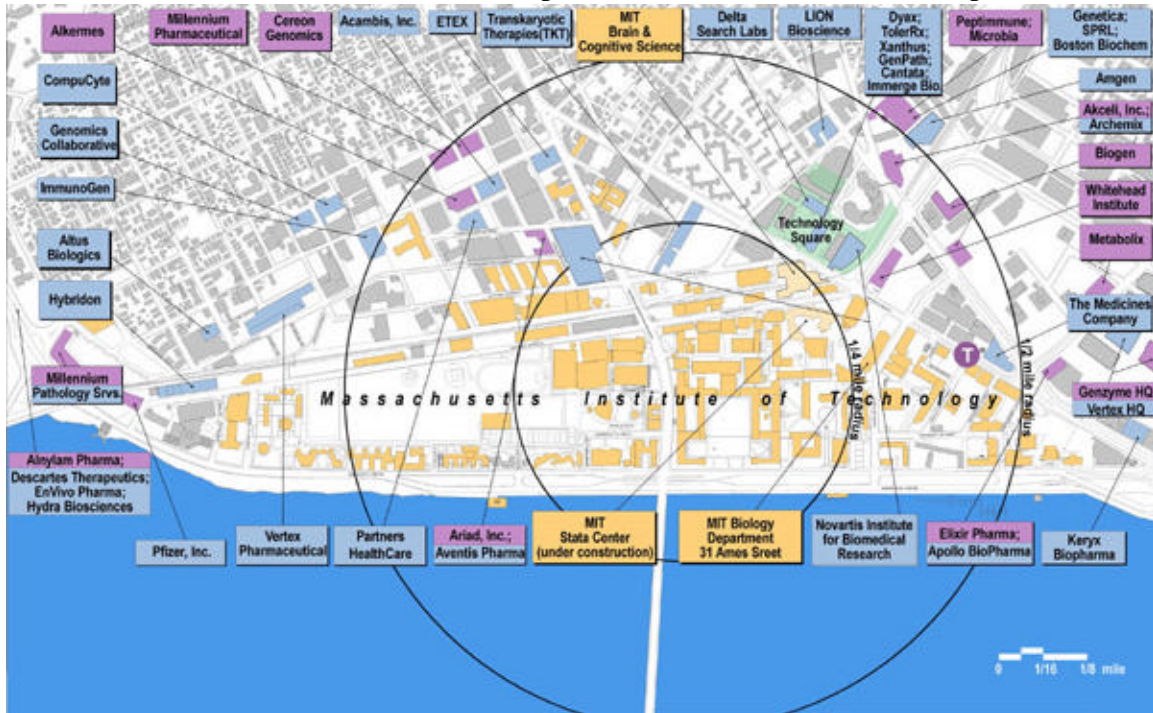
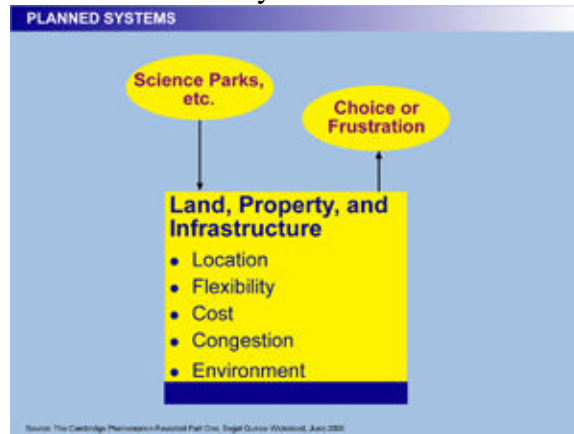


Figure 6
The Necessary Resource of Land



One is tempted to think of land resources as a static component in economic development. In fact, land, through the intervention of the entrepreneurial spirit of real estate developers, can fully participate in the economic development story. Two “land” histories may provide good examples of this viewpoint.

There is a recent story⁶ in which the New York Times Sunday Magazine Supplement on June 8, 2003, traced the amazing history of a mill property in Maynard, Massachusetts from one group of entrepreneurs to others through over a century of change. The complex started as Assabet Mills in 1840 and has grown to a multi-building site of over one million square feet. The property started through the efforts of an entrepreneur, Amory Maynard, who first built a woolens plant using the waters of the river to power the Mill. That first business lasted until 1857 when the business was restructured into the Assabet Manufacturing Company, a company which produced blankets and flannel materials in the nineteenth century. Business thrived until the panic of 1898 when the property and the business was transferred to the American Woolen Company which continued to expand the site so that by 1920 it was the largest wool factory in New England. It was only twenty years later that the effects of the wool industry moving to the South and to factories abroad led to a closing of the Mill in 1950. The next phase was a pathway emanating from MIT. Local business owners had refurbished the mill property to serve as the site for a number of small businesses and manufacturers. It was an MIT graduate in 1957, Ken Olsen, then backed by American Research and Development (“ARD”), the venture capital entity fostered by Karl Taylor Compton and others at MIT, and others from the Harvard Business School as previously noted, that a new startup, Digital Equipment Corporation, located its first offices at the Mill. The continued expansion of DEC, as it became to be known, resulted in the whole complex being purchased by DEC in 1974. This phase of the history of the mill complex continued until 1993 when a new

