SUSTAINABLE DYNAMISM:
A Regional Economic Development Strategy of Continuous Reinvention

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Connecticut's Economic Crisis

- With the end of the Cold War, Connecticut was faced with the collapse of the market for its principal export: defense goods.
- On the heels of this shock to the export base, another export mainstay, insurance services, was shifting its backoffice functions out of Hartford, as the industry began a massive re-structuring.
- Consequently, save the Securities, Commodities, Contracts industry (NAICS 523), centered in Fairfield County, which is a satellite of, and benefits from, the New York City economy, Connecticut's economic fortunes are tied to coattail effects of the movements in the U.S. economy.
- Such an economy cannot "take its own economic fate in its hands," but instead is dependent on externally generated economic fortunes.

Some Impediments to Connecticut's Regaining the Path to Sustained, Long-Term Growth

- Connecticut has some drawbacks in its ability to foster technology transfer and commercialization, and an entrepreneurial climate, inside and outside its universities (Innovation Associates, 2004).
- Connecticut lacks comparable availability of start-up capital including pre-seed/seed capital funds and angel capital networks, networking of universities, industries, entrepreneurs, investors, and infrastructure including incubators and research parks in and around the universities.
- In addition, save some very recent developments at Yale University, the major universities do not have the depth and breath of entrepreneurial activities seen in several model universities, including a range of entrepreneurial courses, business competitions, mentoring programs, and networks.

Key to a Technology-Transfer Ecology: A Science City

- To address the above concerns, three science cities are identified for Connecticut: one emerging and two potential.
- One science city is already in the process of developing in New Haven around Yale University.
- The remaining two identified centers have potential, but are not yet in the development stage:

  ----Hartford, around an expanded RPI-Hartford Campus, the UConn-Downtown Campus, and Capital Community College.

  ----Storrs centered around the UConn Main Campus and a soon-to-be-constructed Mansfield-Storrs town center.

What is a Science City?

- Science parks apparently *do not* make science cities. Throwing several high-tech businesses together in one place to share streets, sewers, and Internet connections does not foster an ecology conducive to triggering a process of sustained innovation

What is a Science City?

- A critical characteristic common to all the successful science cities in North America, Europe, and other developed countries, is the development of Etzkowitz's (2005) "Triple Helix" model of *University-Industry-Government* relations.
  - Facilitates science-based regional economic growth that generates the conditions for sustainable, high value-added growth.
  - Concentrates on the early stage of the product/technology cycle where the volume of output is relatively low, there is a high degree of uncertainty, and the standardized, higher-volume stage of the product's production has yet to be worked out.
  - It is at these R&D and prototype stages where high skilled, high wage workers are needed, as opposed to the lower-skilled, lower-paid workers characteristic of regions that have the comparative advantage in the later, standardized-production stages of the product cycle.

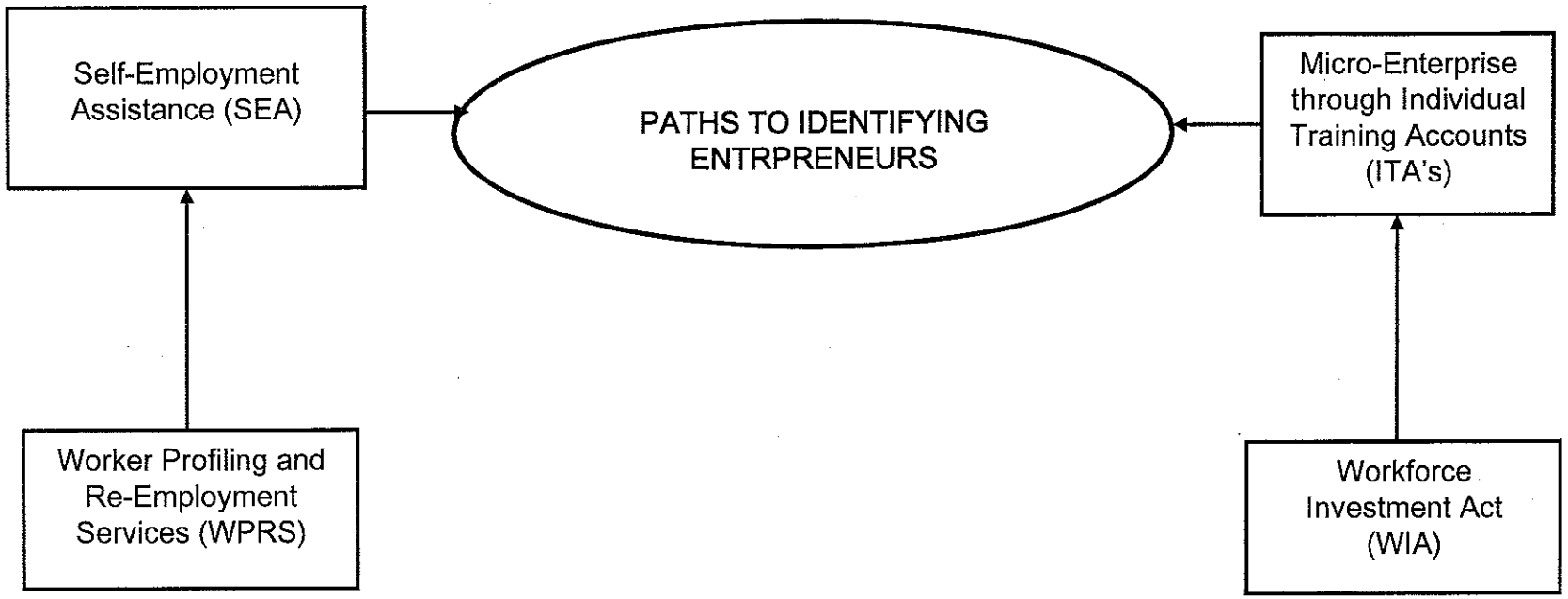
A Tale of Four "Science Cities"

