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The Next Threshold:

Higher Skills and the New England Economy

John C. Hoy

The history of the New England regional economy – its attenuated post-World War II decline and subsequent aggressive renewal – reveals an intensifying relationship between economic resurgence, the supply and continuing demand for professional manpower, and the results of academic research and development. The New England region has “outproduced” the rest of the nation in supplying professionally trained men and women, a leading factor not fully appreciated by those describing the region’s robust economic health in the decade since Neal Peirce wrote The New England States. New England’s “oversupply” in professional fields has given the high-tech and sophisticated services sectors a decided national advantage.

The single most important factor in the enhancement of New England’s future competitive edge nationally and internationally is the maintenance of the current knowledge-based surge of economic growth. This will be accomplished through the continued capacity of New England’s higher education system to oversupply and adjust to the knowledge-intensive employment demands of the future. If the supply of educated manpower and the nationally prominent research and development capacity created by the professionals of the region are to continue, New England cannot rest on current success. Now is the time to use equitable and quality education for all our people to build the foundation for the region’s future prosperity.

New England may be unique among American regions in its common history, its close interrelationships, and physical compactness. But the phenomena it is experiencing today – the “mature” economy, the groping for a “post-industrial” alternative, the worry about accommodating so many millions of people in a fragile life space – may be, if they are not already, the problems of the rest of the United States tomorrow. If New England “fails,” its failure might presage a failure of the whole nation. Thus New England presents a fascinating laboratory and test case in the United States of the metes and bounds of what can be accomplished on a regional basis.

—Neal R. Peirce
The New England States, 1976

John C. Hoy has been president of the New England Board of Higher Education since 1978 and was vice chancellor of the University of California, Irvine, from 1969 to 1978.

International conflict, military affairs, and world markets have shaped New England. The history of New England's wartime vitality (1939–1945), attenuated postwar decline (1945–1975), and ultimate resurgence (1975–1985) is inextricably linked to the skills of its people and their capacity to grow, adapt, and create. The basis of vigorous postindustrial renewal—generated over the course of four decades through basic and applied research and development—was in large measure the product of the region's academic institutions. The complex story of New England's economic revival is essentially the fact of having the professional and intellectual leadership and the skilled work force required to bring about economic renewal. New England's vitality has taken the form of a knowledge-intensive structure that provides sustained job growth, record employment, expanding capital investment, and, during the past two years, the lowest level of regional unemployment in the nation and its highest level of regional, personal, and per capita income.

Recent economic success pervades regional statehouses, boardrooms, academic senates, and the halls of organized labor as a source both of mounting confidence and intense debate about future priorities. There is a tendency, however, to forget the price extracted by thirty years of pre-1975 decline. The painful transition of the New England economy—from its proud but deteriorating manufacturing base of four decades ago to the knowledge-intensive structure we see today—remains one of the least examined social, economic, and educational facets contributing to the renewal of the oldest industrial section of the nation. No comprehensive economic history of contemporary New England has yet been written bridging the period since the Great Depression. One is needed; and, for our purposes, several major factors are relevant and worthy of recall.

New England's Industrial Past

As the United States entered World War II and New England manufacturing geared up for war production, it was impossible to predict the impact the war would eventually have on the economic landscape of the nation or the region. During the period 1940–1945, New England experienced a reprieve in the relentless deterioration of its historic industrial base. Major new expansions in manufacturing employment throughout New England took place during the war years:¹

- A 154 percent increase in the number of workers producing transportation equipment
- A 137 percent increase in the number of workers producing electrical machinery and equipment
- An expansion of metal working from 28 percent of the region's manufacturing employment in 1939 to 38 percent in 1947
- An increase of 80 percent in other manufacturing employment (principally office machines, textile and other machine tools, mechanical power transmission equipment, and guns of all types)

Despite wartime expansion in new manufacturing technologies, New England in 1947 still maintained a “leading industry” list that reflected the region’s traditional prewar nondurable manufacturing economy. The following New England industries continued to be most prominent:

- Cotton and woolen goods
- Boots and shoes
- Textile production machinery
- Hardware
- Nonferrous metals
- Paper and lumber products
- Printing and publishing

Vermont had granite, marble, and burial caskets; Maine—pulp, paper, and processed lumber; Connecticut—watches; Rhode Island—jewelry, textile dyeing and finishing; New Hampshire—foundry products. The region continued to clothe the nation, put shoes on our feet, provide the paper for (and the contents of) the books we read, make the chairs America sat upon, keep our time, and bury us. It shipped curbstones and gravestones, adorned us, and produced our vacuum-tube radios—all products that the rest of the world no longer viewed as exclusively New England’s manufacturing prerogatives.

Although the development of the new war-related technologies would ultimately have a dramatic long-term impact, the postwar New England manufacturing economy sought to return to peacetime patterns and markets. In 1950 New England continued to produce half of the woolen and worsted goods made in the United States and half of the textile machinery manufactured in the nation.

The New England economy was headed for deep trouble. Regional economists struggled to analyze and propose options for industrial maintenance. Their work, in retrospect, has the feel of good minds defining rearguard holding actions. The underlying reasons for regional decline were not mutually understood by government, business, and higher education.

In his 1952 book, *The Economics of New England: Case Study of an Older Area*, Seymour E. Harris pointedly commented on the lack of engagement in regional issues that was exhibited by New England universities:

Many of her major institutions are national in outlook and hence they do not interest themselves in regional problems of research, management and the like. Institutions of higher learning in other regions, particularly in the South and West, contribute much more to the economic development of their regions.²

The process of decline was relentless. At times, unemployment rates were unbearable. In Lawrence, Massachusetts, 26 percent of the adult work force was unemployed in 1949. In city after city, unemployment approached depression levels. New England began to view itself as a region of the past, a region losing opportunity and promise; and the balance of the nation agreed. During an exceptionally prosperous postwar period throughout the rest of the nation in the late forties and in the fifties, no region experienced higher levels of unemploy-

ment than New England. Beginning in 1949, the final collapse of the New England textile industry was both catastrophic and symbolic.

Recovery – or New Beginning

The New England recovery is a humane story of determined families, corporations, and state governments; a saga unwisely relegated to a part of the regional past many believe is best left to the examination of historians in some future decade.

Since the depth of regionwide unemployment at 11 percent in 1975, shortages in fields requiring highly trained professionals and skilled technical and sophisticated service-industry workers have continued to increase. The current employment picture also reveals shortages of unskilled sales, construction, retail, and production personnel. Unemployment in New England stands below 4.0 percent, and Massachusetts each month continues to boast the lowest unemployment rate among all industrial states in the nation.

Growth in the Service Sector

The regional economy has steadily moved into the service sector—with an emphasis on financial, insurance, health care, consulting, professional, and sales employment—providing sophisticated services to the region as well as the nation and the world. Since 1947, when 370,000 New Englanders were employed in services, the service sector has grown fourfold—to 1.5 million in 1985—the largest single sectoral gain in the nation during that period.

The growing importance of the service sector reflects to a large extent broad trends in the national economy. At the same time, New England is developing a sophisticated “high service” component that is increasingly international in dimension. Generally, as economies mature, there is a shift in the composition of employment toward services. While this is a natural outcome of industrial maturity, the process in the New England region has evolved in its own unique way. The traditionally strong service areas of education, finance, and health care have been strongly supplemented by the service-related needs of high technology, international marketing, and consulting.

Since the mid-1970s, the service sector has grown by nearly 40 percent in the region. New England now employs 24 percent of its labor force in services.

Within the service sector, more than one in three jobs are in a health-related field and more than 15 percent are in education. In 1985 alone, services employment has grown by more than 5 percent in the region, and the jobs created have not all been low paying.

Between 1975 and 1983, over 140,000 jobs were created in the health care industry in the region, as compared to 80,000 in high technology. Moreover, these jobs now create payroll expenditures exceeding \$7 billion. However, the health services sector is fragile and is under extreme cost-containment pressure. Increasing dependency on services in general does not create a foundation for future growth.

Manufacturing and services are inextricably linked. If industrial competitiveness is lost, it will be that much harder to maintain the growth of the service sector, especially since it is apparent that the volume of international service-sector exports, while growing, remains small, even within the banking and insur-

ance industries. In effect, in the long run the loss of manufacturing may result in a loss of the very services that advanced products and processes have the capacity to generate.