⁶ “The History of American Capitalism in a Single Industrial Complex” New York Times Sunday Magazine, June 8, 2003, page 46.

management team at DEC decided to sell and vacate the property. DEC was subsequently acquired by Compaq and is now part of Hewlett Packard, an effect of the consolidation of the computer industry. Was that to be the end of the mill property after a 150 years history? No. It was then time for a new initiative, complete with fiber-optic cables suspended from the ceilings in the open bay areas, to take place in 1998. Today the Mill, carrying its new name of Clock Tower Place, has cellular reception towers on the old smokestack, and its corridors filled with new names, the survivors of the next wave of entrepreneurs – the dot com crowd. But survivors there are and to some this Mill represents a microcosm of the economic history of New England for almost two centuries. Innovation created businesses, the impact of change in needs or the movement of the industry to areas with lesser costs of labor, and then the entry of new businesses developed as a result of new technologies.

Having described the history of a building in Maynard, one might think it is a unique case. I shall take a few more minutes to comment about another building, this one in MIT's backyard. I refer to this property as 28 Osborn Street in Cambridge. This was a manufacturing complex, a portion of which was built in 1815, and then occupied by a number of small manufacturing firms, firms which can no longer operate competitively in the Boston/Cambridge area. The original building was the receiving location of the first long-distance telephone call placed by Alexander Graham Bell to his assistant, Mr. Watson, on October 9, 1876 – 127 years ago. The major portion of the property, which was developed in 1848, was occupied by the Davenport Car Works, a firm that pioneered the manufacture of railroad passenger cars and omnibuses. They lasted at this location only until 1857. I will skip all the way to 1907 when a local businessman rented a small portion of the complex and began to make furniture. His company, Kaplan Furniture Company, a name still emblazoned in large white letters on the upper stories of the building, produced high quality reproductions of Federal-style furniture into the 1950's. A small portion of the building was rented by Edwin Land. You may recall the name. He developed "polarizing plastic material" in that space in 1936, in part the foundation for later products including instant photography under the name Polaroid. The site continued under Polaroid's ownership as a manufacturing facility until the company relocated its activities and MIT purchased the property in 1998. In a manner quite similar to that illustrated by the building in Maynard, Mass., the property was substantially renovated and is today occupied by a biotech company known as Transkaryotic Therapies, Inc. ("TKT").

Figure 7
TKT at 28 Osborn Street



The history of 28 Osborn and Clock Tower Place is replicated at a number of sites in the Boston/Cambridge area. One factor driving this opportunity set is that the Boston/Cambridge area has the quite unusual benefit of having eight major research universities located very close by. These universities (Boston College, Boston University, Brandeis University, Harvard University, MIT, Northeastern University, Tufts University and the University of Massachusetts Boston) released an economic impact report this past March, *Engines of Economic Growth*. This report noted that in the year 2000, the eight universities conducted innovative research that resulted in 264 patents, 280 commercial licenses of technology and the start-up of 41 companies in that year alone. As was expressed in the report, the eight institutions are “developers and employers of talent, incubators of business and industry, storehouses of cultural resources, research centers, purchasers, economic magnets, and community partners...”.

Given the presence of these universities, the experience of the development of intellectual capital, the presence of global companies in the area, and financial resources being drawn to this area, it can be argued that a predicate to important economic development should be centers of higher education. This resource, appropriately coupled with financial and human capital, can provide that base from which future economic growth can emanate.

Is this only an observation based on Cambridge, Massachusetts, or even Cambridge, England? Recalling my comments on the UNESCO study, the return on an investment in higher education makes a compelling case for this aspect of the investment process. One can also infer that there is a tremendous appetite for quality higher education. In addition to MIT's experiments under the Cambridge-MIT Institute and the work with the Government of Singapore, you should also be aware of a recent MIT initiative focused on assisting higher education on a global basis. It is known as Open Course Ware. This program, which is in the early stages of its development and is funded by major foundations, has a long-term objective of putting on the Web all of the text and related information that underlies the academic offerings at MIT. With approximately fifty academic courses already on the Web (www.mit.edu), the servers at MIT have received more than one hundred million hits from more than one million individuals, another example of leveraging technology. We see this as an enormous opportunity to more efficiently distribute a portion of the educational content of MIT around the globe.

In summary, we have taken a trip through “Education, Entrepreneurship and Investment”, a trip which is in effect a loop continuously regenerating itself. The key component is Education. It is that area which requires the initial investment. With time and financial capital, economic development may result and generate additional resources to start the process over again. Keep in mind, this is an entrepreneurial exercise-success is not guaranteed.