- Common Factors Shared by All Four Science Cities:
  - The region faced a problem or crisis.
  - An individual, or group of individuals, took the lead in trying to solve the problem or crisis.
  - There was the presence of an institution, or institutions, that played a critical role in generating regional economic renewal.
  - The region pursued an economic development strategy based on technology transfer and science-based growth (Knowledge Economy).
  - The region developed an ecology that fostered entrepreneurial activity.
  - In the initial stages, regional inter-firm networks developed along the Social Network type of industry cluster. (Based on the typology suggested by McCann, Arita, and Gordon; 2002.)

IMPLEMENTING A STRATEGY FOR SUSTAINED REGIONAL DYNAMISM: The Role of Workforce Investment and LMI

- An Excess Supply of Skilled Labor implies an Excess Demand for Entrepreneurs (i.e., Washington's labor-supply pool of entrepreneurs).
- Strategies focus on the role that WIA and LMI can play in meeting the challenges of Connecticut's economic future.
- There is a role for Worker Profiling and the *Workforce Investment Act* in an entrepreneurship-based and workforce development strategy.
- LMI databases are critical for the quantitative assessment and tracking of outcomes of entrepreneurial and science-based economic development strategies.

FIGURE 1: Two Workforce-Investment Paths to Entrepreneurship and Economic Development



Characteristics Common in the Development of the Four Studied Science Cities

COMMON CHARACTERISTIC	PRESENCE IN THE FOUR SCIENCE CITIES
The region faced a problem or crisis.	♦ SILICON VALLEY: Professor Fredrick Terman was concerned that his Stanford graduates were having to go to the East Coast after graduation, due to the lack of jobs in the area. ♦ BOSTON: The Boston region found itself facing industrial decline in the beginning of the 20th Century. ♦ METRO WASHINGTON: The U.S. Capital region faced an economic crisis triggered by the massive downsizing of the Federal workforce by Presidents Carter and Reagan. ♦ RESEARCH TRIANGLE PARK: North Carolina faced industrial decline, and a brain-drain of its college graduates, in the period following World War II.
An individual, or group of individuals, took the lead in trying to solve the problem or crisis.	♦ SILICON VALLEY: Prof. Terman started to encourage some of his students to start companies near Stanford University. Among these students were William Hewlett and David Packard. He helped and encouraged them to commercially produce their audio-oscillator, and, in 1937, they started their company in the famous garage in Palo Alto. ♦ BOSTON: MIT President Karl Compton, a member of the New England Council, extrapolated instances of firm formation by MIT professors into a vision for a new wave of technical industry. Beyond respect for his personal qualities and scientific achievements, his prestige as head of MIT, as well as pride in the region's educational and research institutions, gained Compton an audience for his ideas. In essence, he conceived the idea of *knowledge-based growth and development.* ♦ METRO WASHINGTON: In the case of the Capital region, it was Federal policy and legislation, in conjunction with the presence of some key Federal agencies, such as the NIH and DARPA, that "got the ball rolling" in the region. There were no specific individuals, or group of individuals, as there were in the other three instances. In this case the "individuals" were institutions: the NIH and DARPA. ♦ RESEARCH TRIANGLE PARK: The original impetus for what would become the Park was in early 1954, when Brandon Hodges, the State Treasurer of North Carolina, Robert Hanes, the President of Wachovia Bank and Trust Company, and Romeo Guest, a Greensboro building contractor, who, some say, gave birth to the idea of a research park in the Triangle Area, met to discuss North Carolina's need for industrial growth.