High Tech

High tech remains the most visible symbol of New England's economic resurgence. Among all regions of the nation, New England currently has the highest proportion of its total work force in high technology-related jobs. Massachusetts, with over half of all high-tech employment in New England between 1975 and 1980, led the nation in growth of technology industries at 6.6 percent per annum, topping the national rate of 4.2 percent per annum during the same period. During 1982-1984, the rate of growth in Massachusetts slowed to 5.3 percent per annum, still above the national growth rate of 2.9 percent per annum during the period.³

Despite considerable worrisome attention that high-tech employment has received—given the spate of layoffs in 1985-1986 amounting to ten thousand jobs—the long-term prognosis is favorable. College graduates constitute 20 percent of the employment in high-tech industries generally and 33 percent in the computer industry specifically.⁴ New England's concentration of professional and skilled technical workers as a percentage of the total work force is without peer in the United States.

Total New England employment passed the 6 million mark for the first time in 1984. Continued expansion throughout 1985 and 1986 despite high-tech layoffs points conservatively toward 6.5 million employed New Englanders by 1990, perhaps even more.⁵

The comparative advantage enjoyed by the New England states in the employment of technologically skilled workers is revealed in table 1 on the next page. The region in its entirety developed and continues to maintain a distinctive advantage which, in large measure, provided the mobility necessary to sustain the loss of 263,000 nondurable manufacturing jobs (down 31 percent), as 241,000 new durable manufacturing jobs were created (up 34 percent) between 1947 and 1979.

During the same period, 2,085,000 new nonmanufacturing jobs were created. Of these, 561,000 were in wholesale and retail trade (up 94 percent); 500,000 in government (up 148 percent); and 770,000 in other services (up 209 percent).⁶

New Missions for Higher Education

New England, the smallest geographic region in the United States, with one-twentieth of the nation's total population, has more successfully shifted from a traditional manufacturing-based economy to a knowledge-intensive, high-technology, high-service economy than any economic unit in the industrialized world. The shift has been accomplished in large measure because of the flexibility provided by the skills of working people and the eclectic vision of the region's colleges and universities. Institutions of higher education have offered a concentrated pool of highly skilled people and have consistently made scientific and technological breakthroughs in basic research, applied research, and management processes. Their graduates have created and directed the investment of 25 percent of the venture capital available in the United States.⁷

Table 1

**1980 Employment of Technological Workers in
Top Ten States and Other New England States
Percentage of Total Employment**

State	Employed Persons (16 and over nonagric.)	Engineers—%	Technicians and Technologists—%	Precision Production Occupations—%	Technical Workers Total—%
California	10,640,405	213,232 2.0	261,012 2.5	469,828 4.4	8.9
New York	7,440,768	93,602 1.3	144,310 1.9	304,822 4.1	7.3
Texas	6,311,845	95,967 1.5	142,950 2.3	280,090 4.4	8.2
Illinois	5,068,428	68,692 1.4	97,183 1.9	237,746 4.7	8.0
Pennsylvania	4,961,501	68,046 1.4	98,910 2.0	245,779 5.0	8.3
Ohio	4,558,442	69,584 1.5	86,133 1.9	241,656 5.3	8.7
Michigan	3,750,732	68,867 1.7	68,913 1.8	199,908 5.3	8.9
New Jersey	3,288,302	55,846 1.7	75,223 2.3	143,743 4.4	8.4
Massachusetts	2,674,275	51,510 1.9	64,850 2.4	126,207 4.7	9.1
Florida	4,002,330	43,906 1.1	78,799 2.0	129,705 3.2	6.3
Connecticut	1,482,309	31,838 2.2	34,416 2.3	81,774 5.5	10.0
New Hampshire	432,622	8,604 2.0	11,026 2.5	24,929 5.8	10.3
Maine	459,522	4,330 1.1	6,389 1.4	22,647 4.9	7.3
Rhode Island	426,812	4,795 1.1	7,070 1.7	27,373 6.4	9.2
Vermont	227,195	3,821 1.7	4,689 2.1	9,748 4.3	7.9
Totals for New England	5,702,735	104,898	128,440	292,678	

Source: New England Board of Higher Education Analysis of 1980 Census, Bureau of the Census, U.S. Department of Commerce.

New England's public and independent colleges and universities have been notably free to respond to regional employment demands in a highly independent mode of institutional behavior. State and regional manpower planning has been essentially nonexistent. In essence, higher education has controlled the destiny of the skilled labor market in New England through an elaborate patchwork of public and private collegiate and graduate-level programs. State higher-education governing boards have not analyzed in depth the supply/demand issues confronting state economies. New England's most selective and independent institutions neither welcome nor respond directly to the manpower issues of their respective host states. Most would argue that their mission is and should be a step removed from state and regional concerns and prospects. Visitors from other states and international guests frequently comment upon the very modest level of collaborative planning in higher education here.

The most significant state planning initiative in New England is Governor William O'Neill's *Jobs for Connecticut's Future* (JFCF) initiative, released in January 1986. The JFCF report emphasizes the continuing projected decline in traditional manufacturing and the growth of technology-intensive corporations; it also cites manpower shortages in all sectors, including financial services, education, and retailing. In Connecticut, 91.5 percent of all future jobs will be generated by businesses within the state, both existing and yet to be created. Manpower development and corporate human resource strategies will, to an unprecedented degree, focus on the 75 percent of current New England workers who will be employed in 1995, 80 percent of whom do not have college degrees.

"Free Market" in New England

New England has outproduced other regions of the nation in awarding degrees in those professional fields required by a sophisticated service and technology-driven economy. This has been done in the absence of state or regional manpower planning. For the most part, state policies also reveal a limited understanding of higher education's capacity and limitations. To date, higher education in New England has enjoyed a free market philosophy in the conduct of its own affairs and in establishing which academic priorities to pursue.

Ironically, across the nation, state governments are mounting major, well-funded programs which, in part, seek to emulate New England's success. The competitive thrust of these programs is aimed at successfully encouraging the commercialization of research results. Very slowly, ventures elsewhere have begun to influence public policy in New England and to draw the deliberate attention of political leadership here; and none too soon. State government in New England invests less public revenue in research and development than does any other region of the United States.

As New England becomes vulnerable to foreign and domestic competition, it can no longer afford to be smug about low unemployment, arrogant about regional academic prominence, or satisfied with its gifted corporate entrepreneurship. Our institutions of higher education will confront severe challenges in the 1985-1995 decade and will require farsighted state and regional policy if the region is to sustain and expand the skilled human resources and meet the levels of productivity demanded by global participation. The strategic interests of higher education and corporate New England will converge during this decade. The strategy will focus on (1) enhancing support for basic research; (2) creating state incentives for improving the commercialization of research and development through university-industry partnerships; (3) developing a coherent manpower policy to meet the most acute shortages of scientific, engineering, and other highly skilled personnel; (4) upgrading the quality of public school education; and (5) increasing the participation rate of adult men and women, particularly minorities, in a responsive continuing education system. All these issues require more planning, greater collaboration, and a promise of the highest level of corporate support any region in the United States has yet exhibited.

An Overwhelmingly White Economy

The picture is not promising for every ethnic group within New England. New Englanders are overwhelmingly white. The region's share of the nation's black (1.8 percent) and Hispanic (2.0 percent) populations—amounting to 774,000, or 6.2 percent of New Englanders—is the smallest of any section of the country, except for the mountain states of the West. The concentration of black and Hispanic populations residing in New England cities, however, reveals a very different picture. Ninety percent of the region's blacks and Hispanics reside in Connecticut and Massachusetts. The percentage of combined black and Hispanic populations in Boston is 29 percent, and in Hartford, 54 percent.⁸

Wasting Our Minority Youth

Minority student enrollment among New England urban public school districts

varies dramatically. Boston has a 47 percent black enrollment; Lowell, only 2 percent systemwide. Boston's schools are 28 percent white; Lowell's, 79 percent white. While high school dropout rates vary significantly by community, 25 percent of all New England teenagers now leave high school before graduation. Minority youth leave the schools of Boston and Hartford at the rate of 45 to 55 percent. Unemployment of black and Hispanic high school dropouts regionwide is 21 and 15 percent, respectively. In the cities of the region, the rates are significantly higher. By specific locale, the destructive pattern of dropout, unemployment, teenage pregnancy, juvenile crime, malnutrition, and despondency is viciously compacted. Yet it is abundantly clear that the regional economy will need these young people. The inevitable social and economic dependency their condition forebodes requires determined attention along the lines of the Boston corporate community response in establishing the \$5 million ACCESS program endowment to provide scholarships for Boston's predominantly minority student population.