There was the presence of an institution, or institutions, that played a critical role in generating regional economic renewal.	♦ SILICON VALLEY: Stanford University was founded in 1891 by Governor Leland Stanford at his domain nearby 'El Palo Alto' (the high tree) in memory of his son Leland Stanford Junior. Later, it was especially Prof. Frederick Terman, who was a Stanford graduate himself, whose role was crucial for the development of the local high-tech industry before and after World War II. In the twenties, administrators at Stanford sought to improve the prestige of their institution by hiring highly respected faculty members from East Coast universities. During the fifties, Stanford introduced a lot of new ways of working as a university (which were revolutionary at that time): * The Honors Cooperative Program: graduates could be updated in their specialty. * The Stanford Research Institute (1946): practice focused, non-profit research, which didn't fit within the traditional tasks of a university. * The Stanford Industrial Park (1951): offering facilities for starting companies. ♦ BOSTON: The Massachusetts Institute of Technology (MIT) was founded in 1862, as a unique industrial variant of the land-grant universities, established in each state to support the development of agriculture, the nation's major industry at the time (Rossitor, 1973). The land-grant schools focused on practical subjects, rather than the classic liberal arts, although the later were also included in the curriculum. MIT was designed as a technological university, to train students and infuse new ideas into the region's industrial economy, but also to conduct basic research and pursue those liberal arts with technological relevance like the history of science and technology. ♦ METRO WASHINGTON: Though academic institutions would play an important role at later stages of the development of the Capital region's high-tech clusters, in the embryonic and take-off stages, it was the Federal R&D-oriented agencies, that played the critical role. The presence of the NIH in the Washington region is a defining characteristic for the region's Biotech cluster. It employs a large number of researchers at its home campus in Bethesda, MD. The NIH has been a spawning ground for new start-ups over the last 10-15 years. Other government agencies such as the Walter Reed Army Institute for Research (WRAIR) and the U.S. FDA have also been a significant source of biotech entrepreneurs. Critical for the development of the ICT cluster has been the presence of the Defense Department, and its R&D agencies. The modern computer networking technologies that are the backbone of the Internet and ICT emerged in the early 1970's from ARPANet, which was developed at the U.S. DOD Advanced Research Projects Agency (DARPA, known then as ARPA) (see Kahn and Cerf, 1999). Individuals leaving the Defense Department and the military services formed the first start-ups. In addition, individuals from private industry, both within the region and from without, figure prominently in the development of this cluster. ♦ RESEARCH TRIANGLE PARK: Critical to the idea, and actual birth and development, of Research Triangle Park were the three closely-located academic institutions that inspired the very name of the research park: the University of North Carolina, North Carolina State University, and Duke University. In addition to the three universities, executives from Wachovia Bank and Trust also played major roles in the establishment of Research Triangle Park.

The region pursued an economic development strategy based on technology transfer and science-based growth.	♦ SILICON VALLEY: In 1937, William Hansen, Professor of Physics, teamed with Sigurd and Russell Varian to develop the klystron tube, an electron tube in which bunching of electrons is produced by electric fields and which is used for the generation and amplification of ultra-high frequencies. During World War II, the brothers Sigurd and Russel Varian worked rent free in a Stanford lab on their klystron tube. Later on, radar and Varian Associates' (1948) inventions, involving microwave radiation, evolved. Stanford gave them, besides rent free lab use, $100 for supplies. In return, Stanford was to share in any profits. The investment of Stanford was one of the best ever because it brought in several millions of dollars in royalties. Also during World War II, Professor Terman made good contacts within Washington. After his return to Stanford, he succeeded in getting a lot of governmental contracts for Stanford and local companies. ♦ BOSTON: When the conventional approaches failed, the New England Council explored a series of alternatives based on the knowledge resources of the region. The focus gradually shifted from incrementally improving existing firms, to a discontinuous approach, that is, creating new industries. The Council early recognized that a concentration of academic and industrial research laboratories was New England's competitive advantage. The initial idea was to encourage the formation of small firms. The Council's "New Products" committee, established to assist existing firms, turned to the more far-reaching idea that New England's intensive research universities could substitute for the natural resources that the region lacked. This approach foreshadowed a completely new perspective on how to think about comparative advantage. This foreshadowed, by 80 years, Baumol and Gomory's (2003) concept of *acquired comparative advantage*, and modern, regional economic development theory, with its emphasis on the *strategic management of places*. Much of the model of university-based economic development was derived from the activities of Vannevar Bush, an electrical engineering professor, and then Dean and Vice-President of MIT. Bush was a prototypical entrepreneurial academic, combining in a very effective manner both intellectual and commercial interests in the course of his career. ♦ METRO WASHINGTON: The U.S. Capital region's move to science-based growth, predicated on technology transfer was exogenously imposed, as opposed to policies developed by individuals and institutions indigenous to the region. The changes in employment structures and incentives were coupled with new opportunities for the commercial exploitation of intellectual property rights that accrued from publicly funded research. These new structures and incentives were, in turn, the result of changes in Federal policy and legislation that created a pool of educated, unemployed workers, in conjunction with new opportunities for the private sector to contract with the Federal Government and commercialize new technologies, motivated many former government employees and contractors to respond to the crisis by starting up new firms. These legislative changes created new commercial opportunities that have lured many scientists into starting their own companies, and thereby, facilitate the process of technology transfer. ♦ RESEARCH TRIANGLE PARK: Unlike the other three science cities, Research Triangle Park would approach knowledge-based economic development from a different perspective. Instead of creating new firms and products, the founders' vision of the Park was a place to attract the R&D operations of existing firms. They believed that, due to the close proximity of the three universities, they would "by the very research atmosphere that their very existence creates," will act as a magnet to attract industry "by providing a wellspring of knowledge and talents for the stimulation and guidance of research by industrial firms."

The region developed an ecology that fostered entrepreneurial activity.	♦ SILICON VALLEY: Stanford Professor Fredrick Terman was concerned that a lot of his graduates went to the East Coast because of the lack of jobs in the Valley. To solve that problem, he started to encourage some of his students to start companies near the university. Among these students were William Hewlett and David Packard. In the meantime, some other students founded small companies that were going to be the center of a local electronics-industry. During 1937, William Hansen, Professor of Physics, teamed with Sigurd and Russell Varian to develop the klystron tube, an electron tube in which bunching of electrons is produced by electric fields and which is used for the generation and amplification of ultra-high frequencies. During the Second World War the brothers Sigurd and Russell Varian worked rent free in a Stanford lab on their klystron tube. Later on, radar and Varian Associates (1948) inventions, involving microwave radiation, evolved. Stanford gave them, besides rent free lab use, $100 for supplies. In return, Stanford was to share in any profits. The investment of Stanford was one of the best ever because it brought in several millions of dollars in royalties. ♦ BOSTON: MIT President Karl Compton, a New England Council member, extrapolated instances of firm formation by MIT professors into a vision for a new wave of technical industry. In addition, much of the model of university-based economic development also came from MIT, specifically from the activities of Vannevar Bush, an electrical engineering professor, and then Dean and Vice-President of MIT. Bush was a prototypical entrepreneurial academic, combining in a very effective manner both intellectual and commercial interests in the course of his career. Nevertheless, though New England had capital and technology, and creative leaders like Compton and Bush, it still lacked a systematic methodology for firm formation. Immediately after World War II, Compton organized a consortium of universities, investment banks, and insurance companies, to found the first venture capital firm, *American Research and Development* (ARD), through the sale of equity in the firm. The organizational design and staffing of the project were derived from MIT and Harvard Business School. Technological opportunities were enhanced by World War II R&D projects, focused at universities, and expanded after the War into civilian as well as military fields. ARD's initial success, after a decade of initial investments, was the *Digital Equipment Corporation* (DEC), based on a Navy research project to develop a pilot training device. ♦ METRO WASHINGTON: The beginning of the biotech industry can be traced to 1973 when Stanley Cohen and Herbert Boyer invented their genetic engineering techniques. The earliest entrepreneurs in the Capital region started firms during this time of high opportunity. The earliest biotech firms were started up by individuals who had previously been employed by prominent suppliers to the National Institutes of Health (NIH). The presence of the NIH in the Washington region is a defining characteristic. It employs a large number of researchers at its home campus in Bethesda, MD. The NIH has been a spawning ground for new start-ups over the last 10-15 years. The modern computer networking technologies that are the backbone of the Internet and ICT emerged in the early 1970's from ARPANet, which was developed at the U.S. DOD Advanced Research Projects Agency (DARPA, known then as ARPA) Individuals leaving the Defense Department and the military services formed the first start-ups. In addition, individuals from private industry, both within the region and from without, figure prominently. Entrepreneurs hail from a variety of different organizations. Government agencies served an important incubator function in both industries. However, they were not the sole source of entrepreneurial talent. There is evidence of a great diversity in the backgrounds of the entrepreneurs. Over time, new generations of new firms spun-off from the earliest start-ups, and entrepreneurs who cashed in from one new venture created other new companies. ♦ RESEARCH TRIANGLE PARK: As previously mentioned, the Research Triangle Park followed a different path than the other three science cities studied here. The idea of using the three triangle universities to *attract research companies into a park area* central to the universities quickly emerged from the early discussions. Thus, there was not the emphasis on entrepreneurship and new firm formation. Rather, the emphasis was on