While there are dramatic differences between the conditions confronted by young white urban ethnics in the fifties, sixties, and seventies and those confronted by minority youth in New England cities now, employment demand is decidedly the most significant factor. Jobs and careers exist in abundance today. New England must, as a matter of the highest public priority, invest in the resolution of minority retention in the public schools, access to higher education, job counseling, and student financial aid. Our willingness to do so may be the most accurate measure of whether the states of this region are fully capable of understanding the very purposes of prosperity in a commonwealth.

New England Capacity to Assimilate

It is worth recalling that among all regional populations during the postwar era, New England possessed the highest proportion of émigrés or first-generation Americans. In 1950, almost 50 percent of New England white residents were foreign-born or children of foreign-born (see table 2). By 1960, this proportion was still 40 percent. The education, assimilation, and employment of this extraordinary concentration of new citizens during three decades of economic decline (1945–1975) may reveal more about the human achievement of the region than any other single historic factor shaping the current regional economy.

Educationally and economically, the aspirations of ethnic urban New Englanders sustained the struggling low-wage industries of the region. Recent and incumbent Governors Brennan, Garrahy, Kunin, Dukakis, and Sununu are only a few of the elected leaders whose political vision has been shaped by the process of immigration, education, and assimilation. Their diverse recollections harbor the harsh realities that influenced the achievements of their foreign-born parents or grandparents. Both political parties have been molded by the assimilation process. Yankee ingenuity itself has been informed by the fresh blood of new entrepreneurial coalitions, the educational and scientific attainments of white ethnic groups, and the actions they took to become part of the economic mainstream of a depressed regional economy. New England, particularly the southern tier states, must exhibit the same level of determination to include our minority youth, who cry out for opportunity.

Table 2

**U.S. States with Greatest Relative Concentration of
White Foreign-Born and White Children of
Foreign-Born, 1950 and 1960**

1950			1960		
Rank	State	% of Total White Population	Rank	State	% of Total White Population
1	Rhode Island	49.9	1	New York	41.2
2	Connecticut	49.5	2	Massachusetts	40.5
3	Massachusetts	49.5	3	Connecticut	40.2
4	New York	49.2	4	Rhode Island	40.1
5	New Jersey	44.8	5	New Jersey	37.7
6	North Dakota	39.6	6	North Dakota	30.5
7	New Hampshire	36.1	7	New Hampshire	29.2
8	Minnesota	34.7	8	Illinois	26.9
9	Illinois	33.4	9	Michigan	26.6
10	Michigan	33.3	10	Minnesota	25.8
17	Maine	27.1	15	Maine	23.3
18	Vermont	25.6	18	Vermont	22.0
	United States*	25.0		United States*	20.8

*United States excluding Alaska and Hawaii.

Source: Robert W. Eisenmenger, *The Dynamics of Growth in New England's Economy, 1870-1964* (Middletown, Conn.: Wesleyan University Press, 1967).

International Interests vs. Internationalization

The key elements in the continuing discussion of New England's strength must include a focus on international and interregional competition for rapid development of quality new products. New England's economic future is intimately tied to the knowledge industry of the region, and the regional economy is one of the most promising in the nation in terms of international markets and investments. Yet the process of internationalization in New England remains characteristically piecemeal and competitively uncoordinated. Traditional campus initiatives abound; their link to new corporate developments in New England is as yet untested. The trade-centered programs of state government agencies in tourism, economic affairs, manufacturing exports, and financial services are unfamiliar to most academic specialists. Consulates of foreign governments in New England find the complex array of independent initiatives bewildering, though each with whom we have had discussions is open to facilitating imaginative working arrangements—thus expressing considerable knowledge of their necessity for New England development.

Within higher education, international substance must become part of both general and professional education. After years of neglect and increasing specialization, the integration of international economic perspective is a necessity. As Sven Groennings, a New England Board of Higher Education senior fellow, has pointed out, leaders in academia and in government—especially state government—need fresh rationales and intellectual connections to economic realities and problems.⁹

It is significant to note that 52.9 percent of all 1984 recipients of engineering doctorates were not American citizens; in 1965, 22 percent were foreign recipients. In 1984, foreign nationals received 39.9 percent of all U.S. Ph.D.s in economics; 38.4 percent in mathematics; 36 percent in computer science; 28.6 percent in business and management; and 27.9 percent in physics and astronomy. Only 4.3 percent of U.S. psychology doctorates were awarded to foreign nationals, though more psychology Ph.D.s were awarded to Americans than in any other field with the exception of education.¹⁰

The regional economy is becoming increasingly integrated with international markets and investments while also becoming knowledge intensive and producing innovative technological goods in circles of severe international competition. New England's sophisticated professional services sector is increasingly international. These are major changes in dimension and in kind, and they are at the cutting edge of regional economic development. Historically, higher education has adapted to and contributed to changes in society, the economy, and technology, and to national needs. At issue now is how the relationship between the internationalization of the economy and the development of higher education's capabilities and functions can be advanced most constructively in an era of international competitiveness. New England should take the lead.

Internationalizing Local Economies

There has been marked decentralization of international economic and educational interests from Washington to the states and campuses of the nation. Cities are understandably the centers of international economic affairs, trade, and international education. The center of economic relationships is not Washington but places such as Atlanta, Baltimore, and San Francisco, as well as Boston, Burlington, Hartford, Portland, and Providence.

The impact of international competitiveness on local economies has captured the imagination of Americans at the same time that they have welcomed the quality and price advantage of imported products. It is no accident that 50 percent of the revenues of American advertising firms and 33 percent of accountant fees are related to international trade.¹¹ While national security issues and the case for citizen education in global affairs remain the major elements in arguing for international education, a general understanding of national defense and cultural matters is insufficient to prepare students and citizens for the frontier of world economic activity that as workers, consumers, investors, and voters they must measure. The international telecommunications revolution will accelerate the need for strategic insight—economic and political. The integration of the international dimension throughout the spectrum of New England life is inevitable. The question is whether we are prepared to address the issue with foresight and imagination.

Higher Education Research and Economic Development

New England's current lead over other sections of the United States in research and development will be under increasing pressure—as well it should be—as the result of state investment in other sections of the nation. Unless we strengthen and build on our delicate competitive edge, the region is in danger of losing the

razor-sharp but thin margin of excellence we appear to take for granted. The concentration of highly skilled workers and professional leadership provides the basis for regional participation in the information-based global economy of the next decade.

Public sentiment nationally and particularly in New England clearly is calling for fulfillment by the 1990s of the promise of a modern multipurpose system of higher education. Continuing education programs, because of their flexibility and adaptability, offer diverse potential for development of targeted job retraining, career change, and skill-enrichment initiatives. But retraining programs must be rigorous. The appropriate questions to be resolved by higher education, government, and business must focus on the quality of retraining offered, for whom, and at what cost, not whether the priority itself is appropriate. Demographic realities and technological competition demand that New England institutions possess a creative response at all levels of higher education, with greater openness to the targeting of collaborative ventures with both industry and government.

The question now is no longer how to reindustrialize the economy but rather how best to sustain and expand the level of human productivity and competence within the new economy. Leaders and planners in business, labor, education, and public policy have a shared responsibility to lead the debate and action on this issue.

Can we afford to rely on the impact of world-class achievements during the past decade without planting contemporary seeds of creativity immediately for future harvest? I think not. We must recognize that vastly increased state tax revenues, generated by five years of intense economic success, must provide the new seed monies required for government to create higher education-private sector partnership programs for future economic development. Seed money is essential for the next growth cycle and must be wisely committed now, particularly in the face of unfocused and contradictory federal policy, which will not be clarified until the 1990s at the earliest. The new role of state investment in human capital and economic development is in its infancy.

The New Role of Higher Education

University faculty in all fields, as well as campus administrators, have an obligation to become intellectually alert to and programatically sensitive toward the human potential of the regional society and the economic factors that will enable New England to respond to the growing dependency of the uneducated and structurally unemployed or unemployable—those they have not served. The region's most nationally prominent institutions are aware of this fact. Clearly, the major issue confronting all postsecondary institutions is how resources in colleges and universities will be reallocated and expanded to address the goal of educational opportunity and the requirements of a new era without disrupting the essential continuity and depth of intellectual development of the past. Institutional responsibility must provide for the continuation of significant intellectual vitality, in its richest sense, which has characterized New England's historic contribution to the nation and world community.

The impact of economic growth or decline is most assuredly a concern academia is beginning to understand. William D. McElroy, former chancellor of the

University of California, San Diego, and past chairman of the National Science Foundation, was deeply distressed with the simplistic rhetoric applied to the military-industrial complex during the days of intense student unrest on campuses fifteen years ago. He later wrote in his essay "The Utility of Science" the following assessment of the issues surrounding the question of economic growth:

I know that in some circles it is regarded as unseemly to speak favorably of economic growth. We are told that we should stop that growth, end our preoccupation with the dollar, cease being fascinated with technological change. We should, instead, get on with the business of redistributing our assets and resources to enhance the quality of life for all our citizens. But it is well to bear in mind that the multitude of goals to be achieved under the rubric "quality of life," from eradicating poverty to cleaning up the environment, can be financed only partially by shifting our present national priorities. Solutions to these problems will be heavily dependent on a healthy annual increment of economic growth. Solutions will also be heavily dependent on the marshalling of new knowledge through fundamental research and the achievement of new technologies."¹²

As New England's industrial base faltered and its economy struggled from 1945 to 1975, a modest degree of academic engagement was revealed by the higher education community. The worsening economic situation of the region became a threat to the social structure of which the academy was a prominent, though aloof, partner. In such fields as optics, abrasives, precision instruments, and defense-related industries (arms manufacture has vigorously dominated sectors of New England manufacturing since the American Revolution, as it appears it will again in the 1990s), academic and business connections did operate to mutual benefit. But such was not the case with New England agriculture, fisheries, furniture, energy resources, and traditional manufacturing, generally. The decline of these sectors may in part reflect a pattern of neglect or indifference fostered by a tradition of intellectual noblesse oblige shared by New England scholars and scientists. Absent were the necessary ingredients (of research and development) required to rebuild industries through innovation and the applied assessment of knowledge to regional economic issues early enough to be of use. During the 1945-1975 period, the public universities of the region had neither the engineering faculty nor research and development resources to contribute. Indeed, more scholarly attention and research has been accorded these sectors of the economy since their demise than during their attenuated period of decline. The price paid for the underfunding of public higher education led to the attendant loss of human energy and personal aspiration of young people who, had they lived in other regions, would have successfully pursued postsecondary education.

The physical decline of hundreds of New England towns and the major cities of the region as a result of the limited commitment to human capital renewal is still in evidence. We must seek to avoid contemporary repetition of this tragic pattern. Public higher education should have the resources and prerogative to be engaged in analyzing, shaping, and responding to the economic growth of the region and to present compelling public policy analysis to government and industry concerning the options available for investment of state and corporate wealth on behalf of society.

Research: The Critical Factor

Quality higher education is the crucial factor in the knowledge-intensive New England economy. We need greater understanding of how competencies are taught and learned and how well colleges and universities are assessing what students know. Schools are the central capital investment and infrastructure of a knowledge society, as Peter Drucker has pointed out: human capital, "defined as the skill, dexterity, and knowledge of the population, has become the critical input that determines the rate of growth of the economy and well-being of the population."¹³

A national yardstick of the importance of New England academic institutions and nonprofit research institutes is the region's capacity to compete for research and development grants and contracts awarded by the federal government. Analysis of 1982 National Science Foundation data published in 1984 profiles considerable evidence of the region's competitive position.¹⁴

New England institutions (academic, nonprofit, and corporate) are highly competitive with all other regions of the United States in award of federal obligations. Support to the region is the most concentrated in the nation. With only 5.3 percent of the total U.S. population, New England receives 11 percent of the total federal obligations for research and development to industrial firms and 12 percent of the total federal obligations for research and development to colleges and universities. In selected categories, New England receives 12 percent of NASA and 13 percent of Department of Transportation research and development expenditures, together with 15 percent of the total obligations of the National Science Foundation.

In biomedical areas, 15.5 percent of National Institutes of Health (NIH) research grants are awarded to the region's colleges and universities, institutes, and nonprofit hospitals, as are 19 percent of NIH fellowships and training grants. The National Institutes of Health awards 38 percent of research and development obligations to non-university-owned, but university-affiliated, voluntary hospitals in New England.

Of all the contracts and grants the Department of Defense (DOD) awards to university and nonprofit research institutes in the United States, 40 percent go to New England institutions. DOD contracts and grants for 1985 are presented in table 3, on page 104. The nation significantly depends upon New England's nonprofit defense-related research network. The \$1 billion of New England DOD academically related research budget should be compared with the \$1.5 billion in total expenditures of the six New England states provided in 1987 for the support of the public and independent colleges and universities, including all state student financial aid.

Do New Englanders understand the significance of the local research and development enterprises they fund through their federal tax dollars? A public opinion poll cosponsored by the New England Board of Higher Education and the Council for the Advancement and Support of Education (CASE), conducted in 1984 by the Opinion Research Corporation, offers a clue. The poll found the following significant differences when comparing New England and national attitudes on whether federal support for higher education and medical research should be increased, stay at its present level, or be decreased:¹⁵

	"Increase."		"Stay as is."		"Decrease."		"No opinion."	
	N.E.	U.S.	N.E.	U.S.	N.E.	U.S.	N.E.	U.S.
Government aid for higher education	73%	61%	20%	28%	6%	10%	2%	1%
Government funding for medical research	82%	73%	17%	21%	1%	5%	0%	1%
Government financial aid for college students	71%	53%	21%	35%	6%	11%	2%	2%

Table 3

Department of Defense (DOD) Research and Development Contracts to Colleges/Universities and Nonprofit Organizations in New England, FY 1985

New England Colleges and Universities	Amount Awarded	Type of Institution
1. Massachusetts Institute of Technology	\$ 360,104,000	Private
2. University of Massachusetts	6,141,000	Public
3. Yale University	5,507,000	Private
4. Harvard University	4,637,000	Private
5. Trustees of Boston University	3,691,000	Private
6. Brown University	3,530,000	Private
7. University of Rhode Island	3,413,000	Public
8. Wentworth Institute of Technology	3,199,000	Private
9. Northeastern University	2,476,000	Private
10. Emmanuel College	2,436,000	Private
11. University of Connecticut Foundation	1,346,000	Public
12. Dartmouth College	1,152,000	Private
13. Trustees of Boston College	1,048,000	Private
14. University of Lowell	650,000	Public
Subtotal, New England Private	\$ 387,780,000	97.1%
Subtotal, New England Public	\$ 11,550,000	2.9%
Total, New England Public and Private	\$ 399,330,000	
New England Nonprofit Research Institutes		
1. Charles S. Draper Laboratory	\$ 305,238,000	
2. Mitre Corporation	260,995,000	
3. Woods Hole Oceanographic Institution	11,548,000	
Total, Nonprofit Research Institutes	\$ 577,781,000	
Total, Colleges/Universities, Nonprofit Research Institutes	\$ 977,111,000	
	U.S. Population	Proportion of DOD Nonprofit Grants
New England	5.3%	40.06%
Balance of U.S.	94.7%	59.94%

Source: New England Board of Higher Education Analysis of U.S. Department of Defense data as published in the *Chronicle of Higher Education*, 26 June 1986 (institutions receiving \$500,000 or more).

New England public opinion has consistently supported federal increased expenditures for higher education and academic research in all categories. New Englanders, however, are less supportive of defense expenditures than the rest of the American public.

A Unique New England Capacity: Producing Professionals

With 5.3 percent of the total U.S. population in 1982, New England produced the following proportions of advanced degrees:¹⁶

- 7.3% of medical residents (specialists)
- 8.0% of Ph.D.s in all fields
- 8.3% of Ph.D.s in all scientific disciplines
- 8.6% of law school graduates
- 9.3% of MBAs
- 10.0% of Ph.D.s in humanities
- 10.1% of Ph.D.s in engineering
- 11.0% of Ph.D.s in physical sciences

In specific disciplines within the sciences, such as computer science, electrical engineering, mathematics, physics, and astronomy, New England production of Ph.D.s is twice the national rate. The advantage such output represents to the region is reflected in the location new Ph.D. recipients choose for employment.