	attracting the R&D facilities of existing firms. Nevertheless, this approach was still new, at the time. Manufacturing firms tended to have their R&D facilities near their production facilities. The idea of spatially separating these activities, and concentrating the R&D facilities of different firms, from different industries, in one location, to tap into externalities, and economies of scale and scope was a new idea. Further, the founders of Research Triangle Park recognized the now frequently followed policy of basing the future economic fortunes of the region on being the location for the high-end, high-skilled, earlier, pre-standardization, stage of the production and product cycle.
In the initial stages, regional inter-firm networks developed along the Social Network type of industry cluster. (Based on the typology suggested by McCann, Arita, and Gordon; 2002.)	♦ SILICON VALLEY: Silicon Valley actually developed such that it has the characteristics of both the Pure Agglomeration and Social Network types of clustering. Particularly, the benefits of industrial clustering for the semiconductor industry have been analyzed in terms of the role played by informal local information spillovers, and also in terms of the advantages associated with a high quality and highly flexible local labor market. Both firms and the local industry have evolved largely by non-price mechanisms, in the sense that information and labor market externalities play a key role, as do certain 'trust' relationships between local firms, if and where they exist. In terms of McCann et al.'s cluster characterizations, Silicon Valley is primarily a 'pure agglomeration,' with possibly also some aspects of a 'social network.' In fact, the historical record indicates that its social network features were the original spark that ignited the Silicon Valley cluster-from Professor Terman's and other Stanford professors' social networks to the Home Brew Computer Club in the 1970's. ♦ BOSTON: The science city aspects of Boston's resurgence had the characteristics that were similar to, though not exactly, those that later characterized the development of the Silicon Valley science city, and discussed above. And, like Silicon Valley later, it appears to be social networking that launched Boston's revolutionary approach to regional economic resurgence. As Silicon Valley would do later, it took on the characteristics of both the Pure Agglomeration and the Social Network type of cluster. However, as its first success, the mini-computer industry, matured, it took on the more extreme features of a purely Industrial Complex, particularly losing its social network aspects. This may have played a critical role in its subsequent extinction. This is a trap the region's Biotech cluster seems to have avoided. ♦ METRO WASHINGTON: As in the case of Boston-Route 128, a city and surrounding suburbs already existed long before the Biotech and ICT clusters arose in Metro Washington, whereas, urbanization/suburbanization was the result of the rise of Silicon Valley and Research Triangle Park. Thus, pure agglomeration characteristics pre-dated the rise of the Biotech and ICT clusters. However, due to the concentration of high intellectual capital, social networks were established trough interest/advocacy groups and technology councils. ♦ RESEARCH TRIANGLE PARK: Though following a different route than the other three studied science cities, Research Triangle Park, nevertheless, also began with the social networking of several individuals that were interested in developing an idea for a research park centered within the geographic proximity of three closely-located North Carolina universities (Duke University, the University of North Carolina, and North Carolina State University). The original social network later expanded to bring in new members as the process progressed from the idea stage, to the fund-raising/attracting investors stage, to a shift in concept and change in direction, and finally to the implementation stage. Within the McCann et al. typology, the social network aspects of Research Triangle's R&D cluster has given way to the Agglomeration Economies type of cluster.