The Pragmatic Region

Of all recipients of Ph.D.s awarded in the nation in 1984, the percentage of those in selected disciplines who are employed in New England include the following:¹⁷

Political Science/International Affairs	5.0%
Business and Management	6.2%
Engineering	6.3%
Economics	7.8%
Mathematics	8.6%
Physics/Astronomy	8.3%
History	9.4%
Computer Science	10.7%
Biochemistry	11.9%
Foreign Language	13.7%

In the absence of quality comparative data on corporate demand, the degree of “overproduction” by New England institutions during the past two decades has provided the most significant human resource “insurance policy” available in the technologically advanced regions of the nation and perhaps the world.¹⁸

Massachusetts ranked third among the nation’s top ten states enrolling seven thousand or more graduate students in science and engineering. The rates of growth in matriculated graduate students during the period 1976–1983 are presented in table 4, on page 106.

The pursuit of undergraduate degrees in business and management is remarkably high in New England, exceeding national output by an estimated 50 percent

Table 4

**Rates of Growth in Number of Matriculated
Graduate Students, Science and Engineering,
in Top Ten States, 1976-1983**

Number of Graduate Students		State	Average Annual % Change, 1976-1983	Rank on Growth
1976	1983			
35,807	40,058	California	1.6%	10
31,159	40,203	New York	3.7%	5
17,380	23,170	Texas	4.2%	3
15,031	20,067	Massachusetts	4.2%	3
14,633	16,802	Ohio	2.0%	8
13,923	17,598	Pennsylvania	3.4%	6
13,744	16,786	Illinois	2.9%	7
7,397	11,319	Florida	6.3%	1
7,284	8,207	Indiana	1.7%	9
7,186	9,619	New Jersey	4.3%	2

Source: New England Board of Higher Education Analysis of *Surveys of Science Resources Series*, National Science Foundation (Washington, D.C., 1985).

Table 5

**Percentage of Students Enrolled in Business and
Management Programs (1976, 1978, 1980) in
New England and U.S., and Degrees Awarded (1982)**
(numbers in %)

State	1976	1978	1980	1982*
Connecticut	11.1	17.4	20.3	22.1
Maine	13.7	14.6	15.7	13.6
Massachusetts	16.2	16.5	15.7	19.0
New Hampshire	21.4	24.7	26.5	23.8
Rhode Island	17.6	19.8	19.8	24.0
Vermont	9.0	10.5	11.6	11.2
United States	11.7	13.2	13.7	NA

NA signifies that information is not available.

*Percentage of bachelor's degrees awarded.

Sources: New England Board of Higher Education Analysis of National Center for Educational Statistics (NCES) data, 1976, 1978, 1980; and 1982 unpublished NCES regional data.

(see table 5). New England institutions of higher education and their students are far less liberal-arts oriented than their image projects. The highly visible concentration of nationally selective independent colleges and universities undoubtedly explains the image, but not the reality, of liberal learning in New England.

A Distinguished Level of Production

The baccalaureate sources of male and female doctorate recipients in the United States reveal that the most productive New England campuses continue to be the region's independent colleges and universities, including those listed here:¹⁹

Universities

1. Boston University
2. Brandeis
3. Brown
4. Dartmouth
5. Harvard
6. M.I.T.
7. Wesleyan
8. Yale

Colleges

1. Amherst
2. Bennington
3. Bowdoin
4. Hampshire
5. New England Conservatory
6. Smith
7. Wellesley
8. Williams

The leading public university in the region is the University of Massachusetts at Amherst, which ranked twenty-third among all U.S. colleges and universities in output of baccalaureates who received Ph.D.s in 1984. M.I.T. ranked fourth, Harvard ninth, and Yale twentieth among the top thirty nationally.²⁰

Another way to compare the relative concentration of scientific and engineering talent (see table 6) in a given state is to use the ratio of academically employed scientists and engineers to state population (see table 7 on page 108). Massachusetts ranks an undisputed first in the nation by this measure. With a ratio of 3.5 scientists and engineers per 1,000 population, the colleges and universities of the Commonwealth possess by national standards an exceptional pool of talent for teaching and research.

Table 6

Engineering Degrees in New England and the U.S.

(1971, 1978, 1979, 1980, 1982)

Degree	1971	1978	1979	1980	1982
Bachelor's					
N.E.	3,419	3,719	4,309	4,619	5,296
U.S.	43,167	46,091	52,598	58,117	66,990
% (N.E. to U.S.)	7.9%	8.1%	8.2%	7.9%	7.9%
Master's					
N.E.	1,414	1,421	1,316	1,541	1,627
U.S.	15,899	15,736	15,624	16,927	18,289
% (N.E. to U.S.)	8.9%	9.0%	8.4%	9.1%	8.9%
Professional Engineering					
N.E.	113	110	62	77	69
U.S.	494	446	412	302	254
% (N.E. to U.S.)	22.9%	24.7%	16.5%	25.5%	27.2%
Doctor's					
N.E.	335	264	232	244	293
U.S.	3,640	2,573	2,815	2,753	2,887
% (N.E. to U.S.)	9.2%	10.3%	8.2%	2.9%	10.1%
All Degrees					
N.E.	5,281	5,514	5,925	6,481	7,285
U.S.	63,190	64,846	71,449	18,099	88,420
% (N.E. to U.S.)	8.4%	8.5%	8.3%	8.3%	8.2%

Source: New England Board of Higher Education Analysis of *Surveys of Science Resources Series*, National Science Foundation (Washington, D.C., 1985).

Table 7

Science and Engineering (S&E) Ph.D. Employment at Universities and Colleges, Top Ten States, 1980

State	Ph.D. S&E Empl.	State S&E Empl. Rank	State Pop. 1980	State Pop. as % of U.S. Pop.	State Pop. Rank	Ratio State S&E Empl./1000 State Pop.	Rank State S&E Empl./ State Pop.
California	39,658	1	23,668,000	10.4	1	1.68	5
New York	35,297	2	17,558,000	7.8	2	1.49	7
Illinois	21,208	3	11,427,000	5.0	5	1.86	4
Massachusetts	19,789	4	5,737,000	2.5	11	3.45	1
Pennsylvania	16,086	5	11,864,000	5.2	4	1.36	8
Michigan	14,678	6	9,262,000	4.1	8	1.58	6
Texas	13,545	7	14,229,000	6.3	3	0.95	10
Ohio	12,449	8	10,798,000	4.8	6	1.15	9
Indiana	11,600	9	5,490,000	2.4	12	2.11	2
Wisconsin	9,615	10	4,706,000	2.1	16	2.04	3

Source: New England Board of Higher Education Analysis of *Ph.D. Scientists and Engineers Employed at Universities and Colleges*, National Science Foundation (Washington, D.C., 1982).

Table 8

Income from Wages and Proprietorships, New England States, 1981-1985

(in billions of dollars)

State	Nat'l Rank	Billions of Actual Dollars		Billions of Real Dollars (1982)		Real Growth	Annual Growth Rate
		1981:1*	1985:4§	1981:1	1985:4	1981:1-1985:4	
New Hampshire	1	\$ 6.1	\$10.2	\$ 6.7	\$ 9.0	34.2%	6.4%
Massachusetts	4	45.3	70.1	49.6	62.0	25.1%	4.8%
Connecticut	9	27.4	40.8	29.9	36.1	20.5%	4.0%
Vermont	10	3.2	4.7	3.5	4.1	19.3%	3.8%
Maine	15	6.6	9.6	7.2	8.5	16.8%	3.3%
Rhode Island	19	\$ 6.4	\$ 9.1	\$ 7.0	\$ 8.1	15.0%	3.0%

*First quarter 1981.

§Fourth quarter 1985.

Source: New England Board of Higher Education Analysis of *The Bi-Coastal Economy*, a report of the Joint Economic Committee of the U.S. Congress, 14 July 1986.

Leading the Bicoastal Economy

The Bi-Coastal Economy, a report by the Democratic Staff of the Joint Economic Committee of the U.S. Congress, reveals that growth in the gross national product (GNP) since 1980 has averaged 2.3 percent. While comparative data in gross state product are surprisingly not tabulated, the Joint Economic Committee has gathered state-based information on income from wages and proprietorships. The national ranking of the New England states is presented in table 8.

Rise in personal income and continued job growth led the committee to suggest the following:

If this trend of a regional disparity in family income growth were to continue, by the middle of the next decade, there would be a more than 40% difference between the average income of families living in the coastal group of states and families living in the rest of the country. That would roughly equal the regional disparity which existed between northern and southern states during the first half of this century.²¹

The report reveals that California, alone in the West, and fifteen East Coast states—sixteen states in all, containing 70 percent of the U.S. population—generated 70 percent of real growth in wage and proprietorship income between the first quarter of 1981 and the last quarter of 1985, and 90 percent more job growth per capita than the rest of the nation. My own analysis reveals that among all the bicoastal states, the New England region, with 5.3 percent of U.S. population, experienced the highest rate of real income growth (1982 base), producing \$23.9 billion of the \$234 billion national total, or 10.1 percent.

As Edward Moscovitch pointed out in the *Wall Street Journal*: “Without a doubt,” the leading element in “the Massachusetts Miracle” is the “\$1.5 billion of federally sponsored research performed each year by its scientists and engineers.” He recommended that “state governments should find ways of providing seed money to help promising university and industry researchers compete for federal grants, and promoting applied research in fields related to their economic base,” and added that contrary to conventional wisdom, the “boom clearly traces back to the late 70’s before [Proposition] 2½ was enacted.” He believes the Commonwealth’s attractiveness to thinkers and entrepreneurs “lies deeper than its tax structure.”²²

New England State Investment in Higher Education: Gaining on the National Average

As New England has continued to lead the nation in gain in per capita income during the period 1983–1986, the level of state tax revenues available for public investment has increased proportionately.

Despite consistent improvement in state funding for higher education, New England per capita and per \$1,000 of personal income investment remains below the national average. The proportion of New England total state revenues committed to higher education also remains below the national average. Given the robust regional economy and the exceptional dependence of the economy on teaching, research, and academic public service, continued improvement in public investment is necessary. The New England states provided 4.3 percent of all U.S. state expenditures for higher education in 1986, up from 3.8 percent in 1982 (see tables 9, 10, and 11 on pages 110 and 111).

The Need for a Science and Engineering Policy for the Region

Regional strength in applying scientific talent to new products and services is vital to the future prosperity of New England. It is essential for us, at minimum, to develop a broad and coherent science and engineering policy to guide and assess priorities for the future.²³

Table 9

State Tax Funds for Higher Education Operating Expenses, Per Capita Appropriations, New England and U.S., FY 1982-1987

(in dollars)

State	1982	1983	1984	1985	1986	1987
Connecticut	\$ 72.73	\$ 80.09	\$ 86.78	\$ 96.04	\$104.60	\$116.87
Maine	57.87	63.32	66.52	78.89	87.28	108.30
Massachusetts	72.08	81.58	98.59	110.61	122.65	140.81
New Hampshire	40.23	36.03	42.01	43.60	51.48	57.32
Rhode Island	86.90	94.70	101.46	108.43	114.76	121.26
Vermont	63.96	71.13	75.28	78.87	83.02	88.30
New England	69.25	76.55	85.14	97.38	107.07	121.98
United States	\$ 97.20	\$102.53	\$109.35	\$118.59	\$130.12	NA

NA signifies that information is not available.

Sources: New England Board of Higher Education analysis (August 1986) of data from state higher education offices; *Statistical Abstract of the United States, 1986, 106th ed.*; M. M. Chambers and Edward R. Hines, *Appropriations: State Tax Funds for Operating Expenses of Higher Education, 1981-1982 through 1986-1987*, National Association of State Universities and Land Grant Colleges, Washington, D.C.

Table 10

Appropriations of State Tax Funds for Higher Education Operating Expenses in New England, FY 1987

State	Appropriation (in thousands)	2-Year Gain (as a percentage)	10-Year Gain (as a percentage)	Per Capita Appropriation (in thousands of dollars)	Per \$1,000 Pers. Income
Connecticut	\$ 368,648	22%	153%	\$116.9	\$ 8.3
Maine	125,216	37%	194%	108.3	11.5
Massachusetts	816,379	27%	240%	140.8	11.4
New Hampshire	55,961	31%	145%	57.3	5.0
Rhode Island	117,149	12%	108%	121.8	10.9
Vermont	46,778	12%	132%	88.3	9.5
New England	\$1,530,131	25%	190%	\$121.7	\$10.0

Sources: New England Board of Higher Education analysis (September 1986) of data from state higher education offices; *Statistical Abstract of the United States, 1986, 106th ed.*; M. M. Chambers and Edward R. Hines, *Appropriations: State Tax Funds for Operating Expenses of Higher Education, 1981-1982 through 1986-1987*, National Association of State Universities and Land Grant Colleges, Washington, D.C. Disposable personal income by state, figures for 1984, from the Department of Commerce Bureau of Economic Analysis, reported in K. Halstead, *State Profiles: Financing Public Higher Education, 1985-86*.

Because high technology and traditional industries will continue to be affected by the adverse consequences of foreign competition, a serious attempt must be made to unite state government, universities, and corporations in assuring the increased level of funding required to improve facilities and equipment, raise the standard of teaching, and encourage talented young people to enter science and engineering programs.

Three elements of a science and technology policy are essential:

Table 11

Appropriations for State Tax Funds for Higher Education in New England and U.S., FY 1982-1987

(in millions of dollars)

State	1982	1983	1984	1985	1986	1987
Connecticut	\$ 229.4	\$ 256.6	\$ 273.7	\$ 302.9	\$ 329.9	\$ 368.6
Maine	66.9	73.2	76.9	91.2	100.9	125.2
Massachusetts	417.9	473.0	541.6	641.8	711.1	816.4
New Hampshire	39.3	35.2	41.1	42.6	50.3	56.0
Rhode Island	83.6	91.1	97.6	104.5	110.4	117.1
Vermont	33.9	37.7	39.9	41.8	44.1	46.8
New England	871.0	962.8	1,070.8	1,224.8	1,346.6	1,530.1
United States	\$22,954.5	\$24,212.9	\$25,824.0	\$28,006.5	\$30,730.0	NA

NOTE: The New England Board of Higher Education predicts that Massachusetts will rank first among all states on ten-year rate of gain in FY 1987. While this is impressive, the Commonwealth ranked fiftieth in proportion of public revenues invested in higher education a decade ago, and will, following ten years of effort, only reach the national average in FY 1987. The capacity to do so is clearly related to sustained improvement in the state's economy from 1975 to 1985.

NA signifies that information is not available.

Source: New England Board of Higher Education analysis (September 1986) of data from M. M. Chambers and Edward R. Hines, *Appropriations: State Tax Funds for Operating Expenses of Higher Education, 1981-1982 through 1986-1987*, National Association of State Universities and Land Grant Colleges, Washington, D.C.

1. The ability of the region to expand funding for basic research and applied research sciences
2. The creation of legitimate programs that will enhance the process of commercialization while maintaining the integrity of academic inquiry
3. The continued development of highly trained personnel to meet the basic, applied, and entrepreneurial requirements of the regional economy

Over the last decade, colleges and universities in the region have demonstrated the quality of their programs by continually competing effectively for their share of federal research and development grants. In 1976, New England attracted an 11.1 percent share; in 1983, a 12.2 percent share, as compared again to a base of 5.3 percent of national population. Indications are that the New England share will have been maintained when the National Science Foundation reports 1985 data in 1987. We must ensure that we are continually at the frontiers of new knowledge. It is in basic research that the region will continue to find the seeds of renewal and the new products and processes necessary to be competitive in the international arena.

The Example of Biotechnology

Biotechnology is one example of a direct link between our successes in securing federal research grants and developing new products commercially. The strong links between the biomedical and biotechnical industries and universities have encouraged the emergence of more than 130 biotechnology corporations in the

region, almost all of which are continuously linked to academic laboratories.

Biotechnology is entering a fragile stage in its development. Much of the past development of the industry has focused on research efforts to develop recombinant DNA, cell fusion, and bioprocessing techniques. After twelve years of research following the first successful insertion of foreign DNA in a host organism in 1973, the biotechnology industry is bringing products to market. Potential industrial applications include production of pharmaceuticals, animal and plant agriculture, specialty chemicals and food additions, environmental applications, commodity chemicals, and bioelectronic instruments, including biosensors and new conducting devices called biochips. The drive now is to move scientific ideas into the marketplace safely.

Universities in New England play a major international role in the development of biotechnology products worldwide by carrying out research independently or in cooperation with industry. The success of biotechnology commercial development in the region will critically depend on translating scientific processes from the universities into safe, competitively priced, well-marketed products. Undoubtedly, the acceleration of this process requires an increasing emphasis on (1) promoting commercial-academic research; (2) encouraging the development of entrepreneurs in the universities; (3) developing university-business liaison functions to protect intellectual property rights and secure adequate funding for product development; (4) arranging viable university-industry partnerships; (5) investing more of a university's endowment fund in the commercialization of potentially successful research ideas; (6) securing equity involvement for academic participants in any products developed; and (7) utilizing the region's capability of securing federal funding for research ideas to upgrade and maintain laboratories in state-of-the-art fashion. Extensive partnerships in research development among universities will prove to have a vital role in generating commercial potential and ultimately employment from research ideas.²⁴

The dramatic increase in the development of partnerships between universities and emerging biomedical industries reveals the accelerating pace of technological changes as well as the new mode of collaboration. Biomedical collaboration is a generation ahead of the more collegial high-tech university patterns of a decade ago.

Both universities and industries are testing the mutual benefits emerging from new patterns in research-licensing agreements that permit industry access to new science and encourage privileged development of products in advance of competitors. Corporate access to personnel with outstanding credentials at relatively low cost will allow leading universities to develop additional intellectual resources through collaborative arrangements as corporations continue the investment cycle. The pattern is intimate and risks limiting the dissemination of significant discoveries.

The Study of Productivity

The U.S. work force remains the most productive in the world; the New England work force is the most productive in the nation. However, Japanese and western European productivity is improving faster than our own. Research into how higher education affects human productivity in the work force is comparatively

scarce. Yet it will be surprising if this decade does not see a measurable increase in significant research on the interdependence of education, productivity, and quality of product. The inquiry itself will invite new levels of collaboration between higher education and business. Certainly as the nation's economy grows in knowledge intensity, such investigation should help to shape the nature of collaborative settings. Reassessment of the measures of productivity will be an essential ingredient, as will the evaluation of enabling and humane working conditions necessary in enterprises requiring more of educated workers than has been the case in the past. Corporations have already revealed a level of intellectual curiosity about themselves in this respect and will, with encouragement from the academy, participate in well-conceived studies and experimental modes of employment—with employee support and interest. Several dimensions of the productivity issue require renewed attention and each should be developed in New England:

- Quality of the New England product—production of goods and services that are technically superior and improved by advanced processes of production, product reliability, and enhanced service
- Quantity of the product—improvement through technological innovation and motivation of skilled workers to match or excel productivity standards nationally or internationally
- Regional emphasis on the production of goods and services that are more highly valued by consumers than those which can be produced with less education and skill
- Regional recognition of excellence in design, variety, and choice of products through state-of-the-art industrial processes
- Pursuit of state policies that provide enabling conditions and incentives that encourage full employment: training, child care, flexible scheduling, and innovative compensation and benefit programs
- Regional pride in and capacity to change, develop, and respond to new ideas, research applications, and humane modes of encouraging innovation
- Emphasis on encouraging high-morale work settings that provide individual challenge, and personal respect as a hallmark of New England management-labor relations

These factors are evident in corporate settings throughout the international marketplace. Educated labor is the critical element. For New England, appreciation of the unique role of skilled labor should be a regional advantage.

Business must clearly define for colleges and universities their needs for educated personnel—not on an urgent quarterly basis, but two to four years in advance of demand. Strategic planners in business must assess and communicate to higher education what skills are required, particularly in the high technology and sophisticated services sectors. Higher education cannot be expected to provide capable manpower without understanding the changing requirements of the business world. Planners must have an in-depth knowledge of the forces impinging on their companies from within and without, including social and historical

factors. Corporations must recognize that rapid economic change will require workers to attain new skills continually and adapt to new conditions throughout their working lives. Academia has the obligation to provide a competent and flexible work force, knowledgeable and courageous enough to shape and alter corporate structures and capable of addressing the necessity for continuing and self-education.

Human Resources and Manpower Policy

Given the sustained low regional unemployment rate, professional manpower policies have particular significance for the region.

Communication among corporations, institutions of higher education, and professional associations with regard to manpower issues remains far more limited than we imagined. The candor and the channels of discourse within most professional fields remain confined to subsets and specialities among the professions.

The absence of clearing centers jointly sponsored by government, higher education, and business and industrial associations has quite naturally led to the extraordinary expansion of executive search and relocation services as for-profit organizations. Such services are expensive and focus primarily on corporate demand rather than on the career plans of individuals. Further, executive search organizations are highly competitive and whatever knowledge they possess does not enter the public realm.

The state and federal system of occupational classification is out of date. Long-term federal and state preoccupation with the legitimate concerns of unemployment has led to a lack of attention to the rate of change in technical-sector occupations. Leadership occupations that have the greatest impact on total employment growth and change within corporations are not understood by state and federal agencies.

New England possesses unusual strength in advanced professional education. Yet we know little about the extent of this resource, its full scope, sufficiency, and economic impact, and how best to measure, harness, and channel this growing asset toward the careers and public- and private-sector institutions that offer the greatest promise of serving the interest of regional economic and social development.

Insight into Employment Demand Essential

A regional clearinghouse would help. It would centralize and coordinate the information and forecasting that are now available, and it would serve as a resource to assist in developing supply and demand data for business, higher education, and government in the states. Given the limits and lags of data collection, organization, and dissemination, such a clearinghouse would hardly address perfectly our varied information needs, but it would certainly advance the level of information and opportunities available.

Public understanding of corporate manpower planning remains limited at best. For example, among our most sophisticated high-tech industries, the layoffs which were heralded by the press and which involved professional and technical personnel amounting to cadres of two hundred, five hundred, or fifteen hundred

individuals revealed to the external community corporate incapacity to assess market conditions and adjust demand through an orderly process. Sudden and large-scale layoffs lead to lack of confidence in subsequent demand for new professional and technical staff when conditions improve. While fluctuations in demand appear inevitable, there remains the question of whether corporate leadership is as capable as it should be of handling the ups and downs of its personnel requirements. A process capable of managing personnel supply and demand would be less costly than shakeouts and would have the added financial benefit of instilling employee loyalty and long-term confidence in corporate prospects.

State Coordination

During the past decade, the New England states have engaged in a plethora of major and minor reorganizational efforts aimed at creating improved state-level coordination of higher-education initiatives. During an eight-year period, twenty-four different individuals have served as state chancellors or interim chancellors of higher education in the six states. In the Commonwealth of Massachusetts, eight incumbents have served as chancellor or acting chancellor since 1978. The absence of stability in the principal public higher-education executive position explains to a considerable degree the general absence of planning and the current level of political involvement in decision making. Longevity of tenure among governors and legislative leaders as well as college and university presidents is greater.

However, the most stable leadership group in the region exists among corporate executives, particularly in the new technology industries founded in New England. Disdain for politics and distress with the slow rate of academic change has kept the most creative corporate executives away from the time-consuming process of bringing about changes in public policy and reform in education. Nonetheless, one measure of the deep significance corporate New England attaches to education-related public policy issues is the increasing coverage education receives in the business pages of New England's major dailies and business journals. The politics of higher education may appear to be rougher of late than the politics of law, medicine, and the "politics of politics itself," but increased willingness on the part of committed business leaders to become involved as trustees, advocates, and commentators is overdue. It is telling that no corporate leader has, as yet, commented substantively in print or in public on the priorities the business community would urge the new chancellor of higher education in the Commonwealth of Massachusetts to consider.

The Impact of Demographic Change

The anticipated decline in college enrollments, projected to be most severe throughout New England between 1988 and 1992, will be extremely difficult for the least selective campuses. The decline will create a level of intense competition that may also threaten the survival of quality among all but the most highly selective colleges and universities in the region. Is business concerned? Is it involved? Are our state legislatures prepared to assess the potential impact of campus closings during the great shakedown of 1988-1992? For example, the most difficult period will occur during the academic years 1988-1989, 1989-1990,

and 1990–1991 in Massachusetts. Of the projected fifteen-year decline in high school graduates between 1979 and 1994, 44 percent is expected to occur during this three-year time frame.²⁵ The gap between campus capacity and entering freshman enrollments will be repeated four years later as graduate and professional schools face enrollment declines. Perhaps most significant for the economy will be the manpower shortages confronting corporate, government, and non-profit employers between 1992 and 1996, when college graduates throughout the region will be in short supply. Advertising revenues will be dramatically inflated through the Help Wanted pages of the *Boston Globe*, the *Hartford Courant*, the *Providence Journal*, the *Concord Monitor*, the *Burlington Free Press*, and the *Portland Press Herald*. But the graduates will not be available to respond.

What the enrollment projections now reveal is that traditional employment markets will change, wages will rise, and economic expansion will be limited by the supply of educated men and women. Most institutions of higher education, having recognized the need to capture new clientele, have systematically engaged in sophisticated and costly marketing, recruiting, and retention efforts. Also effective have been offerings for adults—flexible, varied, and job-related curricula as well as off-campus classes, evening and weekend offerings, and job-site instruction. These shifts have expanded the regional network, providing educational services to an older New England population whose constituents are concerned about their preparedness to participate fully in the region's "new" economy. The current high demand for skilled employees has persuaded many individuals to delay improving their prospects. Campuses have responded with highly distinctive yet totally independent strategies. The point is that higher education has responded to an enrollment market that is more dynamic than any since the GI Bill opened up the American system of higher education.

Is There a Pending Crisis?

The sharp increase in demand for new technical skills has produced a series of severe problems for colleges and universities. Technology-related classes are badly overcrowded, faculty underprepared or in short supply, equipment obsolete, and instruction generally lagging behind "state of the art" realities—all of which suggests a rapid deterioration in the learning process for many students. There is a growing shortage of qualified technical instructors, as more generous salaries plus better equipment and facilities for research lure faculty away from academia into the private sector. A glut of undertrained engineers in dated disciplines is a distinct possibility by the end of the present decade, a possibility reminiscent of the boom-and-bust cycle of 1959 to 1975.²⁶ New England higher education, government, and industry must now take immediate steps to address the most pressing areas of qualitative decline and must establish strategies to resolve intermediate and longer-term issues. Government leaders have a greater than ever stake in providing incentives for higher education and business to move toward sorting out and solving projected manpower shortfalls. No area of state policy requires greater attention.

Admission of part-time students into professional and doctoral programs is receiving increased attention as a way to educate older qualified people. Part-time students already comprise a sizable graduate enrollment in Ph.D.-granting institutions, but they are not necessarily enrolled in the doctoral program at

M.I.T., Harvard, or Yale. Boston University, the Hartford Graduate Center, Northeastern, the University of Rhode Island, the University of Massachusetts, and the University of Connecticut are presently lacking sufficient resources to undertake the assignment.

Business leaders have already begun to look to nontraditional sources for college-educated and professionally trained employees. As the New England economy gains national stature, and with unemployment remaining at historic lows, it is possible to predict joint corporate programs aimed at encouraging in-migration of well-educated, professional people, attracted to New England's expanding economic environment and its unique culture and lifestyle. The "cultural amenity" factor is particularly attractive to professionals in the work force, those who are motivated not only by good job prospects but by the obvious attractions of "a premier place to live, study and work."²⁷ New England is currently successful in retaining its college graduates. With respect to people who were attending college in 1975, 72 percent continued to reside in the same state and 16 percent were living within the Northeast in 1980. The region should continue to improve upon retention of graduates above the age of twenty-five, seeking in sensible ways to halt the historic net out-migration of all age groups in New England.

Professional manpower is critical to the future economic development of the region. In terms of managerial and professional occupations, there is net in-migration with the exception of Massachusetts and Rhode Island. In the period 1975-1980, in-migration accounted for a relatively small part of changes in the labor force, and prospects are not very encouraging that this situation will change in the future, particularly with housing prices rising faster than the significant improvement in personal income.

Maintaining a Margin of Excellence

In order to allow individuals and corporations to exploit new growth opportunities, the problem-solving skills of professionals in all fields in the future will have to be increasingly adaptable. Given the reality of labor shortages, by 1995 there could be a rapid increase in wage levels, which might undermine our ability to compete. If the region is to remain competitive, institutions of higher education must adjust their curricula to allow for the internal mobility of personnel, worker changes in location or function within an organization, and the eventuality that a person may switch from mathematics to computer science or from computer science to electrical engineering or from high-tech management to patent law in the course of a professional career.

While it is very likely that employers will be scrambling to attract and retain the available science and engineering talent, I am particularly concerned about regional commitment to maintain and expand research and development capacity unless a higher proportion of prospective students select science and/or engineering as a course of study and increased corporate and state resources are made available to support these programs.

As W. Lee Hansen suggested this past February in his report to the Science Policy Task Force of the U.S. House Committee on Science and Technology, it seems likely that the shortage of new entrants may induce existing personnel to switch jobs and/or occupations, delay retirement, or become retrained.²⁸ The critical issue is whether we will provide incentive for enough scientists and engineers

to remain in higher education to offer education and training for future generations. We will not be able to provide the education and training needed to meet the challenge of international competition unless a high priority is placed on upgrading public school, collegiate, and university teaching.

As stated in *A Threat to Excellence*: "It is impossible to maintain superiority at the college and university level without competent education at the primary and secondary levels. Moreover, students going on to post-secondary vocational education programs must 'relearn the basics,' diverting resources that could be used more productively for technical training. For students seeking jobs directly after high school, the public school system must constitute the future backbone of the region's skilled and technical work force. . . . It is clear to Commission members that the existing public school system is not fulfilling its goals."

A further comment in *A Threat to Excellence* demonstrates the need for action: "What are the processes by which new thinking gets into the system? Many of our faculty are on the fringes of what were yesterday's scientific advances. . . . If officials in higher education attempt to adjust curricula based on an outside view of what we (industry) are doing, their changes are going to be outdated very quickly. Once they catch us in a time frame, we will already be doing something else. We must tell universities and community colleges what our manpower requirements will be."²⁹

Over 25 percent of the New England high school population fails to graduate, destined to expand a growing disenfranchised and dependent segment of our society. Given the dramatic demographic changes that are likely to occur in the next six years, solving the high school dropout problem is an urgent priority. As a region, we must act decisively to correct the level of waste of human talent that we have tolerated for several decades.

The latest Department of Labor surveys reveal that the five fastest growing occupations are data processing mechanics, office machine services, computer operators, computer programmers, and computer analysts. All of these placements could be filled by individuals with solid high school education, supplemented with community college degrees.³⁰ Improving the quality of our educational system at each level is essential if we are to address emerging entry-level requirements in growth fields.

Reaching a Consensus

Implicit in all of these comments is a clear consensus in favor of an ongoing and focused dialogue among business, education, and government to maintain regional educational quality. Public policy and business policy have mutually supportive roles to play in helping colleges and universities respond flexibly to changing industry manpower needs. Moreover, if our competitive educational advantage over other regions is no longer assured (or no longer as secure as it has been in the past), the region will, of necessity, move from dialogue among key participants in the region's economy to collaborative action.

It is increasingly imperative that the region focus on the quality of high school education for the declining number of students between the ages of fourteen and eighteen. Our future economic success is critically tied to higher levels of academic achievement among non-college-bound students, not just among those who will pursue postsecondary education.

Conclusion

Skilled human capital is the rockbed of New England's economic strength, the vital resource in establishing the future capability of the region to compete nationally and internationally. Education is critical to increasing productivity and improving the quality of New England products and their acceptance worldwide. The region cannot rest on current success. Now is the time to use education to build the foundation for future regional prosperity.

Science and engineering, the availability of skilled labor, a decided edge in professional leadership, and a unique concentration of venture capital have provided the basis for New England prosperity since 1975. We must recognize the growing importance of basic research to our economic competitiveness. Before it is too late, New England must increase the quality of education and training at all levels throughout the region. Business must respond with imagination and long-term commitment to education to assure the quality training of young scientists, engineers, and educated manpower generally. We must act together to develop a comprehensive growth policy for New England aimed at developing a particularly flexible regional labor force skilled to meet the pace of economic change.

As international competition intensifies, the emerging threshold of New England's economy will require that knowledge be qualitatively applied more rapidly to the solution of technical, economic, and social problems than at any point in our history. In learning how to do so, we must strengthen the entire educational system.

There is no time for bickering—political, academic, bureaucratic, or corporate. Strong, farsighted leadership is required and bold collaborative steps must be extended to correct the tragic pattern of human waste the region has permitted to prevail in the conduct of its public schools. While partnerships in behalf of genuine reform are emerging throughout the region, the patterns of action have been studiously slow.

A major premise of this discussion returns to the question of whether or not New England is prepared to invest in the creative priorities that have generated economic growth in the first place. A corollary question is whether or not the policy lesson is fully understood. The connection between quality basic education, research and development, and skilled job creation is axiomatic. The possession of an unequalled concentration of skilled people, rich and flexible modes of venture capital, and an expanding role in national and world affairs will quicken the pace of innovation throughout New England. The centrality of knowledge to continued regional prosperity is indisputable. Do we have the vision to address the unresolved issues hindering the provision of educational equity and quality for all our people? Will greater numbers be left behind without skills? As the answers to these questions become clear in the next decade, we will be in an all too prominent position to judge how well New England has invested her renewed prosperity. ♣

Notes

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